National Park Service
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Natural Resource Stewardship and Science

Southeast Coast Network Climate Science Strategy

Natural Resource Report NPS/SECN/NRR—2011/436



ON THE COVER
Hatteras Island, North Carolina, after Hurricane Isabel showing a new breach severing Hatteras Island
Photograph by: U.S. Geological Survey, 2003.

Southeast Coast Network Climate Science Strategy

Natural Resource Report NPS/SECN/NRR—2011/436

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Executive Summary

1. The Southeast Coast Network (SECN) is one of 32 National Park Service (NPS) Networks established to implement an integrated monitoring program under the Natural Resource Challenge. In 2001, the SECN began planning and implementing its long-term "Vital Signs" Monitoring Program, and completed its long-term monitoring plan in 2008. As a part of the National Park Service's effort to implement its climate change initiative, the Southeast Coast Network received planning funds in FY2010 to identify ways to augment its existing Vital Signs Monitoring Program to (a) improve parks' ability to incorporate climate science into planning, while (b) collaborating with and contributing to other DOI climate science programs within the South Atlantic LCC (SALCC) and Southeastern Climate Science Center (SECSC) to meet the other Departmental goals.

2. Within SECN parks, air temperature, precipitation patterns, drought frequency and intensity, sea level, ocean acidification, sea surface temperature, and storm intensity are expected to change as a result of climate change. Because of the interconnected nature of the natural and developed landscape within the Southeast, climate change has multiple direct and indirect impacts on park resources. For example,

    a. Higher productivity in forested portions of the landscape, changing productivity in portions of the of the agricultural sector, and increasing urbanization will result in marked and widespread changes in land use in the watersheds upstream and surrounding SECN parks.

    b. Primary stressors (increasing temperatures, changes in precipitation, and more frequent extreme weather events) and secondary stressors (public health, property damage, economic restructuring, and resource availability) will cause changes to the distribution and behaviors of plant, animal, and human populations within the Southeast.

    c. Changes in land use, human population distribution, and precipitation will have impacts on water quality and quantity in all network parks and all systems (riverine, estuarine, palustrine, and groundwater).

    d. Coastal parks will also face the challenge of relative sea level rise and the resultant increased risks of erosion and inundation.

    All will affect how parks respond to climate change in the future, including how managers will work with partners and policymakers to manage off-site stressors, coordinate mitigation/ resilience responses, protect at-risk trust natural and cultural resources, and prepare for changes in visitor base, visitation rates, and resource values.

3. As part of the SECN Climate Science Strategy, the network will be responsible for accomplishing six new goals in addition to those presented in the original monitoring plan:

a. Enhance existing SECN monitoring efforts to collect data that better inform forecasting models of climate-change-induced shifts in resource distribution, condition, and value.

b. Coordinate with and provide data to the NPS Adaptation Planning Specialist (funded in FY2010) to ensure SECN/SALCC/SECSC monitoring data, findings, and forecasts are incorporated into scenario planning efforts.

c. Integrate data management with the South Atlantic Refuges I&M Network (SARMN) to facilitate wider and standardized spatial coverage of key resources within SECN/SARMN ecosystems.

d. Facilitate the standardization of monitoring methods and data management among partners within, and cooperating with, the SALCC so data can be rapidly found, merged, explored, and analyzed for the purposes of adaptation planning and conservation design.

e. Collaborate with the SALCC, SARMN, and other partners to adapt Vital Signs Monitoring protocols to evaluate effectiveness of conservation actions taken to mitigate forecasted risks.

f. Serve as an integral part of the planning and operations of the SALCC and other partners to ensure seamless coordination among DOI Climate Science programs.

4. All current SECN Vital Signs were evaluated for inclusion in the SECN Climate Monitoring Program based on ecological relevance, partnership opportunities, and utility of data to existing or planned climate science efforts within the region. This was done through a combination of more than 30 scoping meetings, conceptual modeling, and literature review. Ten Vital Signs were identified for changes in sampling design based on their ability to:

    a. provide data relevant to predicted consequences of climate change,

    b. inform science-based management of biophysical, socioeconomic, or cultural resources,

    c. provide data relevant to one or more of the social systems within the human ecosystem of the South Atlantic, and

    d. provide data that can be used to modify or improve existing management-relevant climate response models.

5. The NPS Inventory & Monitoring Program has committed a base increase of $200,000 to the SECN to meet critical monitoring needs of the network in support of this strategy. These funds will be used to enhance the network's salt marsh elevation and tidal monitoring station networks, hire a permanent data manager to facilitate the integration of datasets among NPS and other agencies coordinating climate response activities, and begin deployment of continuous groundwater monitoring equipment on existing wells. These specific efforts were selected because of their relevance to coastal ecosystems within the Network, their direct

relevance to likely climate impacts, and the need for resultant data for adaptation planning efforts.

6. To fully implement this plan the SECN requires an increase in its annual operational budget of $389,711 and four additional FTEs. Through partnerships identified during the planning process in FY2010, it is anticipated that the I&M program's commitment of $200,000 can be significantly leveraged with other efforts being carried out in the region and the Atlantic Coastal ecosystem to meet these needs.

1. Introduction and Background

Purpose and Scope of the SECN Climate Science Strategy

In 1999, the National Park Service (NPS) initiated a long-term ecological monitoring program, known as "Vital Signs Monitoring," to provide the minimum infrastructure to allow more than 270 national park system units to identify and implement long-term monitoring of their highest-priority measurements of resource condition (Fancy et al. 2009). The overarching purpose of natural resource monitoring in parks is to develop scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, and determine how well current management practices are sustaining those ecosystems.

The NPS Vital Signs Monitoring Program addresses five goals for all parks with significant natural resources:

- Determine the status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and work more effectively with other agencies and individuals for the benefit of park resources.
- Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management.
- Provide data to better understand the dynamic nature and condition of park ecosystems and provide reference points for comparisons with other, altered environments.
- Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.
- Provide a means of measuring progress towards performance goals.

The National Park Service has now completed the first steps in developing a long-term natural resource inventory and monitoring program to provide information on the status and trends of selected park resources as a basis for making decisions and working with other agencies and the public for the long-term protection of park ecosystems. As a result of completing basic natural resource inventories and initiating ecological monitoring of park "Vital Signs", the NPS has acquired large amounts of detailed, park-specific data and information to inform on-the-ground strategic conservation efforts at individual parks and at landscape scales. As a part of the NPS Climate Change Response Program, the NPS will seek to collaborate with partners to identify and monitor climate change effects in parks and to apply accurate and relevant science to management and policy decisions (NPS 2010).

The Southeast Coast Network (SECN; Figure 1) is one of 32 National Park Service Networks established to implement an integrated monitoring program under the Natural Resource Challenge. In 2001, the SECN began planning and implementing its long-term Vital Signs Monitoring Program, and completed its long-term monitoring plan in 2008 (DeVivo et al., 2008). Beginning in FY2010, with the new Administration's focus on climate change science, the SECN began planning for enhancing its original program as a part of the DOI and NPS strategy to improve the ability of resource managers to include climate change science in planning and management.

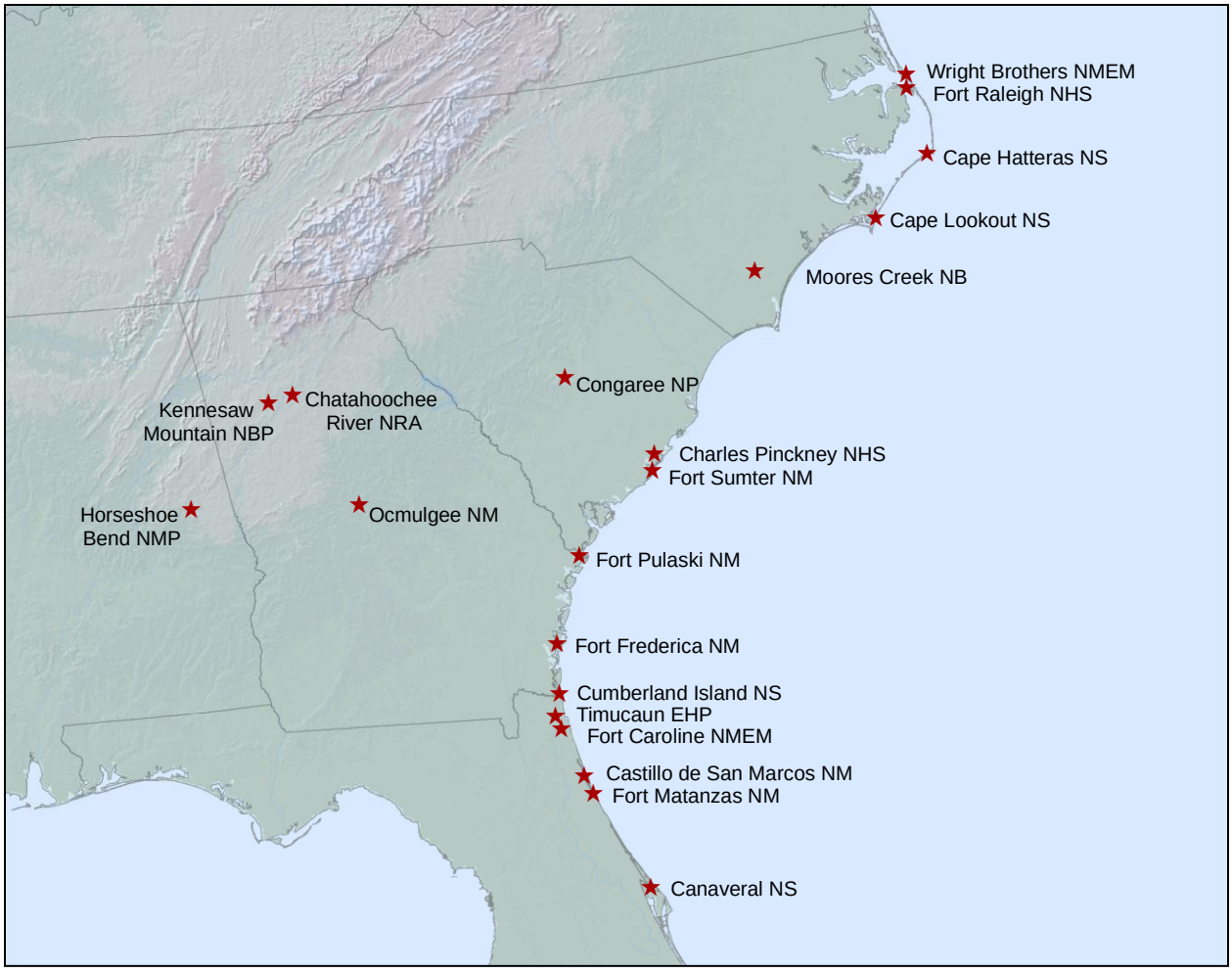


Figure 1. Location of parks within the Southeast Coast Network.

The purpose of the Network's new efforts, described herein, is to conduct the SECN Vital Signs Monitoring Program within a broader coordinated partnership such that data can be used by NPS and other strategic partners to better plan for—and respond to—impacts caused by global climate change.

Policy Mandates Linking Climate Science to Resource Management

Beginning in 2009, the federal government engaged in a renewed effort to consider the interwoven effects of energy production and consumption and the effects of global climate change in the stewardship of its resources. As a part of EO 13514 (2009), The President directed all federal agencies to participate in the Climate Change Adaptation Task Force and develop strategies in support of the national adaptation strategy.

The subsequent Secretarial Order 3289 charged the DOI Bureaus to take the lead in protecting our country's water, land, fish and wildlife, and cultural heritage resources from the dramatic effects of climate change by establishing a *"... Department-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective*

response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages."

To achieve this, the Department has implemented three new activities to increase each bureau's ability to incorporate potential climate-change impacts on DOI-managed resources:

a. Each bureau and office "must consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, developing multi-year management plans, and making major decisions regarding potential use of resources under the Department's purview,

b. DOI Regional Climate Science Centers (CSCs) will be established by USGS beginning in FY2010 to provide climate-change-impact data and analyses to support management of climate-change-related impacts on all Departmental resources, and

c. Landscape Conservation Cooperatives (LCCs) will be created to provide a vehicle for "DOI bureaus and agencies to work together and in partnership with other federal, state, tribal and local governments, and private landowner partners to develop landscape-level strategies for understanding and responding to climate change impacts." Specifically, LCCs are charged with defining objectives, developing spatially-explicit strategies, and providing scientific and technical decision support to inform natural and cultural resource management across terrestrial, aquatic, coastal and marine ecosystems."

The Department later added that:

d. The Department's climate science response effort "will support the integration of our nation's scientific database, improving availability and dissemination of climate change impact and vulnerability information, and access and decision-support to scientists, resource managers, decision makers, and the general public through www.data.gov and other appropriate mechanisms (DOI 2010)."

As a portion of the National Park Service's effort to implement these new programs, the Southeast Coast Network received planning funds in FY2010 to identify ways to augment its existing Vital Signs Monitoring Program to (a) improve parks' ability to incorporate climate science into planning, while (b) collaborating with and contributing to other DOI climate science programs within the South Atlantic LCC (SALCC) and Southeastern Climate Science Center (SECSC) to meet the other Departmental goals.

Program Study Area

The SECN contains 20 parks, 17 of which contain significant and diverse natural resources. In total, SECN parks encompass more than 184,000 acres of federally-managed land across North Carolina, South Carolina, Georgia, Alabama, and Florida. The parks range in size from slightly more than 20 to nearly 60,000 acres, and when considered with non-federal lands jointly managed with SECN parks the Network encompasses more than 253,000 acres.

Although the Southeast Coast Network will be implementing an enhanced climate change monitoring effort that focuses on the coastal parks in the network (Table 1), we are presenting a framework that encompasses the needs of all SECN parks in a manner consistent with other

cooperating agencies and programs throughout the South Atlantic LCC. New field efforts will be primarily implemented on our coastal parks, but wherever possible the network will work to ensure that climate science is useful to all parks in the network.

Table 1. Coastal parks of the Southeast Coast Network [Park codes in italics are administered by the non-italicized park unit above].

Park Code	Park	Significant Natural Resources	Federal Acres	Non-Federal Acres	Total Acres
CAHA	Cape Hatteras National Seashore	Yes	34,500	–	34,500
FORA	Fort Raleigh National Historic Site	No	355	–	355
WRBR	Wright Brothers National Memorial	No	421	–	421
CALO	Cape Lookout National Seashore	Yes	25,174	3,070	28,243
FOSU	Fort Sumter National Monument	Yes	194	<1	195
CHPI	Charles Pinckney National Historic Site	No	28	–	28
FOPU	Fort Pulaski National Monument	Yes	5,365	258	5,623
FOFR	Fort Frederica National Monument	Yes	239	2	241
CUIS	Cumberland Island National Seashore	Yes	18,849	17,567	36,416
TIMU	Timucuan Ecological and Historic Preserve	Yes	8,417	37,583	46,000
FOCA	Fort Caroline National Memorial	Yes	133	5	138
CASA	Castillo de San Marcos National Monument	Yes	20	<1	21
FOMA	Fort Matanzas National Monument	Yes	298	–	298
CANA	Canaveral National Seashore	Yes	57,648	14	57,662
	Total		**184,581**	**68,605**	**253,187**

Furthermore, the SECN Climate Science Strategy will be coordinated with the full suite of climate programs and partners within the broader SALCC as described in Chapter 5 (Figure 2; Table 2). Most notably, the SECN will work closely with the South Atlantic Refuges Inventory and Monitoring Network (SARMN) to coordinate monitoring methodologies across parks and refuges and contribute data to both the SALCC and the SECSC for climate modeling and scenario planning. This will provide a network of nearly 50 DOI-managed lands where coordinated monitoring data can serve as a network of reference sites for a) evaluating the success of conservation actions, and b) investigating effects of climate change across elevational, hydrological, latitudinal, and ecological gradients. This will be augmented by further coordination with coastal monitoring efforts among DOI, DOC (NOAA National Estuarine Research Reserve), and academic (Long Term Ecological Research) programs within the program area. The unified approach to monitoring resources between NPS, USFWS, and other monitoring programs will greatly enhance the SECN's ability (and that of its partners) to better understand the dynamic nature and condition of park ecosystems as those systems respond to climate change.

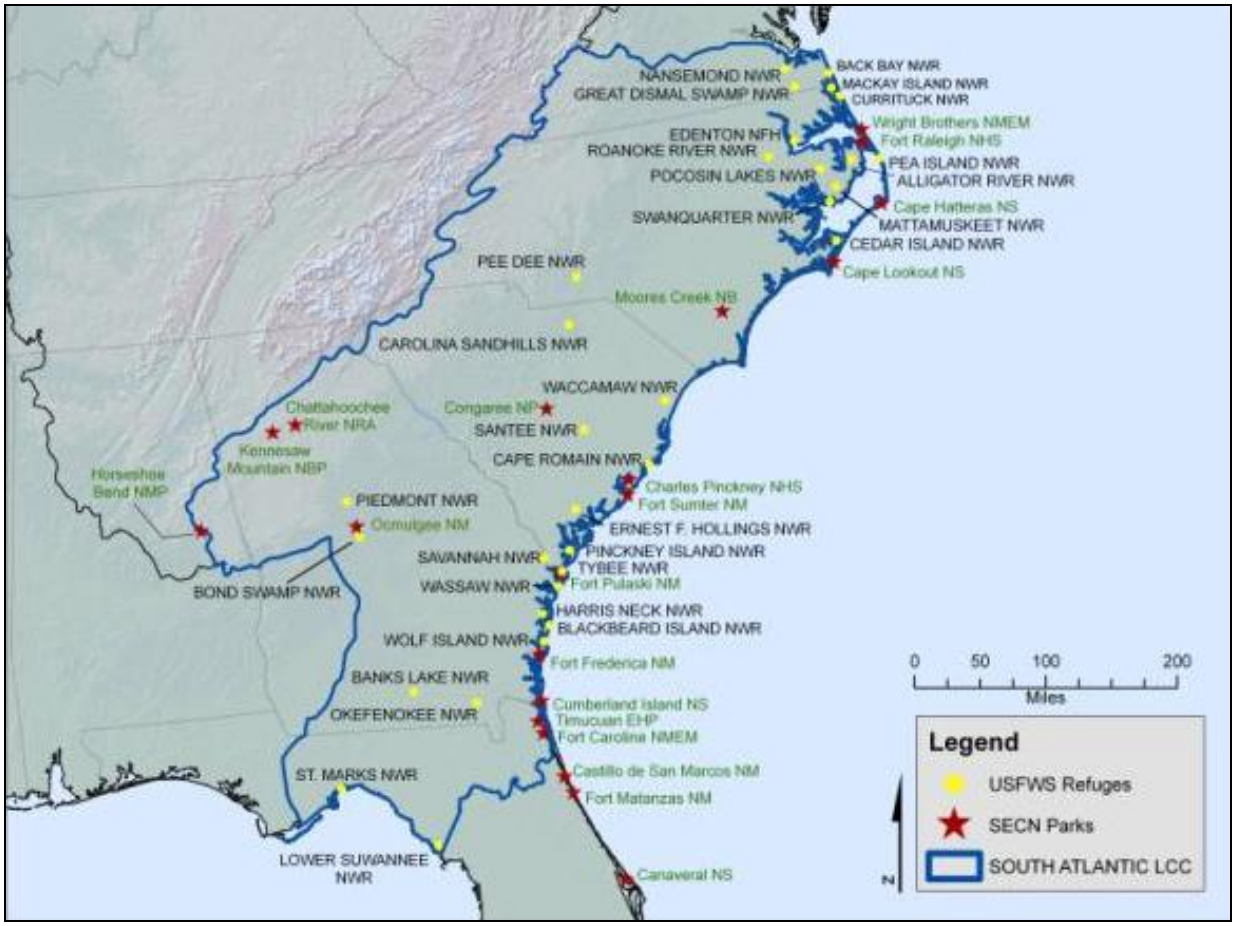


Figure 2. Parks of the Southeast Coast Network, and Refuges within the South Atlantic Landscape Conservation Cooperative.

Strategy Organization and Context

Guiding Principles

The SECN Climate Change Monitoring Plan is designed around seven principles:

- Expected impacts to the Southeast resulting from climate change are consistent with those presented by Burkett et al.'s (2001) report *Potential Consequences of Climate Variability and Change for the Southeastern United States*. This is discussed in more depth in Chapter 2.

- Park climate change planning should occur within the context of the human ecosystem conceptual model as presented by Machlis et al. (1997) and Machlis and Kendry (2005). Although it is not currently within the purview of this program to monitor many of the coupled human and cultural resources that will be affected by climate change, it will determine with whom the network needs to collaborate to ensure that our parks can best use monitoring data.

Table 2. Fish and Wildlife Service Refuge System units Within the South Atlantic LCC and within 50 miles of the coast. Refuges marked with an (*) are within 10 miles of the coast.

Unit Name	Region	Acres
Alligator River National Wildlife Refuge	4	230,467.5
Back Bay National Wildlife Refuge	5	10,615.7
Banks Lake National Wildlife Refuge	4	8,146.1
Blackbeard Island National Wildlife Refuge	4	4,928.5
Bond Swamp National Wildlife Refuge	4	19,522.5
Cape Romain National Wildlife Refuge	4	36,695.2
Carolina Sandhills National Wildlife Refuge	4	102,310.9
Cedar Island National Wildlife Refuge	4	14,863.4
Currituck National Wildlife Refuge	4	9,094.9
Ernest F. Hollings Ace Basin National Wildlife Refuge	4	20,461.2
Great Dismal Swamp National Wildlife Refuge	5	107,929.8
Harris Neck National Wildlife Refuge	4	2,549.7
Lower Suwannee National Wildlife Refuge	4	53,899.6
Mackay Island National Wildlife Refuge	4	8,358.7
Mattamuskeet National Wildlife Refuge	4	49,582.7
Okefenokee National Wildlife Refuge	4	513,981.6
Pea Island National Wildlife Refuge	4	4,503.9
Pee Dee National Wildlife Refuge	4	9,486.5
Piedmont National Wildlife Refuge	4	42,332.8
Pinckney Island National Wildlife Refuge	4	3,314.6
Pocosin Lakes National Wildlife Refuge	4	113,890.7
Roanoke River National Wildlife Refuge	4	35,996.2
Santee National Wildlife Refuge	4	49,329.2
Savannah National Wildlife Refuge	4	46,542.3
St. Marks National Wildlife Refuge	4	70,487.7
Swanquarter National Wildlife Refuge	4	15,180.5
Tybee National Wildlife Refuge	4	511.3
Waccamaw National Wildlife Refuge	4	57,774.8
Wassaw National Wildlife Refuge	4	10,027.8
Wolf Island National Wildlife Refuge	4	3,268.8

- Monitoring of select Vital Signs is an integral part of an overall strategy to adaptively identify resources affected by climate change, assess their vulnerability, identify management options, and deliver conservation actions designed to protect critical resources.

- The SECN climate monitoring efforts will be based on the Network's existing approved Vital Signs Monitoring Plan (DeVivo et al. 2008). This will be accomplished through the addition of new monitoring objectives relevant to managing responses to climate change combined with altering existing sampling designs, adding additional measures, and working with partners to acquire new or improved relevant data sets.

- NPS can take advantage of existing modeling efforts planned or underway to fine-tune or localize scenario projections at the local level. The SECN will not be responsible for the

modeling efforts required to link climate data to climate-based management, but will coordinate with partners to ensure maximum utility of those models to park planning and adaptation efforts.

- The appropriate level for integration of climate science with park operations is in the context of conservation planning and design (not day-to-day operations), and the primary vehicle to insert climate science into park operations will be through close coordination with the SALCC and the SECSC.

Strategy Components

The SECN Climate Science Strategy includes four focus areas:

- **Developing and refining a shared landscape-scale ecosystem conceptual framework** in partnership with the South Atlantic LCC around which to respond to potential climate change impacts to natural and cultural resources.

- **Collaborating closely with adaptation planning personnel** to provide data and information that will help define (and reduce) key areas of uncertainty driving climate change impacts to parks, their resources, and their use.

- **Enhancing current Vital Signs monitoring efforts** to improve climate change forecast, impact, vulnerability, and decision support models resolution, improve understanding of key climate-related ecosystem drivers, and facilitate data transfer among agencies.

- **Coordinating monitoring efforts** among agencies within the South Atlantic and adjacent LCCs to provide system-scale datasets of high value to park and landscape-scale planning and response to climate change.

Organization of the Report

Chapters 2 and 3 focus on the historical trends related to climate metrics in the Southeast and Southeastern coastal zones, and present a conceptual framework for analysis, interpretation, and adaptation planning in response to climate change.

Chapter 4 presents needs for climate change monitoring data within the ecological and planning frameworks, and how the data collected will integrate with adaptation planning and forecasting efforts.

Chapter 5 presents other information or data gaps that, if addressed, will further enhance parks' abilities to plan for, and respond to, climate change.

Chapters 6 and 7 present the organizational and budgetary needs to implement this strategy.

Emerging Roles for the Southeast Coast Network

To meet these new challenges, the SECN will be responsible for accomplishing six new goals in addition to those presented in the original monitoring plan:

- Expand existing SECN monitoring efforts to collect data that better inform forecasting models of climate-change-induced shifts in resource distribution, condition, and value.

- Coordinate with, and provide data to, the NPS Adaptation Planning Specialist (funded in FY2010) to ensure that SECN/SALCC/SECSC monitoring data, findings, and forecasts are incorporated into scenario planning efforts.

- Integrate data management with the South Atlantic Refuges I&M Network to facilitate wider and standardized spatial coverage of key resources within SECN/SARMN ecosystems.

- Facilitate the standardization of monitoring methods and data management among partners within, and cooperating with, the SALCC so that data can be rapidly found, merged, explored, and analyzed for the purposes of adaptation planning and conservation design.

- Collaborate with the SALCC, SARMN, and other partners to adapt Vital Signs Monitoring protocols to evaluate effectiveness of conservation actions taken to mitigate forecasted risks.

- Serve as an integral part of the planning and operations of the SALCC and other partners to ensure seamless coordination among DOI Climate Science programs.

The following chapters present the plan and resources needed to accomplish these new goals.

2. State of the Climate

Climate is a dominant factor driving the physical and ecologic processes affecting the SECN (Davey et al. 2007). Climate variations are responsible for short- and long-term changes in ecosystem fluxes of energy and matter and have profound effects on underlying geomorphic and biogeochemical processes. Southeastern climates are humid and warm-temperate to subtropical, with significant maritime influences from the Atlantic Ocean and Gulf of Mexico. The southern end of the Appalachian Mountains also influences climate patterns in the SECN park units located in eastern Alabama and northern Georgia. Extreme weather events in the SECN drive both coastal and riverine geomorphic changes. Impacts from storm washover episodes associated with strong nor'easter events in the winter and tropical systems in the summer and fall, and the recovery periods from such events, are an important issue for coastal SECN ecosystems. Thunderstorms are an integral part of the SECN climate, especially during the spring and summer months. The El Niño Southern Oscillation (ENSO) plays a large role in the interannual variations of the climate of the SECN, with El Niño years typically bringing lower temperatures in winter and spring, increased winter precipitation, and fewer tropical systems. Potential sea-level rises due to predicted global-scale climate changes are also a concern for many SECN park units. Periods of prolonged drought introduce stressors to vegetation communities with potentially severe effects. Human impacts on the landscape of the SECN region have introduced local- and regional-scale climate changes in the SECN, many of which are adversely impacting the region's plant and animal communities. Because of its influence on the ecology of SECN park units and the surrounding areas, climate was identified as a high-priority Vital Sign for the SECN (Davey et al. 2007).

Historical and Projected Climate Trends in the Southeast

Temperature

The average annual temperature of the Southeast did not change significantly over the past century as a whole (Table 3; Karl et al. 2009). Since 1970, however, annual average temperature has risen about 2°F, with the greatest seasonal increase in temperature occurring during the winter months. The number of freezing days in the Southeast has declined by four to seven days per year for most of the region since the mid-1970s (Figure 3).

Table 3. Observed temperature and precipitation changes in the Southeast are summarized for two different periods; Southeast average temperature declined from 1901 to 1970 and has increased strongly since 1970. From Karl et al. (2009).

Average Change in Temperature and Precipitation in the Southeast					
	Temperature Change in °F			Precipitation Change in %	
	1901-2008	1970-2008		1901-2008	1970-2008
Annual	0.3	1.6	**Annual**	6.0	-7.7
Winter	0.2	2.7	**Winter**	1.2	-9.6
Spring	0.4	1.2	**Spring**	1.7	-29.2
Summer	0.4	1.6	**Summer**	-4.0	3.6
Fall	0.2	1.1	**Fall**	27.4	0.1

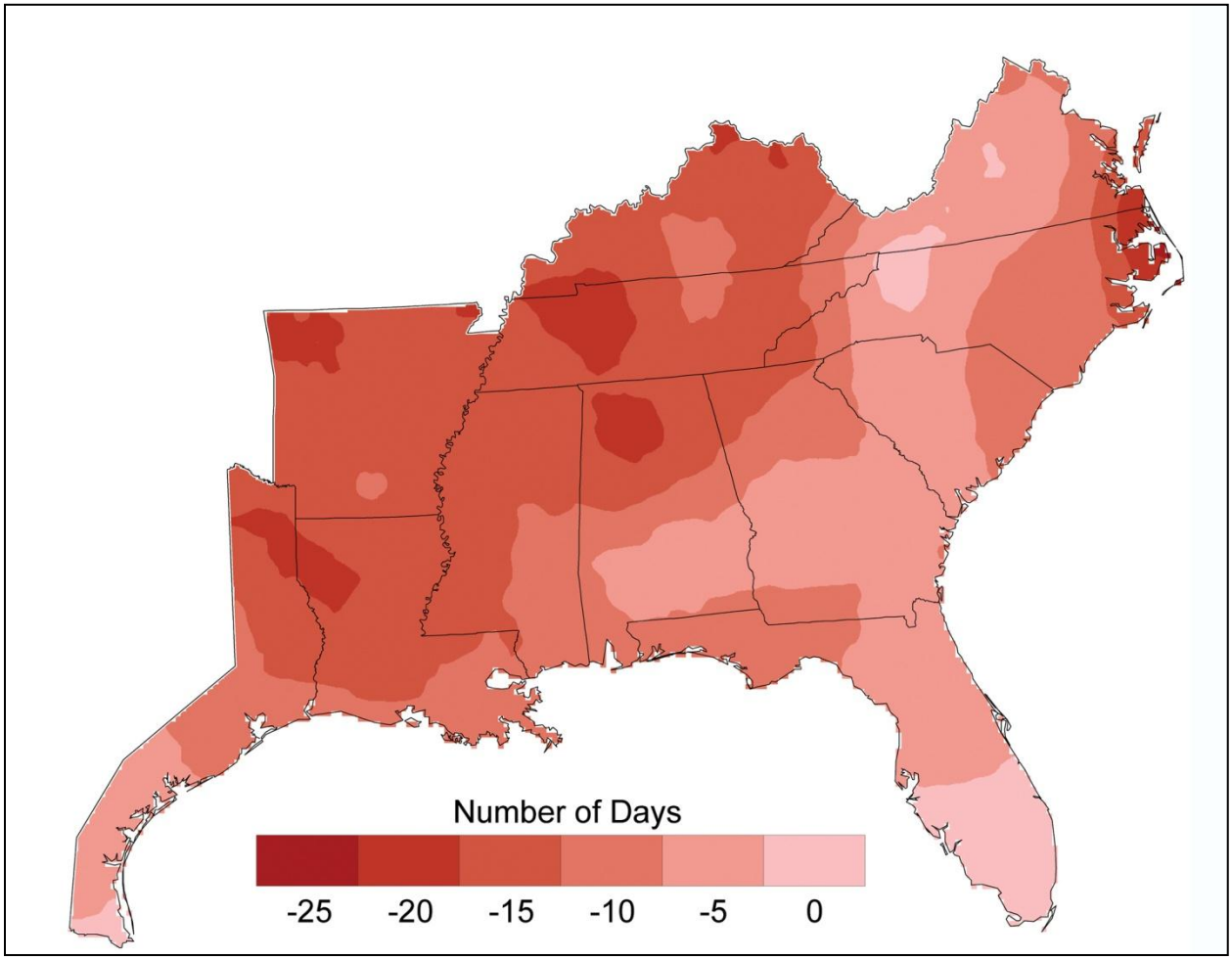


Figure 3. Since the mid-1970s, the number of days per year in which the temperature falls below freezing has declined by four to seven days over much of the Southeast. Some areas, such as western Louisiana, have experienced more than 20 fewer freezing days. Climate models project continued warming across the region, with the greatest increases in temperature expected in summer, and the number of very hot days increasing at a greater rate than the average temperature (from Karl et al. 2009).

Temperature patterns for parks within the SECN (Figure 4, Figure 5, Figure 6) show large fluctuations over the past century, with no obvious trend (Davey et al. 2007). The warmest temperatures on record in the SECN generally occurred during the 1920s and 1930s, even as late as the 1940s in portions of North Carolina. After a cooling in the 1960s, temperatures in the SECN commenced a gradual warming trend that continues to this day. It is not clear how much of this observed pattern may be due to discontinuities in temperature records at individual stations, caused by artificial changes such as stations moves. These patterns highlight the emphasis on measurement consistency that is needed in order to properly detect long-term climatic changes.

Climate models project continued warming in all seasons across the Southeast and an increase in the rate of warming through the end of this century (Karl et al. 2009). The projected rates of

warming are more than double those experienced in the Southeast since 1975, with the greatest temperature increases projected to occur in the summer months. The number of very hot days is projected to rise at a greater rate than the average temperature (days where maximum temperatures exceed 90°F). Under a lower emissions scenario, average temperatures in the region are projected to rise by about 4.5°F by the 2080s, while a higher emissions scenario yields about 9°F of average warming (with higher increases in the summer resulting in a much higher heat index). Because higher temperatures lead to more evaporation of moisture from soils and water loss from plants, the frequency, duration, and intensity of droughts are likely to continue to increase (Karl et al. 2009).

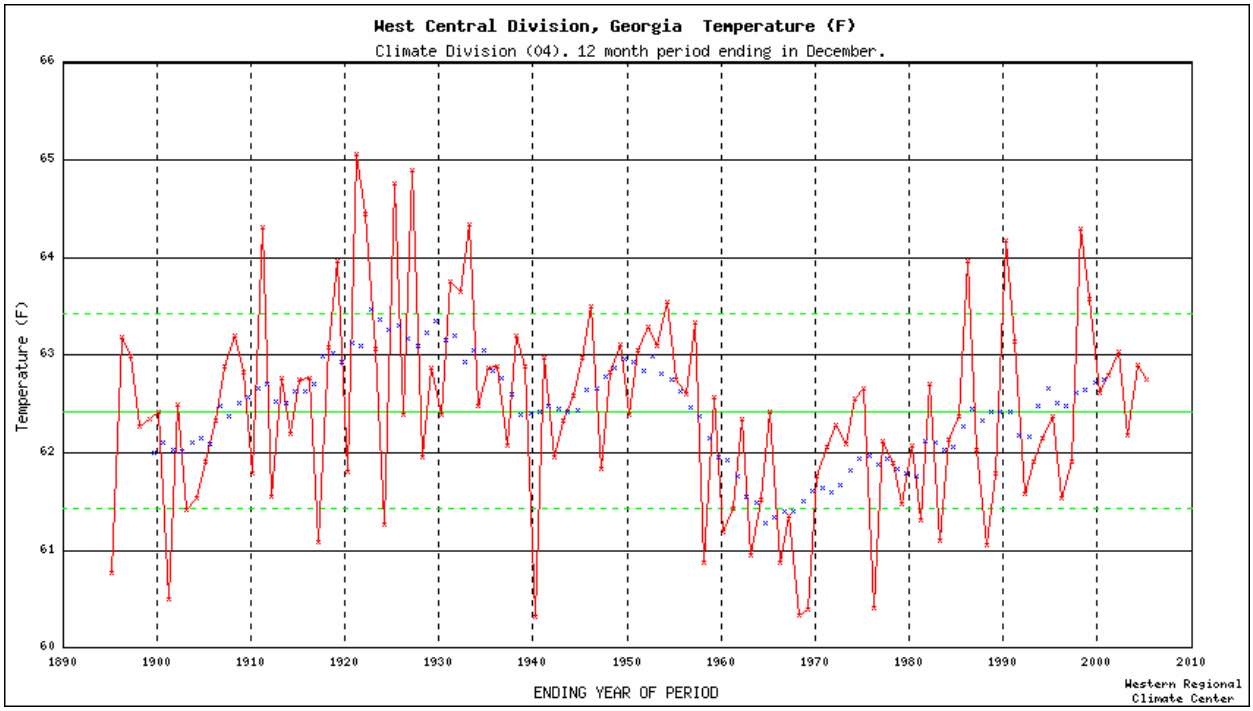


Figure 4. Temperature time series, 1895-2005, for the western Georgia region within the SECN. These include twelvemonth average temperature (ending in December) (red), 10-year running mean (blue), mean (green), and plus/minus one standard deviation (green dotted).

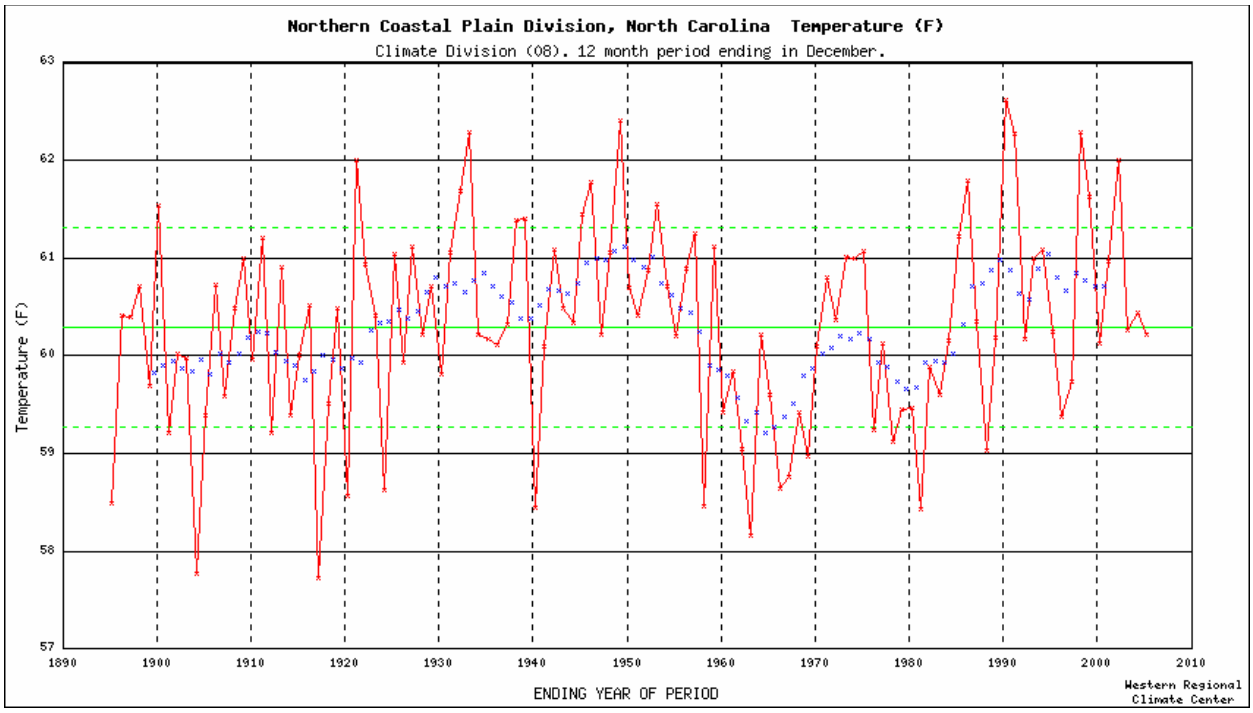


Figure 5. Temperature time series, 1895-2005, for the northern North Carolina coastal region within the SECN. These include twelvemonth average temperature (ending in December) (red), 10-year running mean (blue), mean (green), and plus/minus one standard deviation (green dotted).

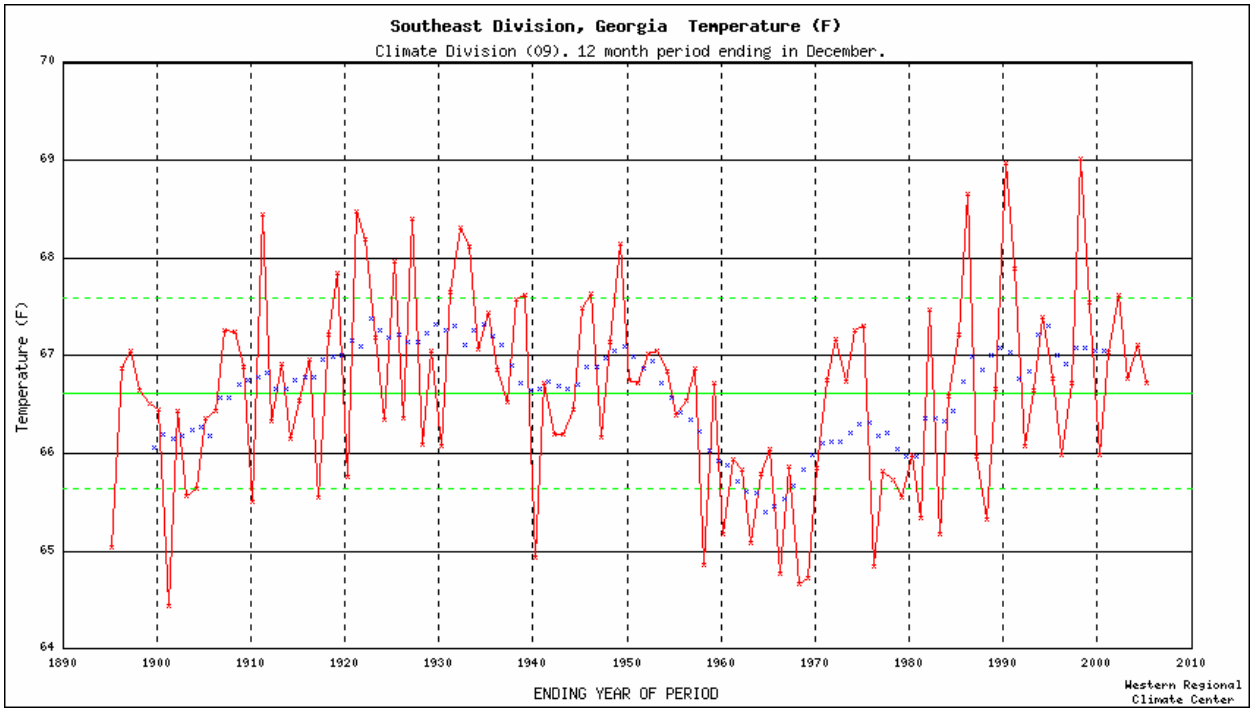


Figure 6. Temperature time series, 1895-2005, for the Georgia coastal region within the SECN. These include twelvemonth average temperature (ending in December) (red), 10-year running mean (blue), mean (green), and plus/minus one standard deviation (green dotted).

Precipitation

Average autumn precipitation has increased by nearly 30 percent for the Southeast since 1901 (Table 3; Karl et al. 2009). The decline in fall precipitation in South Florida contrasts strongly with the regional average. There has been an increase in heavy downpours in many parts of the region (Karl and Knight 1998, Keim 1997) while the percentage of the region experiencing moderate to severe drought increased over the past three decades. The area of moderate to severe spring and summer drought has increased by 12 percent and 14 percent, respectively, since the mid-1970s. Even in the fall months, when precipitation tended to increase in most of the region, the extent of drought increased by 9 percent.

Although increases in precipitation have been observed across the Southeastern US, this pattern is not apparent across much of the SECN (Figure 7, Figure 8, Figure 9; Davey et al. 2007).

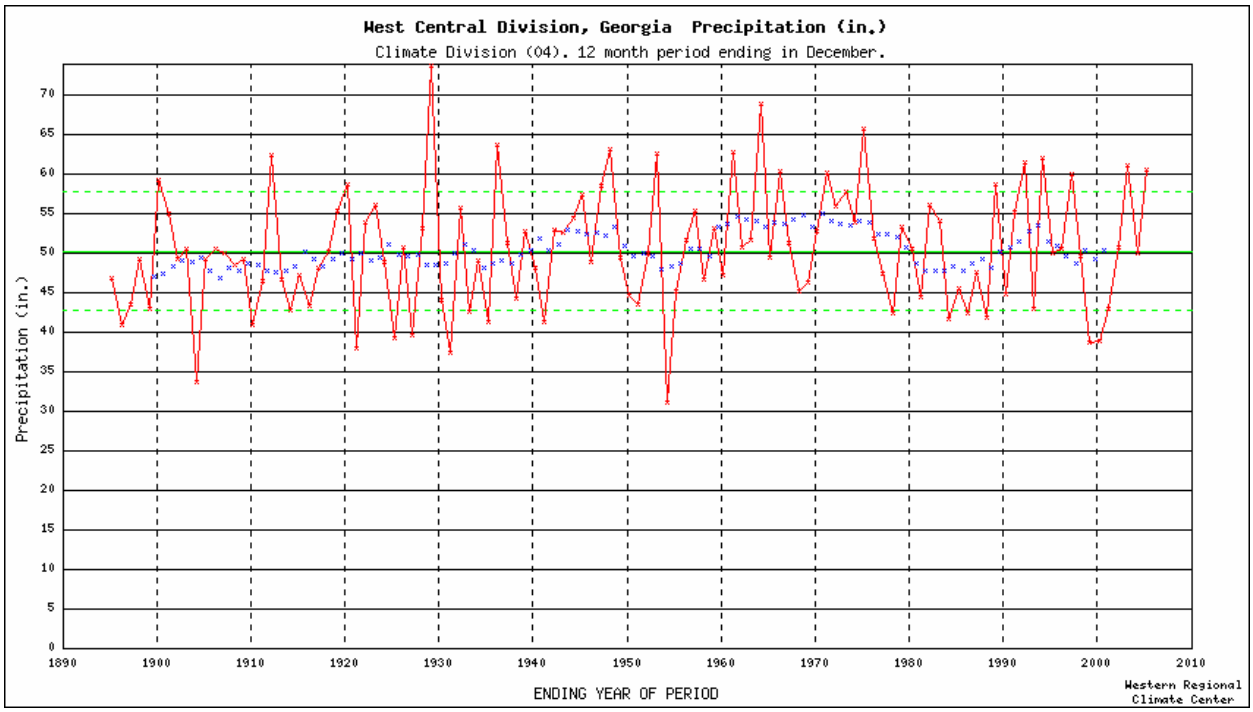


Figure 7. Precipitation time series, 1895-2005, for the western Georgia area within the SECN. These include twelvemonth precipitation (ending in December) (red), 10-year running mean (blue), mean (green), and plus/minus one standard deviation (green dotted).

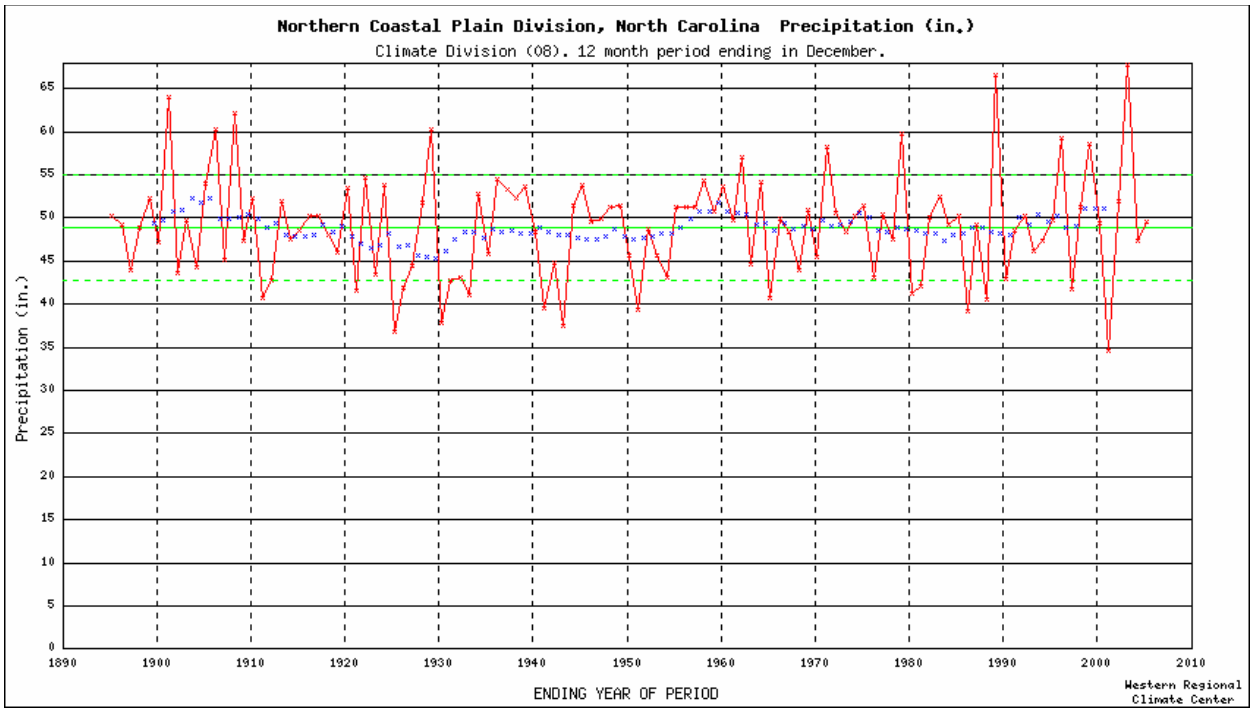


Figure 8. Precipitation time series, 1895-2005, for the northern North Carolina coastal region within the SECN. These include twelvemonth precipitation (ending in December) (red), 10-year running mean (blue), mean (green), and plus/minus one standard deviation (green dotted).

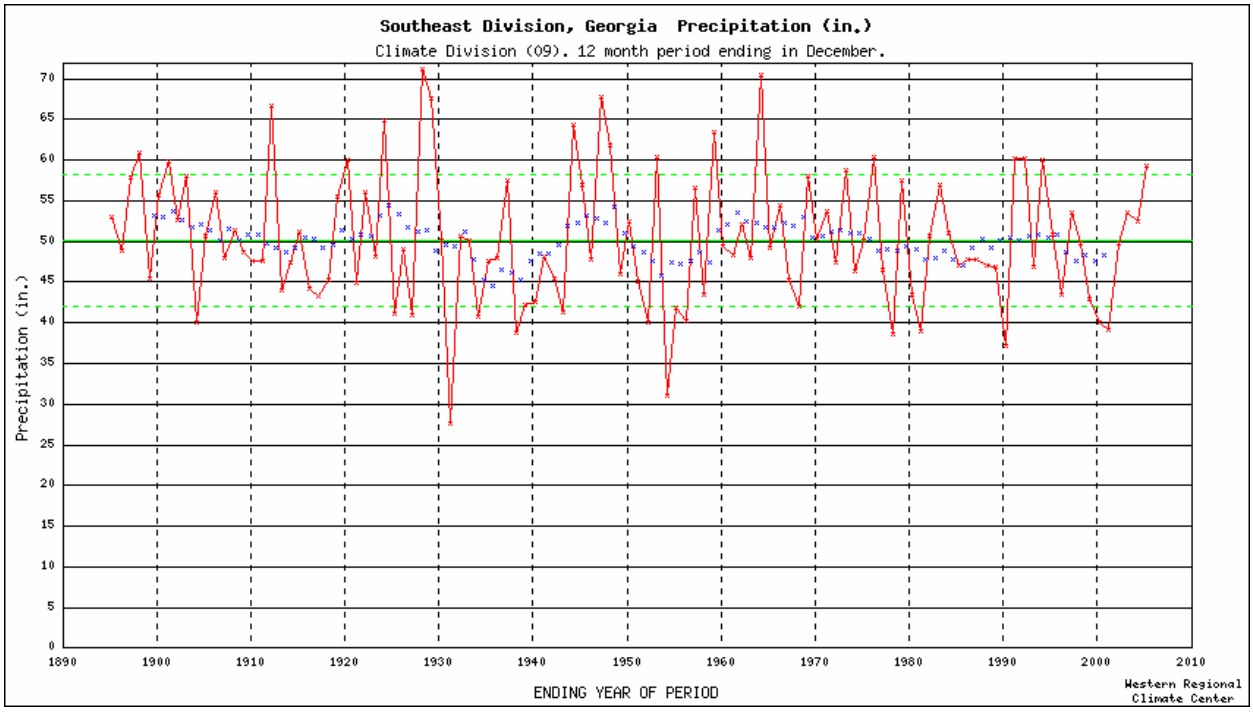


Figure 9. Precipitation time series, 1895-2005, for the Georgia coastal region within the SECN. These include twelvemonth precipitation (ending in December) (red), 10-year running mean (blue), mean (green), and plus/minus one standard deviation (green dotted).

Sea Level Rise

Sea level rise, as well as the frequency and intensity of storm events, are the climate measures of most concern to Atlantic coastal regions due to the combination of potential impacts to natural and human systems.

Sea level rise is considered one of the most-certain impacts of global climate change, with sea level rising an average 4-8 inches over the last 100 years (Burkett et al. 2001). The rise in sea level relative to the land surface in any given location is a function of both the amount of global average sea level rise and the degree to which the land is rising or falling (Karl et al 2009). During the past century in the United States, relative sea level changes ranged from falling several inches to rising as much as 2 feet. Shoreline retreat is occurring along most of the nation's exposed shores.

The amount of sea level rise likely to be experienced during this century depends mainly on the expansion of the ocean volume due to warming and the response of glaciers and polar ice sheets (Karl et al. 2009). Karl et al. (2009) also suggest that recent estimates of global sea level rise substantially exceed those presented in the 2007 IPCC report, with projections of sea level rise between 3 and 4 feet in this century (Figure 10). Even a two-foot rise in relative sea level over a century would result in the loss of a large portion of the nation's remaining coastal wetlands, as they will not be able to build new soil at a fast enough rate. Accelerated sea level rise would affect seagrasses, coral reefs, and other important habitats and would also fragment barrier islands, and place into jeopardy existing homes, businesses, and infrastructure, including roads, ports, and water and sewage systems.

In the SECN, rates of Relative Sea Level (RSL) rise (a combination of sea level rise and land accretion or subsidence) for select long-term tide gauges have ranged from 2.22 mm per year in Wilmington, NC, to greater than 3 mm per year at Fort Pulaski, GA (Zervas 2001).

Storm Frequency and Intensity

The frequency of storms with intensity greater than Category I displays a bimodal distribution along the South Atlantic coast (Hopkinson et al. 2008; Figure 11). The frequency is lowest along the GA/SC coast and increases both southward and northward. Within the network, the highest frequency of storms occurs along the North Carolina Coast.

Hayden and Hayden (2003) examined the frequency during the last century of extratropical storms at four NSF-sponsored long-term ecological research (LTER) sites along the Atlantic coast (Figure 12). The results varied with latitude, with an increase of 25 storms per year at Plum Island (in Massachusetts), 15 storms per year at the Virginia Coast Reserve, 8 storms per year at the Georgia Coastal Ecosystems site, and no change at the Florida Coastal Ecosystems site.

Change in storm intensity over time is one potentially significant measure of climate change in coastal areas in the Southeast. Metrics of activity include direct measures such as storm counts and the duration and magnitude of wind speed as well as integrative measures of energy such as the Accumulated Cyclone Energy (ACE) index and the Power Dissipation Index (PDI; Bell et al. 2000, Emanuel 2005). Emanuel (2007) showed that in the Atlantic, the PDI is strongly correlated with sea surface temperatures, both of which have been increasing since the early- to mid-1970s (Emanuel 2007; Figure 13).

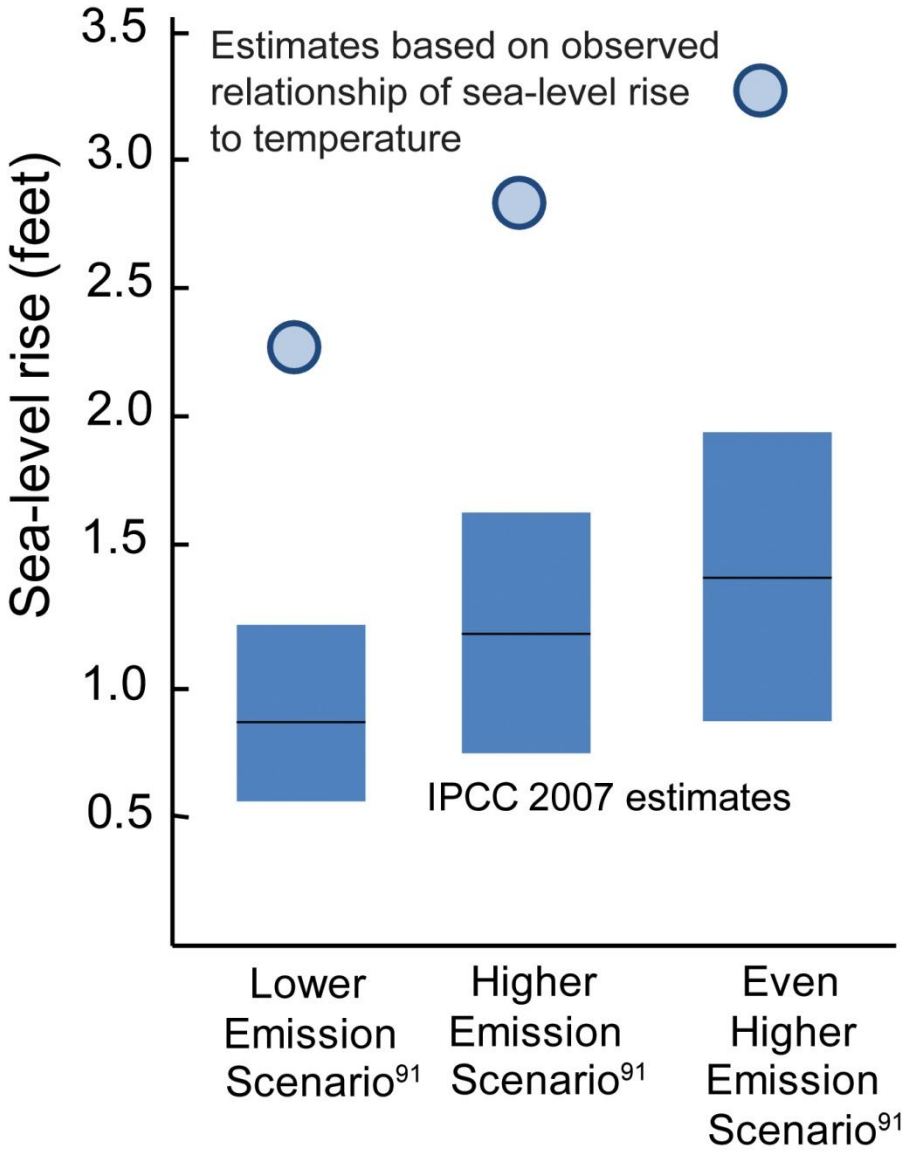


Figure 10. Estimates of sea-level rise by the end of the century for three emissions scenarios. Intergovernmental Panel on Climate Change (2007) projections (range shown as bars) exclude changes in ice sheet flow. Light blue circles represent estimates derived using the observed relationship of sea-level rise to temperature. Areas where coastal land is sinking, for example by as much as 1.5 feet in this century along portions of the Gulf Coast, would experience additional sea-level rise equivalent to the amount lost to subsidence (from Karl et al. 2009).

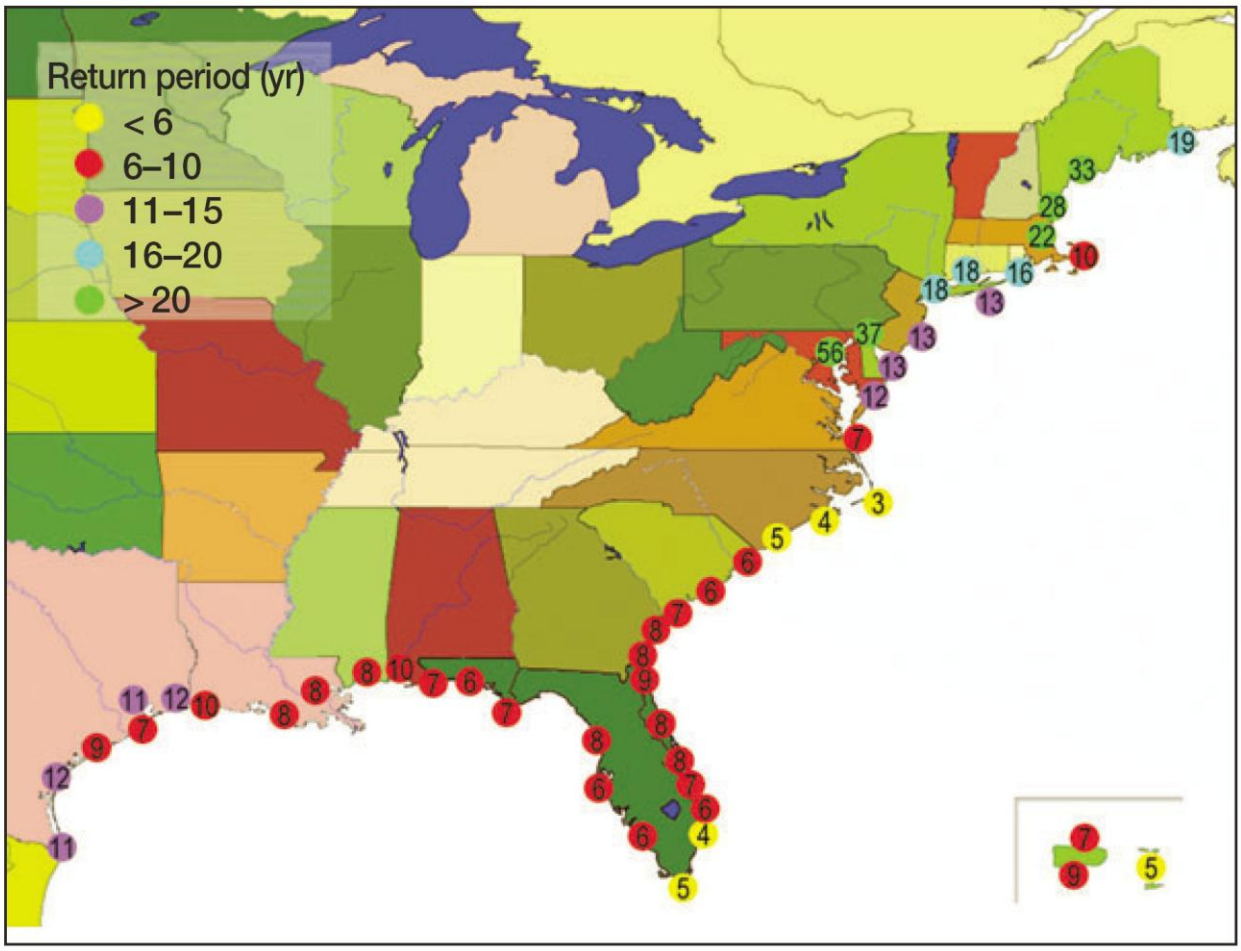


Figure 11. Return period for a Category 1 or stronger hurricane on the US east coast and the Caribbean (from Hopkinson et al. 2008).

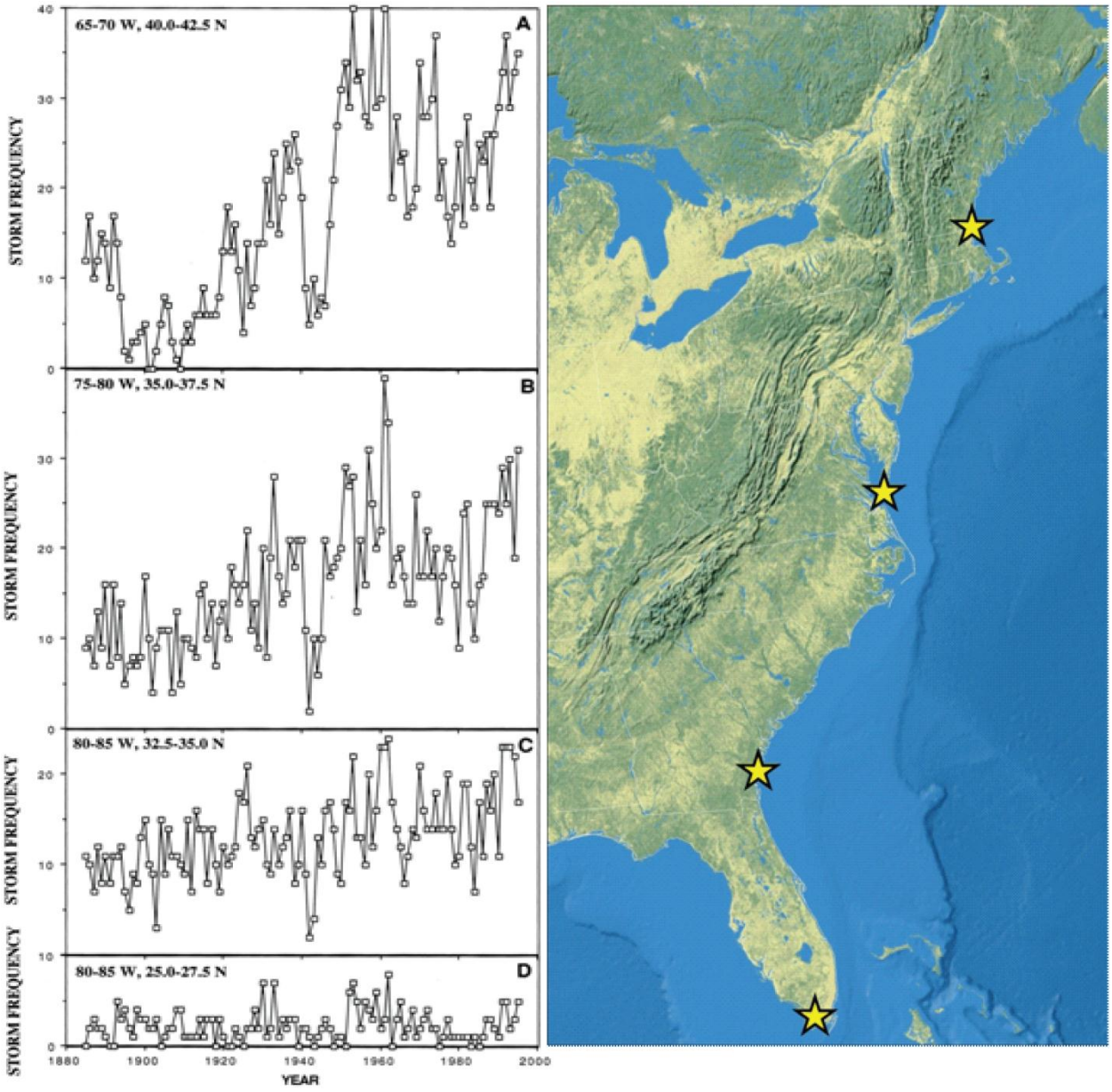


Figure 12. The number of storms per year at the Plum Island LTER site (A), Virginia Coast Reserve LTER site (B), the Georgia Coastal Ecosystems LTER site (C) and the Florida Everglades Ecosystem LTER site (D). Storm frequencies are given in storms per year. The latitude and longitude of the grid cell used to tabulate storm frequencies are shown in each panel (modified from Hayden and Hayden 2003 and Alber 2009).

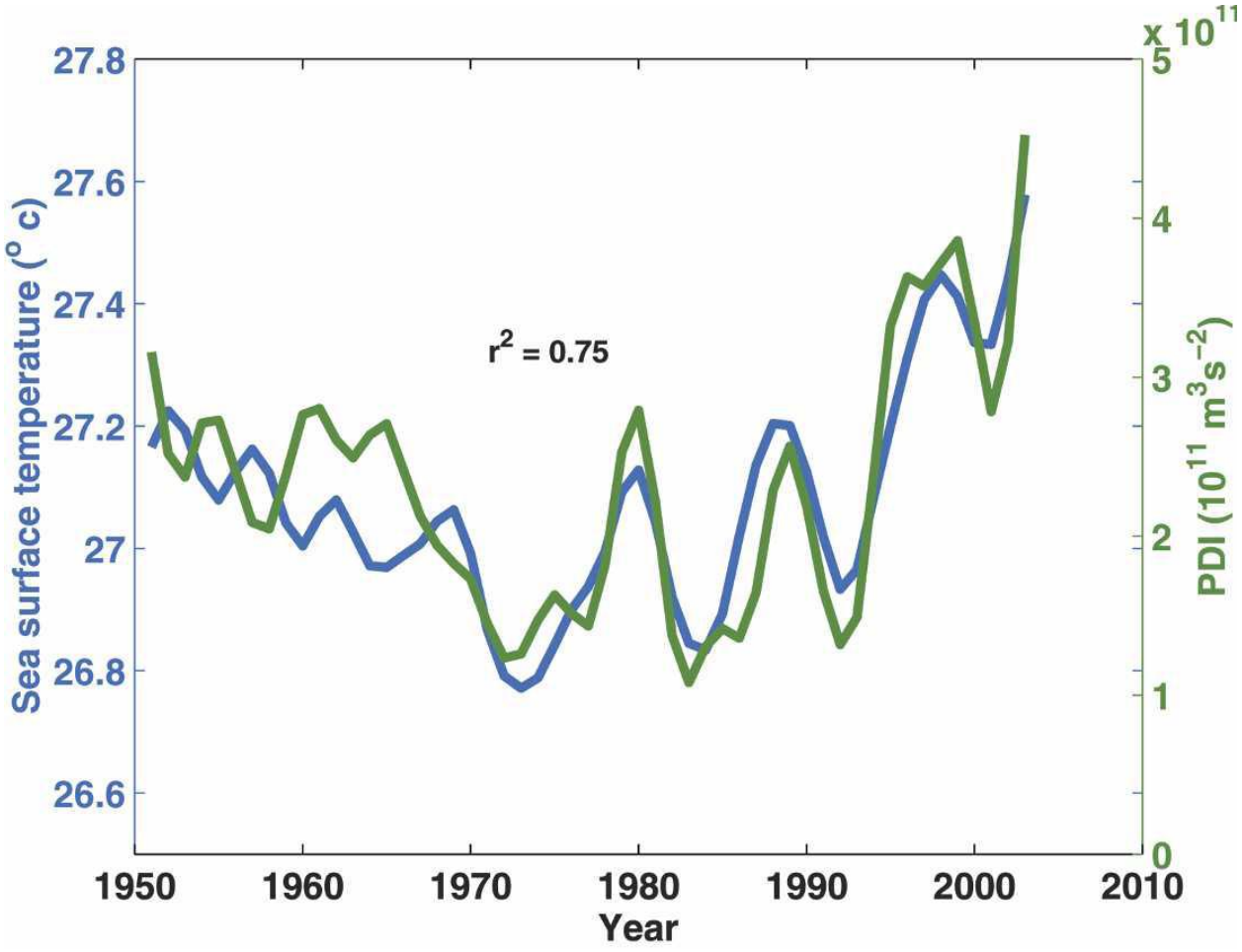


Figure 13. Power dissipation index (green) and scaled Hadlen Centre sea surface temperature (blue) for the main development region of the Atlantic. The time series have been smoothed using a 1-3-4-3-1 filter to reduce the effect of interannual variability and highlight fluctuations on time scales of 3 years and longer (from Emanuel 2007).

Climate Patterns and Variability

Interannual climate variability in the southeastern U.S., including the SECN, is influenced by the El Niño / Southern Oscillation (NAST 2001). Warm ENSO phases (El Niño events) tend to bring cooler and wetter winter conditions across this region. Increased occurrences of severe thunderstorms are also evident in the SECN during warm ENSO phases, particularly in the winter and spring months. Hurricanes and other tropical storm activity tend to decrease in the SECN during warm ENSO phases. Furthermore, Peters et al. (2003) found that ENSO oscillations were a good predictor of vegetation response at a large and course scale, where both crop and forest condition is optimal during ENSO neutral phases, and poorest during warm phases (Mearns 2003).

Katz et al. (2003) found that ENSO was not strongly correlated with daily weather variables (Mearns 2003). The Bermuda High, a subtropical Atlantic circulation feature that occurs over the North Atlantic Ocean, was found to be more strongly correlated with both precipitation and seasonal mean temperature in the Southeast (Katz et al. 2003). During winter months, the Bermuda High Index (a measure of the east-west position of the southern pole of the North

Atlantic Oscillation), is strongly correlated with daily maximum and minimum temperature means and higher daily probability of precipitation (Katz et al. 2003). As this feature shifts westward, hurricanes and frontal systems track westward around the high pressure, resulting in less precipitation along the eastern coast (Stahle and Cleaveland 1992).

Ecological Forecasting Models

As a part of the Department of Interior's climate science strategy, the U.S. Geological Survey (USGS) will analyze climate-change data and develop tools for assessing how changing conditions are likely to impact natural resources. The 2008 Omnibus Budget Act and Secretarial Order 3289 established a new network of eight Department of Interior Regional Climate Science Centers to provide technical support for resource managers.

In 2009 The Southeast Regional Assessment Project (SERAP) was the first regional assessment to be funded by the USGS National Climate Change and Wildlife Science Center (*http://nccw.usgs.gov/*). Since then, the USGS has been working closely with the developing Department of Interior Landscape Conservation Cooperatives to ensure that the project will meet the needs of resource managers in the Southeast. In addition, the South Atlantic LCC is providing resources to the SERAP to expand the scope of the project.

SERAP is now completing a suite of regionally downscaled climate projections and using those data to forecast the likely changes to the Southeast's ecosystems. By concurrently downscaling global climate models while developing change assessment tools for resource managers, SERAP teams are near completion of several loosely-coupled models that can provide useful decision-making tools for assessing the impacts of climate change. These models include downscaled relevant climate data, impacts of relative sea level rise, changes in vegetation, land use, and wildlife habitat distribution, changes in streams and aquatic habitats, and resultant forecasts of species distribution shifts.

Climate Downscaling

Downscaled climate models are a foundational data input pertinent to all models developed as a part of the SERAP effort. Basic data (temperature and precipitation) as well as numerous derived data will be downscaled to 12 km grid cells and forecast to the year 2100 (Table 4). Downscaled models will be run using three emission scenarios – A1Fi, A1B, and B1 – to encompass high, intermediate, and low emissions projections. Other SERAP research teams will then use the downscaled models to forecast changes to targeted resources within the region.

Table 4. Downscaled climate projections to be used as input for all models developed as part of the USGS Southeastern Regional Assessment Project (USGS, S. A. Jones, written communication, 2010).

Climate Product	Source	Spatial Resolution	Temporal Resolution	Relationship to Integrated Assessment Components
Maximum Temperature	Direct Output	1/8°	Daily	Hydrologic Dynamics Species Range Dynamics
Minimum Temperature	Direct Output	1/8°	Daily	Hydrologic Dynamics Species Range Dynamics
Precipitation	Direct Output	1/8°	Daily	Hydrologic Dynamics Species Range Dynamics
Evapotranspiration	Derived Product	1/8°	Daily	Hydrologic Dynamics Species Range Dynamics
Solar Radiation	Derived Product	1/8°	Daily	Hydrologic Dynamics
Drought Index	Derived Product	1/8° - Ecoregion	Weekly	Hydrologic Dynamics Aquatic Modeling Species Range Dynamics Vegetation Dynamics Carbon Sequestration
Fire Frequency	Derived Product	Ecoregion	Monthly	Vegetation Dynamics Carbon Sequestration
Frost Days	Derived Product	1/8°	Annual	Species Range Dynamics
Growing Season Length	Derived Product	1/8°	Annual	Species Range Dynamics
Insect Outbreak	Derived Product	Ecoregion	Annual	Species Range Dynamics Carbon Sequestration

Integrated Coastal Assessment

SERAP is developing two models of direct relevance to SECN coastal ecosystem: coastal inundation and erosion vulnerability (Figure 14), and coastal wetland loss (Figure 15). To estimate effects of climate change variables, the USGS is factoring in parameters to represent local processes that affect land-surface elevation and other types of ecosystem changes. The team is using Bayesian network modeling approaches to design new tools for decision makers to visualize and assess change in coastal regions where a combination of inundation, land loss, and habitat change is occurring and expected to continue.

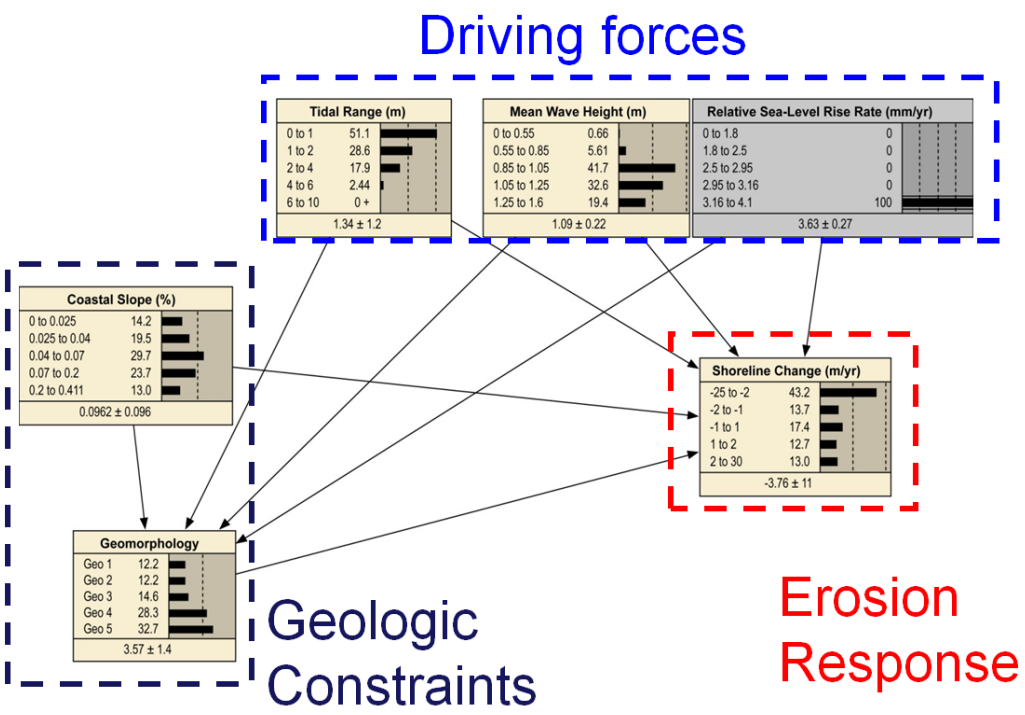


Figure 14. Example Bayesian network model for sea level rise and erosion in southeastern coastal areas. From Thieler et al. (2010).

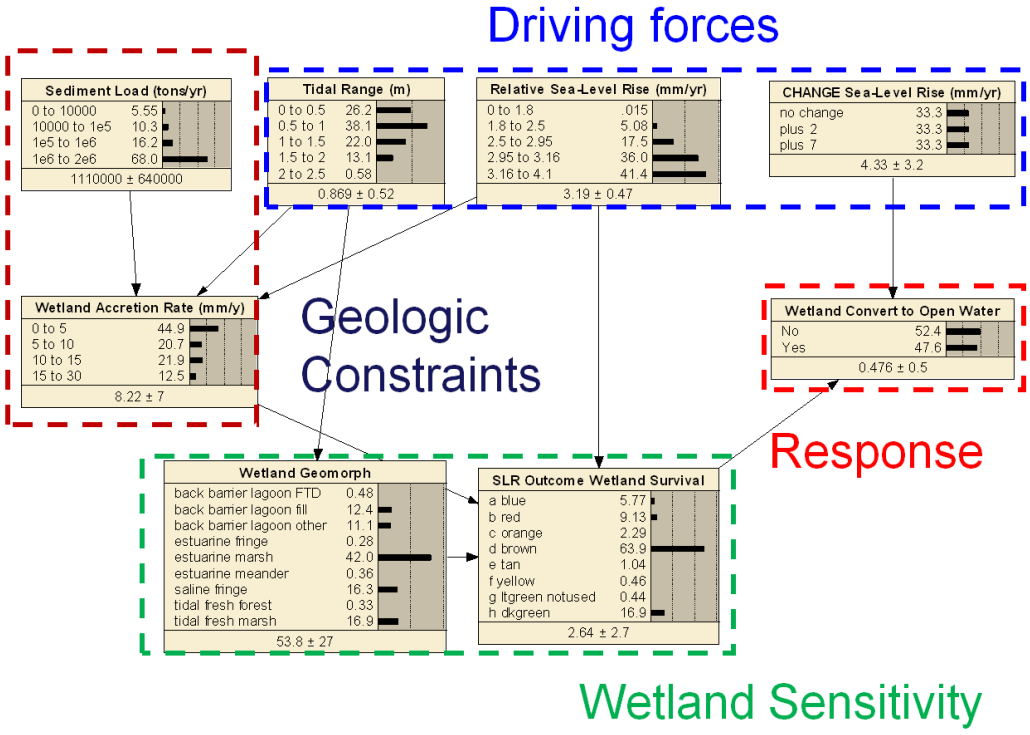


Figure 15. Example Bayesian network model for wetland response to sea level rise in southeastern coastal areas as a result of climate change. From Thieler et al. (2010).

Integrated Terrestrial Assessment

As a part of the SERAP project, the USGS is integrating models of urbanization and vegetation dynamics with the regional climate models to assess how landscape change could impact priority species (Figure 16). Models for North American land birds, for example, can predict locations where responses to climate change are most likely to occur, expressing results in terms of species persistence to help resource managers understand the long-term sustainability of bird populations (Figure 17). The models are designed such that they can be applied later to other taxonomic groups.

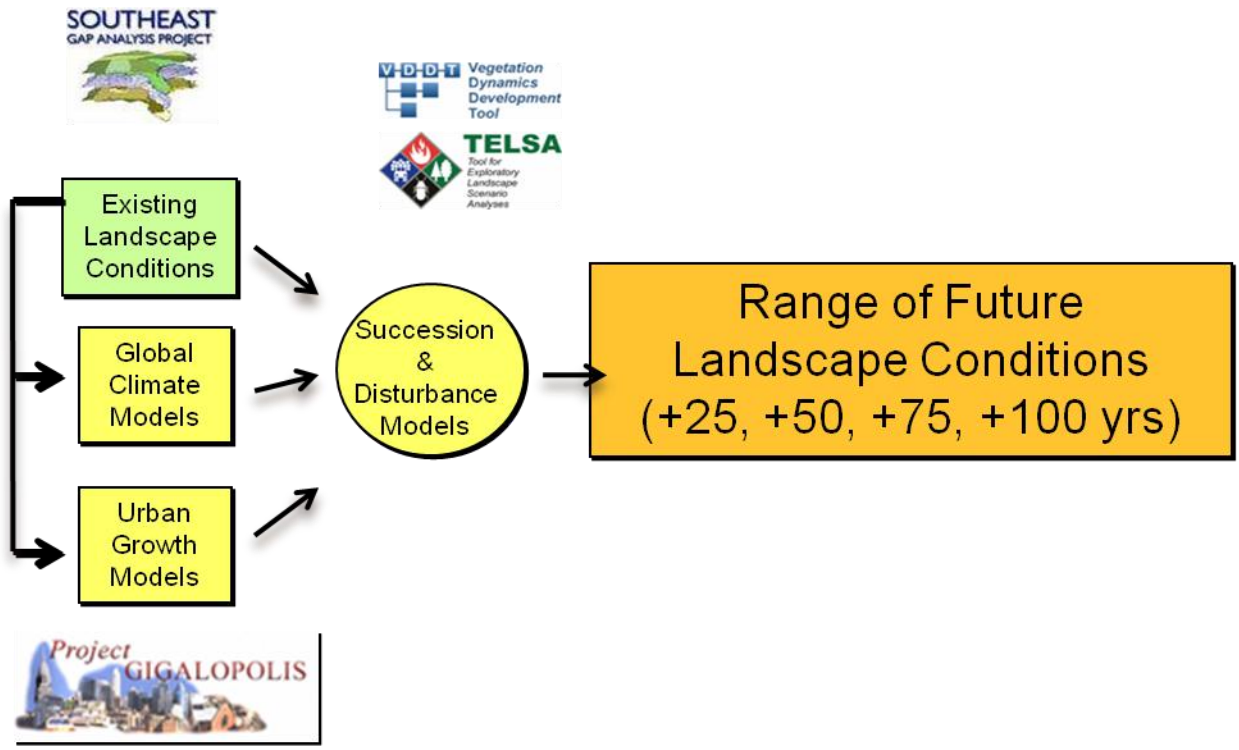


Figure 16. Schematic of linked models to determine range of future landscape conditions based on downscaled climate, urban growth, vegetation succession, and historical landscape condition information. From Collazo et al. (2010).

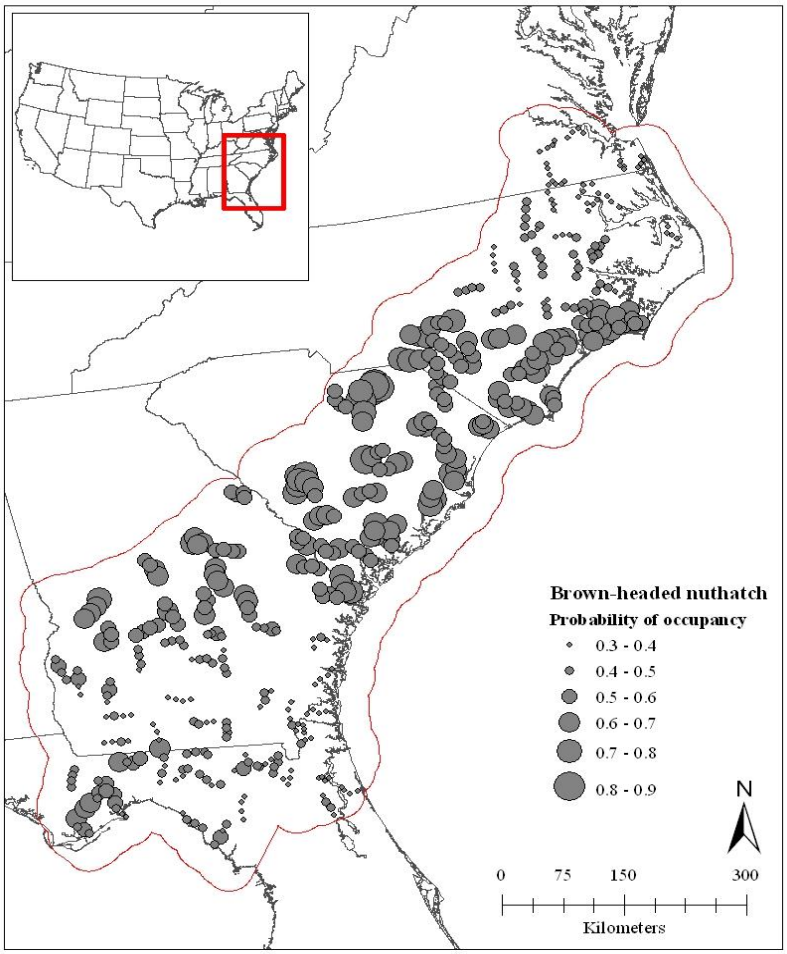


Figure 17. Example projected occupancy map for brown-headed nuthatch in response to climate change.

Integrated Aquatics Assessment

Aquatic habitat is sensitive to streamflow, which during the next century is expected to be affected by changes in precipitation, evapotranspiration, land use, and water demand (for drinking water supply and irrigation). To predict consequent effects on riverine ecosystems, SERAP is assessing how these forecasts will affect flow in river systems, and subsequent changes in hydrology and stream habitat (Peterson et al. 2010;Figure 18). Based on habitat forecasts, SERAP is developing models to assess impacts to priority aquatic species within the region.

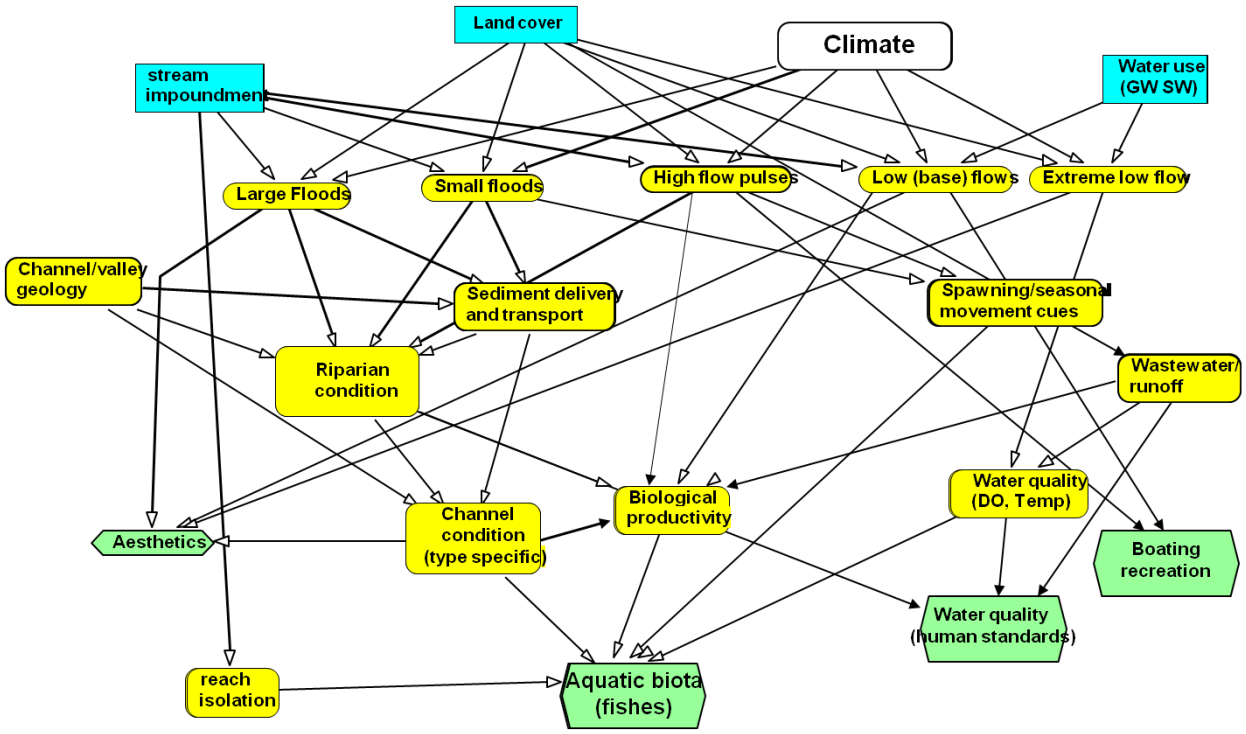


Figure 18. Schematic of integrated model of resource use, land cover, climate, hydrology, geomorphology, and ecological components to forecast climate change impacts on aquatic biota, water quality, aesthetics, and boating and recreation. From Peterson et al. (2010).

3. Conceptual Framework for Climate Monitoring

Climate change is one of several landscape-scale factors that will be shaping ecosystems in the South Atlantic region for the next several decades. The synergistic effects of climate and land-use change drivers will combine to frame the resource management challenges of the future.

Projected Consequences of Climate Change

Burkett et al. (2001) presented eight possible consequences of climate change in the Southeast including changes to human population demographics, agricultural and forest productivity, land-use change, sea-level rise, changes to water and air quality, temperature and precipitation changes, and changes to estuarine productivity (Table 5). These consequences go beyond purely climate projections, and apply to responses throughout a coupled human-natural ecosystem within and surrounding SECN parks (Figure 19). The tightly-coupled relationship between the human and natural systems and consequent vulnerability to climate change impacts are most pronounced in the coastal zones of the Southeast, and will affect the distribution, condition, resilience, and value of resources NPS is mandated to manage and protect.

Table 5. Projected consequences of climate change on watersheds and ecosystems within the South Atlantic coastal zone (modified from Burkett et al. 2001).

Category	Description
Human Population Demographics	The increase in the southeastern summer heat index simulated by both the Hadley and Canadian climate models would likely affect human activities in the Southeast during the 21st century.
Agricultural Productivity	Agriculture could possibly benefit from increased CO_2 and modest warming (up to 3 to 4°F) as long as rainfall does not decline, but there are differences in individual crop responses. Management adaptations could possibly offset potential losses in individual crop productivity due to evapotranspiration.
Forest Productivity	Biological productivity of pine and hardwood forests will likely move northward as temperatures increase across the eastern U.S. Hardwoods are more likely to benefit from increases in CO_2 and modest increases in temperature than pines (but both will benefit).
Land-Use Change	Under the Hadley model scenario, the region's land-use change in the next century is likely to be dominated by non-climate factors such as commodity prices and demographic forces. Forest and agriculture land uses are likely to continue to be urbanized. But under more extreme climate scenarios, land reallocation could possibly be more dramatic as climate more dramatically influences agricultural and forest productivity.
Sea Level Rise	During the 21st century, the IPCC projects that sea-level rise will likely accelerate 2- to 5-fold compared to the global rate during the 1900s (which was 4-8 inches). This would very likely have dramatic effects on population centers, infrastructure, and natural ecosystems in the low-lying South Atlantic coastal zone.
Water and Air Quality Changes	Water and air quality are concerns given the changes in temperature and precipitation that are simulated by climate models, combined with changing land use and human demographics.
Temperature and Precipitation Changes	Changes in minimum temperature, rainfall, and CO_2 will likely alter ecosystem structure, but interactions are difficult to model or predict, particularly relative to disturbance patterns.
Estuarine Productivity	Changes in freshwater inputs and tidal inflows into coastal estuaries will likely alter the ecological structure and function of these highly productive and valuable ecosystems.

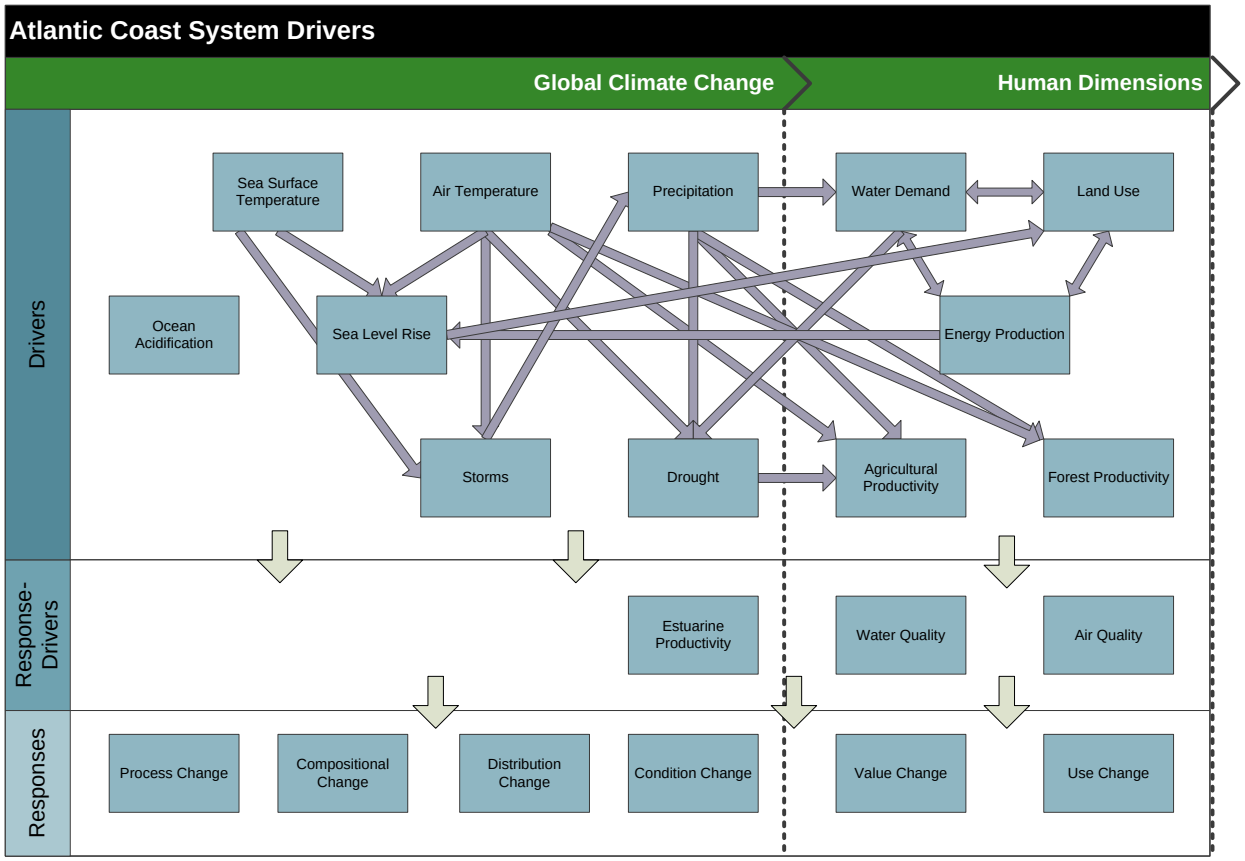


Figure 19. Conceptual model of system ecosystem drivers and responses based on global climate change and linked human-caused changes. See Appendix E for further discussion of the conceptual model.

Implications for Park Management

Changes to both the natural and human systems in and around SECN parks will have profound impacts to how parks are managed, particularly in parks within the coastal zone. Based on a review of existing ecosystems within and around each park, nearly all projected consequences of climate change will have direct and indirect effects on park resources (Table 6).

Table 6. Projected consequences of climate change on parks and surrounding watersheds and ecosystems within the Southeast Coast Network. For a description of projected consequences, see Table 5.

Category	KEMO	CHAT	HOBE	OCMU	CONG	MOCR	CAHA	CALO	FOSU-CHPI	FOPU	FOFR	CUIS	TIMU-FOCA	CASA-FOMA	CANA
Human Population Demographics	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Agricultural Productivity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Forest Productivity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Land Use Change	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sea Level Rise						X	X	X	X	X	X	X	X	X	X
Water and Air Quality Changes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Temperature and Precipitation Changes	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Estuarine Productivity							X	X		X	X	X	X	X	X

In summary,

- Higher productivity in forested portions of the landscape, changing productivity in portions of the of the agricultural sector, and increasing urbanization will result in marked and widespread changes in land use in the watersheds upstream and surrounding SECN parks.

- Primary stressors (increasing temperatures, changes in precipitation, and more frequent extreme weather events) and secondary stressors (public health, property damage, economic restructuring, and resource availability) will cause changes to the distribution of plant, animal, and human populations within the Southeast.

- Changes in land use, human population distribution, and precipitation will have impacts on water quality and quantity in all network parks and all systems (riverine, estuarine, palustrine, and groundwater).

- Coastal parks will also face the challenge of relative sea-level rise and the resultant increased risks of erosion and inundation.

All will affect how parks respond to climate change in the future, including how managers work with partners and policymakers to manage off-site stressors, coordinate mitigation/ resilience

responses, protect at-risk trust natural and cultural resources, and prepare for changes in visitor base, visitation rates, and resource values.

The Human Ecosystem Model as Organizing Concept for Climate Response

Machlis et al. (1997) proposed using the Human Ecosystem Model (HEM) as an organizing framework for conservation science, particularly in systems where the human and natural environments are closely coupled (Figure 20). Although consideration of linked human and natural systems has been a key component of ecosystem management since the 1980s, the underlying concepts have been a fundamental concept within resource management sciences since the 1930s (Force and Machlis 1997). The combined impacts of climate change and other drivers already acting upon the environment in the South Atlantic affect both natural and human systems, and require an integrated management response. The HEM is therefore an appropriate and directly applicable framework to explore effects of climate change, measures of resource condition as those effects are realized, and potential management or mitigation options.

The HEM provides a framework for collaboration and coordination among natural resource, cultural resource, economic, policy, education, and communication practitioners to achieve large-scale conservation goals. Recently, the utility of the HEM as a tool to frame an integrated science approach to scenario development and evaluation (both very relevant to climate change) was demonstrated by the DOI's Strategic Science Working Group's evaluation of possible outcomes resulting from the Mississippi Canyon 252 / Deepwater Horizon Oil Spill in the Gulf of Mexico (Machlis and McNutt 2010, DOI SSWG 2010). Within this framework, the Working Group explored effects of the spill on an expanded list of biophysical resources found within the Gulf of Mexico (Table 7). These resources, with some additions, are also significant to the coastal zone of the Southeast Coast Network and the South Atlantic LCC.

The HEM is particularly relevant for DOI agencies, and especially the National Park Service because of its explicit inclusion of cultural resources within its management purview (Figure 20). Although it is not within the mission of the SECN to undertake monitoring of cultural (or socioeconomic) resources at this time, the HEM does provide a framework for program expansion or for strategic partnership development with other organizations and programs working within the South Atlantic LCC.

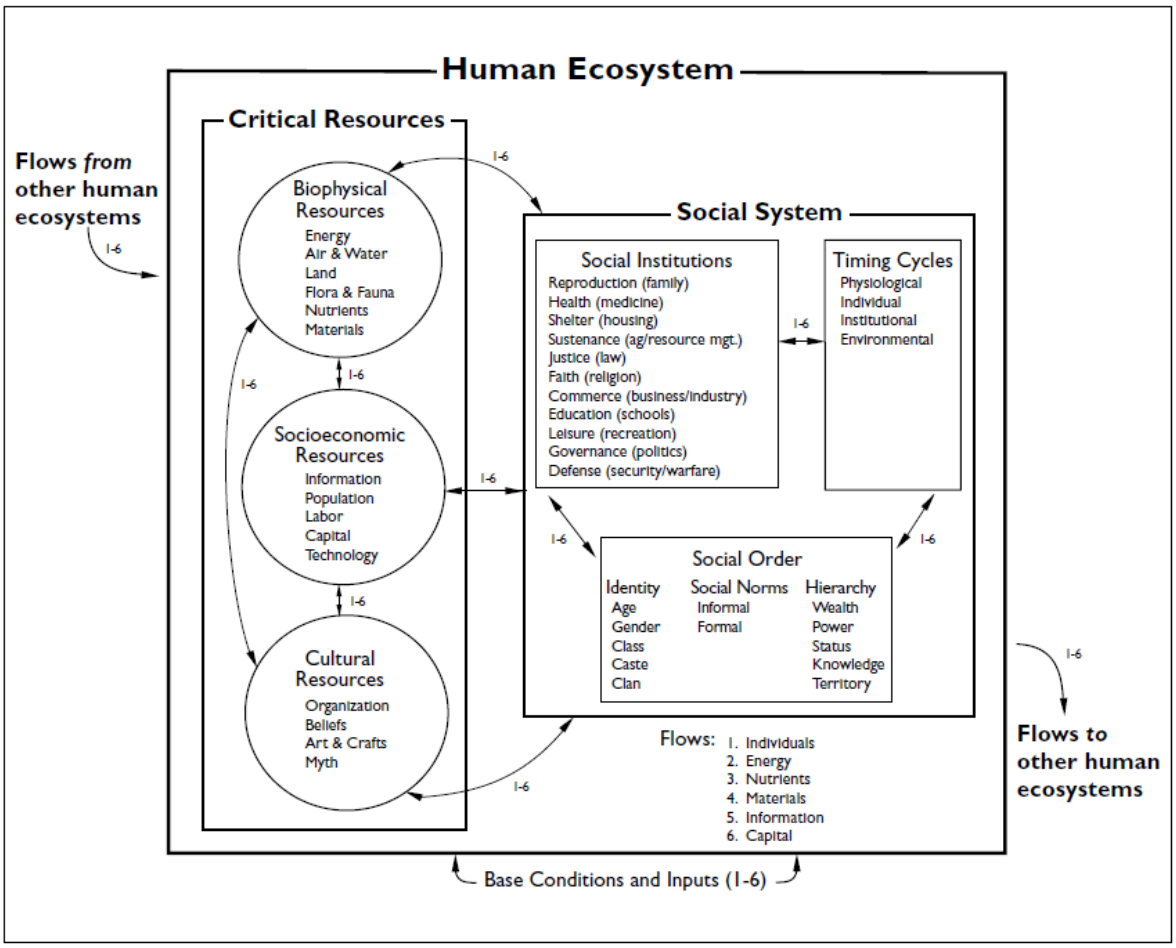


Figure 20. Conceptual diagram of the Human Ecosystem Model.

Table 7. Selected additions to the Human Ecosystem Model, Biophysical Resources (modified from DOI-SSWG 2010).

Flora / Fauna	Energy	Land
Plankton	Wind	Wetlands
Nekton (all kinds)	Solar	Uplands
Megafauna	Tidal	Beaches
Picoplankton	Electricity/ natural gas	Barrier islands
Birds	Current	
Fish	Wave energy	
Submerged aquatic vegetation	**Water**	**Materials**
Marine mammals	Fresh water	Wood
Turtles	Salt water	Soil
Coral	Surface	Rock
Terrestrial wildlife	Salinity	Metal
Terrestrial animals	Temperature	Calcium carbonate
Domesticated animals	Depth	plastic
Insects	Turbidity	
Forests	Groundwater	
Mangroves		
Grass beds		

Climate Change Effects on the South Atlantic Human Ecosystem

Because of the tightly linked relationship between the human and natural systems within the Southeast, and the scale at which climate change is expected to affect both systems, the South Atlantic Human Ecosystem (SAHE) is a valuable framework to use for identifying at-risk resources, strategies for resource conservation, and indicators by which we can both assess risk and progress toward protection of those resources.

Although the SAHE will likely need to be subdivided to address specific conservation needs, it does provide adequate resolution to explore the likely consequences of climate change to critical biophysical, socioeconomic, and cultural resources (Table 8), resultant adaptation strategies that will likely be required of the social system to manage those resources (Table 9), and monitoring data that will be required to inform those science-based management decisions (Chapter 4).

Table 8. Potential consequences on the critical resources of the South Atlantic Human Ecosystem. Resource categories are based on the Human Ecosystem Model (HEM) (Machlis et al. 1997).

Climate Change Effect Category	Biophysical Resources	Socioeconomic Resources	Cultural Resources
Human Population Demographics	• Increased energy production • Increased inland surface water extraction • Increased coastal groundwater extraction • Increased nutrient inputs to waters and lands • Changes in fishing pressure	• Increased human populations in urban centers • Variable population changes in coastal areas • Increased energy demand • Increased water demand	• Changes in science literacy • Changes percentage of people who speak English as a primary language
Agricultural Productivity	• Changes in nutrient and sediments inputs to water systems • Increased groundwater extraction	• Changes in agricultural sector job market • Changes in agricultural sector price of goods • Increased demand for food products • Increased demand for clothing products	
Forest Productivity	• Changes in wildlife habitat type, quality, and availability • Changes in corridor suitability • Changes species distribution and abundance • Changes in ecosystem structure, function, and composition	• Increasing demand for forest products	
Land Use Change	• Increased land/ ocean footprint for energy sector • Increased water consumption for energy sector • Changes in ecosystem structure, function, and composition • Altered hydrology • Altered sediment transport and inputs into water systems	• Changes in local demographics • Increased water demand • Increased energy demand	• Further disconnect between human population and nature • Increased rarity and changing values of key resources
Sea Level Rise	• Increased erosion and inundation • Changes in freshwater and salt water tables • Changes in coastal wetland condition and distribution	• Property and infrastructure damage in coastal areas • Changes in recreational opportunities • Increased demand for coastal zone protection measures	• Loss or impairment to historically significant/ valuable resources • Excavation or discovery of new cultural resources • Loss or emigration of historically significant human communities
Water and Air Quality Changes	• Changes in ecosystem structure, function, and composition • Increased nutrient inputs and loadings into estuaries • Changes in freshwater inputs into estuarine systems • Altered species composition, abundance, and distribution • Altered primary and secondary production in freshwater and estuarine systems	• Increased risk to human health from degraded air and water quality	• Restricted use of historical subsistence and recreational practices
Temperature and Precipitation Changes	• Changed distribution and composition of species and habitats		
Estuarine Productivity	• Changes in species composition, structure, and function	• Changes in productivity of finfish and shellfish fisheries	

Table 9. Expected adaptation responses by components of the social system to climate-change-induced effects on critical resources within the South Atlantic Human Ecosystem. Social system components and resource categories are based on the Human Ecosystem Model (Machlis et al. 1997).

Social System Components	Biophysical Resources	Socioeconomic Resources	Cultural Resources
Social Institutions	• Changes in land form types can alter the types and opportunities and opportunity for recreation in coastal zones, including such things as fishing, wildlife viewing, and ORV use. • New management policies, regulations, and statutes to manage newly-affected natural resources	• Commerce potentially affected by resource condition, threats, and scarcity and resultant changes in relative economic value and utility. • Insurance sector likely affected by increasing costs of damages in coastal areas. • Housing and construction sector likely to expand with expected urbanization trends.	• New management policies, regulations, and statutes might be required to manage affected cultural resources • Impacts in highly-vulnerable areas might require protection or preservation of at-risk resources of importance to regional or national cultural heritage.
Timing Cycles	• Changes in water releases to concurrently manage energy production, river fish habitat, and estuarine productivity. • Changes in timing of crop planting and harvesting.	• Funding, planning, and implementation of resource protection measures will need to span multiple years.	• Changes to timing of activities permitting subsistence or recreational fishing or hunting.
Social Order	• Adjustments to policies and areas required for protection of trust biophysical resources.	• Changes in demographics, science/ climate literacy	• Adjustments to policies and areas required for protection of trust cultural heritage resources. • Changes in education and outreach efforts to reconnect people to the environment.

It will be incumbent on park resource managers to use best available science to manage responses to climate change and projected impacts. Park managers need scientifically credible information on the status, trends, condition, and risks to biophysical, socioeconomic, and cultural resources in order to best manage and conserve them, and at the same time will require a firm understanding of (and perhaps influence on) the social systems in which that resource protection occurs.

4. Network Climate Change Monitoring

Overview

Nearly all Vital Signs being monitored by the SECN can be analyzed and interpreted in the context of responses to climate change after a sufficient period of record is collected, and in fact, impact of climate change on park resources was one factor cited as a reason for monitoring nearly all of the Network's Vital Signs (DeVivo et al. 2008, Appendix 5).

To identify new climate change monitoring objectives, potential uses of climate change monitoring data, and opportunities for collaboration among agencies conducting related monitoring efforts, the SECN facilitated or participated in more than 20 scoping, briefing, or informational meetings between October 2009 and September 2010 (Table 10). Although climate change monitoring was not always the primary purpose of the meeting, all were related to the myriad climate programs underway throughout the region. Particularly during the first half of the year, it was the goal of the SECN to identify a) monitoring needs that would better allow parks to meet their mandate of including climate science in management, b) identify what other efforts were concurrently ongoing or being initiated, and c) rapidly identify opportunities to collaborate and coordinate those efforts.

All SECN Vital Signs were evaluated for inclusion in the SECN Climate Monitoring Program based on a combination of ecological relevance, partnership opportunities, and utility of monitoring data to existing or planned climate science efforts within the region. Ultimately, 10 Vital Signs were identified for changes in sampling design based on their ability to a) provide data to better understand landscape-scale consequences of climate change that will drive impacts to resources on SECN parks, b) inform science-based management of biophysical, socioeconomic, or cultural resources, c) provide data relevant to one or more of the social systems within the human ecosystem of the South Atlantic, and d) provide data that can be used to modify or improve existing management-relevant climate response models (Table 11).

Network Climate Change Vital Signs

Protocols or data processing methods for 10 SECN Vital Signs will be modified to enhance NPS's ability to include climate science in management decisions (Table 12). New monitoring objectives for each Vital Sign are shown in Table 13. Although we will have new data management and reporting tasks with all 10 Vital Signs, the largest changes to the program will result from changes to the Network's *Salt Marsh Elevation*, *Groundwater Dynamics*, *Amphibians*, *Landbirds*, and *Plant Community* protocols. These are discussed in further detail below.

Table 10. Partial list of scoping, briefing, and informational meetings attended or facilitated by the Southeast Coast Network in FY2010 during the development of the SECN Climate Change Monitoring Plan.

Date	Meeting	Attendees	Purpose
Oct 8	Georgia Coastal LTER	Merryl Alber, Director, Georgia Coastal Ecosystems LTER	Discuss coastal climate change research focus of the Atlantic Coastal LTER network
Oct 29	Atlantic Coast Network Coordination Meeting	Staff from SECN and NCBN	Discuss current Vital Signs Monitoring programs, potential climate change needs, and strategies for coordination among coastal networks.
Nov 1-6	CERF Annual Meeting	Federal, State, NGO, Academic, and others	Coastal and Estuarine Research Federation 20th Biennial Conference, Estuaries and Coasts in a Changing World as it relates to global climate change. Meeting presented a number of opportunities to formally and informally discuss trends in salt marsh community monitoring and develop partnerships.
Nov 3-5	Southeast Coastal and Ocean Stewardship Workshop: Challenges in a Changing Environment	NPS park resource managers, superintendents, regional and WASO science staff, and invited technical experts.	Discuss key questions facing coastal parks including impairment and effects of climate change.
Nov 24-25	LCC Operations Plan Development	LCC climate-change program leads for FWS and NPS	Write draft operations plan for the South Atlantic LCC that discusses DOI- and other partner-based coordinated approach to climate science and resource conservation
Dec 7-8	Kennedy Space Center Climate Change Meeting	Science staff from NPS, NGS, U of Florida, and NASA	Evaluated and discussed issues related to climate change and consequent effects to foreshore geomorphology
Dec 17-18	URI CESU Climate Meeting	Federal, state, NGO, and academic science and policy staff	Identify potential coastal climate-change research projects.
Jan 13-16	Northeast Regional Meeting on RSLR	Science Staff from NPS, NGS, USGS	Develop methodology for assessing inundation risk from sea level rise and storm surge in coastal NP using high accuracy geodetic control.
Feb 4-5	NOAA Coastal Monitoring Coordination	Science staff from NOAA, NPS, FWS, and USGS.	Discuss potential and means to coordinate and standardize methods for monitoring coastal resources to support landscape-scale analyses of climate change impacts
Feb 18	UGA Scoping Meeting	Academic research faculty and staff from Marine Sciences, Ecology, and Forestry programs	Present program and potential climate change monitoring options for review.
Feb 23-25	Raleigh climate downscaling meeting	DOI agency and academic climate change forecasting project leads	Evaluate ongoing climate downscaling projects funded by NCCWSC, present preliminary findings to other DOI agency personnel for comments, and identify means by which to ensure maximum utility of data, model outputs, and findings to a broad range of audiences.
Feb 28-March 5	NOAA Coastal Training Program / Research Winter Meeting	Science and program staff from NOAA System-Wide Monitoring Program (SWMP)	Presented results of February 4-5 meeting and what SECN
Mar 18	NOAA NERR Central Data Management Office	Data management staff from NERR and SECN programs	Evaluate data models for current monitoring programs and devise options for seamlessly merging data sets.
Mar 30-31	Interagency South Atlantic LCC Scoping Workshop	LCC partners from federal, state and NGO organizations	Develop draft governance structure and mission statement for the South Atlantic LCC
Mar 29-Apr 1	NCTC LCC Data Workshop	Federal (DOI and other), state, NGO personnel	Determine data management and acquisition needs to support national network of LCCs and associated programs within the context of DOI/OMB policies.
Apr 7	NPS and GTM Project Scoping Meeting	Staff from State (FL) agencies, NPS, and GTM-NERR	Evaluate joint salt marsh monitoring methodology and efforts in FOMA and GTM.
Apr 19-23	LCC Scoping Team Meeting	LCC steering committee members from FWS, NPS, USFS, USGS, and State agencies	Vette mission, governance, and primary science needs for the South Atlantic LCC.
Apr 7	SERAP Project Meeting	Project staff from USGS, NGO, and academic institutions	Update on regional and SALCC climate change forecasting models and exploration of potential integration with SECN monitoring efforts.
	SERAP Integration	Regional Director and senior science staff from USGS Southeastern Regional Office	Discuss SECN climate change monitoring program and specific project needs and integration opportunities for coordination with SERAP or forthcoming regional CSC.

Table 11. Matrix of SECN Vital Signs and the applicability of resultant monitoring data to a) better understand impacts of climate change in SECN parks, b) explore effects on critical resources and social systems within the South Atlantic Human Ecosystem, and c) refine or enhance existing climate change effects models. Vital Signs highlighted in grey are those that will be enhanced as a part of the SECN Climate Monitoring Program.

		Expected Response Categories								Critical Resources			Social Systems			
Network Vital Sign	Measures	Human Pops	Agriculture	Forestry	Land Use Chg	SLR	Water Air Qual	Temp Precip	Estuaries	Biophysical	Socioeconomic	Cultural	Institutions	Timing	Order	Model Utility
Air Quality	Atmospheric ozone concentration, damage to sensitive vegetation		X		X		X	X		X	X	X				
Wet and Dry Deposition	Wet and dry sulfate and nitrate deposition				X		X	X		X		X				
Visibility and Particulate Matter	IMPROVE suite for visibility and fine particulates, particle size analyses: pm 10, pm 2.5, haze index				X		X	X		X		X				
Air Contaminants	concentration of mercury, semi-volatile organic compounds, acidic components of contaminants				X		X	X		X	X					
Weather and Climate	Air temperature, precipitation, relative humidity, tides, location and magnitude of extreme weather events	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coastal Shoreline Change	shoreline position and slope					X				X	X	X	X			X
Salt Marsh Elevation	Sediment elevation, salinity					X			X	X						X
Stream/ River Channel Characteristics	percent cover of coarse woody debris, detritus, distribution and extent of geomorphic features (runs, riffles, pools); grain size distribution; distribution, extent, and rate of change of erosion features.				X			X		X						X
Groundwater Dynamics	water table levels for freshwater and saltwater	X	X			X				X	X				X	X
Surface Water Dynamics	discharge, magnitude and duration of flooding events	X				X		X	X	X	X	X		X	X	X
Marine Water Quality	pH, temperature, dissolved oxygen, turbidity, salinity, concentrations of chlorophyll a, TDN, TIN, TDP, TIP, metals, and volatile organic compounds	X			X		X	X	X	X	X				X	
Riverine Water Quality	pH, temperature, dissolved oxygen, specific conductance, turbidity, trace ions, nutrient concentrations	X	X	X	X		X	X	X	X					X	
Invasive/ Exotic Plants	occurrence of invasive plant species		X	X	X			X		X						
Marine Invertebrates	occurrence of selected marine invertebrate species				X	X		X	X	X	X					
Fish Communities	Fish community diversity, relative abundance, Index of Biotic Integrity, percentage of non-native species, number of crevice spawner species				X		X	X	X	X				X		
Amphibians	species occurrence, diversity, percent area occupied, disease incidence				X		X	X		X					X	X
Landbirds	species occurrence, diversity, relative abundance				X			X		X	X		X		X	X
Small Mammals	species occurrence, diversity, percent area occupied, relative abundance				X			X		X					X	
Plant Communities	Plant species occurrence, diversity; percent cover by herbaceous, shrub and overstory; rooting by feral hogs and armadillos; occurrence of disease, occurrence of insect outbreaks, occurrence of non-native species; NVCS class				X			X		X					X	X
Shorebirds	number and location of piping plover, red knot, Wilson's plover, American oystercatcher					X				X	X		X		X	
T&E Species	Abundance, distribution, and recruitment of rare species such as sea beach amaranth, beach mouse, sea turtles, red-cockaded woodpeckers				X	X		X		X			X		X	
Fisheries Take	species occurrence, weight, size based on compilation of existing data from State and other sources								X	X	X		X	X	X	
Visitor Use	Monthly and annual visitor attendance compiled from existing Park and other sources	X									X					
Fire and Fuel Dynamics	burn area and extent, down woody debris, duff depth			X	X			X		X						
Land Cover and Use	Extent and distribution of land cover and use types, fragmentation, extent and distribution of management actions (compiled from park records).	X	X	X	X					X	X		X		X	X

Table 12. Changes to SECN Vital Signs with the additional focus of climate monitoring. Vital Signs marked with an asterisk (*) will have significant changes or additions to field methodology and protocols.

Network Vital Sign	Base Monitoring Plan	Climate Monitoring Changes
Weather and Climate	Weather and climate measures limited to air temperature, precipitation, relative humidity, tides, location and magnitude of extreme weather events. Data collected through data mining and data sharing agreements with other agencies.	List of measures expanded to include downscaled climate forecast data for areas surrounding the parks (generally based on boundaries defined during watershed or natural resource condition assessments), and real-time calculation of derivative measures as data are collected.
Coastal Shoreline Change	Measurement and modeling of coastal shoreline position and slope using survey-grade ATV-based GPS equipment seasonally to annually of park foreshores, augmented with post-storm measures where necessary. Permanent NGS 3D monuments will be installed along the shoreline to develop a long-term baseline elevation reference network	No changes to methodology, but shoreline position and slope data will be integrated with existing models that forecast coastal inundation and erosion risk, and data and models will be updated following major storm events.
*Salt Marsh Elevation	One sentinel site (with three replicate stations) deployed at each SECN park with salt marsh systems. Stations installed and benchmarked to allow for measurement of changes in elevation relative to surveyed benchmarks. Elevation and relevant covariates (pore soil water salinity and vegetation) measured 1-4 times annually.	Sampling design increased to up to 10 sites per park (depending on size and habitat) to allow for measurement of variability in elevation change within park systems. Methods will be coordinated with NOAA, USGS, FWS, and other NPS Networks to ensure consistency of data at the landscape scale. Data from NOAA tidal gaging stations will be used to in conjunction with RSET elevation data to assess trends in relative sea level rise. Tidal and RSET data integrated with existing coastal wetlands and inundation risk / forecasting models.
Stream/ River Channel Characteristics	Percent cover of coarse woody debris, detritus, distribution and extent of geomorphic features (runs, riffles, pools); grain size distribution; distribution, extent, and rate of change of erosion features measured in stream riverine systems.	No change to methodology. Data integrated with existing coupled climate downscaling, hydrologic, land use, stream habitat models to forecast changes in availability and types of habitat available in network parks.
*Groundwater Dynamics	No field methods proposed. Water level (salt and fresh) and ground water quality data acquired through data mining and data sharing agreements with other agencies.	Data loggers installed at existing well locations based on recommendations listed in the SECN Groundwater Inventory (Rasmussen et al. 2009) Additional monitoring wells installed as funding permits.
Surface Water Dynamics	No field methods proposed. River discharge data acquired through data mining and data sharing agreements with other agencies.	Where feasible, gage stations installed or upgraded at FOFR, FOMA, FOPU, FOSU, MOCR and TIMU as recommended in the draft SECN Surface Water Monitoring Protocol (Rasmussen et al. *in preparation*). Surface water forecasting data acquired from USGS.
Amphibians	Visual Encounter Survey (VES) and Automated Recording Device (ARD) measurements of species occurrence, diversity, percent area occupied, disease incidence, and relative abundance at up to 30 spatially-balanced randomly sampled locations in all network parks once every three years.	No changes in methods. Data to be used by USGS to develop integrated models that couple climate downscaling, hydrologic, land use, and vegetation models to forecast species distribution shifts in response to climate change.
*Landbirds	Variable Circular Plot (VCP) measurements of species occurrence, diversity, relative abundance at up to 30 spatially-balanced randomly sampled locations in all network parks once every three years.	VCP methodology being discontinued in favor of using data collected using automated recording devices. Recorder deployment increased from 14 to 60 days to allow for measurement of arrival phenology of migratory birds. Data to be integrated with existing coupled climate downscaling, land use, and vegetation models to forecast species distribution shifts in response to climate change.
*Plant Communities	Plant species occurrence, diversity; percent cover by herbaceous, shrub and overstory; rooting by feral hogs and armadillos; occurrence of disease, occurrence of insect outbreaks, occurrence of non-native species; NVCS class	Establishment of fixed sites in network parks to implement data collection methods developed by National Phenology Network.
Land Cover and Use	Extent and distribution of land cover and use types, fragmentation, extent and distribution of management actions (compiled from park records).	Land cover and land use data acquired through data acquisition and sharing agreements with the South Atlantic LCC to ensure consistency of data use among partner agencies. Additionally, coastal land cover and habitat data will be acquired from NOAA to ensure consistency of data sets and use among partners within coastal and marine systems. Land use and vegetation community forecasting data acquired from USGS.

Table 13. Climate change monitoring objectives for SECN Vital Signs focus of climate monitoring.

Network Vital Sign	Additional Monitoring Objectives	Justification
Weather and Climate	• Evaluate divergence from forecasted data based on low- medium- and high emission scenarios.	Important for scenario planning to narrow down potential projections and likely consequences.
Coastal Shoreline Change	• Determine foreshore slope.	Data to be used to develop localized coastal inundation and wetland loss models.
Salt Marsh Elevation	• Determine changes in relative sea level rise • Determine variability in salt marsh elevation within SECN parks • Determine changes and latitudinal trends in salt marsh elevation • Determine status, trends, and variability in tidal measures	Data to be used to develop localized coastal inundation and wetland loss models.
Stream/ River Channel Characteristics	• Evaluate divergence from forecasted data based on low- medium- and high emission scenarios.	Important for scenario planning to narrow down potential projections and likely consequences.
Groundwater Dynamics	• Evaluate changes in groundwater conditions that are closely related to changes in anthropogenic use patterns (i.e., projected population growth along the coast) that might be exacerbated by climate change.	Data to be used in coastal wetland loss models. Increases understanding of the nature of external park impacts such as ecosystem and habitat alterations due to changes in surficial aquifers or landscape subsidence as a result of changes in the confined aquifer.
Surface Water Dynamics	• Evaluate divergence from forecasted river flow data based on low- medium- and high emission scenarios.	Data to be used in coastal wetland loss models. Important for scenario planning to narrow down potential projections and likely consequences.
Amphibians	• Evaluate divergence from forecasted amphibian distribution data based on low- medium- and high emission scenarios.	Data to be used to develop and validate regional species forecasting models. Important for scenario planning to narrow down potential projections and likely consequences.
Landbirds	• Evaluate divergence from forecasted bird distribution data based on low- medium- and high emission scenarios. • Determine changes and trends in timing of migration.	Data to be used to validate regional species forecasting models. Important for scenario planning to narrow down potential projections and likely consequences.
Plant Communities	• Evaluate divergence from forecasted vegetation community data based on low- medium- and high emission scenarios. • Determine changes and trends in timing of leaf-out, budding, and flowering of key indicator species.	Data to be used to validate regional species forecasting models. Important for scenario planning to narrow down potential projections and likely consequences.
Land Cover and Use	• Evaluate divergence from forecasted land use data.	Important for scenario planning to narrow down potential projections and likely consequences.

Salt Marsh Elevation

Prior to the climate change initiative, the SECN began deploying RSET stations at eight parks along the South Atlantic Coast (DeVivo et al. 2008). Under the original sampling design, one site was to be selected at each park (with three stations) following the methods described in Cahoon et al. (2006). Because of the need to keep stations out of public view and the sensitivity of southeastern marshes to trampling, site installation is limited to the low marsh areas, with installation of stations following methods developed by Louisiana Department of Natural Resources (Folse and West 2004). As of October 2009, stations had been deployed at Timucuan Ecological and Historic Preserve and site selection had been completed at Cape Lookout and Cape Hatteras National Seashores.

Prior to efforts to reevaluate the sampling design and monitoring objectives related to climate change impacts, the SECN had intended to complete station installation by the end of FY2011.

As part of the SECN Climate Monitoring Program, the network will begin to greatly expand its coastal salt marsh monitoring efforts in response to additional monitoring objectives related to climate change impacts. Specifically, the SECN will be collecting data to:

- Better understand local salt marsh accretion and subsidence rates and how those rates translate to changes in relative sea level, and

- Provide data for coastal vulnerability and erosion, and coastal wetland loss forecast models.

It is anticipated that model integration will be accomplished between NPS and USGS in partnership through the Southeast Regional Assessment Project and (ideally) the Southeastern Climate Science Center.

To meet the new monitoring and modeling data needs, the SECN will modify its existing sampling design to increase the number of stations deployed and include tidal measures for each station (Figure 21):

- At each of the five larger parks (Canaveral, Cumberland Island, Cape Lookout, and Cape Hatteras National Seashores, and Timucuan Ecological and Historic Preserve) the number of monitoring sites will be increased from one to up to 10 sites, with three stations installed at each. Stations will be installed and surveyed in to NGS standards and tied to the coastal shoreline monitoring monuments so that elevation data can be referenced to the National Spatial Reference System.

- Data from relevant nearby tidal elevation gauging stations available through NOAA's National Water Level Observation Network (NWLON) will be included in the data analysis to measure changes in relative sea level in addition to changes in sediment elevation.

In addition to changes in sampling design, the SECN is working to ensure that the methods employed by the SECN are closely coordinated with other partners throughout the Atlantic Coast so that data can be seamlessly integrated into a coast-wide data set. In March 2010, NPS and NOAA hosted a meeting in Silver Springs, MD attended by science staff from NPS, FWS, USGS, and NOAA to coordinate coastal monitoring efforts. All agencies agreed to develop minimum standards for a variety of coastal monitoring protocols in use across agencies, most of which are currently being implemented in a similar fashion. NOAA and the NPS Southeast Coast Network are currently working on jointly-authored monitoring protocols for salt marsh elevation and benchmark installation, and will be developing SOPs to guide minimum data collection standards to be reviewed and implemented by partnering agencies (including USGS and USFWS).

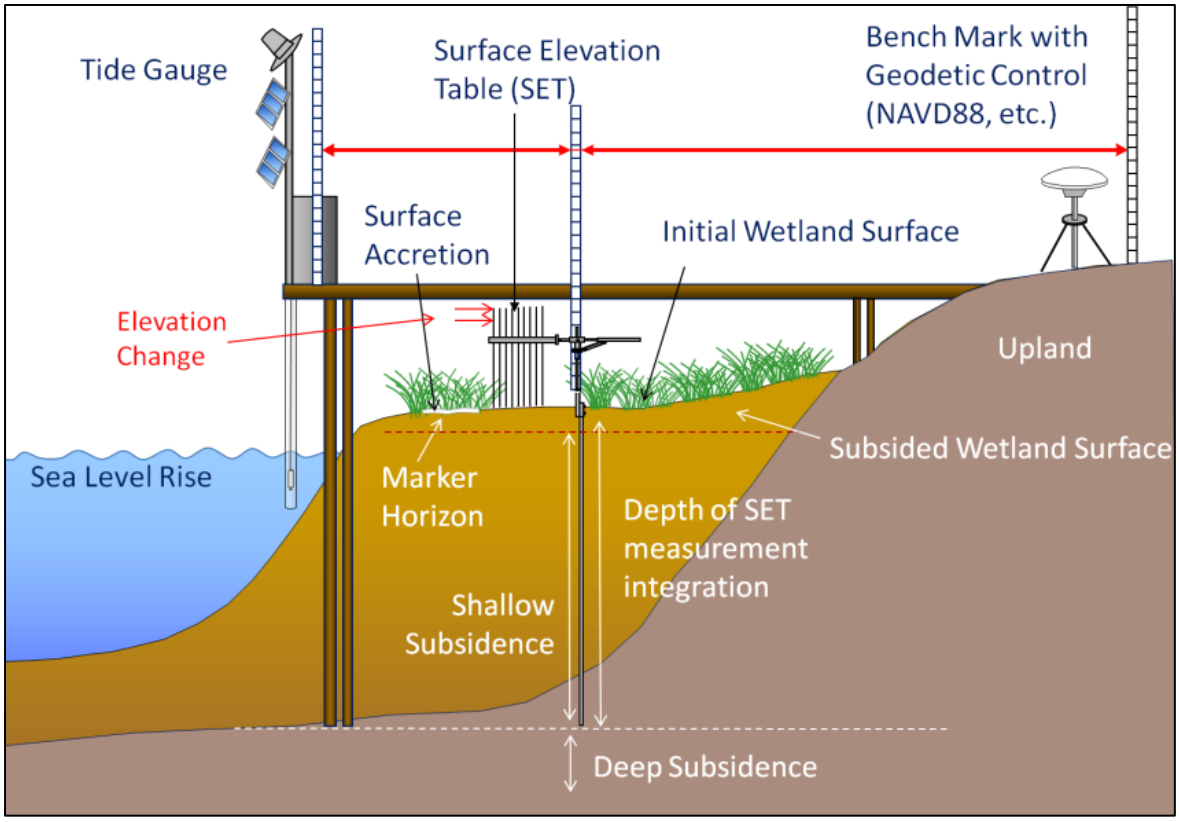


Figure 21. Schematic of combined RSET and tidal gaging stations to allow for measurement of both salt marsh accretion and subsidence and sea level rise in a manner that provides measurement of relative sea level rise (NGS, P. Hensel, personal communication).

Groundwater Dynamics

Implementation of the *Groundwater Dynamics* Vital Sign began in FY2010 as one of the network's data acquisition protocols; however, the approved monitoring plan did not call for the installation of new wells or data loggers in existing wells (DeVivo et al. 2008). The SECN's groundwater monitoring protocol (Rasmussen and others, 2009) does identify several data gaps where installation of additional wells or data loggers would greatly enhance the Network's ability to evaluate trends in groundwater resources.

The identification of gaps in the existing well network will be used as a guide to identify potential partnering agencies to acquire a coast-wide SECN groundwater monitoring network and make data more useful within the boundaries of nearby parks and in a regional context. Monitoring data will be used specifically to evaluate changes in groundwater conditions that relate to changes in anthropogenic use patterns that may be indirectly coupled to changing climatic conditions. Additional monitoring objectives will be useful in understanding the nature of external park impacts such as ecosystem and habitat alteration due to changes in surficial aquifers or landscape subsidence that could be a result of changes in the confined aquifer level.

To meet the new monitoring and modeling data needs, the SECN proposes to initially focus efforts at parks identified as lacking important baseline datasets regarding either the surficial water table (i.e., CONG) or the confined aquifer (i.e., CAHA, CALO, CANA, CUIS). The

following tasks briefly describe additional work elements proposed to address ground dynamics in the context of regional and local anthropogenic-climate induced change:

- Outfit and monitor selected wells with pressure transducers and water-quality data loggers (Figure 22),

- Cap currently flowing wells with logging pressure gages and begin monitoring pressure records using hydraulic head as a surrogate for water level changes,

- Participate with partnering agencies (USGS, USFWS) as wells as local, non-profits, and other state and federal partners in efforts to plan and conduct regional synoptic groundwater surveys, and

- Identify the location of non-flowing or abandoned wells encountered as part of ongoing Vital Signs monitoring that are located on or near Park lands that should be prioritized for permanent closure.



Figure 22. Example of well outfitted with automated data collection equipment platform.

Amphibians and Landbirds

Amphibian and bird monitoring protocols will be modified to provide data that can be input into occupancy models under development by USGS. These models have two objectives—to assess potential impacts of climate change on habitats of priority species in the southeastern US by mapping and predicting cover dynamics, and to assess patch occupancy and range dynamics of North American avian species in response to land cover dynamics and climatic change. The USGS SERAP project is attempting to secure funding to expand its integrated terrestrial assessment to assess patch occupancy and range dynamics of amphibian species.

To accomplish this, the SECN will combine methodologies of its amphibian and bird monitoring efforts by sampling bird communities using automated recording devices (as opposed to variable circular plots) and by expanding the sampling period from 14 to 60 days (to ensure sampling during the spring migration period).

The changes in methodology will more adequately characterize the sites due to a) multiple repeated sampling events, b) consistent sampling time of the ARD records, and c) collecting data across a wider range of environmental conditions known to influence detectability (e.g., precipitation, humidity, temperature). Singing and calling rates of many birds decrease as the morning progresses.

In addition to changes in sampling methodology, the SECN will evaluate recordings to assess changes in bird and vocal anuran phenology. The increase in sample size (and duration) will allow the network to more adequately capture the variability in arrival and stopover of migratory birds, and vocal anurans that breed in early and late spring.

Plant Communities

Phenology is defined as the relationship between climate and periodic biological phenomena; examples include the timing of: leaf development, bud development, flowering, leaf fall, animal movements/migration, and insect life cycles (Lieth 1974, Haggerty and Mazer 2008). Phenology has a long history (Leopold and Jones 1947, Puppi 2007) as pre-historic farmers were likely the first phenologists, carefully tracking the response of plants and animals to the seasonal cycles in order to better understand when to plant crops (Puppi 2007). Aldo Leopold stated that "by tracing [organisms'] responses to the sun, phenology may eventually shed some light on that ultimate enigma, the land's inner workings" (Leopold and Jones 1947). The use of phenology as a means of monitoring climate change is a rapidly developing field. Because phenology is dependent on climate, long-term patterns of climate change can be tracked by monitoring phenological occurrences (Badeck et al. 2009, Bradley and Mustard 2008, Cotton 2003, Haggerty and Mazer 2008, Schwartz 1994).

National Park Service Inventory and Monitoring Networks across the nation are currently cooperating with the National Phenology Network (NPN) to implement phenological monitoring protocols. The National Phenology Network is a cooperative network of government agencies, educational institutions, educators, students, NGOs, and citizen scientists (http://www.usanpn.org) that has developed and tested a peer-reviewed monitoring protocol to quantify phenology. Although the SECN is not currently involved in plant-phenology monitoring due to our current staffing structure, we plan to adopt the phenology protocols developed by the

NPN cooperative. Phenological monitoring is a time-intensive activity, and monitoring must be conducted on a precise schedule of visits and re-visits to a given location.

Given the diversity of SECN parks in terms of vegetation communities, geographic location, and the combination of four National Seashores with several inland piedmont / coastal plain parks, the Network is ideally located to monitor the phenological responses of a wide variety of plants. For example, spring ephemeral plant species are very sensitive to variations in hydroperiod, temperature, and daylight. Studies have shown that some spring ephemerals respond negatively to early onset of spring (i.e., warmer temperatures earlier in the year) by blooming earlier, producing fewer seeds, or senescing after a shorter-than-normal period (Abu-Asab 2001, Farnsworth et al. 1995, Kudo et al. 2004, Lapointe 2008). This has direct implications to climate change, and suggests that populations of spring ephemerals may decline in response to climate change. Thus, including spring ephemeral plants in phenological monitoring will provide data to help SECN park managers to better understand the effects of climate change. Variations in the timing of plant reproduction can also have significant impacts on wildlife species that depend upon specific plant phenological stages for food or cover resources, and result in reduced fitness and impaired reproduction (Both and Visser 2001, Marra et al. 1998, Sillet et al. 2000).

Implementation Priority

Initially, the SECN will likely lack sufficient funding to implement all enhanced Vital Signs. Priority for field methods will be placed on upgrading the Network's Salt Marsh Elevation and Groundwater monitoring systems (in that order) because of their relevance to coastal ecosystems. Regardless of funding, the Network will expand the data collection period for vocal Anurans and landbirds, but analysis of phenological data will be dependent on the capacity of the network to hire staff or forge partnerships to process the increase in recordings. Plant phenological monitoring will only be implemented if the Network secures additional funding for dedicated staff.

Other changes described above that are largely changes in data acquisition, interpretation, and transfer will be implemented as funding/opportunity permits.

Cultural and Socioeconomic Climate Change Vital Signs

Monitoring of Vital Signs pertaining to critical socioeconomic and cultural resources will be a significant information need for parks to adequately plan for climate change, but are beyond the current scope of the SECN program. These types of measures will not be monitored as a part of the SECN program, but we do envision a pilot project in partnership with the SALCC to select appropriate measures, develop methods, and conduct a baseline inventory of the condition of these other critical resources. Potential metrics are presented in Table 14 (Force and Machlis 1997).

Table 14. Potential social indicators to be evaluated for use in scenario planning and management of climate change impacts within the South Atlantic Human Ecosystem. Measures modified from those used in 1997 Interior Columbia Basin Ecosystem Management Project (Force and Machlis 1997).

Variable	Indicator	Measure
Natural Resources		
Energy	Occupied housing units heated with wood	% of occupied units heated with wood
Land	Federal land	% of land owned by federal government
	Population density on nonfederal land	Number of people per acre of nonfederal land
Water	Not available	
Materials	Material production	Dominant manufacturing or extractive industry
Nutrients	Agricultural product	Ratio of $ value of crop to livestock products
Socioeconomic		
Information	Library loans	Number of books loaned by public libraries per capita per year
Population	Total population	Total resident population
	Rural population	% of total population residing in rural areas
Labor	Unemployment	% of civilian labor force unemployed
Capital	Bank deposits	$ value of monthly bank deposits
	Income	Median household income
Cultural Resources		
Organization	Not available	
Beliefs	Votes by political party	% of votes cast for Republican presidential candidate
Myths	Major religion of family	Major religious group
Social Institutions		
Health	Infant mortality	Number of infant deaths per 1,000 live births
	Physicians	Number of physicians per 100,000 population
Justice	Law enforcement	Number of police officers with arrest powers per 1,000 population
Faith	Religious adherents	% of population who claim adherence with an established religion
Commerce	Earnings	$ value of earnings in all industries
Education	High school graduates	% of adult population graduated from high school
Leisure	Not available	
Government	Voting rate	% of population >18 years of age participating in presidential elections
	Local government finances	$ value of local government expenditures per capita
Sustenance	Resource-related employment	% of labor force in agriculture, forestry, fisheries, mining
	Land use	Acres of irrigated land
Identity (social order)		
Age	Median age	Median age
	Dependency ratio	% of persons <18 and >64 years of age
Gender	Women in labor force	% of adult women in labor force
	Sex ratio	Ratio of females to males
Class	Professional and skilled employment	% of labor force in professional occupations
Caste	Ethnic/racial composition	% of total population in ethnic/ racial groups
Clan	Household composition	% of households with children under 18 headed by single parents

Table 14. (Continued).

Variable	Indicator	Measure
Social Norms (Social Order)		
Informal	Divorce Rate	Number of divorces per 1,000 population
Hierarchy (social order)		
Wealth	Poverty rate	% of persons living below poverty level
Power	Elected positions	Number of elected positions per 1,000 population
Status	Not available	
Knowledge	College graduates	% of adult population who are college graduates
Territory	Home ownership	% of housing units occupied by owner
Social Cycles		
Physiological	Elderly population	% of total population who are 70 years old or older
Individual	Employment terms	Full-time workers
	Work days	Seasonal workers
Institutional	Not available	
Environmental	Not available	

5. Critical Project Needs

The SECN has identified several necessary projects to implement its climate science strategy. These include addressing key information gaps, comparing methodologies before and after protocol changes, expanding the Network's data management system, and implementing several one-time costs associated with installation of long term monitoring stations that were not included in the Network's original Vital Signs Monitoring Plan.

Where available, cost estimates are provided, but the source of funding is at this time unidentified. Where possible, the SECN will seek external (to the Network) funding to implement these projects either as standalone NPS efforts, or in partnership with other federal, state, or academic agencies working within the SALCC.

Monitoring Infrastructure

RSET Installation ($120,000). At each of the five larger parks (Canaveral, Cumberland Island, Cape Lookout, and Cape Hatteras National Seashores, and Timucuan Ecological and Historic Preserve) the number of monitoring sites will be increased from one to eight sites, with three stations installed at each. Stations will be installed and surveyed in to NGS standards so that elevation data can be referenced to the National Spatial Reference System. *This is a priority infrastructure need of the network and will be funded out of base SECN dollars during the first three years of strategy implementation.*

Tidal Station Installation ($150,000-200,000). Where necessary, NPS will work with NOAA and other cooperators to ensure Network- and LCC-wide coverage of NWLON station data. Based on an analysis of existing NWLON station coverage, the SECN will need to install tidal monitoring stations at CALO and CANA. Stations will be installed and maintained by NOAA according to NWLON protocols. The estimated installation costs are $75-100K each. Two additional stations at TIMU and CUIS might also be necessary pending further investigation and analysis (see below).

DOI I&M Program Integration. Beginning in FY2010, the Southeast Coast Network and FWS South Atlantic Refuges monitoring programs will co-locate management offices at the University of Georgia in Athens, GA. Program and data management staff, as well as water and climate change staff will be housed in a shared facility on Whitehall Experimental Forest. This is being done through a Cooperative Ecosystems Study Unit (CESU) agreement with the University that includes funding for field intern, technical writing, and GIS capacity needs.

Protocol Enhancement

Groundwater ($65,000). With the additional deployment of groundwater data loggers at coastal well sites, the SECN will deploy data management, analysis, and reporting tools to accommodate those data. This will include site and well information as well as water chemistry data collected. Expanding the groundwater module of the decision support system to support these enhancements will require the development of groundwater data logger and well components in the current SECN conceptual object model and database design (as well as the business logic to support these components as required by the groundwater monitoring protocol). Finally, one or

more data summary reports will be created for the output and/or presentation of this dataset. The cost estimate above includes the creation of two data output reports.

Tidal Gage Suitability Study ($50,000). A one-year study of tidal fluctuations within TIMU and CUIS will be conducted to determine if tidal conditions within the parks are adequately characterized by existing tidal gauges. This is required to ensure a network-wide coverage of NWLON station data that will be "tied to" RSET data to monitor trends in relative sea level.

Coastal Monitoring Standards Development. Although purposes for monitoring coastal resources vary among agencies, DOI agencies and NOAA have agreed to develop minimum data standards (MDS). These will be developed primarily in partnership with the NERRS, COOPS, NGS, USGS, and NPS SECN and NCBN networks but will be shared with other NPS regional networks and USFWS as they are developed. These standards (MDS) will be delineated in a common set of peer reviewed technical reports (grey literature) within both NOAA and NPS.

Bird Monitoring Methods Comparison ($31,800). With the planned change in methods from Variable Circular Plot to Automated Recording Device based methods, the SECN will fund a one-year, three-park study to compare sampling methods in FY2011. Bird communities will be sampled using both methods at 30 spatially-balanced randomly selected sites at KEMO, HOBE, and CHAT, and data will be analyzed for comparability, and ability to adequately characterize the avifauna.

Human Ecosystems Inventory. Because much of the interpretation of climate change data and its incorporation into long-term management plans will be tied to the human component of the ecosystem, network parks (and partners) will need a consistent geospatial definition and representation of the human ecosystems within the South Atlantic LCC and around SECN parks.

Socioeconomic and Cultural Inventory. Protocol development/inventory of cultural and socioeconomic measures of human ecosystem condition.

Data Management

The SECN has developed a unified server-based data management system to house, manage, and report all of its monitoring data (Wright et al. 2008). The system is based on a conceptual object model designed to serve as a framework for deploying linked database modules to handle both Vital Signs monitoring and program management data. The Network has identified seven modules that will need to be deployed or updated to support the climate change monitoring mission. Costs provided are based on prior network expenditures, but several (or all) modules might be completed by Network or partner staff.

Bird Monitoring ($7,500). The existing data management module will need to be revised to accommodate ARD- rather than VCP-based data. The existing VCP-based monitoring module will be retained should additional future data be collected using those methods, and the existing amphibian ARD module will be adapted for use with bird data. Costs of this component include updating the forest breeding bird object model and database design to include ARD methodology and adapting the amphibian ARD report for bird monitoring.

Derivative Climate Measures ($5,000). The additional derivative climate measures mentioned in Chapter 4 will be added to the data acquisition and manipulation functions already in place. Adding derivative climate measures to the current SECN decision support system will require the generation of at least one additional data analysis report. The cost listed here is for the addition of a single data analysis report. Costs will be higher if additional reports are required ($5,000 per report) or if additional data are required to generate the derived climate measures (due to the required enhancement of the object model and database prior to generating the report). *This is a priority infrastructure need of the network and will be funded out of base SECN dollars during the first three years of strategy implementation.*

Tidal Data ($50,000). Data acquisition and processing modules will be developed to query NOAA/NWLON datasets for tidal gage stations near coastal network parks. Adding tidal data to the data management system will require the development of a tidal data component in the current SECN conceptual object model and database design, as well as enhancements to the data import tool to successfully harvest data from external sources for use in the SECN data management system. Finally, one or more data summary reports will be created for the output and/or presentation of this dataset. The cost estimate above includes the creation of two data output reports.

Phenology ($7,500). Phenology data for amphibian, bird, and plant protocols will need to be incorporated into those protocols; a module for producing phenology reports will be deployed that unifies phenological data across Vital Signs. The addition of phenology data to multiple protocols will require updates to the current SECN conceptual object model and database design; InfoPath data entry forms will need to be updated and one or more data analysis output reports generated. The cost listed above includes the generation of one output report. Additional reports would add approximately $5,000 to the cost, per report.

RSETs and Fixed Station Water Quality ($5,000). Following the development of data standards for the RSET and fixed water quality station monitoring protocols, the modules for both protocols will need to be updated to accommodate additional data fields (or changes to existing ones). The addition of data fields to these two protocols will require updates to the current SECN conceptual object model and database design; InfoPath data entry forms and data analysis output reports will need to be updated as well. Upon modification, each component will require testing to ensure everything is working properly. If additional data analysis output reports are required, the cost estimate above will rise by approximately $5,000 per report.

Refuge I&M Program Integration. Existing site information tables will be updated to accommodate USFWS refuge units in addition to park units and the SECN system will be evaluated to ensure cross-agency security measures are in place that allow for NPS and USFWS entry and retrieval of monitoring data. Incorporating the refuge I&M program will have no costs associated with it unless USFWS are not using the same protocol as the SECN I&M Program. If additional parameters are required to be added to the SECN decision support system, the cost would be approximately $5,000 to update the conceptual object model, database design, and InfoPath forms. Additional reports would cost approximately $5,000 each.

THREDD Server Installation. With the assistance of USGS, web services will be installed on the SECN data server to allow USGS and LCC partners to incorporate SECN data in climate change forecasting models. Data will either be housed by USGS or the Georgia Coastal Ecosystems LTER. THREDD server installation will have no cost associated with it unless additional software purchases are required.

Predictive Models

The USGS has expressed interest in working with the SECN to develop or refine climate change forecasting models for use in the South Atlantic (including in and around SECN parks). These models will be completed at no cost to the SECN.

Amphibian Occupancy Forecasting. Existing SECN amphibian occurrence and co-located habitat data will be used to adapt existing bird occupancy forecasting models to amphibian taxa.

Coastal Inundation Risk and Wetland Loss Forecasting. SERAP will adapt its coastal inundation and erosion vulnerability, and coastal wetland loss forecasting models. The models will utilize park-specific data sets for coastal slope, groundwater level, mean wave height, relative sea level rise, wetland accretion, and tidal range data to develop localized forecasts of erosion and inundation risk as well as the probability of conversion from wetlands to open water.

Resource Vulnerability Assessments. Vulnerability or risk assessments are likely to be an LCC-wide need, but have not been discussed as part of the LCC planning process to date. We propose funding a pilot/proof-of-concept project in FY2012 that builds upon a resource stewardship strategy, and potentially expands into a permanent role at either the Network, LCC, or CSC level in the future. Project not to be funded out of SECN Vital Signs or Climate Change base funds.

6. Administration and Staffing

If fully implemented, the expanded roles of the SECN under the climate science strategy will require adjustments and additions to current staffing and partnership structure to ensure the Network's ability to meet new program goals without impacting its ability to carry out the goals of the original Vital Signs monitoring program as defined in DeVivo et al. (2008). This will be done through a combination of changes to the current staffing plan, relocation of existing office locations, and formal engagement of new strategic partners.

Staffing

Several changes to the existing organizational chart and position descriptions (see Appendix E) will be required to carry out the expanded climate monitoring mission. The network will require an additional four FTEs to fully implement the plan: three technicians to collect salt marsh elevation, groundwater/surface water, and phenological data, and a second data manager responsible for the majority of the data-integration tasks outlined above (Figure 23).

Modified Positions

Integrated Science Program Manager. The network coordinator role will expand to have significant interagency coordination responsibilities to ensure that climate science, monitoring data, methods, and data management strategies are coordinated across the South Atlantic LCC project area, while ensuring that goals and objectives of the core Vital Signs Monitoring Plan continue to be met.

Serves as lead for climate change science and landscape conservation planning for parks within the network. Advises South Atlantic LCC Primary responsibility for ensuring that climate monitoring science is incorporated into forecasting models being developed by LCC partners and used by adaptation and conservation planning personnel to enhance science-based management of park natural and cultural resources in response to climate change and other landscape-scale factors. Facilitates the standardization of monitoring methods and data management among partners within and cooperating with the SALCC so that data can be rapidly found, merged, explored, and analyzed for the purposes of adaptation planning and conservation design. Collaborates with the SALCC, SARMN, and other partners to adapt Vital Signs Monitoring protocols to evaluate effectiveness of conservation actions taken to mitigate forecasted risks. Serves as an integral part of the planning and operations of the SALCC and other partners to ensure seamless coordination among DOI Climate Science programs. Retains supervisory controls over core science staff, management of network budget, and is responsible for network annual work plan and administrative reports.

Network Monitoring Coordinators. At the GS-12 level, incumbents will continue to perform the full suite of Vital Signs monitoring responsibilities within their current scope of scientific expertise (either terrestrial, coastal, aquatic, or data management). At the full performance level, incumbent will perform supervisory functions (>25%) and some program management duties. Supervisory duties will be limited to data management, field monitoring, and student intern staff. At full performance, the person will oversee the production and completion of Vital Signs data summaries. Prepares annual summaries and budget forecasts for Vital Signs monitoring operations for inclusion of annual work plans and administrative reports. Serves as primary agreements/contracting representative on all agreements related to Vital Signs monitoring and as

an alternate ATR/COTR on other network agreements. *NOTE – Only one position be promoted and will serve at the full performance level at any given time.*

Other Changes. The current positions for water quality biologist (coastal), botanist, and wildlife biologist, all currently filled as term positions will be converted to permanent positions when next advertised.

New Positions

Coastal Climate Change Biologist. Primarily responsible for overseeing field operations for the installation, maintenance, and data collection at salt marsh elevation monitoring stations, and assisting with field efforts related to shoreline position monitoring, groundwater, and coastal water quality monitoring. Also responsible for maintenance of the coastal shoreline monitoring equipment. *This is a priority staffing need of the network and will be funded during the first year of strategy implementation.*

Climate Hydrological Technician. Primarily responsible for overseeing and conducting field operations for the stream habitat and groundwater monitoring protocols, including station/well installation, maintenance, and data collection. Position will also have primary maintenance responsibilities for maintenance of vehicle and boat fleet housed in the Athens I&M Headquarters office.

Climate Change Biologist. Responsible for implementation of bird, plant, and Anuran phenological monitoring in conjunction with existing terrestrial monitoring protocols, and serving as network volunteer coordinator to engage citizen scientists to assist with monitoring measures related to climate change.

Climate Change Data Integration Specialist. Responsible for developing software applications that facilitate data sharing and integration among partner programs, including, but not limited to, the South Atlantic LCC, FWS Refuges I&M program, DOI Southeastern Climate Science Center, USGS Southeastern Regional Assessment Program, NOAA, USFS, EPA, and the Georgia Coastal Ecosystems Long Term Ecological Research program. *This is a priority staffing need of the network and will be funded during the first year of strategy implementation.*

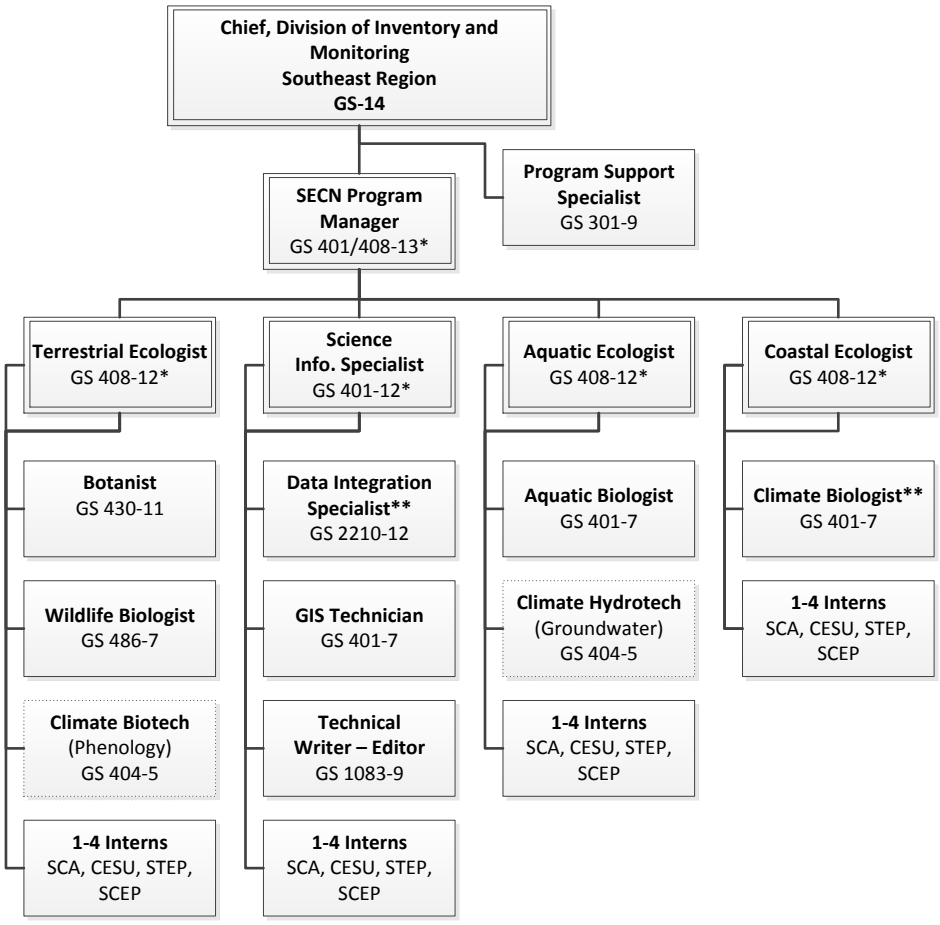


Figure 23. Proposed organization chart for the SECN Vital Signs / Climate Change Monitoring Program. Positions denoted with dotted lines will not be funded without additional funding. [* - Grade levels shown are based on current status without consideration of changes due to proposed additional climate change responsibilities; ** - New positions to be added to the Network in order to implement the SECN Climate Science Strategy].

Office Locations

During the next three years, the network will consolidate its current three program office locations to two locations. The office currently operated at Cumberland Island, in Saint Marys, GA, will continue to serve as the primary office from which plant, bird, and amphibian monitoring occurs.

Program management, data management, climate change, and water resources monitoring will be conducted out of the new joint NPS/FWS Inventory and Monitoring offices at the University of Georgia in Athens, GA. Athens was chosen as a new office location because of available space to house an interagency Inventory and Monitoring program, our ability to co-locate with the South Atlantic CESU coordinator position (which will also serve both LCC and NPS Regional Climate Science roles), proximity to partners from other academic, state, and federal programs working on climate change issues, and access to University resources that will enhance the Network's ability to conduct a science program (library, research faculty, student interns, etc.).

The SECN and FWS will hire or relocate up to 10 people to the Athens facility during FY2010 and FY2011, with additional staff moving upon completion of permanent facilities (scheduled late FY2011 early FY2012).

Partners

In addition to the myriad partners with which the SECN currently operates in the implementation of its core Vital Signs monitoring program, several agencies or organizations within the region will be critical to the successful implementation of the SECN's climate science strategy (Table 15). The network expects this partnership list to expand as its climate strategy is implemented, partners from other state, federal, and NGO agencies are engaged, and also as the science program of the SALCC is designed and implemented.

Additionally, the SECN is one of several core DOI programs that will operate within the South Atlantic LCC to implement the Department's "approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages" (Figure 24).

South Atlantic Landscape Conservation Cooperative. The South Atlantic LCC is one of 22 cooperatives established in FY2010 to address the unprecedented conservation challenges resulting from climate change. The cooperative has a specific goal to work in partnership with other federal, state, tribal and local governments, and private landowner partners to develop landscape-level strategies for understanding and responding to climate change impacts. Specifically, LCCs are charged with defining objectives, developing spatially-explicit strategies, and providing scientific and technical decision support to inform natural and cultural resource management across terrestrial, aquatic, coastal and marine ecosystems. The SECN has participated as a steering committee member since its inception, and will continue to work closely with the LCC staff to ensure a smooth connection between monitoring efforts of the network (and partners) and the decision support tools to be developed by the LCC.

South Atlantic Refuges Inventory & Monitoring Program. In 2010, the National Wildlife Refuge System began implementation of its Inventory and Monitoring Program. Like the NPS I&M program, that of the refuge system is intended to monitor select indicators in the status and trends of ecosystem condition in an effort to improve science-based management of resources. The refuge network within the South Atlantic LCC was the first network in the region funded. In an effort to better understand the effects of climate change on DOI-managed resources and to improve our ability to support the SA-LCC, the I&M programs of NPS and FWS have opted to co-locate program offices and coordinate data collection and management activities to the greatest extent feasible. Program management and data management staff will be located in Athens, GA, to facilitate development of cross-agency monitoring and data analysis techniques that can be shared with partners within the South Atlantic and adjoining LCCs.

U.S. Geological Survey Climate Science Center / Southeast Regional Assessment Program. The Southeast Regional Climate Science Center was established by USGS in FY2010 to provide climate-change-impact data and analyses to support management of climate-change-related impacts on all Departmental resources. As a precursor to its establishment, the USGS initiated the Southeast Regional Assessment Project to pilot some of the modeling and data management

tools that might support the broader DOI and LCC communities. The SECN will work with USGS to adapt models relevant to park planning and operations, as well as coordinate data integration between the monitoring and modeling efforts conducted by both agencies.

NOAA Office of Ocean and Coastal Resource Management. Beginning in 2010, SECN and NOAA committed to coordinating monitoring efforts within shared coastal ecosystems. Specifically the two agencies (as well as other partners in FWS, USGS, and NPS) agreed to develop consistent data collection and management standards for salt marsh elevation and plant community, tidal, and water quality data. SECN and NOAA are currently working on a series of joint protocols, technical guidance documents codifying the standards, and in FY2011 will develop an interagency agreement to implement those jointly-developed standards. Furthermore, the data management staff from the SECN and NOAA will be developing tools to synthesize data across agencies.

Georgia Coastal Research Council / Georgia Coastal Ecosystems LTER. Since 2007, the SECN has been collaborating with the University of Georgia (UGA) and the Georgia Coastal Research Council (GCRC) in the development of tools to facilitate coordinated water resource monitoring and management across agencies in the South Atlantic coastal area. A cornerstone of this collaboration has been the development of a metadatabase-level catalog of water resource monitoring and research sites that includes information such as lead agency, site locations, analytes measured, and period of record. By the completion of the initial phase of the project, the database included 41 programs, with metadata on 16,182 stations at which 1,093 distinct parameters are measured (i.e., 286,042 total station parameter records) (Sheldon et al. 2009). The database can be accessed at (http://www.gcrc.uga.edu/wqmeta/). Recognizing that water quality and quantity are both likely to be significantly impacted by climate change throughout the SECN, this project was expanded in 2010 to cover the geographic scope of the entire South Atlantic Landscape Conservation Cooperative. As part of this new project we have already added over 20,000 coastal monitoring locations by automatic harvesting of metadata from USGS and USEPA, and so will approximately double the number of location and measurement parameter entries. Additionally the GCRC will serve as a key partner to engage other cooperators within the South Atlantic Governor's Alliance, the Long Term Ecological Research Station network, and the coastal research community.

University of Georgia / South Atlantic Cooperative Ecosystems Study Unit. In partnership with the University of Georgia and the South Atlantic Cooperative Ecosystems Study Unit, the SECN and UGA established the Southeast Coast Network Climate Science Support Center (SECN-CSSC) in 2010. The purpose of the SECN-CSSC is to facilitate student and research associate support, and assist the SECN developing and implementing both terrestrial and marine inventory and ecological monitoring projects for the 17 SECN parks. These activities will provide technical and strategic support to the SECN from the project development phase to the implementation and operational stages of the Network's program, particularly as the NPS program expands its scope to include climate science.

As part of this partnership, University staff and students will closely collaborate on many inventory and monitoring projects. To date the SECN has partnered with six departments at UGA to implement various portions of its inventory and monitoring program. Establishment of

the SECN-CSSC at the University of Georgia will leverage, expand, and institutionalize nearly 10 years of collaboration among NPS, UGA, state, and federal partners.

Table 15. Working partnerships in which the Southeast Coast Network will engage to carry out its climate change monitoring program.

Agency/Program	Purpose/Role
South Atlantic Landscape Conservation Cooperative	Coordination of monitoring methods between I&M program (NPS/FWS) and LCC members and partners.
South Atlantic Refuges I&M Program	Technical support of each others' programs. Space sharing agreement for Athens office to cover FWS costs (agreement for space is currently between NPS and UGA). Coordination on emergency response efforts related to natural resource monitoring. Agreement to develop/implement consistent monitoring methods where scientifically appropriate and to develop unified data management system to house long-term monitoring data.
NOAA Office of Ocean and Coastal Resource Management NOS/OOCRM Program	Implementation of minimum data standards developed in partnership between NPS and NOAA.
Georgia Coastal Ecosystems LTER / Georgia Coastal Research Council	Management of metadata-level data sets related to water quality and other data sets, coordination on salt marsh elevation monitoring, and coordination of research needs among the South Atlantic Governor's Alliance and the NOAA SeaGrant South Atlantic Research Priorities project.
US Geological Survey	Expand or adapt models developed by SERAP, or additional models developed by Southeast Climate Science Center to provide park-specific forecasts of stressors and resultant changes suitable for use in adaptation planning.

Additionally, the SECN is one of several core DOI programs that will operate within the South Atlantic LCC to implement the Department's "approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages" (Figure 24).

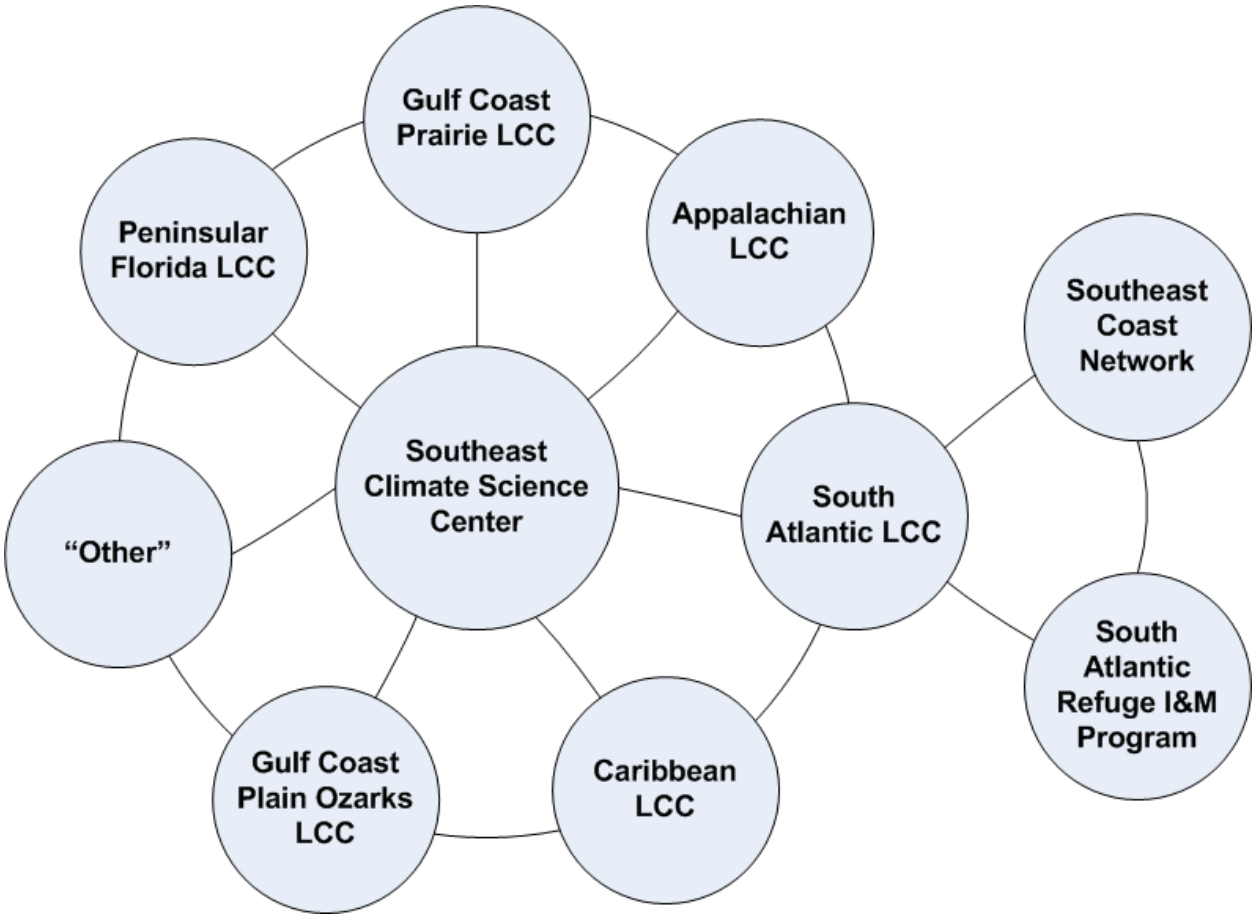


Figure 24. Relationship among funded and planned positions from DOI bureaus contributing to climate change science and monitoring within the Southeast.

7. Budget and Implementation Schedule

In this chapter, we present the budget of the SECN Climate Science Strategy during the first year of operation beginning in FY2011. To fully implement the Network's Strategy, the SECN would require an increase in base funding of $370,367 (Table 16).

The NPS Inventory & Monitoring Program has committed a base increase of $200,000 to the SECN to meet critical monitoring needs of the Network in support of this strategy. These funds will be used to enhance the Network's salt marsh elevation and tidal monitoring station networks, hire a permanent data manager to integrate data among agencies, coordinate climate response activities, and begin deployment of continuous groundwater monitoring equipment on existing wells. These specific efforts were selected because of their relevance to coastal ecosystems within the Network, their direct relevance to likely climate impacts, and the need for resultant data for adaptation planning efforts.

The remaining $170,367 will be supported through other sources (external funding or partnerships). We have estimated a recurring cost of $60,000 to cover the costs of maintenance of tidal gauging stations at CANA and CALO, which is the minimum number of stations that will ultimately need to be deployed. We are currently in discussions with NOAA to ensure that long-term tidal gage station maintenance costs are paid by NOAA rather than NPS as a cost-saving measure. Additionally, roughly $110,000 is allocated to costs associated with personnel and travel to implement phenological and groundwater monitoring efforts. These positions will be filled as term/temporary hires as funding becomes available. The SECN has already secured funding for one position to be filled in FY2011 through the Youth-In-Parks program.

The network has also identified an additional $425,000 in one-time expenses to deploy additional RSET stations, tidal gauging stations, and monitoring database enhancements above and beyond recurring base needs (Table 17). The Network will fund these efforts through "directed studies" funds, by leveraging base monitoring appropriations, or through partners identified in Chapter 6. In total we have identified roughly $900,000 in one-time expenses and critical project needs that the Network will seek to implement during the next five years.

Assuming an annual 2% programmatic COLA increase and a 5% inflation rate of salary costs to account for COLA and within-grade increases, fixed salary costs would rise from 57% to 66% of the total budget by 2016 (Table 18).

Table 16. Projected base costs for the SECN climate monitoring program. [VSMP – Vital Signs Monitoring Program; CCMP – Climate Change Monitoring Program; WQM – Water Quality Monitoring].

Category	Total Cost	VSMP	WQM	ECM	Other
Personnel					
Network Program Manager	119,595	109,595		10,000	
Coastal Ecologist	113,185	98,185		15,000	
Aquatic Ecologist	106,152	2,563	103,589		
Wildlife Ecologist	99,123	99,123			
Science Information Specialist	111,351	101,351		10,000	
Botanist	77,774	77,774			
Wildlife Biologist	54,420	54,420			
Aquatic Biologist	55,502	55,502			
GIS Intern	31,273	31,273			
Coastal Biologist	46,763			46,763	
Hydrologist	46,763				46,763
Climate Biologist	46,763				46,763
Data Integration Specialist	111,522	79,207		32,315	
Program Support Specialist	18,554	18,554			
Cooperative Agreements					
Technical Writer - Editor	35,000	35,000			
Rent Costs	23,000	11,000		12,000	
Tidal Gage Station Maintenance	60,000				60,000
Intern Support	120,995	120,995			
Climate Science Support	62,000	62,000			
Contracts					
Data Management	145,000	145,000			
Lab Analyses	25,000	25,000			
Vital Signs Monitoring					
Coastal Water Quality	5,000	5,000			
Salt Marsh Elevation	45,000	5,000		40,000	
Coastal Shoreline	5,000	5,000			
Plant and Wildlife Communities	8,000	8,000			
Data Sonde Maintenance	14,931	4,500	10,431		
Groundwater	25,000	15,000		10,000	
Stream Habitat	5,000	5,000			
Operations / Equipment					
Office Operations	12,000	12,000			
Computers	9,500	8,500			1,000
Vehicles	25,000	25,000			
Utilities	10,500	10,500			
Regional Assessments	35,693	26,151	2,280	3,922	3,341
Travel					
General Monitoring Travel	64,507	54,507		10,000	
Salt Marsh Elevation	10,000			10,000	
Phenology	7,500				7,500
Groundwater Monitoring	5,000				5,000
Network Meetings	15,000	15,000			
Fleet Costs	8,000	8,000			
Total Base Costs	**1,820,366**	**1,333,700**	**116,300**	**200,000**	**170,367**

Table 17. Projected one-time costs for the SECN climate monitoring program and potential primary partners for project implementation.

Category	Total Estimated Cost	Partners	Notes
Capital Investments			
CANA Tidal Gage	80,000	NOAA	Gap analysis completed that identified holes in SECN's coverage of tidal gages
CALO Tidal Gage	80,000	NOAA	
RSET Installation	120,000	NPS	
Groundwater Station Equipment	30,000	NPS	
Protocol Enhancement			
Tidal Gage Suitability Study	50,000	NOAA	
Minimum Standards Development	45,000	NOAA	
Bird Monitoring Methods Comparison	31,800		
Human Ecosystems Inventory	50,000	CESU	
Socioeconomic and CR Inventory	50,000	CESU	
Data Management			
Bird Monitoring Module	7,500	NPS	
Derivative Climate Measures	5,000	NPS	
Groundwater	65,000	NPS	
Phenology	7,500	NPS	
RSETs and Fixed Station WQ	5,000	NPS	
Tidal Station Data	50,000	NPS	
Refuge Integration	20,000	FWS	NPS and FWS I&M programs co-located to ensure seamless cross-agency data integration
THREDD Server Installation	5,000	USGS	Costs for travel for USGS personnel to work with NPS data managers
Modeling			
Amphibian occupancy forecasting	50,000	USGS	Potential expansion of SERAP models
Coastal Inundation Risk Modeling	50,000	USGS	
Resource Vulnerability Assessments	50,000	CESU	
Coastal Wetland Loss Forecasting	50,000	USGS	
Total Project Costs	901,800		

Table 18. Projected salary costs for the Southeast Coast Network through FY2016 assuming a 5% inflation rate (to account for within grade and COLA increases) and a 2% increase in programmatic COLAs. Total income for the SECN only includes permanent base funding. [VSMP – Vital Signs Monitoring Program; CCMP – Climate Change Monitoring Program; WQM – Water Quality Monitoring].

	FY 2011								
Positions	**VSMP**	**WQM**	**ECM**	**Total**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**
Network Program Manager	9,595		10,000	119,595	125,575	131,853	138,446	145,368	152,637
Coastal Ecologist	98,185		15,000	113,185	118,844	124,786	131,026	137,577	144,456
Aquatic Ecologist	2,563	103,589		106,152	111,460	117,033	122,884	129,028	135,480
Wildlife Ecologist	99,123			99,123	104,079	109,283	114,747	120,485	126,509
Science Information Specialist	101,351		10,000	111,351	116,919	122,764	128,903	135,348	142,115
Botanist	77,774			77,774	81,663	85,746	90,033	94,535	99,262
Wildlife Biologist	54,420			54,420	57,141	59,998	62,998	66,148	69,455
Aquatic Biologist	55,502			55,502	58,277	61,191	64,251	67,463	70,836
GIS Intern	31,273			31,273	32,837	34,478	36,202	38,013	39,913
Coastal Biologist			46,763	46,763	49,101	51,556	54,134	56,841	59,683
Data Integration Specialist	79,207		32,315	111,522	117,098	122,953	129,101	135,556	142,333
Program Support Specialist	18,554			18,554	19,482	20,456	21,479	22,553	23,680
Total Salary Cost	**727,547**	**103,589**	**114,078**	**945,214**	**992,475**	**1,042,098**	**1,094,203**	**1,148,914**	**1,206,359**
Total Base Funding	**1,333,700**	**116,300**	**200,000**	**1,650,000**	**1,683,000**	**1,716,660**	**1,750,993**	**1,786,013**	**1,821,733**
Fixed Salary Cost Percent	**55%**	**89%**	**57%**	**57%**	**59%**	**61%**	**62%**	**64%**	**66%**

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Appendix A. Scoping Meeting Notes

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Georgia Coastal LTER Meeting, Athens, GA, 8 October 2009

Met with Merryl Alber, who leads the Georgia Coastal Ecosystem LTER, located between FOPU and FOFR on the Atlantic coast.

Notes of interest:

- Four coastal LTERs bounding the our target area:
    - Plum Island Ecosystem LTER (Boston area)
    - Virginia Coast Reserve LTER (Between ASIS and CAHA)
    - Georgia Coastal LTER
    - Florida Coastal Everglades LTER (Well south of the study area)
- NSF has asked UGA/Merryl to submit a proposal for an additional $1.6 million per year to coordinate climate change related efforts among the four LTERs. Due in the next couple of weeks and the funding should be coming fast (I assume it's part of the ARRA funds for climate-related research). She has added NPS as one of the federal partners on the proposal.
- Florida Coastal Everglades and Plum Island Ecosystem are both installing flux towers to match those already installed at Virginia Coast and Georgia Coastal Reserve. Part of the AmeriFlux network (http://public.ornl.gov/ameriflux/) which does continuous monitoring of CO_2, water, and energy exchange between terrestrial systems and the atmosphere. Not that we'd be looking to install these at our sites, but we shouldn't have to now.
- In gearing up for this, she's developed a presentation on coastal trends based on the LTER data from all four sites. She's sending me a copy and I will post on the sharepoint once I have it, but there's some good tidbits in there:
    - Based on the data there appears to be a big difference between the middle Atlantic systems and what is seen in Pacific or south Florida systems. Mostly that sea level rise, inundation, and storm frequency and intensity are bigger drivers than water chemistry and acidification.
    - Based on that they're planning on adding in a component of socioeconomic impact analyses as a part of their work. Big storms and higher water in a largely developed/ actively developing portion of the country will have non-ecological impacts. This will be good for NPS to tap into from a scenario planning standpint in the long term.
    - Steve had said he wanted some "bullets" of what we know now, and we will have some answers to that in short order.
- Strong interest in expanding the water quality metadata project up the coast to the NCBN this FY and should be doable pretty easily (http://www.gcrc.uga.edu/wqmeta/).

- Strong interest in using that as a model for coordinating RSET/ SET work and data, though they would want to do something that combines data rather than metadata.

- Agreed to help facilitate a workshop on campus with climate folks similar to the workshop proposed by Charlie Roman. My thought was to give a presentation on the NPS's efforts and brainstorm what we could be doing/ adding to better address climate issues. I think between that workshop and one up in RI, combined with Sara and I ironing out where our best areas of overlap are we should have our "inside game" up to speed enough to begin solid partnership development.

- Suggested contacting Marie Bundy who is now the NOAA NERR coordinator (not sure of the exact title) as a meeting participant.

NOAA-NPS-USFWS-USGS Salt Marsh Monitoring Meeting,
NOAA, Silver Spring, MD,
4-5 February 2010

Executive Summary

Representatives from the NOAA Offices of Ocean and Coastal and Resource Management (OCRM), National Geodetic Survey (NGS), and Center for Operational Oceanographic Products and Services (COOPS) met with representatives from three Department of the Interior Agencies including the National Park Service (NPS), U.S. Fish and Wildlife Survey (USFWS), and U.S. Geological Survey (USGS), to discuss the development of common approaches and standards for monitoring salt marsh condition, extent, and transgression in the face of climate change. A specific focus was given to protocol implementation along the Atlantic Coast through both the NPS Southeast Coasts and Northeast Coasts and Barriers Network's Inventory and Monitoring Programs (IMP) and the National Estuarine Research Reserve System Wide Monitoring Program (NERR SWMP). Meeting Goals were agreed to include:

1) An understanding of the data standards and monitoring approaches currently used by both agencies for Salt Marsh Monitoring;
2) Identification of which standards and approaches should be shared between the agencies;
3) Where necessary, identify a process for joint protocol development that incorporates input from all parties.

Day 1 discussion consisted of overviews of the NPS IMP, NERR SWMP, USFWS National Wetlands Inventory, as well as specific review of the respective protocols for transect based salt marsh monitoring. These reviews were followed by general discussion of the similarities and differences in approaches. It was noted that the NPS protocols are primarily designed to lend themselves to quantitative assessment of marsh condition and habitat extent through the use of a stratified random sampling approach while the NERRS protocols focus more on developing a mechanistic understanding of marsh function across elevation gradients through the use of a systematic sampling approach. In addition the NPS protocols were generally limited to the low marsh (especially in the SE) while the NERRS transects cross from water line to upland. These differences are linked to limitations imposed by the range of conservation mandates faced by the respective programs on the types of allowable activities. The USFWS protocols were not being implemented system wide and included an upland component that was lacking in the other programs.

Day 2 discussion focused on discussions of data management approaches and mapping efforts. Staff from the NPS SEC group explained the implementation of their monitoring database and how it may be made useful to the NERRS as they begin to implement their biological monitoring program. NERRS staff also provided an overview of their Land Use and Habitat Change mapping program.

Recommendations and Major Action Items

General

- NERRS and NPS necessarily take different approaches to standardized salt marsh sampling design given the different types of questions being asked by the respective systems – i.e. quantitative assessment for NPS and mechanistic understanding for NERRS
- Differences in sampling design should not preclude development of a common set of **Minimum Data Standards** (MDS) for a range of common sampling protocols
- Standards will be developed primarily in partnership with the NERRS, COOPS, NGS, USGS, and NPS SECN and NCBN networks but will be shared with other NPS regional networks and USFWS as they are developed.
- These standards (MDS) will be delineated in a common set of peer reviewed technical reports (grey literature) within both NOAA and NPS.
- This technical series should be identified as the core set of salt marsh monitoring minimum data standards for our programs and agencies though an addendum to either the current seamless network DOI-NOAA MOU or, more appropriately, the still in development DOI-NOAA Climate Change MOU. This addendum should be developed after the completion of at least some of the reports but does not need to wait for completion of the entire series
- The monitoring areas in which we agreed to work on minimum data standards are:
    1) Surface Elevation Tables –
        - NGS already has an established protocol for use of RSETs and it would not take a great deal of work to establish this as the first of the technical series
        - Any protocol should consider the use of historical data from SETs that have not been installed to this standard
    2) Vertical Control –
        - The NGS products and services committee has already approved the principles of a common approach to establishing a local vertical control network in marsh environments but it is only in presentation form and needs to be converted to a technical protocol
        - These general principles will need to be supplemented by the more detailed approaches being developed by NGS and the Chesapeake Bay VA NERR
    3) Fixed Station Water Quality Monitoring –
        - The NPS SECN already uses NERRS protocols and approaches but some work will be need to identify what of the NERRS SOPs is generic enough to be formalized in a technical paper applicable to both agencies
    4) Tidal Datums –
        - COOPS protocols and standards will be adopted
        - COOPS will work with Park networks and individual Refuges to determine whether their boundaries fall within an NWLON gap and asses the availability of historical tidal information and benchmarks.
        - Should this be wrapped into the Vertical Control paper?
    5) Soils, Pore Water Chemistry, and Hydrology –

- This topic was cut from the workshop and needs to be discussed further via WebEx

6) Emergent Vegetation Monitoring –
   - This will focus on the types of data being collected within program specific sampling designs, not the designs themselves
7) SAV – NCBN currently monitors SAV through a probability-based spatial sampling strategy, using a transect based approach.
8) Habitat Mapping
9) Nekton
   - NPS NCBN has extensive Nekton monitoring protocols
10) Data Management and Database Development
   - The NERRS does not yet have a salt marsh monitoring database and it was agreed that the NPS SECN presented a good model to follow
   - It was agreed that the best model for data management would be a multi-agency shared database that allowed single point of entry for data collected from multiple programs. However, numerous obstacles present themselves including:
     - Surmounting inter-agency interoperability and security concerns
     - Public access – NPS uses a more limited form of data release than NERRS through its DataStore.
     - Maintenance costs and infrastructure and human resources – who would provide?
   - It was therefore agreed that at the minimum the NERRS would use the NPS model as a basis for their own database and that as the two databases developed they would share data, metadata, and data types through web services so that all the data would be available to users of both networks

Next Steps

- Hold WebEx(s) for further discussion of:
  - Soil and ground water sampling approaches
- Have NPS representative attend NERRS Research Coordinator meeting in Woods Hole, MA to discuss database approaches.
- Hold meeting on shared database development between NERRS CDMO and NPS SECN staff in mid-March (11th-12th?)
  - Meeting to be held in Georgetown, SC (at CDMO collocated with NIWB Reserve)
  - Attended by:
    - NERRS: Dwayne Porter, Tammy Small, Brooks Folk, Erik Smith, Whit Saumweber
    - NPS SECN: Tony Curtis, Joe Devivo, Christina Wright
- Identify reference documents for Salt Marsh Monitoring MDS Technical Series
- Development position statement for Technical Series coordinator/developer (to be shared among agencies)

Detailed Notes
Day 1

Introduction - Tony Curtis

- Purpose – to develop standards to monitor salt marshes in the SE.
- Goals: listed on agenda:

  - To understand data standards and monitoring approaches currently used by both agencies for
    Salt marsh monitoring
  - Identify the standards and approaches that should be shared between the agencies
  - Identify the process for joint protocol development

- This meeting grew out of conversations at the CERF meeting in Portland – we decided to explore how to monitor salt marshes in SE NPS network consistent with SWMP program in NERRS. We decided to meet in Jan-Feb, 2010 to discuss data standards. Galen Scott offered to introduce us to the NGS" toys". Interest grew in having this meeting.
- Those in attendance at this meeting represent the NPS – Inventory and Monitoring programs; USGS, Don Cahoon; NOAA NERRS and NGS staff; WASO staff from NPS; and USFWS.

NERRS SWMP and Sentinel Site Initiative –Whit Saumweber

NERRS Mandates

1. 27 NERRS soon to add 28th in Wisconsin
2. Authorized in Coastal Zone Management (CZM) Act – tied into state CZM programs. Makes NERRS unique from other federal programs. Reserves are owned and operated by state employees – NOAA provides funding support.
3. Protected for long-term research and monitoring, education, and resource stewardship. Research is mandated by the CZMA.
4. Goal is to, among other things, increase the use of reserve science and sites to address priority coastal management issues

System Wide Monitoring Program (SWMP)

- One of our system-wide activities.
- Goal of SWMP is to identify and track short term variability and long-term changes in the

integrity of habitats

- Three components to SWMP:
  1. Abiotic Monitoring –
     a. Suite of parameters measured at 4 fixed stations in each reserve. Siting of these sites is related to gradients of both physical variable and

anthropogenic impact. At least one station per reserve is telemetered and thus NERRS is considered a Federal backbone component of the US Integrated Ocean Observing System (IOOS).

2. Biological monitoring –
    a. Toolbox approach used because each reserve has its own unique issues – reserves will choose protocols accordingly. Idea is to develop toolbox of accepted protocols for use across the system.
    b. Emergent and Submersed Aquativ Vegetation monitoring protocols are the only biological monitoring "tools" that will be implemented system wide.
    c. Protocols developed based on NPS protocols. We are just beginning to implement these protocols on an operational, system-wide basis, this year.
    d. Two tiers to bio-monitoring – 1) mapping and 2) transect oriented approach. Tier 1 has been rolled into land use mapping and the protocols are developed as a result of a broader habitat mapping strategy within the NERRS. So when we talk about vegetation monitoring we are talking about the transect oriented approach.

3. Land use and habitat change – NERRS has developed standard protocols for high resolution land use/land cover mapping in the reserves with the intention of having baseline maps for all reserves developed by 2012 from which future habitat change will be measured.

Climate Change – NERRS Sentinel Sites and adaptation capacity building

- Builds on the strength of SWMP. Integrates high accuracy geospatial infrastructure with vegetation monitoring creating a coastal network of sentinel sites to monitor sea level rise.
- Integrated approach – tide stations (NWLON or short term tide stations) linked to NGS CORS Network, the more traditional ground surveys, and accurate elevation maps linked to the monitoring transects. Also includes surveying surface elevation tables (SETs) to the network.
- Tie this infrastructure to integrated ecosystem models (inundation models).
- USWFWS using SLAMM – we want to improve on SLAMM model and include some biotic feedback into these models. NOAA NCCOS funded project in the Gulf of Mexico will begin working on this approach in Gulf Coast NERRS. NERRS wants to improve on the SLAMM model in support of its own management needs. NERRS has active stewardship programs involved in restoration and land acquisition – we want to enhance our decision making related to such things as establishing marsh buffers along coastal communities and enhancing carbon sequestration.
- 5 basic Sentinel Site questions:

1. Where do marshes sit in tidal frame?
2. How is the local tidal range changing?
3. What is happening to marsh surface relative to the water level?
4. Can we detect vegetative response to these factors?
5. How does the sea level change response compare to the response of vegetation to other physical forcing factors?

- Framework concerns
    1) How are reserves classified in terms of their dominant climate related stressor?
    2) How sensitive are habitats to these stressors?
    3) How does our ability to measure these impacts compare to the natural variability in the system?
- Requirements or Best Achievable resolution:
    1) We are challenged to apply surveying protocols that are designed to achieve mm level accuracy in marsh environments. We are working to identify the best achievable resolution for elevation monitoring in collaboration with NGS and CO-OPS. The VA reserve staff are working with NGS and CO-OPS working to develop protocols for surveying.

NERR Salt Marsh Monitoring Methodology- Ken Moore (see presentation)

- 2003 established protocols for the NERRS
- SWMP is intended to explore the cause and effect relationship of what is happening in reserve habitats and linkages between water column and watershed processes. First, we needed to monitor habitats and focused on SAV and emergent.
- We want to assess long-term change and short-term variability.
- We borrowed from ongoing work. Randomized approach or should we do systematic sampling to repeat non-destructively. We wanted to establish backbone of sampling that we could build on by leveraging other funds. Most have done that leveraging.
- We require identifying study area and habitat – sub-set of habitats and a hypothesis needs to be defined. Stratify segments if necessary in equal sections, transects run from upland to marsh randomly within the segment. Across transects, random sampling and then systematic sampling from random points. Total number of samples (intervals) needed to detect differences - min. 20/seg.; within each sample location – perm. Locator marker and offset 1 meter offset; wells, SETs or other permanent sampling at alternative side (180); non-destructive measure of abundance measured in sampling plots.
- initial sampling years at higher frequency than later sampling years to evaluate temporal variability.
- Seagrass protocols modified from Short et. Al. 2002, Seagrass Net

- Protocols – peer reviewed. It's a backbone-type sampling. There have been some modifications.

Discussion:

- **Question: How many reserves are these protocols implemented in?**
  Response: Approximately 20 reserves have implemented protocols on emergent, SAV or both. Intervals of sampling dependent on how big the habitat is that will be sampled. Flexibility is built into protocols. Conceptually we provide funds for half reserves to do this every other year. We had funds to pilot a few years ago and those reserves have found funds to continue on their own. This year we have funding to do this sampling again within a subset of our reserves. Other reserves (Gulf of Mexico) have funds to do vegetation monitoring but using slightly different protocols – it's a challenge to coordinate protocols.

- **Question: What is the temporal frequency of sampling?**
  Response: It depends on the size of the system - Initially for emergent it is yearly, then hopefully more than that - but dependent on funds. For SAV, annual but seasonal is optimal. Need to sample to determine peak biomass and then target that time of year for annual sampling. But dependent on the location of the transect and knowledge of the system to determine what change you are looking for.

  We are just beginning to do this operationally – so we are evaluating the various approaches. Work plans for this year's funding had to be designed to focus on sentinel sites for climate change and integrate with HMC.

- **Question: For sentinel sites, are the sites chosen differently than they were chosen originally?**
  Response: In some cases yes – it's a delicate balancing act – the original vision for SWMP did not include sentinel site approaches. So we are working on integrating the concepts and approaches. All reserves have bought into this conceptually and are opportunistic in how we make this happen.

<u>NPS: Overview of NPS Inventory and Monitoring Program and Goals</u> – Joe Devivo (see presentation)

1. **History of our program**

- decentralized organizational structure
- Little institutional knowledge remains
- Most natural resource efforts focused on natural resource parks
- 1993-formation of NBS greatly reduced our science capacity

Preserving Nature in The National Parks – call for action to address science capacity in NPS – recognition to do better science.

- 1998- Omnibus management Act – directed NPS to inventory and monitor natural resources and shall use science to do resource management.
- 1999- National challenge document – to build science capacity. Huge influx of money to do that. Key component – inventory and monitoring program.
- 1/3 – of program funds for data management. Focusing on integrating science with park management. Emphasis was to support local management, not responding to status and trends across parks. Effected where NPS does inventory and monitoring.
- Because it was a base increase and not soft money – we began to think long-term on how to do status and trends on resources of parks – not just management of the daily impacts;
- We had a mandate to conduct data information management and do it well. This has strengthened our data management capacity and ability to share information with partners and general public.
- 5 goals of Inventory and Monitoring program:
    1. Establishing inventory and monitoring as standard practice and integrated with everything we do (facilities, trail; planning)
    2. Inventory of natural resources to bring all 272 of natural resource parks to basic level of info. - Species present, WATER QUALITY data.
    3. Develop long-term monitoring programs for networks of parks
    4. Integrate natural resource inventory and monitoring information into NPS planning, management, and decision making.
    5. Share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives.

- We have established 272 monitoring programs into 32 networks of park. Boundaries for networks based loosely on geography and ecosystem within each network.
- Today – we are dealing with number of networks along east coast. Northeast Coastal and Barrier network, mid-Atlantic, NE temperate, gulf coast network, etc…
- Inventories covered a lot more than species: Natural resources, base cartographic data, geology maps, soils, meteorological data, air quality, water body location and classification, water quality data, vegetation maps, species lists of vertebrates and vascular plants, species distribution and vascular plants of management concern.

- Each network was charged with developing its monitoring program. Each program was charged with developing a suite of indicators – vital signs to determine the status and trends in the condition of selected park resources.
- Each of network went through 3 phases of planning
    1. Define ecosystem: Identify goals and objectives for monitoring; identify, evaluate, synthesize information, draft conceptual models;

2. Selecting what you were going to monitor: Initial prioritization and selection of vital signs: Update and expand upon Phase I work; and select vital signs.
3. What protocols are you going to implement in full monitoring plan: Detailed design work; protocols, sampling design; design database; write data management plan.

- Current status: All 32 networks are in phase 3- operational
  Inconsistent use of cross network protocols. All programs designed independently, originally no expectation of need to roll up data, each program designed to meet different park-based objectives;
  If we have to roll up nationally, will do it qualitatively. Each network was strongly encouraged not to re-invent methodologies if they were developed in another network.

2. Climate initiative- rethinking what we are doing

Climate Change Initiative is receiving $10m in FY10 and received $3M to IM program. SECN and NCBN received base funding increases to address 2 issues: 1) expand and tweak coastal monitoring network to address issues related to climate change; 2) work within this LCC context – being worked out now about what that means.
-Landscape Conservation Cooperative (LCC) – jointly going to add USGS-USFWS to integrate climate and resource management and partnerships. Still being defined.
- challenges – climate change gives us a set of monitoring objectives that require system-wide roll-up data; LCC initiative has strong national-level control and consistency goals – will be a monitoring component through monitoring in USFWS; in the coastal zone we are almost able to do that, but not quite.

Question: Will there be another look at "rolling up the data?"
Response: We are looking at doing that in the form of a report card. Assumption is that with the climate initiative and the need to think about data on a regional or ecosystem scale we will think about ways to do that with our new protocols. We have freedom to think about this with the mandate and funds to develop a strategy. Doubt that it will be done on a national level – more on a regional or ecosystem level.

Question: When did the climate initiative begin?
Response – since 2008 in DOI, but this just took off in 2010. Just because we did not have funds for it, we were thinking about it. We knew that inundation and SLR were issues that were affecting our coastal habitats. Now we are thinking of rolling information up to establish consistency.
-Within Parks – the biggest role is LCC
-USFWS – will be launching in S. Atlantic first. The N. Atlantic and Gulf, Pacific and Alaska will be responding as well.
Data standards – USFWS starting IM in refuges calls for top down standardization. NPS doesn't push top-down. - New science needs related to climate change are causing us to rethink this. But will be moving in that way because they have a mandate to report on – so will develop broader standards to report on – part of the report card approach. They are working closely with Parks Canada which has a requirement to report nationally and so they are working closely with Parks Canada.

Question: Is there a data clearinghouse for monitoring protocols or a product?
Response: Yes – each network has a data management strategy which is served out of the national office. There is a plan to deliver the data in a report and analysis. Each network has a strategy for doing this dependent on the protocols. At least delivered on an annual basis. Networks – are just groups of parks. This year, we are trying to integrate data analysis and reporting among them within the inventory and monitoring framework and the new climate initiative. Some networks overlap. In addition to the network's data management strategy, there is an NPS data and metadata repository – the NPS Data Store (currently transitioning into a new system dubbed IRMA). In addition to data served by the individual networks, snapshots of data and information products are served through the Data Store.

NERRS Abiotic Monitoring – Eric Smith (see presentation)

- protocols have been around for a while so there is extensive documentation available.
- What we are doing and what we mean:

  - short term variability and long-term change is NERRS mantra. No probabilistic sampling as a system. Some reserves do that on their own. But we have opted for limited fixed stations and invest in temporally intensive data locations.
  - at least 4 stations – flexibility on how they are established (salinity, impacted, or depth gradients) - some chose access as a factor.
  -two components of water quality: physical properties and chemical parameters – We also measure weather parameters at each reserve.
- Physical property standards (DO, salinity, pressure, pH, conductivity, temperature)
  - have to buy YSI- 6600's, sensors– can choose vented or non-vented.
  - deployed in bottom waters (approx. .5 m above bottom). Sampling interval – 15 minutes continuously.
  -chl A fluorescence sensors deployed at most sites, but not a requirement in original protocols.
  -sensors calibrated pre and post deployment. Electronic calibration logs submitted as part of QA/QC

- Chemical Monitoring (Chlorphyll A, dissolved nitrate, nitrite, orthophosphate, and ammonium)

  - Same locations at YSI loggers
  - Monthly discrete sampling at all 4 locations
  - Monthly diel sampling at minimum of 1 location. Can move among YSI's according to established procedures.
  - Monthly discrete sampling – duplicates collected between 3 hrs. before slack low-water and slack low-water. Can take them at surface or at depth, one at top and one at bottom – lots of flexibility in how one does this.
  -2009, decision made that single grabs may be taken if triplicate grab samples are collected at least every other month at one of the long-term monitoring stations. This

station must be randomly chosen. Decision was made largely due to cost savings. There is debate about departing from a consistent monitoring program.

- reserves contract labs which submit analytical SOPs, holding times, MDL's, etc. as part of metadata submission
-NERRS conducts periodic inter-laboratory comparisons of standard nutrient reference samples.

-Intensive documentation of data and procedures. Send to Centralized Data Management Office (CDMO) for data archiving. Lots of rules to follow on how to QA/QC data, when you have to submit data. Within a week of pulling a sonde from a telemetered site, expect to submit data to CDMO to serve up.
-Nutrient data submission and QA/QC – very prescriptive as well.

- We have an organizational structure to monitor and push ourselves. Most reserves are in compliance.

Depth data question: are we going back to correct. Density changes with salinity which changes as a result of tidal characteristics. Are the depths raw or corrected for atmospherically corrected for depth at CDMO?
Response: Right now data is raw but we will be correcting it though raw data will always be available as well.

Curtis: SE Coast Network – Outer Banks to Canaveral (see presentation)

- Salt marsh community monitoring includes
- marsh elevation/accretion, soil pore water, vegetation, fixed station WATER QUALITY, marine water quality, water level monitoring, SAV and benthic habitat (deferred)
- Other associated monitoring includes coastal shoreline change, landscape change detection, weather and climate protocols, coastal watershed condition assessment.
- Assessments are conducted at 9 National Parks in SECN (see slide for details)
- Objectives:
  1. determine rate and accretion and subsidence;
  2. determine status and trends in soil salinity.
- Vegetation monitoring objectives: to determine species composition, cover and height, and marsh extent
- Water quality monitoring objectives: determine trends and diel, monthly and annual variability of basic abiotic monitoring parameters (DO, pH, salinity and temperature) at select sites in park estuaries; and determine trends and monthly and annual variability of total dissolved nitrogen and phosphorus, secchi depth, and Chlorophyll A.
- Marine water quality – determine status, trends and spatial variability of basic physical and chemical parameters in park estuaries.
- Water level monitoring objective: to determine the rate of SL change over time
- Measurements:

1.RSET – measures sediment elevation over time relative to a fixed datum
2. Accretion – measures rate of accretion/erosion using cryogenic techniques
3. Pore water salinity – measures soil salinity – indicator of vegetative productivity and species distribution
4. Vegetation – measures species cover, height and marsh extent
5. Water level
6. Marsh extent – remote sensing measures variability in land cover
7. Coastal shoreline – measures foreshore and bay side shoreline position

- References
  – Cahoon et al, 2002
  - Folse and West, 2004
  - Geoghegan et al, 2009-NGS protocols for elevation
  - Wenner and Geist,- water quality parameter
  - Strobel and Heitmoler, 2001,
  -Roman et al. 2001 – for salt marsh veg –(also using what Ken Moore is working on).
- Deployment requirements –
- sites cannot be seen by visiting public
- cannot affect veg. health
- must be randomly selected to facilitate inference to the entire marsh
- and avoid trampling marsh.
- Sampling design uses probabilistic spatially balanced approach to facilitate - inference to broader marsh – not working in high marsh only lower marsh that is inundated daily by tides. Design was generated by using RRQQRR methods (Theobold et al., 2007). Assumption is that the low marsh will be the first to respond to major drivers of ecosystem change (i.e., relative sea level rise).
- Site selection criteria
  -inundated by tides daily
  -accessible by boat at low tide
  - within 5 nautical miles of boat launching facility
  - vegetated salt marsh
  -out of public view
- Using platforms – 9 meters long from water, permanent, not visible by public, does not damage vegetation
- Monitoring Periodicity
- elevation, accretion, porewater- quarterly
- water level– daily
- veg plots- annually
- veg extent – 3 years
- Fixed station – daily
- marine water – 5 years, 10 years
- weather, climate and tides – daily

- coastal shoreline change – 6 months on foreshore/ 3 years back shore. Foreshore monitoring done with vehicle with GPS, slope, aspect and position – not done with remote sensing.
- Landscape change – 3 years

Question: How do they determine number of plots in a marsh?
Response: Based on logistics. within a Park is divided in ½ hectare potential sampling sites. Through a spatially-balanced sampling design, up to eight sites are selected, each containing RSET stations and platforms (9 meter platforms). Each site has 3 platforms, each with one SET, 1 accretion site, 1 pore water site and 3-5 vegetation plots. Observations are tied into the NSRS. They will be getting elevations routinely along the platform and in each veg. monitoring plots — but they have not employed the veg. monitoring yet. . We are currently working with CO-OPS to determine where to deploy water level stations - combination of temporary and permanent water level stations. Plots – are 1- 2 meter plots.

Question: What are the impacts of platforms?
Response: Studies show that if the width of platform is equal to or less than half the distance above ground, there is little or no impact to vegetation.

Question: What is the density of SETs in park and how they are arrayed?
Response: In larger parks, up to 24 RSET individual stations. In smaller parks, density reduced. A station is a single RSET. A site is 3 stations based on Cahoon. Parameters are vegetation, elevation, accretion, soil porewater per site. Have not decided upon veg. protocols. The platform is spatially balanced – do it once and can infer out as long as the site is based on the power analysis. Keeping it restricted to lower marsh because they infer about the upper marsh.

Question: Platforms have no slats in it. Why?
Response: When installed, no footsteps in marsh – constructed from a boat inward. There are gaps between the two boards.

Question: How do NERRs deal with boardwalks?
Response: We have narrow grading and the marsh can grow up around it. We use PVC and grates to avoid treated lumber and have a policy of not stepping off into the marsh. In upper marsh, no boardwalks are necessary – we don't sink and have minimum lasting impact. Boardwalks are for soupy environment. PVC was too hard, grates too expensive, have gone with treated lumber ultimately.

Comment: Challenge in carrying heavy concrete out to the site.
Comment: Using ceramic tile to measure deposition due to bioturbation of marker layers. Challenged to measure short term deposition, accretion – hard to tease it apart.

NE Coastal Barrier Network- Sarah Stevens (see presentation)
Monitoring Activities:
- Veg
- Nekton
- SET

- Marsh Birds
- Estuarine WATER QUALITY monitoring (Neckles and Cocke of USGS and work with EPA on this protocol) – fixed and probabilistic
- Sea grass condition and distribution
- Coastal shoreline position – protocol using GPS – out for peer review and will be published
- Beach/dune topography-running profile from shore over dunes and use of LIDAR. Should be completed by end of year. – collect LIDAR every other year. Working with USGS – multi-return LIDAR for full park not just along coast
- Forest Health – do it in a number of smaller cultural parks.

Vegetation monitoring objectives:

- Changes in community composition.
- Changes in species abundance
- Changes in non-vegetative parameters (bare ground/open water)
- Presence/emergence of invasive species

Prior to 2007 had fixed monitoring stations. They revised their monitoring protocols in 2007 to enhance randomization and inference to broader marsh.

- increased randomization – original protocols marsh sites not selected randomly so could only
  infer about those particular marshes. Wanted to infer at park level.
- increased statistical robustness by assuring independence between plots
- Increased sampling effort to cover more marsh sites and samples – 9 marshes/50 plots/every 2 years.

Sampling design –

- Divide all marshes in 5-8 ha units using GIS, based on edge of tidal creeks, ditches, etc.. and randomly select 6-9 transects from total population of marshes. Inferences extends to all salt marshes in a park.

-changed way we select plots. Baseline placed along marsh edge. Randomly select one transect and systematically place 9. See slide for further details.

-original protocols: go with both estimates, but decided on just visual estimates. Point intercept was too intensive for the types of marshes.

So veg. monitoring takes place on 9 sites within each park.

Nekton monitoring

– occurs on each of the same sites.

-habitat sampled – salt marsh pools greater than 2 sq. meters; and salt marsh ditches (greater than 15 cm wide) and creeks. Collect data every 2 years. Use enclosure gear, approx. 10-20 stations per marsh, species composition and density, length measured for 15 individuals for each species

-sampling design – transects on each marsh for navigational purposes. – can see pools between transects, GPS pools, classify pool size: small, medium or large pools. Determines how many

stations at each pool. Do that at beginning of every field season. 15-20 pools per site and randomly selected.

Sediments are firmer so don't have the no-walk policy.
Creeks and Ditches – delineate in GIS, randomly select points in GIS for sampling, pick 8-10 random sampling stations.
Ditches – delineated in GIS, divided into 30 m segments and segments randomly chosen – select 8-10 points.

Nekton Monitoring: Throw trap and ditch net method.
Sampling conducted two times during field season. Identified to species and counted, 15 individuals from each species measured. Water quality and veg characteristics measured as well.

NECBN Monitoring Database –
-access database, have been using this since 1997. Don't get elevations at nekton monitoring point.
-data linked to spatial data, user's guide, data dictionaries, etc. available on line.

SETS -
- SETS s installed - are now being co-located with salt marsh veg. and nekton monitoring.
- SETs not chosen randomly except for Assateague. Some sites not co-located with other salt marsh monitoring protocols in other parks.
- depths of rods vary, many historical SETs were not driven to refusal but only to 3-4 meters.

Considerations:

- Randomly choosing additional sites in order to co-locate more SETs with veg and nekton monitoring.
- Adding additional SETs to assure consistency in terms of methodology (depth of rods)

USFWS –Saltmarsh Monitoring by the USFWS - Ralph Tiner.

1. Remotely sensed monitoring – changes in marsh areas and marsh types. Covers large or smaller areas.
2. On the ground monitoring: (accretion, erosion, subsidence, salt balance, etc.)
3. Analyzing veg. and soil changes (plot analysis and reference wetlands)
4. Evaluating wildlife habitat

Remotely sensed monitoring: - USFWS uses aerial imagery to track changes in wetland type
Reports: Regional - Status and trends of wetlands 1998-2004; and local reports.
Considerations for site-specific monitoring
- Aerial imagery– low tide, peak growing season, cloud-free, large scale or high resolution, CIR.
-Integrating trends with NWI updates.

Monitoring salt marsh migration – Study Objectives:

-establish permanent plots to document changes in coastal plant communities over time – veg patterns, soil properties.
Determine how long it takes for significant changes to occur – how long to change habitat types or soil characteristics.

Methods – analyze existing photos on possible study sites, review sites in field, lay out transects along gradient from salt marsh to forested wetland to low land upland forest, -establish permanent plots (30 ft. radius circular plots for forest, 15 for shrub, 5' radius for marsh)
-veg sampling (tree, shrub, herb, woody vine; stress indicators (chlorosis, dieback, death..
-soils (see slide).

Pilot Refuge – Forsythe National Wildlife Refuge. Transects go from marsh to upland to forested areas. Sites non-randomly selected.
Freq. of sampling – every five years. Timed with refuges CCP which is updated every 15 years.

Future plans – start piloting in additional refuges.
Interested in setting up plots that are not now marshes but may become marshes in 50 years.

Question/comments:
Cahoon: Excited to see the transects into the forest. Cahoon is finding that when trees die, roots die and accelerates subsidence. A drought lead to shrinking of soils and subsided about 2-4 cm per year for a few years. Came back but indicates that droughts exacerbate subsidence. We need to be able to explain the geomorphic processes that impact marshes.

You want to measure water level, accretion/subsidence, and water levels. Need to monitor hydrology's, aquifer dynamics.

Good contact person regarding migration study – Ralph Tiner.
-USFWS may be able to get the IM money. Salt marsh integrity index – Susan Adamovitch at Rachel Carson Refuge is the contact person.

NGS – Geospatial Infrastructure Requirements and Recommendations - Galen Scott (see presentation)

Geospatial Infrastructure for Change Monitoring within Coastal Sentinel Sites.

- Need to monitor changes at the mm/year scale. We are pushing the technical capabilities of the technology and infrastructure to measure at this level.

We are looking at changes in the land/water interface and how ecosystems are responding to these changes in this interface.

Challenges:
-multiple datums – multiple sensors each with zero point.
-spatial scale – chasing mm changes – local vs. network accuracy
-time scale – need ongoing obs. For decades into future.

Can accomplish relatively high accuracy measurements on the local scale with less accurate connections to regional or national scale.

Three height systems:

-tidal datums – for discreet areas that they are measured – avg. over 19 years.
Orthometric datums – referenced to geoid model. Reference to NAVD 88
Elipsoid – Use GPS to tie to ellipsoidal model of earth NAVD 83

- Conditions in the marsh make elevation monitoring difficult. Need to compare between sites and need a larger reference system to compare between components. We can't do that accurately because too expensive to do this. As you go up spatial scale, reduce the accuracy. We need to identify appropriate reference frames to address the questions that we are interested in.

- Earth is dynamic and how we measure the reference frames is changing. The reference frame itself is changing. This gets very complex.

- Need 3 different observing systems to know what is going on:
    1) Tide station – pier driven to a depth of refusal;
    2) CORS in uplands (electronic benchmark that measures regional land motion).
    3) SETs driven to refusal

- Tide station measures water level relative to land. CORS measure what is happening to the land. The SETS monitor what is happening in the unconsolidated sediments within the Marshes. Need to tie these together with high accuracy elevations through local benchmark network.
- Also, need to measure the stability of the benchmarks.
-NGS can help make the accurate measurements.

Case for a common vertical reference frame.

– can compare multiple trends over time. NERRS and NGS working to develop the vertical control infrastructure to tie all the monitoring infrastructure together and monitor the spatial relationship between the sensors over time.

- 1300 CORS around the country
- NWLON stations
- SET technology

Need a local network of control points to tie these things together and measure between them and determine what is moving to correct for trends we see in sensor data.

NGS is helping to figure out how to do the surveying methods for NERRS Sentinel Sites work through protocol development process at Chesapeake Bay VA Reserve.

-Setting up a local tidal control network within a park and tie your sensors to it, this is how to set it up and tie it in:
-need at least 3 different marks that you are going to observe over time. Have at least 2 to check the others against.

-make the link with the National Spatial Reference System. Most accurate way to do that is leveling, but this may not be possible due to remote location and associated expense. Other options include static and kinematic GPS with decreasing levels of relative accuracy.

1. Make network tie, put 3 marks in ground, occupy each one simultaneously with static GPS techniques for 5-48 hours at least twice at least 12 hrs. apart to get different satellite constellation. Submit data to NGS on line, will give you a data sheet, and develop an OPUS solution – this will create a network link.

2. Then begin tying in other sensors. Establish best achievable accuracies between the marks, double run loops. Level data may be reduced using LOCUS

3. If you can't level to monitoring sites static or kinematic (RTK) GPS may be an option. This gets cm level accuracy. Need to do this for all sensors from each benchmark and must be done again after at least 12 hours to get different constellation of satellites.

Maximum distance between marks for RTK – need to consider communication between base station and radio, and need same atmospheric conditions over both Rover and Bay station so that the communication between satellites are getting same correctors. Talking about several km if confident that atmospheric conditions are constant.

Need to monitor infrastructure over time because marks move.

Online Tools -

- OPUS – On-line positioning user service. Static observations can be submitted to OPUS – will archive OPUS solution and can repeatedly submit observations over time and have history of results. This functionality is being developed. Submitting data on line is the way to go.
-LOCUS – submit leveling data on line and will give height differences. Will give heights along a leveling transect at end points and points in between.

Establishing heights on SETs – new fixed dimension SET based on error analysis of previous instrument designs, NGS approved guidelines for establishing orthometric heights on SET foundations; statistical framework for SET experimental design and data analysis, technical assistance for SET deployment design and data analysis protocols. Procedures are there for connecting SET bench marks to the NSRS.

- Have been talking about local network and establishing heights on local networks. Need to put heights on veg. transects, ground water sensors, water quality sensors. Protocols are being developed now at the CBVNERR with NGS field staff.
- Grav – D. NAVD88 is going away. We are computing a new geoid model based on gravity. Can then be able to develop elevation changes with more accuracy plus or minus 2 cm. NOAA got a bump to base to do this. This will be the way to do this in about 2018.

NGS Resources:

- Geospatial Infrastructure Installation Process Steps – 12 step process will provide training in another forum.
- Geodetic and tidal datum training.
- State and geodetic advisors
- SET design and implementation protocols.
- Money available thru the height modernization program – increasing density of CORS.
- Regional spatial reference centers that may be supportive.

Conclusion – by concentrating geospatial infrastructure can enhance capacity to assess change and increase our confidence in our understanding of complex spatial relationships.

Alison Allen – CO-OPS (see presentation)

Tide Station and Water Level Monitoring

How to know if you have tide control in the your parks and reserves:

NWLON – 210 long-term tide stations. All collect water level and other parameters

-3 functions: provide tidal datum info. For country; linkage between tidal and geodetic datum; provides important information on sea level change for country and link with land motion.

-been around for 150 years.

Attributes of network – vertical datum reference; long-term, continuous time series, data collection processing and product delivery. Rigorous QA/QC process.

-Standards are based on transportation needs

-there is a long-term and real time component and the stations are multi- purpose applications.

-too expensive to have one everywhere – so there is a hierarchy of gauges – long –term, temporary for hydrographic survey, shoreline mapping, restoration – for up to a few years.

-Short term tide stations, similar but not as robust.

Sensors:

- calibrated to collect all ranges of tide so doesn't bottom up, no changes in sensor "0", installed to minimize error.

-leveling at stations – leveled at installation and annually, and after major event such as hurricane or earth quake

-NGS accuracy standards

-uses a variety of benchmarks (surface and deep-rod marks); min. of 10 benchmarks, level to 5 every year. This way we can re-establish connection if tide station is blown out. Level between benchmarks.

Tidal datums –

- vertical datum; used as a base elevation to reference heights or depths; based on a phase of tide- tidal datums are always local. The degree to which they can be extrapolated to other areas depends on distance and geographic and hydrographic features.
- Tidal datums are maintained in 19 year epochs based on the longest know period of variability known as the Metonic cycle
Datums need to be periodically updated due to sea level rise.
- The current epoch is 1983-2001.
- Short term stations can be linked to a long-term station through series of calculations. – accuracy related to geomorphic similarity, length of data, distance between subordinate and permanent station.

Applying tidal stations and data for marsh restoration.

- Used to determine local datums, establish relationship between tidal datums and marsh surface, vegetation or critical elevations for each project. Can install 30 day tide station in marsh to be restored.

Tidal and geodetic datum not the same and relationship between them is not constant.

- Long-term sea level trends from over 30 years, can provide important trends to SWMP fixed water quality stations.
- Mean sea level changes monthly and over time- that is why it's important to compare short term data with nearby long-term data.

NOAA Tidal GAP Analysis-first cut:

-NE and SE National Parks-NWLON coverage is region within which a subordinate station could be installed and use NWLON station as a good reference.
-we have a gap associated with Cape Cod Sea Shore,
-Fire Island is in a gap
-Assateague – some of the inside areas are gaps
-Core and Pamlico Sound – gap
- Canaveral National Seashore – gap in the inside areas.

Next – what are specific monitoring goals and what historic monitoring has been there and are the historical benchmarks still there that you can recover the heights.

Narragansett Bay example:

1. Look at what is there
2. Historic stations with possible tidal benchmarks
3. Any recent information 1983-2001 tidal datum epoch.
4. Where there are geodetic connections
5. Where are CORE stations
    - Lead to a recommendation with Narragansett Bay
    -

NWLON Gap

- good candidate for a control station. All tidal datum attributes for the station don't necessary translate to all areas. Can evaluate whether the NWLON station datum are accurate and applicable to the short term station location – need to look at extreme.
- Can compare statistical information but not necessarily behavior of extreme episodic events such as storm surges.

Next Steps and Summary:
-NPS-USFWS –
1. look at each park and evaluate historic and existing infrastructure;
2. install NWLON or short term stations
3. Take their infrastructure and bring vertical stability to the sensors.

Solution should be driven by requirements of network – may be unique to each park or refuge.
Take home messages:

- Tide and geodetic control go hand in hand. Plan in a comprehensive manner to avoid having to dedicate more time, funding, personnel, and effort.
- Integrate vertical control into long-term operational planning. Lots of applications that can be brought to these systems.
- for long-term climate monitoring , need to work together.

NGS and CO-OPS have supported the COE districts and they have put their infrastructure in place to coordinate datum. They are updating their national network – and they are very independent districts and they have institutionalized this. We are also working with USGS in the coastal zone. Climate element with COE – using NOAA long-term trends in construction and restoration projects.

Lots of sites where tidal component is minor (e.g. Currituck Sound). Can establish sea level datum with long-term station and compute a statistical relationship of water level relative to land. A statistical model that can be translated to the marsh surface.

End of Presentations on Day 1:

Discussion

Commonalities:

- systematic sampling across gradients across limited areas
- monitoring applied across broader areas

Ken Moore: Two different approaches – can they be integrated?
Tony Curtis: There is an opportunity to do what Ralph Tiner is doing to monitor change into the uplands. We want to collect equivalent data that we can cross reference and data store that it represents research and monitoring goals and that it is standardized. NPS has to monitor based on inference to whole marsh. Develop monitoring plan that is spatially balanced, equivalent plot data – we establish a data standard. Data at spatially random sites is equal to data that NERRS is doing.

We have not talked about sampling methodologies. – not sure if we will get there today.

NPS only monitors percent cover. After 70% there is some asymptote after which biomass increases.

Unlikely that we are going to agree on a protocol. Identify what the lowest common denominator is that we can shoot for. Plants will be harder. But SETS and sondes can be standardized.

SETs

- Agreement that SETs should be installed to refusal – what do we do if it is very shallow – not very stable. Put a sewer pipe, suck out material, fill with concrete with rebar in – makes it stable. Define what is refusal – hit 300 times for example, and if it doesn't move more than a cm – its there. We need to come up with a definition of refusal. Can use 80 ft. if you can, but at 60 ft, it is still stable. Keep the definition rather flexible – the rods may be going laterally. Idea of refusal using a demolition hammer or a jack hammer.
- Need to survey them repeatedly.
- RODS are a benchmark so follow NGS 3D standard – 3 D ROD mark.
- Reasonable limits to refusal are defined in NGS protocols –hit it 25 times and doesn't move more than a foot…

-Important to notice how much rod you put in because it integrates the depth at which it is installed.
-at depth, the processes occurring are more regional – that is the assumption. That is why you need GPS.
- SETS need to be surveyed in on a regular basis – 30 days after installation, 12 months later, and repeated visits every two years – multiple day occupation.
-**Question - why do the SETS have to be grade A benchmark?** If we have a benchmark network that is not up to benchmark standards, we don't need to abandon them. You want to make sure that you have a stable benchmark. If your marks are of questionable stability, that is fine if you can evaluate stability through leveling.
- We have SETs all over park – trends over time are good. If you can get high accuracy network then tie the existing benchmarks to it. But what does this mean for pre-existing data?
- Three benchmarks – you want to find different types of benchmarks if possible.

Question - How can shorter pipes and older version be inter-comparable as we go forward - install to refusal in the future, but historical data sets can be useful – can develop a rate of velocity of historic benchmarks based on future heights and relation to new benchmarks. Establishing three highly accurate benchmarks in area is critical and correct for velocity. New installs of SETS may be hollow pipes to look at velocity.

- Every other year re-surveying is standard but if a mark is stable over a few years, can reduce the surveys.

- Installation of SETS – randomly selected but depending on the funding source and question you are asking. Need a minimum of three. If interested in trajectory of whole system three is all you need. But if you can install 3 in different habitats its more powerful. Think value added to other data sets and funding sources– needs to be in discussion. Randomization is done if you have lots of data points – most important characteristic of sample is representativeness – not randomness. Restricted randomization is fine by habitat type and elevation. Representative is key so you can make inferences. How much do you want to lock in to a specific design? Depends on what you are monitoring for? Does combination of two designs prevent us from rolling information up. Could you take Tony's low marsh data set and roll up our lower marsh data set, can we integrate? Because we don't have that many data points, we should include them in the same analysis.

Sampling Approach

If you are looking at Sentinel sites, you are looking at marsh as a whole – not just a portion of the sentinel site. But how do you define sentinel site? Eric looks at a sub-basin that has proven to have transgressed? Tony might be looking at a particular marsh.
-How does Eric place his infrastructure? Stratified random sampling of transects – not inferring for entire system – just for sub-basin. We need to be careful about what we are inferring about. If we want to say something about NIWB- we need to include a random sampling technique.
- take what you have and hypothesize that this is what you expect – and test it.
-Goal is to get a mechanistic understanding of what is happening in the system. Give up on the one hand that you can't predict for the whole system for deeper understanding of what is happening mechanistically.
-we may not know if we are representative of mid-Atlantic ecosystems – not sure if we are in fact a sentinel site.
- We need a Mecca of data to understand mechanistically what is having with our marshes.
- also need to know what questions you want to answer and can answer to design monitoring program.

To make data useful to the larger group, what metadata do we need to standardize. What are key questions do we want to answer?

Identify areas where we should come to common ground on

- SETS – priority – easy win.
- Vegetation- priority – we can come to a least common denominator
- Database – priority
- Fixed station WATER QUALITY- we are close on this one too. But need to standardize calibration because we are using non-random fixed station designs.
- soils and pore water salinity, aeration
- SAV

Hierarchal – identify things that are very basic

Even though we have different sampling designs, lets do it the same way with the same data and metadata standards so we can integrate the data. Goes back to the toolbox approach. We get hung up on sampling design question. Rather, just state what you are doing, pick something, and do it well and individually can decide if they want to use the data point.
-we need a minimum standard that is really good and we can use everyone's.

Conclusions from Day 1:

1. We want minimum standards for SETS, vegetation, metadata, fixed station water quality, soils, and SAV.
2. Low hanging fruit – can do hydro periods – flooding frequency, start at SETS and tidal heights. We can pull from existing data to say something already. We are 99% there. We are all doing the same stuff – just with different sampling design.
3. Transition area – should we focus on – we need to look at those areas – we need to look at what is there before - we need to discuss how to integrate our mapping and in-situ monitoring strategies to look at adaptation.

Day 2

NPS SECN Data Management - Christina Wright

Data management:
-integrated, enterprise level solution

- SQL server for the backend – generates charts and graphs
- Share Point server for the front end – moss version so people can enter data remotely and reporting
- Data visualizations – more charting options
- Uses Bing Maps – Microsoft version of Google earth
- Development tools – Microsoft InfoPath.

Have issue topics
-Explore data – by protocol (water quality, shorebird, coastal assessment, weather and climate, etc..
- Can enter data or view reports. All forms are in there, inventory of equipment.
- Can archive all data forms
- Entering field – is provisional at first but not reported until its QA/QC
- Canned Reports already designed based on need – generates graph, exports charts and graphs as pdf and tables as a web archive (XML), delimited file (csv) or an excel file (xls).

RSET data entry:
-forms include site characterization, salinity meter calibration, soil porewater salinity, accretion, etc.

- A new record is a new observation. Relating information to elevation happens on back-end. In station form (generic) you put information on elevation.

Additional Functionality:
-minimal metadata required before certification
-majority is based on spatial components
-certification is the data QA process – checking for completeness and accuracy (data verification).
Two tables in database – one submitted and one certified. Reports are run off of certified database.

Data Exploration tool – for complex querying
-no mapping functionality – need to do that manually.

Spatial data visualization – not spatial analysis – this is what park managers want to see.

Discussion

Saltmarsh entry data – yes. We can have a follow-up web ex for that part of the database. Can put in accretion, equipment, soil data, survey control data, ecological community data based on TNC classification, veg. species.

Philippe - RSET data – would be helpful to have information on instrument dimensions – not all the same – to translate benchmark elevations and SET readings need it to be referenced to instrument.
NPS has an equipment description category – took the structure of the data from LA DNR data forms with added benefit to the NPS. They are the CRIM sites. NPS missed the control number so that they can contribute to the OPUS DB.

Whit – ways to move forward. No work done on bio-monitoring database in NERRS and we need to think about that. Talked about a couple models. Included sharing database with the NPS in some way, having CDMO steal ideas and incorporate them into CDMO server or some combination thereof.

Dwayne – excited about what I saw – we don't have to re-invent the wheel. We would like to have a partnership it's a win-win for NERRS program.
Whit – would you like to bring this to the CDMO server?
Dwayne – the NPS is consistent with CDMO database structure, there is no reason why we can't maintain separate databases with the same structure.
Tony – we would like to have access to each other's data.
Sarah – NPS – thoughts on data storage and sharing data. We want to have one data Base with NOAA and the NPS with one data base structure. Best model is to have a single database that we all use – question is how to maintain it. NPS doesn't have funds to maintain it on an annual basis. We need to get support at the national level in the NPS.
Marie – does NPS have relationship with another entity that provides flexibility in data firewalls? NPS does not have one not but will have a relationship with U. GA to discuss those issues. NPS has a project with UGA to look at making data availability in water quality.
Financial support of data base and how do we make it available across the board across firewalls: Needs to have a discussion with National Data Manager. Perhaps we can work with National Biological Information Infrastructure – but its funding and program is rumored to be disappearing so hesitant to put money in NSBII.

- Another option is LTER.
- Whit – we have a mission to provide that information to the public. NPS generally doesn't provide real-time data to the public now. Need ways to flag and protect data. There are some data types that are protected.
- Is data 100% park service data? No .
- This data is monitoring data not hypothesis – driven data so can get it out.
- Idea of coordinating with CDMO – need to develop a protocol to call into each other's data but not have the CDMO handle all the NPS data. Need to deal with firewall issues. That is the model of IOOS. We would have more luck calling into someone else's data than having someone call into the NPS.

- Dwayne – USGS and EPA are not doing a very good job sharing data across agency. We have an opportunity to demonstrate how to do this well.
- Jeff – we need to address technical aspect of this and figure out how to make this work. Then we need to address setting up a procedure and safeguards for data sharing and rules so we don't release proprietary data without consent or establish appropriate uses of proprietary data without stepping on toes. There should be set appropriate uses of proprietary data but need permission to use data and establish rules. Could be password protected data. Maybe moot point because there is no such thing as proprietary agency data in this administration. Cahoon was open to sharing of databases.
- Philippe is working on a SET database entry form for the NERRS that is easier to use and connected to output. Wants it easier than Jim Lynch's database. If he was to develop something in Open Office, how can he understand the data requirements of the NPS so it is as compatible as possible with NPS? Christina suggests that the data forms and restrictions on input to cut down on error could be provided. Make the field forms needed for NERRS available so that we can model from that. Cape Cod NS is working on that – we have an SET access database based on NPS – now enter data into excel and once the data base is running to NPS standards.
- Next steps – need to get Dwayne, Brooks and Tammy together with NPS. Perhaps can meet at CDMO
- No national NPS integrated approach to data management – this is occurring at network level and then will roll up.

- **Next steps:**
- Meeting at RC meeting in Cape Cod – someone from the NPS in NE can attend the RC meeting. Presentation on the general concept that we are talking about at this meeting. The biological monitoring talks will only be for one afternoon. Sarah or someone local or Christina is free to go up. Christina will prepare the talk and Sarah can give it. We will send agenda to the NPS and coordinate from there.
- CDMO meeting in mid-late March.
- Start with e-mail thread on data sharing**.**

Where do we go next:

- Series of Technical papers outlining minimum data standards for elevations RSETs benchmarks, veg, nekton, fixed water quality stations, soil (porewater and hydrology (nutrient, salinity), SAV and benthics, water level and elevations, transition areas, data management standards..
- Minimum standards, each agency peer review, MOU agreement to commit to implement minimum standards if you do it as they are developed and established.
- Hit a couple of the easy ones first and get the MOU agreements first.

-RSET is low hanging fruit – agreement to survey to NGS standards, database include stability parameters to capture old SETs. Agree on minimum data standards, wrap in fixed station water quality, elevation, and tidal datums.

How to proceed:

1. NGS will take the lead in developing the RSET and retooling a document for benchmarks. Develop a written document to describe the 3 slides that Galen has on local network.
2. Database standards will be developed along with the data standards.

NPS: How many networks within NPS do we want to involve – and when do we involve them? Network coordinators and relevant WASO staffs as well. When draft documents are pretty solid, we should send them out for review. For some of these, possibility to be adopted as national standards / SOPs. These will be recommendations for national adoptions.

Could we share a position for a short amount of time between the networks and NERRS to write these up. This will be a lot of work. NPS will see if they can see if they can find a detail to work on this and we will identify a position as an NRAP.
-involving USFWS and USGS – start with NPS first and then bring them in.

National Science Foundation funded program – take PhD students to work on federal projects. We should look into this – can write up a project statement and pass it through NPS and NSF Program – IGERS Program.

First step – position description – Whit will work on that over the course of the next few weeks. We will extract from that for NRAP.
-identify documents pertinent to technical papers
-setting up a meeting with data management folks in mid-March
-RC meeting
-FTP site to upload presentations and documents.

End – Met the goals.

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Water Quality Monitoring & Climate Signals Meeting,
University of Georgia, Athens, GA,
18 February 2010

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Notes and Recommendations

1. Need to integrate methods with what's going on with climate change work in the west coast.

2. It will be very important to make sure to effectively understand and report uncertainties in analyses.

3. Ensure that the network of groundwater wells and data loggers is complete. See groundwater inventory and protocol for recommendations on data gaps to fill for coastal parks. Conductivity will be an important measure.

4. Be sure to look at regional subsidence (N.B. this will be handled through coordination of RSET stations).

5. Interplay of anthropogenic and natural change will be particularly important in the Southeast.

6. Use data collected at inland parks as reference for measuring impacts to coastal parks.

7. Baseline hydrology inventory potentially a need.

8. Conduct a groundwater synoptic survey (widespread, short period of time) and include water quality measures

9. Strong recommendation to steer away from EMAP protocols for water quality. It's important to focus on protocols designed to measure temporal trends when looking at effects of climate change.

10. Be sure to look at ways to do post-event monitoring following hurricanes. There is potentially an NSF program to get funding for this that focuses on rapid assessment of event-driven needs. Look into the Global Lake Ecological Network (GLEON) for potential parallels.

11. SAVs will be more important than benthics, but there's a strong body of work on benthics from USF and CoC.

12. Carbon monitoring would be good. Fractionate if possible among soils, air, water, and plants.

13. Check with Bob Teske on forestry climate change detection

USGS CC Downscaling and NCCWSC Project Leader Meeting, Raleigh, NC, 23-25 February 2010

Attendes: About 35 people – mostly USGS. John Gross and Joe DeVivo attended for NPS. These notes from John Gross.

Project summary page: http://nccw.usgs.gov/2009RFP-projects.html

Executive Summary:

Participants and purpose: Principal investigators of projects funded by the NCCWSC in FY 2008 & 2009 and some 'clients' (NPS, FWS staff). Keynote presentations on GCMs, statistical downscaling, and dynamical downscaling. Intended to educate participants on CC models and techniques, foster collaboration, and identify next steps especially for data sharing/management of downscaled model results.

Highlights: Talks by Kathrine Hayhoe and Steve Hostetler on models and downscaling techniques. USGS program leaders very clearly directed scientists to work with and address needs of management agencies. Learning about THREDDS server / data sharing system.

Likely outcomes: More organized system for sharing downscaled model results; enhanced connections between clients (NPS, FWS) and modelers/researchers. I'm confident all participants are better informed of supporting efforts.

Regional Climate Science Centers (CSC)

U Alaska has been announced as the winner of the first CSC. USGS expects to fund three in FY 10; the rfp for the other FY10 Centers will be announced in March (the strongest rumors favor the PNW and SE). USGS expects keen competition for these Centers. Proposals may be for a specific site, or submitted by a broadly distributed consortium. The general concept is for each center to be funded at about $4 mil/yr, with perhaps 25% of the budget to permanent staff salary.

LCCs

Current understanding (this is _highly_ dynamic) is that commitments for leadership are:

FWS – 9; BOR - 1 or 2 (Upper Colorado River basin; maybe Lower or one LCC for both upper and lower Colorado); BLM – 1 (Great Basin). Unconfirmed rumor that BIA is considering a larger role in a Pacific Northwest LCC.

USGS is ready to issue memo to move funding, but this is difficult since LCCs keep changing. USGS has also committed funding to put scientists in LCCs, but there's no specific goals so no clear guidance on what kind of scientist to hire. I.e., we're all confused and trying to ride the bike as it's being built.

NCCWSC Overview (Doug Beard, Interim Leader)

Research emphasis areas for funded proposals:

- Fish $1.8 mil
- Arctic $0.8
- Estuaries and Coasts $0.7
- Avian $0.5
- Wildlife and terr - $1.4

Partnerships ($1.4 mil)

- Climate monitoring (NASA, FWS, NSF, Smithsonian, NPS)
- LCCs

IT, data portals, and related are a huge issue, and data sharing is a priority.

- Need to establish a collaborative environment
- System archive for sharing data
- Long-term archival and storage
- Data systems integrated with LCCs. Working with FWS on this. Mtg late March/early April at NCTC.

NCCWSC Proposal focus for 2010 is Vulnerability Assessments. About 150 pre-proposals were submitted. USGS is targeting a success rate for full proposals of about 1.5:1 or 2:1 (submitted: funded). Pre-proposals were due 19 February. Awards announced in May.

Overview Plenary on GCMs - Katharine Hayhoe

Considerably updated and expanded from Dec 2008 NCCWSC presentation (the 2008 presentation available from:
*nccw.usgs.gov/documents/**NCCWSC**_Plenary_PowerPoint_Presentations.pdf*)

Sources of uncertainty in projections:

- cannot predict human activities and emissions. This is a big one.
- sensitivity of system
- extent to we can successfully simulate the climate system

    - But have been two cases where models results conflicted with observations, and further examination identified errors in observations (e.g. RS algorithm)

- There are continuous, random variation in climate

- The response of local and regional climate to global-scale change

Main center for socio-economic models is University of MD – e.g. GCAM

SRES scenarios – none of these have a climate policy, so to some extent they are all 'business as usual'. New approach for AR5 – use of RCPs (might mean relative concentration profiles). These closely match several AR4 scenarios.

- upper end of AR5 scenarios are virtually identical to old one.

    - For AR5, climate models not yet frozen, so we can (must) use old projections for now. Models will not be frozen until at least next year

    - Some scenarios do go lower than AR4

- Big effort to stabilization at certain concentrations of CO2s. NAS report this summer on stabilization efforts (these are also in new SRES efforts, and described in Moss et al. 2010).

- No stabilization is 'business is usual' –ALL stabilization scenarios require massive changes, and the later these are implemented, the more massive they need to be.

Latest comparison – Myhre et al. ERL 2009 – carbon emissions increased 40% since 1990 (presumably an update from Rahmstorf et al.). (I've put this on CC SharePoint, in Info Ref Library, peer-reviewed section)

Measuring sensitivity of GCMs - ECS

ECS – Equilibrium Climate Sensitivity – Global mean annual temperature increase with a doubling of CO2. Very difficult to accurately and precisely estimate. IPCC reports a mean of about 3 C.

Distribution of estimates right-skewed: range from about 1 to max > 10; high point of cdf about 2.5 but mean is 3. Most likely values are in the range of 2.5 – 5. This is the range of CGMs, so they are already conservative in that none of the existing GCMs includes the higher end of the distribution.

Action Item: Management agencies to articulate and communicate questions for GCM community (see update below).

Clearly articulate the kinds of questions that we might want to ask of models. Present these to the modeling community for a general synthesis. These could include such things as:

- Summary of appropriate use of models for e.g. decades-long or 1000 yr runs (models handle these time frames very differently)

- Which models work particularly well/poorly in some geographical regions?

- Year to decade models of specific forcings – e.g. ENSO in SE

- Multi-decadal runs for e.g. broad-scale ecosystem changes.

- What information we need:

- Which models best accommodate the relevant time and spatial scales?

- Which models should we avoid for which applications?

- Recommendations on format for results – how can these best be communicated?

- How do we acquire results and information?

- How often do documents and results need to be updated (when is this document likely obsolete?)

- Do we want good accounting of e.g. variation (extremes, drought) versus mean fields?

Post-meeting update: Most (maybe all?) of these GCM topics are addressed by the very recent (Dec. 2009) report to the Water Utility Climate Alliance – Barsublie et al. 2009. This is an _excellent_ report for climate model wonks (146 pages – not a light read). I've put a copy on SharePoint, in the Info Library peer-reviewed section (I think this section best reflects the technical nature of the material).

Kathrine Hayhoe – Statistical Downscaling

Regional modeling is too expensive for individual project to undertake, so mostly limited to using results already available. Very little funding for regional modeling, and most of this is for air quality studies.

- Downscaling approaches

- Traditionally 4 downscaling techniques

- Clustering – analogues, weather states

- Weather generator -- stochastic methods

- Regression – linear, non-linear

- Geostatistics - Kriging

NOW much less clear – often use one method, and then combine with one or more other methods. Many different predictors, and scale and inputs vary with most desired results.

Downscaling methods for temperature:

1. Delta approach – calculate predicted change, and add change to finer scale observations
    a. (JG Note: I had not considered this a 'downscaling technique'.)
2. Bias correction – account for Mod-obs at finer scale, then add delta
3. Quantile mapping – Mauer, Santa Clara – Bias correction and spatial disaggregation.
4. Statistical asynchronous regression – ranks quantiles by month in q-q plot, then fit mulitorder polynomial (2-3 rd order typical) or piece-wise linear regression.

Comparison for temperatures.

- For temp, Delta and Asynchronous regression look best.
- For RSME (very preliminary results) – asynchronous regression best by considerable margin.

SD – statistical downscaling, **RCM** – regional climate models (dynamic models)

Conclusions:

- Any downscaling approach better than none.
- Delta better than bias-correction. Both simple so just use delta.
- Quantile-based tend to be better to match tails of distributions
- Assumption of stationarity may be justified, based on preliminary comparisons to RCMs.
- Regional modeling (dynamic) can reduce uncertainty, but scope is very limited and can add other biases
- Best approach likely a combination of models and methods. If can't combine, then be sure to know biases of methods.

Resources:

- Written guidance. Not aware of any good reviews. Rob Wilby did a guide for European apps. 20 page summary of SD. Talking to FWS about producing guide.

(Post-meeting – I put in an Interlibrary loan for:

Wilby, R. L. and T. M. L. Wigley. 1997. downscaling general circulation model output: a review of methods and limitations. Progress in Physical Geography 21: 530-548.

And will post this to SharePoint when it arrives. This looks like a good, although, dated review, and it's been cited about 200 times).

Existing downscaled datasets.

NARCCAP. Number one resource for RCMs. Focused on many models and not so many runs.

- great for comparing SD methods to RCMs.

- Santa Clara site – but monthly

- Kathy took data and converted to daily data. Has taken 4 months to transfer data.

- NE Climate Data (quantile mapping)

    - can get growing seasons, etc.

    - have to register, but free and you won't get emails.

- coming: National-scale Tx, Tn, and precip; station/gridded projections using latest downscaling methods (tentative avail fall 2011). Expecially good for threshold and means.

Existing downscaling software packages.

- Rob Wilby's package Statistical DownScaling Model (SDSM): Downscaling for dummies.
    - great – can pick predictors, methods, and visuallizations
- clim.pact R package. Great package and makes most techniques available via this package.
- Classic (best) Text – Empirical Statistical Downscaling

Lauren Hay and Nate Booth – Spatial data portal (Geo-Data Portal)

To link data for researchers and modelers. Want process so data does not need to be reformatted for each application. Want to store:

- Inputs and outputs
- GCM and downscaled model results
- National hydrological model – basin-scale projections
- Want to be able to scale (basin to sub-basin); want to next models

THREDDS servers – can be insider server container like Tomcat. Focussed (entirely?) on NetCDF.

(THREDDS – Thematic Realtime Environmental Distributed Data Services – www.unidata.ucar.edu/THREDDS)

NcML – NedCEF markup language. Examples of data in or being converted to work with THREDDS system:

- National Map
- EROS
- NLCD
- NOAA
- OGC SOS/Watre ML

GPR – Geodata Processing and Reformatting - Takes slab of grid data, overlays a shapefile polygon and maps parameters to polygon.

National Water Balance Model – 4x4 km water balance by month model – McCabe and Wolock.

Downsizer – climate data retrieval tool. USGS open file report 2009-1166, 27 p.

Ward-Garrison, Christian, Steven L. Markstrom, and Lauren E. Hay. 2009. Downsizer—A Graphical User Interface-Based Application for Browsing, Acquiring, and Formatting Time-Series Data for Hydrologic Modeling. USGS open file report 2009-1166, 27 p.

Project Presentations – (not described in these notes – there were lots of them). See NCCWSC web site for projects: http://nccw.usgs.gov/2009RFP-projects.html

Steve Hostetler – Pleanary presentation: Dynamical CC model downscaling

Dynamical downscaling for process modeling and resource management guidance (Envir. Computing center, COAS/OSU)

One goal is to use runs from ~ 21 kpa and examine fidelity in reproducing really broad trends in Holocene to recent changes in vegetation.

Dynamic approach:

- True simulation of high resolution forcing and climate
- Internally consistent set of atmosphere/surface variables like water balance, energy balance
- Very time consuming and computer intensitve

- Limited number of driving GCMs (they're using 3 or 4). Requires very large input files with many variables. Not all GCM groups saved the necessary outputs so these are simply not available.

- RCMs has added model bias (e.g. convective parameterizations, exit boundary mistakes) compared to SD approaches.

Domains: N. America – T31 resolution (what does this mean?). Planned runs are:

- 50 km NARCCAP domain, 23 levels

- 15 km western NA

- 15 km eastern NA

- Not tractable or practical to run all NA at 15 km

- Working with LCC boundaries for test cases

- Only some time periods; big hole 2010-2050.

Example from GYA – projects differences in precipitation trends above and below 2500 m.

Saved fields – 3 hr surface, 6 hr for atmospheric; will save about 150 TB of output.

Working with FWS-Denver to develop data portal. Web app under development – can click on map report summary plots of variables with metadata and to download underlying data.

Also talking with BLM about using in rapid assessments. Summary products and some data to be delivered via Great Northern data system. Hard-core data served from more robust system at OSU.

Nate Booth – Geo Data Portal Discussion

Project Goals

- Goals – deliver downscaled GCMs for other NCCWSC use (longer term to serve approved products to public)

- Reformat GCMs output into more model-ready form (into model 'unit' inputs)

- Develop software capability that can support other NCCWSC data dissemination needs

To use:

- define area

- select target datasets

- select time frame

- submit and wait.

Gridded data is averaged/allocated into areas of interest (area-weighted averages).

Pint dats is passed through and tagged with the unit it falls in

Can also access directly via **Web Service** to automate model inputs and runs.

Desired output data formats:

- NetCDF is default = CF and point formats
- R data frame or e.g. time series object
- Users need contribute to examples of file in correct format
- Standard GIS format – text file with centroid of each cell and with attributes of that grid cell

Need to discuss common geospatial layers (is this National Map?)

- Common data layers – land cover and land use, population trends, housing, energy development and infrastructure, roads, pollutants, airsheds, impoundments, shipping/coastal impacts, etc.

Thursday -- Next steps

(most of the rambling discussion deleted ..)

Options: Workshop w/ major players on downscaling (Post meeting update: Apparently such a meeting is already planned, to be held at NCTC this summer his summer or fall).

- lessons learned with downscaling – actual process and methods
- lessons from what was done with downscaled data

Synthesis paper comparing/contrasting downscaling techniques. Probably requires workshop to refine idea and ID key participants. (see previous note about Barsugli et al. report)

Summary of meeting

Next workshop

Robin / Doug will draft proposal and circulate to group to refine.

2011 is going to be a very difficult budget year – would be very good to have products and examples of successes in time for the fall budget squabbles.

Southeastern Regional Assessment Program Project Meeting, Athens, GA, 7-8 April 2010

General Notes

Water census pilot project happening in the ACF basin. Eric Evenson is doing it.

Sue Ceilinski runs the FWS water team that includes ACF. Brian needs to get plugged in with her.

USGS and USFS are trying to come up with a plan on how to get and spend 500K tied to the CSC & SERAP project.

USFS Collaboration Cadre dealing with climate change.

NASA ROSA's proposal.

DAY 1

SERAP Overview from Sonya

Pilot started in late summer 2009.

Objectives

- Uncertainty analysis of ds models.
- Single portal for combining data

Appalachian LCC boundaries are changing, and being partially merged with the GCPO LCC.

Climate downscaling happening to 1/8 degree. 12-km grids.

DSing being done with beysian model averaging and EMIC for error evaluation.

Integrated Coastal Assessment

- Visualization tool
- Beysian approach to coastal change
- Effects of SL rise on biota
- Gom.usgs.gov/sir/sir.html. will be extended to FL (funding already in place).

Integrated Terrestrial Assessment

- Landscape conditions

- Gcms
- Urban growth
- Used to predict patch occupancy for birds
- Starting with SALCC

Integrated Aquatics Assessment

- Watershed model for entire ACF basin, with subbasin considerations
- Channel classification
- Ecological model
- Aquatic sp. Occupancy modeling

Conservation DSS

- Optimization for conservation alternatives
- Evaluate management options
- Includes land use, climate change, etc.

USGS Modeling Meeting happening in June where lots of the component projects will be presenting. Will be a session on getting set up for thredds.

Adam *talking for a lot of folks on climate stuff

Goals

- Better estimates of uncertainty
- Reduce risk of parametric and structural uncertainty
- One other…

Climate data that will be available:

- Raw gcm runs from IPCC ar4 for four emission scenarios
- Downscaled gcm runs 1/8 degree (). Katherine Hayhoe doing this. Need to confirm what we're getting and when (assumption is late summer). This will eventually be 12km nationwide. She's also doing a bunch of derivative products (need to get a list of what they are).
- 200 model runs from UVic ESM

    - Done with A1Fi and potentially A1b (being done by Penn State)

    - Temp, sea level rise. Precip not good enough to use. Discussion on whether we should be letting individual PIs make determination on "good enough" and publish model results with huge error bars. Not an issue of error; more a question of whether they're accurate at all.

- Probabilistic projections to account for structural uncertainty and spatio-temporal dependence. (reported as percentiles).

Emission scenarios

- Currently tracking the A1Fi scenario pretty close; all others underestimate emissions. Should use this as the first scenario for modeling purposes. This is also the worst-case scenario. Lovely.

- A1B is next closest and has the greatest number of GCMs.

- For a third, do B1 as a "low" estimate.

EMIC

- Looking at 3 paramaters for sampling tails of distribution

    - Longwave radiation relation to co2

    - Effect of aerosols on radiative forcing

    - Vertical ocean diffusivity

        - Speed and magnitude of warming

        - Partitioning of heat anomaly into atmosphere and ocean.

- Potential to collaborate with sea level rise folks since UVic can provide uncertainty estimate of thermostatic (steric) SLR; amount of SL rise due to thermal expansion of the ocean.

For projects

- Projecting out to at least 2050. GCM data available until 2100.

- Starting with the A1Fi scenario to make sure system works soup to nuts with a small number of scenario models. Will add in mid-range scenario second so we can see what things look like when lots of models are incorporated for averaging.

Derivative product needs

- Basic list.

- Would like to add convective precip, but probably too difficult to add in. It's in the GCMs and would be useful for fire models. Helps with understanding thunderstorm precip vs. basic frontal precip.

- Coastal winds.

Either Loren or Adam will be doing the derivatives. Also the portal for simple stuff.

Coastal Vulnerability Assessment

Already have a coastal Bayesian erosion approach from atlantic coast (north)

Trying to forecast ocean coast erosion under varying SLR scenarios.

Integrate with other efforts

Being done in parallel with FY10 Coastal marine geology project going on in the Atlantic.

Data sets include

- cc and sea level rise

- wetland loss, gw impacts, coastal erosion, inundation

- model safety, habitat loss, and other potential impacts

- use that for management decisions.

Netica for Beysian modeling

Atlantic Coast example by Thieler and Hammar0Klose, 1999.

Relative Sea Level is an input variable. This is the hook for Pete Murdoch.

Need test data sets for shoreline erosion at 2km resolution. Using change detection / RS techniques to do.

Basically need to hammer out the range of variability of input variables at the local level to get predicted change distributions.

Measuring beach slope everywhere.

This work is being funded by the CEN; this will be a parallel for the SE Coast, but with

Jason Hopkins (Netcdf)

External facing thredd servers will be available by September. Cooperators will be able to control the access rights of their data.

Contact jrhopkins@usgs for netcdf/thredd assistance

Coastal visualizaition tool

Don adding in SETs and doing a NGS benchmark survey.

Integrated Coastal Assessment

Ecosystem changes

- rapid assessment of terr. Verts due to habitat loss caused by SLR for Miss and Ala.
- Assessment of SLAMM model results
- Collaborate with USGS/NOAA to look at beysian framework for predicting coastal habitat changes over time.

Habitat models

- 606 spp. Have been modeled for the entire Soutehastern US. Predicted habitat. Tied to one land cover class (sandy beach) that's useful for the species and how that will change.
- Waiting on inundation maps to look at impacts.

Slam stuff.

- Number of doqqs and aerials going back in time. Looking at whether SLAMM models work in predicting what actually happened.
- Photo sequence to be complete by June 2010.
- Photointerp and slam runs by September
- Report in December.

Integrated Terrestrial Assessment

- Urban growth model: SLEUTH. Using road density / network for seeding rather than impervious surface, which they'll end up needing to crosswalk back for plugging into hydrological models.
- ACF CSAs are being worked on. Need to get exclusion layers (what isn't allowed to be developed).
- Will be doing 60m urban growth projections thru 2100 by sept 2010 for 9 SE states.

Vegetation dynamics modeling

- Piedmont by dec. 2010, ACF by sept. 2010, east gulf coast by March 2011.
- Disturbance regime changes based on climate

- Coastal plain: fire
- Piedmont: drought
- Blue Ridge: insect outbreaks.

- Doing one-year steps for ACF, ten-year steps for remainder of SE. too much computing time to do whole SE in 1-year steps but need the resolution for the ACF hydrological modeling.

- No longer doing montecarlo sims; 99% similarity among realizations so they're just doing one.

Species habitat dynamics

- Combining gap habitat affinity model to projected veg dynamics / habitat maps.

Jaime Collazo

Mapping species occurrence dynamics at landscape levels

- Identify habitat features

- Assess sensitivity of vital parameters – *can we get some of Mike's parameters linked to this?*

- Range dynamics—looking at extinction probabilities based on temperature shifts and resultant habitat/occupancy probability shifts.

Hamel habitat rankings (optimal, suitable, marginal)

Jaime has maps on decadal shifts in temperature for the SA coastal plain; need to get for monitoring plan. Data come from Katherine Hayhoe.

Doing look-back in ten-year intervals to develop timeseries of landcover, habitats, and how that relates to birds.

Using 60m resolution data that goes back to '73 (86 and 91 too)

Using Anderson classification system for land classes; between level 1 and 2. Fewer urban classifications.

Day 2

Multiscale Hierarchical Channel Classification (Robb Jacobson)

Focusing on the valley-segment and reach scale characteristics using remotely sensed data.

Want to be able to predict which reaches are more likely to change over time.

Lidar-based dems add lots of small tribs. How do you decide which ones are biologically relevant?

Nettrace algorithm can be used to delineate the valley width; can map confinement boundaries.

Looking at relative cost/benefits of doing the classification at a variety of scales.

Brian needs to contact Robb to see about crosswalking our protocol with what he's doing. Will need to do some landscape-scale parameter estimations for each of the parks, but after done, the classification methods should be transferable to each park.

Challenges with matching up the HUCs and HRUs without losing information about the mainstem.

Landscape Dynamics (John Jones)

Runs the land cover dynamcs and environmental processes project (LCDEP)

More habitat/hydrological measures to look at at the landscape scale that will be relevant for hydrological modeling. Includes plant community structure data.

- Channel shading
- Flow resistance
- Carbon sequestration

Other thoughts

Should aggregate data / clip it by HRUs.

Occupancy Modeling (Jim Peterson)

Two resolutions, nested.

Focusing on fish and mussels.

Coarse resolution modeling done w/I 3 months of getting all the input model info.

Potential interactions with SECN climate change plan

1. Do VS monitoring so that data can feed into management-relevant climate change models
    a. Coastal vulnerability / Inundation
    b. Species occupancy / distribution
    c. Hydrologic (freshwater inputs to estuaries)
2. Use existing landscape-scale datasets or models in lieu of landscape-scale VSs to ensure continuity of data and interpretation between SECN parks and the broader landscape
    a. Land cover and use
    b. Shoreline position.
3. Modular additions to protocols to assess magnitude and duration of effects following storm events.
4. Develop CC response metrics for all vital signs to standardize reporting of CC effects.
5. Standardize data collection with other agencies within the SALCC / SE / Atlantic Coast to help ensure seamless datasets across boundaries.

For Tidal Gages

1. CEN to pay for installation of sites where we have known data gaps.
2. Fund short-term study to see if TIMU/CUIS stations are close enough for establishing distribution curves for Bayesian model input.

For Shoreline Mapping / Geomorph

1. Use available slope data provided by USGS (need to compare SWASH and USGS data sets though to check for utility).
2. Lidar as available for volumetric
3. Use SWASH for storm impact assessment.

Additional Project Ideas

2. Do our biological protocols in the Potato Creek Watershed?????

NERRS – CTP/Research Winter Sector Meeting
Woods Hole, MA, 2-6 March 2010

Date: March 2-6, 2010

Meeting: NERRS- CTP/Research Winter Sector Meeting

Location: Marine Biological Laboratory, Woods Hole, MA

Participants: NOAA staff, NERRS staff, and Tony Curtis, SECN/NPS

Purpose: During the February 2010 meeting between NOAA and DOI, NOAA requested that NPS provide a participant to attend their annual NERRS meeting to provide support to future salt marsh monitoring methodology as agreed upon by NOAA, NERRS, USFWS, USGS and NPS.

Focus: The meeting focus on research operations of each NERR. Significant discussion of the SWMP-Biomonitoring Protocol occurred. Issues discussed included geographical and economical/budget issues, staffing and minimum standards. Data analysis and data base management were also items of discussion. Informal discussion occurred outside of formal presentations and formal meeting times.

On the third afternoon, the entire focus was the NPS/NERRS meeting (February 2010) outcomes. The east coast NERR programs were very supportive of a consolidated methodology for salt marsh monitoring standards. The west coast programs less so.

As NERR biomonitoring ramps up, funding is being programmed to support the individual NERR to commence the third phase of SWMP monitoring.

Following a three hour session where as both Tony Curtis of SECN/NPS and Whit Saumweber of NOAA discussed the findings of the February 2010 joint meeting, the agreed upon methodology and common data structure, NERR agreed to follow the standards agreed upon during the February meeting.

Agenda is attached. Participants included:

Reserve	Research Coord	Email
ACE Basin, SC	Leffler,John	LefflerJ@dnr.sc.gov
ACE Basin, SC	Wenner,Elizabeth	WennerE@dnr.sc.gov
Apalachicola, FL	Wanat,Jennifer	Jennifer.Wanat@dep.state.fl.us
Chesapeake Bay, VA	Moore,Ken	moore@vims.edu
Delaware	Scarborough,Bob	bob.scarborough@state.de.us
Elkhorn Slough, CA	Wasson,Kerstin	kerstin.wasson@gmail.com
Grand Bay, MS	Woodrey,Mark	msw103@ra.msstate.edu
Great Bay, NH	Mills,Kathy	katherine.mills@wildlife.nh.gov
*Guana Tolomato Matanzas, FL	Gleeson,Rick	rglee@whitney.ufl.edu
Hudson River, NY	Fernald,Sarah	shfernal@gw.dec.state.ny.us
Jacques Cousteau, NJ	Kennish,Michael	kennish@marine.rutgers.edu
Jobos Bay, PR	Dieppa,Angel	adieppa@gmail.com

Reserve	Research Coord	Email
Kachemak Bay, AK	Doroff,Angela	angela.doroff@alaska.gov
Mission-Aransas, TX	Buskey,Ed	ed.buskey@mail.utexas.edu
Narragansett Bay, RI	Raposa,Ken	kenny@nbnerr.org
NOAA, Estuarine Reserves Division	Bundy,Marie	Marie.Bundy@noaa.gov
North Carolina	Fear,John	John.Fear@ncdenr.gov
North Inlet-Winyah Bay, SC	Smith,Erik	erik@belle.baruch.sc.edu
Old Woman Creek, OH	Klarer,David	david.klarer@oldwomancreek.org
Padilla Bay, WA	Bulthuis,Douglas	bulthuis@padillabay.gov
*Rookery Bay, FL	Vasquez,Victoria	Victoria.Vazquez@dep.state.fl.us
San Francisco Bay, CA	Ferner,Matt	mferner@slsu.edu
Sapelo Island, GA	Hurley,Dorset	dhurley@darientel.net
South Slough, OR	Rumrill,Steve	steve.rumrill@state.or.us
Tijuana River, CA	Crooks,Jeff	jcrooks@parks.ca.gov
Waquoit Bay, MA	Weidman,Chris	chris.weidman@state.ma.us
Weeks Bay, AL	Phipps,Scott	Scott.Phipps@dcnr.alabama.gov
Wells, ME	Dionne,Michele	dionne@wellsnerr.org

*call in

NOAA	Position	Email
Marie Bundy	Research Coord	Marie.Bundy@noaa.gov
Whit Saumweber	Program manager	whitley.saumweber@noaa.gov
Alison Krepp	Program specialist	Alison.krepp@noaa.gov
Laurie McGilvray	Division Chief	laurie.mcgilvray@noaa.gov

USC – Baruch Marine Lab	Position	Email
Jay Poucher	CDMO Telemetry Coordinator	jpoucher@sc.edu
Melissa Ide	Water Quality and Nutrient Data Specialist	melissa@belle.baruch.sc.edu
*Dwayne Porter, Ph.D.	CDMO Director	porter@sc.edu

*call in

SECN/NPS	Position	Email
Tony Curtis	Coastal Ecologist	tony_curtis@nps.gov

CTP: Coastal Training Program

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM
RESEARCH COORDINATOR MEETING, Waquoit Bay NERR
March 1 - 5, 2010
FINAL

Monday March 1		**Lead**
	Travel day	
All day and evening	Check in/meeting registration	
	Dinner on your own – unless you arrive before 7pm – you can then join us for dinner at Swope cafeteria – served until 7pm Monday evening	
Tuesday March 2		
7:00 -7:50 am	**Breakfast** (Swope cafeteria)	
8-10 am ******* 10:20am-12pm	CTP/RC joint meeting time (**Location: Speck Auditorium**) Welcome Plenary speaker Science Collaborative discussion Break 20 min (**Change location to Candle House**) CTP/RC joint meeting time (**Location: Candle House**) Science Collaborative discussion (continued)	Sci. Collaborative Team
12:00 -1:00	**Lunch** (and brief sector report-outs) location : Swope cafeteria	
1:00 – 3:00 (2 hr) Webex	RC Sector business (**Location: Candle House**) • Welcome and overview of the NERRS RC Meeting: • Goals & Objectives • Introductions around the room • Meeting Agenda: changes / updates • Status of past and future funding opportunities (e.g., NASA ROSES, CSCOR, NSF -NEON) • Strategic Committee proposals (pending and planned) Science Collaborative discussion (begin and set topics for rest of meeting)	Chris Weidman/RC's RCs/Dwight Trueblood
3:00 -3:15	**Break**	
3:15 – 5:00 (1 ¾ hr) **WebEx**	Science Collaborative discussion (cont., if needed) (**Location: Candle House**) Biological Monitoring • status of work plans submitted in 2010 (brief "round the room") • planning for FY 2011, if funding is available	Ken Moore/Marie Bundy
5:00 -6:30	**Evening reception**	
6:30 – 7:30p	**Dinner**	
8:00-9: 15p	Informal round table discussion of Biological Monitoring work plans: discuss questions about methodologies, data analyses, etc. relative to the upcoming projects. Provide input to reserves who are implementing biomonitoring for the first time.	RC's

Wednesday March 3		
7:00 -7:50 am	**Breakfast** (Swope cafeteria)	
8:00- 10:00	CTP/RC joint meeting time: **(Location: Candle House)** Working together in the future- developing a roadmap.	Cory Riley: facilitator
10:00 - 10:20 a	**Break (Location: Candle House)**	
10:15 – 12:00 pm (1 ¾ hr)	RC Sector Meeting **(Location: Candle House)** • Statement of Operational Capacity for SWMP • SWMP Finances • Update on GIS and HMC data input • Vertical control update on training, etc. • Sentinel Site (status of planning and budgeting)	Steve Rumrill/Whit Saumweber Jay Poucher Whit Saumweber
12:00 – 1:00 pm	**Lunch (Swope cafeteria)**	
1:00 – 4:00p	**Get on the bus – 1pm sharp to Waquoit Bay NERR** Tours of Waquoit Bay and Joint CTP/RC sector time	USGS meeting - JH WT
4:00 -6:00p ********* 6-6:30p	4 science presentations "Approaches to understanding nekton dynamics in estuaries: models for nekton biomonitoring and research at the Reserves" **(Location: WBNERR-Visitor Center)** ********* **Get on the bus – 6pm sharp back to Woods Hole for dinner**	Kerstin Wasson, facilitator
6:30 – 7:30p	**Dinner (Swope cafeteria)**	
8-8:40p	**NERR Graduate Research Fellow Talk – Christine Mingione** (Location: Candle House) "Species-specific patterns in bivalve larval supply to Waquoit Bay"	

NOTES:

Thursday March 4		
7:00 -7:50 a	**Breakfast (Swope cafeteria)**	
8:00 - 9:00 a	CTP/RC joint meeting time: **(Location: Candle House)** • NERRS SWMP Plan • CDMO website demo	Saumweber/ Rumrill/ Leister Jay Poucher
9:00 -10:00	RC Discussion of SWMP plan revision **(Location: Candle House)**	Rumrill/Saumweber
10:00 – 10:20	**Break**	
10:20 – 12:00 pm (1 ¾ hr)	RC sector meeting **(Location: Candle House)** • CDMO/DMC - CDMO report - DMC - SWMP Oversight Ctc • GRF update (new format for reports, 2010 RFP, etc.) • Briefing on 2011-2016 draft strategic plan framework. • Performance measures. Reporting and representation of the information by ERD, the NERRS, and RCs.	Erik Smith Jay Poucher Chris Weidman Alison Krepp Alison Krepp Marie Bundy/RCs
12:00 – 1:00	**Lunch (Swope cafeteria)**	
1:00 – ~~3:00~~ (2 hr) 4:00 *Webex*	RC sector meeting **(Location: Candle House)** • Nat. Park Service/NERRS meeting outcomes • Biological Monitoring build-out using FY 2010 funds for FY 2010- 2011 implementation. Planning for FY 12 and beyond	NPS rep, Moore, Saumweber RC's
3:00 -3:15 pm	**Break**	
~~3:15~~ 5:00 pm (1 ¾ hr) *Webex*	• Biological Monitoring (continued) **(Location: Candle House)** • Sci-Collab (RC discussion, if needed) • General discussion of potential collaborative research ideas and other research related items • Discuss future special issues of research results • RC/ CTP Collaboration: moving forward in context of topics listed above	Ken Moore, RC's RCs/ Dwight Trueblood Ken Moore/Mike Kennish
6:00 – 7:30	**Traditional New England Lobster Boil (Swope cafeteria)**	
7:30 – 9 pm	Social time	

NOTES:

USGS - MTG WITH Jeff LOT SUASA

Friday March 5		Lead
7:00 – 8:00 am	**Breakfast , check out (Swope)**	
8:00 -9:45 am	RC/CTP Joint session wrap up **(Location: Candle House)**	
9:45 – 11:00	RC sector: **(Location: Candle House)** • Housekeeping • Action items • Parking lot issues • Workgroups	
11:00 am	**Adjourn (box-lunch)**	

NOTES:

Notes on DOI LCC National Network Collaboration and Analysis Workshop
NCTC, March 30-April 1, 2010

Day 1

Introductory Comments by Leadership Panel:
Suzette Kimball

- Cochair for secretary's panel for putting climate science center network on the ground
- Challenge was how to make it a broad vision. Moving from time/space/mission specific needs to international cooperation/collaboration.
- Need to have good workgroup communication between CSCs and LCCs (separate workgroups so far). Next meeting will have both groups integrated.
- Networking and inclusiveness both important.
- Information from individual LCCs / programs will need to fit into regional/national models being developed by the CSCs.
- Data integration/interoperability of data needs to be at the national level.
- Each CSC will be supporting multiple LCCs. Will be a challenge to prioritize needs across LCCs.
- LCCs and CSCs will need strong national level oversight to ensure that they hang together as a national network/program.
- Need to think hard and well about data collection, analysis, and delivery while maintaining cross-LCC interoperability, especially among LCCs that share a CSC.
- Need to coordinate across programs to ensure we're not duplicating efforts
- From appropriations committee… need to ensure we're spending our conservation dollars appropriately, efficiently, and effectively. They've noticed that all the projects formerly "spun" as homeland security proposals right after 9/11 have been re-spun as climate change projects.
- International data sharing will be important. Resource needs don't follow program/political boundaries and neither should the science.

Paul Schmidt

- More than half the room is here in an "acting" capacity… lots of change coming still.
- Need to identify short term needs, particularly data, and figure out how to meet them.
- Lesson learned from migratory bird JVs is that they had so much flexibility in the beginning that it took a lot of time and energy to get them coordinated later.
- Need to be thinking strongly (at first) about what data we need and what systems we need to deliver conservation in the long term. Let that drive decisions for now.
- Look for and build off existing planning efforts rather than recreate those wheels.
- Look at the 8-point plan developed by the association of fish and wildlife agencies.

Tom Armstrong

- Primary reason for the LCC/CSC is to empower and enable better decision-making.

- US Global Change Research Program (USGCRP) working on IPCC-like report, but for US only.
    - 12 listening sessions going on; just held one in Chicago.
    - Positive response from stakeholders, mostly pleased with the fact that DOI is finally in the game and "gets it." Also liked the fact that it's a stakeholder-driven program. Important for stakeholders to both own and participate in the process. Including ALL stakeholders is a big challenge, but is important to strive for.
    - Sometimes the cultural or physical outcome is the end goal of conservation (not the biological). Though usually these things are all interdependent.
    - Again, notes from congressional committees, is that we need to get our act together and do good science rather than look like we're trying to take advantage of the issue of the day (climate change).
    - Lots of confusion still there
        - Roles and functions of LCCs and CSCs.
        - How does what we're doing compare with those of other agencies such as NOAA's climate service. Currently working on MOU between DOI and DOC to iron out what the two departments are doing to ensure that activities complement one another. Will be a series of implementing agreements that come out under the MOU to address actual implementation issues. Also working on similar agreements with other agencies.
    - Strong desire to see a central repository for information to which decision makers can look for information.
- If we cannot get our act together and work across agencies within the DOI, we stand to lose some of what we already have, as well as not being successful in getting more resources to address climate change.
- Two DOI workgroups now formed: LCC-CSC workgroup co-chaired by Dan Ashe, Kit Batten and Suzette Kimball. Data Integration and Dissemination Workgroup co-chaired by Steve Fancy and Pete Murdoch.

Deanna Archuleta – Deputy Asst. Sec. for Water and Science

- Strong need / desire by secretary to have an interagency approach to the LCC/CSC system as a Bureau.
- Absolutely need to be responsive to other partners.

Q&A

- Suzette. Yes there is an expectation that data from the LCCs will be used by the CSCs and this will come from monitoring programs and project monitoring.
- What happened to regional climate partnerships and is that still part of the vision, seems to have been dropped from the CSC communications? (Suzette) yes this will be critical and will be part of the review criteria for the regional CSCs as they're selected. (Tom)

Will need to bring in the broader community at both the regional and national level to deal with climate change issues. (Suzette) has become a "given" at this point.

- What are some of the obstacles to making this work? (Paul) Currently the social one might be the big one—some have been working within this framework for decades, others for weeks. Also big challenges with meeting expectations in terms of accomplishments and efficiencies. Data management too. (Deanna) Integration in general across the Department, though there's definitely support across the board. Also differences across regions. Also the basic fact that some people are still questioning whether climate change exists.

LCC Breakout Groups

General overview of status, challenges, opportunities, and how we see the LCC network fitting together.
Arctic LCC (Karen Murphy)

- Have steering committee comprised of project-level managers. Co-led by State and FWS. Sets funding priorities. Working to broaden the steering committee.
- Committee working to develop consensus-based conservation goals
    - Unified data needs
    - Improving physical processes that drive habitat change
    - Resource conservation and infrastructure planning and the geospatial tools needed to do it.
    - Supporting subsistence lifestyle. Both a fish/wildlife and cultural aspect.
- Additional conservation goals on the table for discussion in the next few weeks.
- Projects to date have been focused on filling baseline information needs identified by partner programs.
- Convenient that all agencies work within the same boundaries. And one state.
- Challenges
    - Changes happening fast and difficult to predict. BCR extends well into Canada.
    - Not physically connected to any other LCCs. No neighboring LCCs to work with. Trying to stand up western Alaska LCC now so this will be somewhat remedied

California LCC (Rick Karney)

- Ecologically, economically, and politically challenging.
    - Water dependent
    - Biodiverse
    - Central valley of CA is largely intensive agriculture and in addition to fisheries is managed on the margins of water resource availability.
    - Big cities / urban centers.
    - FWS challenge is to find its niche in a broad array of existing programs and partners.

    - Including strong climate program supported by the State/Governor. FWS is having to play catchup.
- Strategy has been to connect through existing programs and entities.
- Taking time to do it "right"
- Starting small (San Francisco bay area) as a demo area and will grow out from there.

Desert (Avra Morgan, BOR and Mima Falk)

- Avra
    - FWS is helping BOR stand up the LCC
    - BOR and its partners typically work on a watershed basin basis; initially wanted to do the Colorado River basin, which covers 4 LCC areas. BOR is unclear about how to work across boundaries with all of the partners – still trying to figure this out.
    - Challenge in trying to figure out the tensions between on the ground need and partners' needs to report upward to different performance goals.
    - Worried about partner fatigue… especially when jurisdictional maps don't overlap seamlessly.
    - Lots of climate science going on with good opportunity to collaborate in the future.
- Mima
    - Good experience co-standing up the LCC.
- Questions/comments.
    - Can we talk to Mexico about coordinating with them?...
    - Big challenge is the basis of LCCs in bird conservation areas now that we've expanded scope of LCC program beyond original intent to more partners.

Great Basin (Nora Devoe, acting Science Advisor for BLM HQ)

- Handout available.
- Working with BLM strongly, who is encouraging national consistency.
- Rapid population expansion
- Energy infrastructure increases will be huge impact in the future. Mostly wind and transmission lines.
- Lots of existing long-standing partnerships.
- Challenge of competing geographies
- Prioritizing needs that go to CSCs and applying outputs on the ground.

Great Northern (Yvette Converse)

- Co-hosted by FWS and NPS.
- 2010 muli-dimensional synthesis planned

- Data management system just getting off the ground.
- Steering committee is at the Director / RD level for most agencies.

Great Plains (Mima again, sitting in for Beth Olms)

- 30 people on the steering committee
- Recently had large scoping meeting with many other agencies. Still no other NGOs
- Partner fatigue!
- To get around it, the consensus was to have the JV become the management entity of the LCC and the JV coordinator to become the LCC coordinator. Mike Carter is the JV chair.
- Did an official RFP with criteria through grants.gov to fund projects.
- Criteria based on ops plan and FWS performance measures. Technical committee will be selecting the projects (including ngos and states I think)
- They are having to do lots of apologizing to partners about the speed of the rollout
- Questions/Comments:
    - Have any LCCs considered doing listening sessions / open houses to engage the broader conservation community and ensure we're working with the full spectrum of partners that we should be.

Gulf Coastal Plains and Ozarks (Bill Uihlein)

- Basically the JV said they wanted to start it up this year even though not officially funded.
- 3 joint ventures involved; 21 agencies involved
- Concern over speed, especially from states. Can get past that with $.
- Forming a steering committee, starting with a leadership summit that will iron out how to make it happen.
- Will have an integrated science team that will be built around subunits and resource challenges rather than driven by agency participation.
- Will be advertising for the science coordinator in the next couple of weeks. To be located at Mississippi State U.
- LCCs have responsibilities way beyond climate change. More than just climate change driving conservation needs.
- Questions/Comments-
    - JVs included are a significant science community and recognized as a leader as such. Will have to have a large role in the LCC as a result. Probably more integrated than in other LCCs.
    - Building committees around "opinion leaders" to get around angst of not having all agencies represented on each committee.
    - Where does mission of the LCC start and the States' needs begin? Generally how do we deal with moving beyond federal trust resources?

North Atlantic (Andrew Milliken and David Whitehurst)

- They have a final draft governance document.
- Many of the same issues as the SALCC but with more human population.
- Doing habitat mapping at the regional level. And maps of priority representative species.
- States are pooling fish and wildlife grant money to fund LCC priority projects. Based on multi-state conservation plan that is also being used as basis for LCC priorities.
- In talks with SALCC on how to coordinate/integrate climate science centers. The science needs to be driven by the needs of the LCCs.
- States' positions…
    - Some shared with federal government but different and "felt" at the state level. CWC plans brought this home, along with the demonstrated need to work at the landscape scale.
    - Need to have a uniform habitat classification system used across the board.
    - Have a northeast monitoring approach
    - Need consistent clear messaging
    - Consistent / clear governance standards and directives would be good; probably to communicate expectations.

Pacific Islands

- Big. Unique. Agencies have a history of working together.
- Hawaii Conservation Alliance is the interagency steering committee.

Plains and Prairie Potholes (Melinda Knudson)

- Focused largely on grassland and migratory birds. And large rivers.
- **Climate change was the #5 ranked driver for conservation planning, behind energy development and agricultural issues.**
- Two primary partners: PPJV and Fish Habitat Conservation Partnership.
- Data sharing going to be tough.
- Beware of mission creep… seem to be expanding to different scope than we originally started (we have by Sec. Salazar's mandate).
- Need to think about and plan for cumulative effects of multiple stressors on wildlife.
- NOTE: She seems to be focusing on project monitoring/ adaptive management as focus for monitoring as opposed to status and trends.
- Need for basic land use / land cover maps, digital elevation models, NWI wetland inventory maps etc., across the board.

South Atlantic (Joe DeVivo, NPS)

- Current Organizational Structure
    - Interagency Scoping Team (IST) formed in November 2009

        - Representatives from Federal and State agencies and NGO's
        - Purpose of IST is to develop the vision, operational structure and recommended governnce for the SALCC
        - Planning meeting scheduled for March 30-31, 2010
            - Draft SALCC Structure and Governance Document
            - Identify current assets and gaps relative to science capacity
            - Create criteria to assess and rank current and future project proposals relative to SALCC science needs
    - Partnership Engagement
        - April 20-22 2010 stakeholder workshop targeting leadership in Federal and State agencies and NGO's
        - Goal to obtain "buy in" to the SALCC
        - Vet IST Structure and Governance document
- Science Capacity
    - SALCC Core Staff in SALCC Office - Raleigh, NC:
        - LCC Coordinator (reporting late spring 2010)
        - Science Coordinator (hired in FY2010)
        - USGS Scientist(s) (hired in FY2010)
        - NPS Climate Change Adaptation Planning Specialist (proposed for FY 2010)
    - Additional capacity
        - NPS and FWS I&M programs (to be co-located in Athens, GA)
        - Others…
- Other notes From a regional/NPS perspective
    - Partner fatigue is a concern heard across LCCs where we're involved. Especially with partners involved with multiple LCCs who are not doing things the same way.
    - Managing expectations will be very important; consistent message on what the LCCs are trying to do is key. Not so much an issue of mission creep; we've had a change in mission of what the LCCs are trying to do, and the LCCs are adjusting to that differently and at different speeds.
    - Very difficult to track who is doing what related to climate change, especially outside DOI.

Southern Rockies (David Raff, BOR)

- Trying to figure out what it means to stand up an LCC…
- Never heard of a Joint Venture before….
- Would like to see LCCs built around each partners' trust responsibilities rather than limit it to fish, wildlife, habitats, and cultural resources.

- Need to be sure that subcommittee structure doesn't fragment the LCC back to what it was before.
- BOR has provided monthly downscaled data archived for entire US. See CMIP 3 at http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php
- 20% variability in 122 monthly downscaled models. Must become comfortable with that kind of variability.

Climate Science Center Roundtable

Robin O'Malley (Moderator)

- Conservation and adaptation occur at the local level, but need to put it in a regional context.
- CSCs are dealing with the global down to regional level – big regional climate signals.
- Not just dealing with climate change. Also have to think about hydrology, fire, invasives, and other things that are closely tied to climate.
- USGS is in charge of the USGS Climate Change and Wildlife Science Center, but is only acting as an agent for DOI in getting the CSCs stood up … these are DOI centers. Working to select the locations of 3 climate science centers this year, two next, and three more in 2012. Will stand them up as resources allow.
- Will likely first be staffed with fish/wildlife/habitats/ecosystems climate people, but will grow to include other disciplines in time. This will be their initial focus.
- Alaska, Southeast, and Northwest this year. Northeast and South Central in 2012.
- Information management will be key. But limited by storage capacity and throughput capacity.
- Regional CSCs will serve a role as a convening body to identify science needs.
- CSCs will have their own steering committee with one person from each LCC in addition to other manager-level people to ensure that the CSCs are producing management-relevant info.
- Plan is $3-4 million per year per center to fund the fish and wildlife and habitats component. Looking at a max of 25% for fixed costs, with the rest going to projects/partners.
- All will be located on university campuses (Sonya Jones, USGS, SE Region has heard different).
- Will need to catalog other agencies/programs/university programs that deal with fish, wildlife, habitat, and resource management for the proposal.
- LCCs are not the only client for the CSCs, but are "first among equals."
- Line between CSCs and LCCs is still unclear. LCCs will be more focused on site-specific stuff; CSCs at a larger scale (LCC/Region/System). LCCs will be more focused on the application side of things. But very blurry line most likely.

Alaska (Stan Smith)

- Alaska Climate Change Executive Roundtable (ACCER) provides overall leadership and oversight to the CSC and LCCs. Includes executive-level people from feds, states, NGOs.
- ACCER has also stood up a Data Integration Forum that is independent of the partners and programs.
    - Has a policy committee and technical working group
    - Idea is that if you manage the data separately than the programs, it will lead to more data sharing and integration

Southeast (Sonya Jones)

- Doing the Southeast Regional Assessment Project as a demo for integrated science and modeling tied to climate models/data
- Portal located at http://serap.er.usgs.gov
- Lots of integrated projects as a model for a CSC.
- CEN efforts in Gulf Coastal Plain (RSET and tidal gage data) and river hydrology (Appalachicola-Chattahoochee-Flint River Basin) to be integrated this FY.
- *NOTE: SE Coast Network will be integrating data from CHAT and KEMO monitoring/watershed condition assessments (part of the ACF basin) and upcoming coastal climate I&M efforts with the SERAP project. CHAT and KEMO draft condition assessment reports already provided to Pete Murdoch, CEN.*

Northwest Nancy Lee

- Lots of climate related partnerships
- Lots of climate related projects
- Will be the foundation for the CSC when it gets funding/location is selected.

Q&A / Comments

- Need to have more clarity on the dividing line between CSC and LCC roles.
- Need to have clarity on who the clients of the CSCs are. Not just the LCCs. Don't know if the CSCs will engage other partners thru the LCC framework or if thru another pathway.
- Relationship between CSCs and LCCs will be partly driven on funding structure. If soft funding requirements exist where partners have to fund USGS, then it's not going to work since there are other cheaper options (i.e., CESU program).

Association of Fish and Wildlife Agencies (Arpita Choudhury)

- Generally positive attitude of states toward LCCs and CSCs, but have the following concerns:

- Difficult to be involved with multiple LCCs and CSCs concurrently given state budget situations and lack of capacity. Applies to other federal programs that are also demanding states' participation.
- States need to be equal partners, and need to be on the steering committees. Seems like a federal takeover to some.
- Fear that existing partnerships that states are involved in will be diminished in capacity as LCCs and CSCs are stood up.
- Concern about mixed messaging. What they are, what they're not, and how states are supposed to engage with them.
- Need to identify what we're doing (clear goals and objectives) before identifying data and capacity needs.
- The information sharing platform for LCCs and CSCs needs to be the same one as used for the State Wildlife Action Plans (SWAPS)
- Need to do a better job of involving states with the process and reasons for the multiple science capacity needs requests (i.e., what are your needs…). Lots of requests coming from federal agencies, but the answers by the States seem to go into a black hole. States are not part of the process and so are frustrated.
- Feds need to take the time to do good communication and outreach to the states so everyone knows what's going on.

From the state agencies…

- National Fish Habitat Action Plan exists as the aquatic corollary to the JVs. Need to make sure they're included in the process.
- End of year will need to have a state of fish habitats report. States involved heavily in doing this.
- LOTS of data in the state systems, some very old, some not well organized. Can't ignore it.
- Lots to do and lots of interest. Need to guard against being redundant.
- Look at climate science as a layer above and beyond other stressors.
- Western State Governor's Assn. concerns:
  - Concerned about sovereignty and they need to manage each State's data at the state level. Data based on same structure so they can talk with one another but managed independently.
  - Looking for common definitions of conservation objectives across the board. States can manage to whatever point they want but at least they'll be comparing apples with apples.
  - Agreement on common metadata standards and data exchange standards will be important.

Facilitated Discussion

- Big side discussion ensued on relationship between CSCs and LCCs.

- RISA program (NOAA) lessons learned: need to include all partners from beginning to end.
- Status and trends monitoring will be key to climate change efforts and for placing LCC goals in the broader ecological context. Needs to be done within a national-level framework.

Day 2

Summary from day 1.

Unprecedented opportunity to move conservation forward, eyes of the world on us, and we're going to be held to the fire to do things well, efficiently, and right.
Opportunity to leave a legacy for Sam Hamilton.
Need to build meaningful partnerships.
Need to take advantage of existing efforts

Kit Batten is leaving the DOI on April 16th for the Heinz Center.
This landscape-scale, partnership approach is what we should have been doing 20 years ago, but the climate change focus is providing the opportunity to start doing it now.

Can't lose sight of our strategic goals but need to deliver in the short term.

There is $2 million set aside for figuring out how the LCC network can work as a connected unified program via data integration as opposed to a collection of independent LCCs.
USGS has an additional $1 million.
Morning Presentations

A lot of time / concern today coming back to the fact that there's a LOT of missing clarity in the roles and functions of what the LCCs and CSCs are, how they're supposed to work, and the resultant confusion as everyone tries to figure it out on their own. There's a need for FWS to spend $2 million this FY for supporting the LCC program at the national network level. Today largely geared toward figuring out to do with that money.

Steve Fancy – DOI Strategic

- DOI has committed to unified monitoring and data management effort that is state of the art.
- The "best available data" that our land managers need to make decisions at the local as well as the landscape level is stored in thousands of locations in hundreds of formats.
- Most of the data we need/use or that will be produced is external to DOI
- Technology exists for doing loosely-coupled distributed systems based on shared standards.
- Need to carefully figure out who the key audiences are for the data and information, what they need (as opposed to what they want), and then figure out how best to make the data easier to discover and access.
- Definitions of Data Integration:
    - Bringing data together from multiple sources and presenting a unified view of the results

    - Combining data from different sources or across agencies.
- Comment by David Hayes last June —"I think the data piece is probably the most important part of this" (he was talking about interagency coordination to address rapid climate change).
- Service Oriented Architecture (SOA) is the OMB, DOI, and industry standard.
- OMB and DOI require a structured, modular process. OMB has a toolkit… www.fsam.gov
- People in DOI Chief Information Officer's office will help us with this

Breakout Group 2 report outs…

Barriers

- There is a lack of a clear vision, goals, and objectives for the LCCs and the CSCs. Need to get clear message Department.
- Boundaries are dumb for LCCs and CSCs. At least there's a rationale for the LCCs though…
- What does an LCC Network mean?
- Maintaining continuity without stifling innovation. The DOI needs to provide guidance that is facilitative but not prescriptive.
- Lack of common terminology
- Uneven capacity among LCCs
- Lack of (biological) monitoring
- There's a culture of competition among regions to start up LCCs; might not be the best thing for the greater good.
- People being stretched too thin.
- Disparate levels of IT capacity among partners.
- Lack of staff stability within the LCCs – majority of people are acting or interim.
- Inconsistency among LCCs on what they're doing, what partners are involved; partners involved in several LCCs are hearing different messages from each LCC.
- Lack of data standards across department and partners
- Not a way to measure the success of LCCs at either the LCC or network levels.
- Navigating and working within the various missions of bureaus.
- Getting buy-in from partners without being clear on what they're buying into.

Sleepers

- Partner fatigue
- Relationships between partner groups and LCCs (i.e., joint ventures)
- Clearly a little tension between USGS, FWS, and other DOI agencies. Then there's the other federal agencies outside of DOI
- SWAPs (State Wildlife Action Plans) need to be an integral part of the planning process.

- Administration changes; losing some of the political will or momentum following the congressional midterms.
- Turfiness and cynicism
- Macroeconomic forces overriding ecologic considerations
- Renewable energy needs overriding ecologic considerations.
- Crossing a threshold where changes happening faster than our ability to predict, plan, and implement mitigation
- Lack of funding with the states
- Lack of incentives for cooperation
- Overhead for services charged among agencies.
- Lack of access to one anothers' data for a variety of reasons.
- Lack of clearly describing assumptions/limitations of underlying data when publishing models.

Short term wins

- Add value to LCCs by explicitly incorporating SWAPs into LCC efforts
- Add capacity
- Get better access across agencies to data.
- Products-need to produce *something* at the LCC level in a very short timeframe to demonstrate proof of concept and added value to partners/OMB
- Better align LCC and CSC boundaries.
- Deliver natural heritage data to all LCCs.
- Communication tools. Need a clear message, and that needs to be turned into a good communications/marketing plan.
- Finalize doc/doi mou
- Deliver maps of swaps, consistent habitat mapping and classification, and consistent ecological habitat and mapping.
- Videoconferencing.
- Data gap analysis.
- Demo report linking habitat/pop shifts to climate change and how that translates to conservation options.
- Basic data needs that everyone has, and we can get some of those from partners already working on it.
- Fund projects that have already been identified by the JVs.
- Fund states to update SWAPs in a coordinated manner with a landscape focus ala what is happening in the northeast and the west.
- Create a visual tool to demonstrate pulling datasets from multiple sources that can be used to market common objectives.
- Augment existing staff above existing LCC coordinators to take leadership of the network (doi-level).

- Publish the vulnerability assessment userguide under development by FWS. Possibly fund some actual assessments.
- Upgrade FWS' network to accommodate data management capacity.

Big Hairy Audacious Goals.

- Define sustainable landscapes within a living national conservation strategy
- Develop national-level conservation objectives derived via consensus process
- Vulnerability assessment of ecosystem services
- Develop national data-sharing network
- Use that to increase public support for conservation
- Generate national seamless LIDAR-based topographic maps.
- Help states and JVs do what they're already doing in a seamless fashion across the country
- LCC has ability to sustain fish and wildlife populations continentally
- Get all agencies and private landowners to embrace LCC
- Establish LCCs as a legislative priority.
- Maintain relevance across administrations.
- Ability to visualize ecological change across the country under different scenarios.
- Need to address the ocean component of the LCCs.
- Linkage with ESA policy
- Do interagency data integration.

Key Strategies

- Department level needs to have a good serious conservation about what these LCC things are trying to do. Needs to be an ongoing conversation.
- SWAPs need to be a part of this planning process
- Data sharing across all federal agencies and with States; each State needs to manage their own data (sovereignty).
- Each bureau should detail someone full time to work with Tom Armstrong at the DOI level as the LCCs and CSCs are being figured out.
- Get agreement for outcomes of LCCs that aren't driven by Strategic Habitat Conservation plans.
- Evaluation criteria for LCCs driven by economic/business plan measures.

Roles of DOI and partners

- Effectively and widely communicate purpose of LCCs to partners
- Provide videoconferencing capacity.
- Executive level interdepartmental coordination and communication
- Establish coalition to fund LCCs as a legislative priority.
- Develop an outreach plan and products on why LCCs matter.
- Obtain funding for data mining legacy databases.

- Facilitate conversations between scientists and managers.

Innovative Solutions

Ideas presented that are on the cutting edge. Not proposals, but there for stimulation of thought.

Chet Koblinski (NOAA)

NOAA received $170 million to install new supercomputers for downscaling, which they're doing. Test modelse running now at 3 km resolution.

NOAA has a proposed Climate Service. Will be pulling from OAR, NWS, and National Climatic Data Centers to form. Basically will have people and money in place to do stuff. Six regions, different maps.

Chet says that he came from NASA where he did rocket science, and that was a lot easier than figuring out how to organize the NOAA Climate Services effort.

Obviously need to work out the relationship between NOAA and CSCs to reduce overlap.

Climate services portal at www.climate.gov; background on www.noaa.gov/climate

Madeline West (Western Governors' Wildlife Council / Alliance)

- Council charged with mapping conservation corridors across states using consistent methods/priorities and turn it into a publicly-available decision support system.
- Received $3 Million from Dept. of Energy to test data decision-support system and protocols.
- Goal to make state data compatible across jurisdictional boundaries.
- Eight projects being funded to start in FY10
- Madeline said that she liked Steve Fancy's recommended strategy for data integration using web services and service-oriented architecture. Said if federal were changed to State, she could have given that talk, and maybe she will.

Stan Smith (USGS) migration to large-scale data integration via the USGS Climate Effects Network

- USGS in Alaska is developing a central data model repository.
- Very much focused on individual projects and how to coordinate data management of them across USGS.
- USGS researchers all maintain their own data and there is no one place where people can discover and access those data sets.
- Proposes a series of 7 to 10 regional data centers with some consistent data structures and metadata standards, so that USGS researchers can send their data to the regional data center where it can be managed and made available to others.
- Stan's recommendation is to (1) start local; (2) create area data centers; (3) centers would coordinate standards and publish data standards in a national repository; (4) support research projects; (5) create a national data store where everyone would submit their data or metadata.

Nate Booth (USGS) Geo-Data Portal

- Provide a subset of processed downscaled models thru web tools.

- Provide catalog of best-available data
- Serve derivative products from modeling efforts that others can use.
- Connecting data needs…
    - Common geo framework
    - Common terminology
    - Collection Standards
    - QA standards
- SOA great for small data sets but isn't good for pushing big pieces of data around.
- EPA exchange network (http://www.exchangenetwork.net)
    - Based on open source community that provides "node" software. People can become nodes.
    - Rigid standards in terms of how nodes are supposed to serve data (standards).
- NOAA IOOS program
- Canada Groundwater Info Network (GIN)
    - Providers push data using their own standards
    - GIN dynamically decodes data into common semantics – Magic decoder ring
- Water Observations—
    - Observations and Measurements Standards via XML.
- USGS BIODATA
    - Funded by NAWQA
    - Algae, fish, inverts, to both USGS and EPA standards.

Day 3

Andrew Milken concerned that we are moving on before addressing the data integration thing. Rex wants to make sure we have an executive summary of leadership panel discussion.

Breakout groups to prioritize stuff from Day 2 breakout groups

Overcoming Barriers

- Need to clarify vision, goals, objectives of LCCs and their relationship to CSCs, and communicate this as a "concept we are considering" to partners, and then ask for their input and feedback, and then revise the goals, objectives and iterate. After getting input from all the partners (and there are about 100 of them), communicate the vision and goals widely.
- Develop a working-level structure for interaction and decision-making. Each DOI bureau should detail someone full-time to the Department to figure all of this out. DOI guidance should be facilitative but not prescriptive.
- Develop a working framework model. Clarify the roles and responsibilities, and describe what the LCC is and is not.
    - Evolve conservation planning strategies. Need to figure out how to do collaborative planning and implementation across agencies that have different missions/views/plans of attack.

- Allow time (several years) for partnerships to develop. Most of the people currently are in interim or acting positions.

Partnership Opportunities

- DOI leadership needs to work with LCC coordinators to develop clear vision, goals, and minimum expectations.
- Recognize and build on existing partnerships (States, Joint Ventures), and identify partnership gaps.
- Develop national and LCC level relationships with States considering SWAPs and other state place-based conservation initiatives.
- DOI needs to engage at the Cabinet level with other federal agencies (DOC, DOE, USDA, CDQ, EPA, NOAA) and with tribes. And other countries, particularly Canada and Mexico. Basically we need to ensure that there's good cabinet-level conversations going on.
- DOI needs partnership strategy that spans a diversity of partner types (science, planning, implementation, political) informed by LCCs.

Big Hairy Audacious Goals

- Develop a living national conservation strategy
    - Sustainability
    - Visualization and forecasting
    - Ridge to reef
    - Cross-boundaries, gradients, ecosystems
    - Includes long-term monitoring commitment
- Maintain robust science to manager partnership at all levels
    - Agency, joint ventures, states, etc.
- Develop national data sharing network
    - Standardization
    - High-priority data sets
    - Comprehensive
    - Includes legacy and baseline data
- LCCs as a legislative priority
- Increase public support for conservation
- Incorporate ocean systems into LCCs.
- True collaboration and reduced duplication of effort
    - e.g., bureaus and agencies.

<u>"Short-term Wins" that we should begin working on right away</u>:

- Each bureau details someone full-time to work as DOI coordinated staff for Tom Armst.
- Develop a strategy for integrating SWAPS (state wildlife action plans), JVs, national fish habitat initiative
- Develop a messaging and outreach strategy

- Schedule a workshop to address the data management strategy
- Do a gap analysis to determine what data and models exist vs. what is needed by each LCC
- Conduct an inventory of existing data sets and information
- Design a web portal for the LCC network.

Close-out Report to Leadership Panel

- definitely need more guidance, but looking to the field level to flush out the details.
- BHAGS all seem to be systems-level challenges.
- Hindsight 20/20 and this meeting would have been good months ago.
- Anxious to get to the follow up workshop on data management and standards so we have some thoughts on how to spend the $2 million.
- Working on a common governance structure that will be shared by all LCCs.
- During Q/A session with leadership panel, it was pointed out that there were two sets of guidance: The DOI guidance emphasizes multiple DOI agencies in each LCC and mentions cultural resources and marine resources equally with fish, wildlife, and habitats. The FWS LCC form and function guidance just talks about fish, wildlife, and their habitats, and some of the LCCs are focusing only on that.

  Miscellaneous notes:
- Many of the LCCs seem to want a lot of flexibility to develop partnerships and do things their way at the local level. The majority of people didn't see the need for a national network of LCCs.
- Several of the LCCs are funding projects to do on-the-ground conservation projects with partners because they have money they have to obligate and don't know what to do with it otherwise.

Appendix B. Aligned Climate Change Science Programs in the Southeast Coast Network

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Congressional Research Service

MEMORANDUM April 26, 2010

To: House Subcommittee on Interior, Environment, and Related Agencies
Attention: Darren Benjamin

From: M. Lynne Corn, Specialist in Natural Resources (7-7267)

Subject: **Science in the Federal Land Management Agencies**

CRS was asked to identify what major science committees, initiatives, programs, and projects (CIPPs) exist in the four federal land management agencies, with special emphasis on interagency and cooperative CIPPs as they relate to climate change and research. We were asked to include programs of the U.S. Geological Survey (USGS), and to highlight relevant major science programs internal to the five agencies. One goal of the effort was to determine whether any of the CIPPs might be duplicative. The authors of this report are Lynne Corn (7-7267, overview and Fish and Wildlife Service), Angela Zahniser (overview and National Park Service), Ross Gorte (7-7266, Forest Service), Carol Hardy-Vincent (7-8651, Bureau of Land Management), Peter Folger (7-1517, Geological Survey), and Pervaze Sheikh (7-6070, Geological Survey).

As we discussed, we ultimately found that a complete evaluation of all the science and climate change programs within and across the DOI agencies and the Forest Service was beyond the scope of CRS' mission. During our research, we found several things. First, some programs have existed for decades, and recently underwent name changes or moved from one agency to another, so there were fewer CIPPs than there first appeared to be. Second, some programs are very new, and their roles are still evolving. Third, while integration of research is a top goal according to many statements from many agencies, the success of that integration in the CIPPs would require a level of investigation into the agencies' inner workings that CRS cannot accomplish.

Even so, the research did show that the stated missions of some of the programs overlap and that efforts might be needed to prevent duplication, promote information sharing, and fill gaps in research. However, duplication of scientific research is not necessarily a bad thing—in the scientific world, it is sometimes encouraged because repeated conclusions give weight to a particular hypothesis. In this light, some duplication is beneficial to scientific understanding. Even if the programs are directed to navigate away from producing duplication or gaps, a review of where these exist could be helpful. If duplication or gaps are found, statutory changes might be needed to address them, or solutions might be as simple as co-housing regional programs to encourage integrated efforts.

As you requested, we have supplied a number of questions that might be posed to an investigative agency such as the Government Accountability Office to evaluate whether the programs are achieving their goals without duplication or gaps. The authors would be available to assist the Subcommittee in developing such a request further.



Science in the Federal Land Management Agencies

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Introduction

Scientific information is central in managing natural resources in each of the four federal land management agencies (FLMs): the Fish and Wildlife Service (FWS), the National Park Service (NPS), and the Bureau of Land Management (BLM), all in the Department of the Interior (DOI); and the Forest Service (USFS) in the Department of Agriculture. Although scientific needs vary among the FLMs, there is significant overlap in the basic information that agencies need, such as habitat connectivity, water quality, species structure and composition, etc. To address these science needs, the FLMs have formed various committees, initiatives, programs, and projects (CIPPs). Some CIPPs are internal to the agencies, while others are partnerships among agencies and with other public and private organizations. Due to varying agency missions, purposes, and timelines, some CIPPs may have overlapping functions, and some could duplicate another agency's efforts.

A caveat is part of this analysis. Duplications and overlaps in scientific investigations, as well as agency missions are not, by themselves, necessarily bad. For example, a single experiment or data set suggesting that global climate change is accelerating would not generate much response or even interest. Rather, the large variety of experiments and data sets, nearly all pointing in the same direction, are generating attention and further research. Together, the agency efforts discussed here might be beneficial, even if duplicative or overlapping.

The Obama Administration has stressed the role of science in natural resource management and planning. Accordingly, many FLMs are strengthening the role of science within their organizations. In addition, a role of the United States Geological Survey (USGS) is to provide reliable scientific information to the other DOI agencies. USGS collects monitoring and inventory data in various fields, but emphasizes high quality, publishable, peer-reviewed science. The emphasis on publishable reports can sometimes be discordant with basic scientific needs of the land management agencies (such as inventory, monitoring, and data collection). Therefore, while this high-level science is often useful to the agencies, some have additional needs for scientific input to aid decision-making, and to communicate with agency staff and the public.[1] At the same time, some officials claim that the cost of USGS scientific services can be higher than the agency is willing to pay, leaving the agencies to perform the work in-house or to obtain services elsewhere. True or not, that impression has left the employees in some DOI agencies with a strong interest in rebuilding the science capacity in their own agencies to complement the USGS work.[2]

Concurrently, the Administration's emphasis on assessing current and future effects of climate change has led to increased budget support for this specific purpose. In FY2010, new funds were appropriated to the DOI land management agencies to address climate change. USGS received $67.5 million; FWS received $40.0 million, NPS received $10.0 million, and BLM received $15.0 million. With the exception of NPS, the Administration has requested increased funding for climate change adaptation in FY2011.

[1] Personal conversations between CRS and several DOI officials.

[2] In the time available, CRS could not document or verify the accuracy of the cost issue and the science research USGS is willing to undertake. But these views are very widespread, and were voiced to several of this paper's authors. Even if these views did not adequately reflect available science capacity, those FLM employees who hold these views would naturally want to augment their own agency's internal science capacity, especially if they believed USGS services to be too costly compared to internal agency science delivery.

The new or expanded programs raise several questions regarding the allocation of federal resources: (a) are climate change funds being used for climate change applications *per se*; (b) are funds being used for basic science needs that exist regardless of climate change; and (c) is new climate change funding causing a duplication of CIPP efforts in some areas while leaving gaps in others? Moreover, are new CIPPs being created for climate change, when CIPPs which serve essentially the same roles and functions may already exist, though perhaps not couched within the framework of climate change?

This report illustrates how each land management agency structures science; how the agencies use USGS science services; the major science-related CIPPs in the agencies; how CIPPs may or may not relate to each other; and how the agencies are using appropriated climate change funds and the effect these funds may be having on existing CIPPs. Finally, a discussion compares CIPPs across agencies, provides an analysis on their functionality, and raises questions that might be considered in future investigations. The report focuses primarily on the three Department of the Interior land management agencies and the Forest Service science program, which provides a markedly different structure and organization for management of science.

Twenty Year History of Natural Resource Science

The management of science in the four federal lands agencies has evolved in the last few decades, and is moving toward landscape scale management.[3] Arguably, the pattern of change is cyclical rather than linear: particularly with the so-called *spotted owl wars* of the 1980s and 1990s in the Pacific northwest, many observers held that the four agencies needed to turn away from an approach that seemed geared to managing for single species.[4] Early on in the Clinton Administration, officials conceived of an approach called *ecosystem management*, with a stated goal of restoring and maintaining "the health, sustainability and biological diversity of ecosystems while supporting sustainable economies and communities."[5] In part, the effort was questioned for trying to achieve a balance among all values and demands, even when there were conflicting values or demands. At the same time, there was support for the approach because of its stress on considering a broad array of constraints and demands on the landscape, and on drawing in a wider array of interested parties.

In 1993, Interior Secretary Bruce Babbitt announced the creation of a new non-regulatory body within DOI, called the National Biological Service (NBS). Modeled after Biological Surveys in Illinois, Ohio, and a few other states, its purpose was to consolidate biological research and information in a single DOI agency. Members at that time expressed concern about the authority of the agency, its perceived interest in surveying for endangered species, perhaps in violation of property rights, and other issues. Eventually, the matter was resolved by moving NBS to USGS, where it became the Biological Research Discipline (BRD).

[3] Interagency Ecosystem Management Task Force, *The Ecosystem Approach: Healthy Ecosystems and Sustainable Economies (Vol. 2)*, Washington, DC, November 1995, p. 1.

[4] For a history of the spotted owl vs. timber harvest controversy, see CRS Issue Brief IB90094. *Spotted owls and old growth forests: archived issue brief* by M. Lynne Corn. Sept. 21, 1992. 15 p. Available from the author.

[5] For additional information on the ecosystem management approach see U.S. General Accounting Office, *Ecosystem Management: Additional Actions Needed to Adequately Test a Promising Approach*, GAO/RCED-94-111, August 1994. Two figures in the report show that in 1994, FWS was dividing the country into 52 ecosystems (compared to 21 under the LCCs, discussed below). And the Forest Service shows about two dozen ecosystems.

Among its roles, USGS "…collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems."[6] A major goal of USGS science is to provide the basic scientific foundation in earth sciences and biological/ecosystem sciences for the management strategies being pursued by DOI land management agencies. DOI agencies rely on USGS, to the extent possible, for scientific data and interpretations to inform their land management decisions. According to some, the USGS emphasis on high quality and peer-reviewed science can sometimes be at odds with the more prosaic scientific needs of land management agencies for inventory, monitoring, data collection in various forms, and other science that may not, by itself, result in publishable material. As a result, some employees in some DOI agencies have a strong interest in rebuilding the science capacity in their own agencies. Some duplication and overlap of scientific research could result.

However, duplication of research is not, in itself, necessarily avoided or undesirable in the scientific world. Hypotheses, especially concerning complex topics like global climate change, are thoroughly tested from a variety of angles. Only once the hypothesis is thoroughly tested, is it considered a "theory" or a "law" and it then becomes part of the body of scientific knowledge. Even accepted theories and laws remain open to re-examination if new information arises. It is through these methods that science gives weight to the viewpoints of one scientist versus another. In this light, some duplication is beneficial to scientific understanding.

Landscape Scale Management

In many respects, landscape scale management looks like a rejuvenation of the ecosystem management approach popular in the mid-1990s. There appears to be no accepted definition of the term, but it appears to be used in a manner similar to ecosystem management, but with a greater emphasis on large tracts of lands or waters, their biological connectivity, and resilience to a changing environment.[7] Necessarily, the larger scale requires the participation and acquiescence of a larger array of parties, though this participation appears to be a consequence more than a goal of the approach.

Secretarial Priorities

The Secretary of the Interior, Mr. Ken Salazar, has expressed great interest in the role of science in the Department, especially in addressing adaptation to climate change. He has established seven Departmental-wide priorities. Three of the seven priorities are: addressing the issue of global climate change; addressing critical water issues; and insuring the integrity of science in support of Interior's decision-making.[8]

> In all of these activities, DOI is putting a premium on integrating our dual science and land management roles.... We are focused on ensuring that our USGS and other agency scientists

[6] See http://www.usgs.gov/aboutusgs/default.asp#what.

[7] No definition of the term was found on the DOI website, for example. Secretarial Order 3289 does not give a definition of the term. The Order emphasizes the need to consider land management on a broader, more integrative scale.

[8] As stated in the DOI Open Government Plan, page 13, http://www.doi.gov/open/upload/DOI_Open_Government_Plan_v1a.pdf. Also as stated in Federal Register Notice, Volume 74, Number 175, Page 46784-46786 See: http://www.doi.gov/archive/strategicplan/FederalRegistryNotice091109.pdf

> are collecting and analyzing data that are providing relevant scientific information about natural resource conditions, issues, and problems to decision-makers in the Department, at all levels of government, and the general public. This is, and needs to be, an interactive process, as our land, wildlife and water managers work with our scientists and help focus the nature of their research and analysis on the reality of on-the-ground changes. This information – baseline scientific information, trends detection, modeling and forecasting, together with the effective dissemination of information and decision support tools – is key to understanding and addressing climate change and its effects.[9]

Discussions with departmental officials revealed that, in an effort to identify and curtail duplicative efforts and to increase interagency communication, department-wide biweekly meetings occur in which all agency science advisors are invited. However, it is unclear which agencies attend consistently, and whether principals commonly delegate lower-ranking officials to attend in their absence.

To achieve the seven aforementioned priorities, the Secretary has established five high-priority performance goals for the DOI. Of the five high-priority performance goals, two are relevant to this report:

> **Water Conservation**: Enable capability to increase available water supply for agricultural, municipal, industrial, and environmental uses in the western United States by 350,000 acre-feet (estimated amount) by 2012 through the bureau's conservation-related programs, such as water reuse and recycling (Title XVI) and WaterSmart Grants.
>
> **Climate Change**: By 2012, the Department will identify the areas and species' ranges in the U.S. that are most vulnerable to climate change, and begin implementing comprehensive climate change adaptation strategies in these areas.[10]

To meet the climate change goal, the Department has created a Climate Change Adaptation Initiative.[11] This initiative will be carried out under three approaches, which are intended to form the foundational elements for eight DOI regional Climate Science Centers (discussed in the USGS section below). These approaches include *climate change impact science* to conduct and communicate climate change research and monitoring; *data integration and dissemination* to improve the DOI's scientific database integration access to climate change impact data; and *enabling science-based adaptation strategies* to enable the design and implementation of adaptive management strategies.

Climate change actions that are already underway include: establishing a Climate Change Response Council (to provide leadership for the initiative); developing a strategy for establishing eight Regional Climate Science Centers (CSCs) (to synthesize climate change impact data and strategies); establishing (or expanding) a network of Landscape Conservation Cooperatives (to draft landscape-level strategies for managing climate change impacts in coordination with the

[9] Statement of Kenneth L. Salazar Secretary, Department of the Interior. Hearing on Energy and Climate Legislation, Senate Committee on Environment and Public Works. July 7, 2009. Available at http://www.doi.gov/news/speeches/2009_07_07_speech.cfm.

[10] Department of the Interior Open Government Plan, page 14. See http://www.doi.gov/open/upload/DOI_Open_Government_Plan_v1a.pdf.

[11] The Departmental Highlights of the FY2011 budget discuss the climate change high-priority performance goal as part of a "Climate Change Adaptation Initiative" and refers to the climate change management approaches and the actions already underway as an initiative. See http://www.doi.gov/budget/2011/11Hilites/DH011.pdf.

CSCs); developing a global change effects network (to establish a unified climate change monitoring network); and implementing a carbon sequestration project (for assessing the potential of geological and biological carbon sequestration).

In FY2010, appropriations specifically and identifiably for climate change adaptation included $132.5 million for BLM, USGS, FWS, and NPS. The comparable budget request for FY2011 for these agencies is $164.2 million.

Table 1. DOI Appropriations for Climate Change
FY2010-FY2011

Climate Change Adaptation ($ in millions)			
	2010 Enacted	2011 Request	Change
BLM	15.0	17.5	+2.5
USGS	67.5	77.9	+10.4
FWS	40.0	58.8	+18.8
NPS	10.0	10.0	0.0
Total	132.5	164.2	+31.7

Source: Information Source: Department of the Interior Budget Highlights for FY2011. See http://www.doi.gov/budget/2011/11Hilites/DH011.pdf, page DH-16.

Also, in a press conference upon the release of the FY2011 DOI budget, the Secretary's prepared statement said that proposed increases in the climate change science budget would:

> ...support Interior's high priority goal of identifying the areas and species most vulnerable to climate change, and to begin implementing comprehensive adaptation strategies.
>
> We will focus on three primary areas to achieve our goal:
>
> First, Climate Impact Science, which will improve our understanding of the impacts of climate change on our resources;
>
> Second, Data Integration and Dissemination, which will improve our nation's scientific database;
>
> And third, we will enable science-based adaptation strategies.
>
> These new approaches will form the foundation for the Climate Science Centers that Interior is already establishing on a regional basis around the country. And for the Landscape Conservation Cooperatives, which are geographically-based cooperatives in which all Interior bureaus will collaborate with outside partners to understand the impacts of climate change and facilitate a coordinated response. Our Climate Change initiative will allow Interior bureaus to both meet their individual mission, and work in synergy with partners to implement integrated science, adaptation and mitigation strategies across broad landscapes.[12]

[12] Secretary Salazar's Remarks at FY 2011 Budget Press Conference, Feb. 1, 2010. Available at http://www.doi.gov/news/speeches/2010_02_01_speech.cfm.

Taken together, the actions and statements appear to place an emphasis on (a) integration of science, (b) science in service of the management of federal lands (and their associated plants, animals, and human heritage), and (c) coordination of that management with that of surrounding lands, especially in a changing environment.

In this light, the Secretary issued Secretarial Order 3289, to provide a department-wide approach to providing scientific tools to understand and respond to climate change.[13] The various parts of this Order are discussed below in the "Secretarial Order 3289" section and in several other sections of this report.

Interagency Science Committees, Initiatives, Programs and Projects (CIPPs)

Since natural resources and their associated management issues often transcend geopolitical or agency boundaries, some FLMs are (again[14]) attempting to broaden their focus to local, regional, and ecosystem levels. Regional assessments are evolving as a tool for conservation planning because they enable managers to assess the status, trends, and risks to biotic and abiotic resources (including water) at different spatial scales. In addition, large amounts of high-utility data are available, especially from sources external to the federal agencies. As such, cross-disciplinary and interagency cooperation is often necessary and useful. To address the growing need for collaboration, to streamline funding, and to reduce duplicative efforts among agencies, several CIPPs within the Department of the Interior were created. Following are basic descriptions of the major interagency CIPPs within DOI.[15]

Cooperative Ecosystem Studies Units (CESUs)

Description and Mission

The general movement toward land management at an ecosystem scale and the increasing demand for scientific research and expertise for U.S. federal land management agencies has fostered the creation of the Cooperative Ecosystem Studies Units (CESU) National Network.[16] The CESU is a geographically-based network that includes federal agencies, universities, and non-profit organizations. It provides research, technical assistance, and education to resource and environmental managers. The CESU program was established by the National Parks Omnibus Act of 1998 (P.L. 105-391 Sec. 203); the CESU Council and Network was established in 1999 through a Memorandum of Understanding. This MOU directs the CESU Council to establish the broad policies of the Network. The objectives of the CESU Network are to:

[13] S.O. 3289 is available at http://www.fws.gov/science/shc/pdf/SecOrder3289b.pdf. The Secretary cited his authority for the order as "Section 2 of the Reorganization Plan No. 3 of 1950 (64 Stat. 1262), as amended."

[14] See "Twenty Year History of Natural Resource Science," above.

[15] The Landscape Conservation Cooperatives might arguably be included in this section due to the role of a number of federal agencies. However, because they are the major initiative within FWS (where they predate S.O. 3289), and FWS retains a dominant role in their operation, they are considered under the FWS heading.

[16] Ecosystem studies include biological, physical, social, and cultural sciences.

Provide resource managers with high quality scientific research, technical assistance, and education;

Deliver timely and relevant research and technical assistance to develop and implement sound adaptive management approaches;

Ensure the independence and objectivity of research;

Create and maintain effective partnerships among federal agencies and universities;

Take full advantage of university resources while benefiting faculty and students;

Encourage professional development of federal scientists; and

Manage federal science resources efficiently.[17]

Cooperators

Thirteen federal agencies are currently participants, and there continues to be interest among other federal agencies for potential inclusion. More than 200 universities belong to various CESUs. The Federal agencies are:

- Bureau of Land Management (DOI)
- Fish and Wildlife Service (DOI)
- National Park Service (DOI)
- US Geological Survey (DOI)
- Bureau of Reclamation (DOI)
- Minerals Management Service (DOI)
- Forest Service (USDA)
- Agricultural Research Service (USDA)
- Natural Resources Conservation Service (USDA)
- National Oceanic and Atmospheric Administration (Commerce)
- Department of Defense
- Army Corps of Engineers (DOD)
- National Aeronautics and Space Administration[18]

[17] Information available at: http://www.cesu.psu.edu/about/default.htm.

[18] Memorandum of Understanding for establishing the Cooperative Ecosystem Studies Units Network, available at http://www.cesu.psu.edu/materials/mou.pdf.

Organization

The goal of a CESU council is to coordinate and support the units within the network by providing guidelines, maintaining networks for communication, and producing an annual report. The council includes representatives from various participating federal agencies. Each CESU is an individual unit, is based at a university, has a senior scientist whose role is to coordinate the science needs of the unit, and concentrates on a particular biogeographic region. A CESU is a working collaboration among federal agencies and universities, where the federal agency provides research scientists and other personnel, and the university provides space, basic administrative support, and access to university faculty, students, staff, and resources. Each CESU must have a host university, its own role and mission statement, a managers' committee, and strategic and annual work plans; each CESU may include multiple federal agencies and/or partner institutions. There are seventeen CESUs in the U.S. (See **Figure 1**.)[19]

Figure 1. Cooperative Ecosystem Studies Units Network



Source: CESU network, available at http://www.cesu.psu.edu/.

Funding

Each CESU is its own unit with a distinctive mission statement and structure; therefore the funding level for each individual unit varies. There are no annual dues or fees. There is no central budget that each unit applies to; rather, each unit is supported by funds supplied by the supporting agencies. However, each CESU has a negotiated rate of 17.5% overhead fee rate paid to the university for each unit. This rate is a overhead cost considerably lower than if the unit operated

[19] Information available at http://www.cesu.psu.edu/about/default.htm.

independent of the university. Some estimate that, otherwise, the overhead costs could be as high as 30% of the total operating costs.[20]

Secretarial Order 3289

Secretarial Order 3289, first issued on September 14, 2009, and later amended on February 22, 2010, established a DOI-wide approach for applying scientific tools to increase the understanding of climate change.[21] It established a Climate Change Response Council, which was charged with implementing DOI-specific climate change activities through planning requirements; broadened the mandate of and renamed the DOI regional Climate Science Centers (CSCs); and stimulated the continued development of the Landscape Conservation Cooperatives (LCCs) and linked them with the CSCs.[22] It also established the DOI carbon storage project, and the DOI carbon footprint project.[23]

Climate Change Response Council

The Climate Change Response Council is charged with coordinating a Department-wide strategy to increase scientific understanding and develop tools to address the impacts of climate change on natural and cultural resources. The council is in the Office of the Secretary, where the Secretary serves as the Chair; the Deputy Secretary as the Vice-Chair; and the Counselor to the Secretary as a second Vice-Chair; other members include the Assistant Secretaries, agency directors and the Solicitor. The council coordinates all climate change activities with all relevant federal departments and agencies, including the Council on Environmental Quality, the Office of Energy and Climate Change, the Office of Science and Technology Policy, the National Science and Technology Council, the Department of Agriculture, the Department of Commerce, the Department of Defense, and the Environmental Protection Agency.

DOI Climate Science Centers

The USGS has been developing regional science centers to provide climate change impact data and analysis.[24] These centers, once known as "regional hubs" of the National Climate Change and Wildlife Science Center, and now CSCs, had their mission broadened by the Secretarial Order to encompass other climate change impacts on Departmental resources.[25]

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[20] Personal discussions between CRS and NPS Science Advisor Gary Machlis and CESU National Coordinator Tom Fish, during the week of March 29, 2010.

[21] It should be noted that Secretarial Order 3285, signed on March 11, 2009, established a Departmental Task Force on Energy and Climate Change. However, the focus of that Order was to establish renewable energy as a Departmental priority, and had very little to do with climate change activities per se. Available at: http://elips.doi.gov/app_so/act_getfiles.cfm?order_number=3285.

[22] The LCCs were initially established within the FWS, and were eventually incorporated into the DOI-wide Climate Change Adaptation Initiative.

[23] The full text of the amended Order can be found at http://elips.doi.gov/app_so/act_getfiles.cfm?order_number=3289A1.

[24] USGS was authorized under P.L. 110-161 to develop regional science centers to provide climate change impact data and analysis.

[25] Secretarial Order 3289, signed on September 14, 2009, directed the renaming of the "regional hubs" as "Regional Climate Change Response Centers." However, when S.O. 3289 was amended on February 22, 2010 (S.O. 3289A1), the (continued...)

Landscape Conservation Cooperatives

This Order also directed the Climate Change Response Council to work with the agencies to expand the network of Landscape Conservation Cooperatives (LCCs) that already existed within FWS. The LCCs are charged with working with the Climate Science Centers to coordinate climate change adaptation efforts. (See "Landscape Conservation Cooperatives," in the FWS section below.)

Carbon Projects

The Order also established two projects—the Carbon Storage Project and the Carbon Footprint Project. The Carbon Storage Project is to develop methodologies for measuring biological and geological sequestration of greenhouse gases; USGS is the lead agency. The Carbon Footprint Project is to develop an inventory of DOI's impact on climate change through greenhouse gas emissions or land use management practices. The Assistant Secretary for Policy, Management and Budget is the lead in managing this project.

Joint Fire Science Program

Description

The Joint Fire Science Program (JFSP) was created by Congress in 1998.[26] It is an interagency research and development partnership between DOI and USDA to develop and implement information and practices for wildfire management.[27] The JFSP develops science-based knowledge and tools to provide support to federal, state, tribal, and local agencies in the areas of:

- fuel inventory and mapping;
- fuel treatment planning, scheduling, and risk assessment;
- fire effects and fire behavior;
- monitoring and evaluation;
- restoration of fire-adapted ecosystems;
- post-fire stabilization and rehabilitation;
- remote sensing; and
- developing and integrating research information for local land managers.

(...continued)

"regional hubs" were renamed again, and directed to be called "DOI Climate Science Centers." For consistency and clarity, the term DOI "Climate Science Center," or "CSC" is used throughout this report when discussing these centers, except in instances such as this when a quote is being used.

[26] H.Rept. 105-163, accompanying H.R. 2107, Department of the Interior and Related Agencies Appropriations, 1998 (P.L. 105-83).

[27] Other federal research on wildfire protection also occurs in other agencies and programs, such as USFS Research. (See below.)

Mission of the Program

The stated mission is to:

- provide credible research tailored to the needs of fire and fuel managers;
- engage and listen to clients and then develop focused, strategic lines of new research responsive to those needs;
- solicit proposals from scientists who compete for funding through a rigorous peer-review process designed to ensure the best projects are funded;
- focus on science delivery when research is completed with a suite of communication tools to ensure that managers are aware of, understand, and can use the information to make sound decisions and implement projects.[28]

Organization

The Joint Fire Science Program is administered by a small program office in Boise, ID, with links to the National Interagency Fire Center, also in Boise. Programs are overseen by a Governing Board, composed of representatives of BLM, NPS, FWS, Bureau of Indian Affairs, USGS, and five representatives from the Forest Service.

Recent Funding

The JFSP received funding through the BLM (initially) or DOI Wildland Fire Management appropriation annually since FY1999, and through the USFS Wildland Fire Management appropriation annually since FY2002. Recent funding is stable; it is shown in Table 2.

Table 2. Joint Fire Science Program Funding, FY2009-FY2011

($ in millions)

	FY2009 Actual	FY2010 Estimate	FY2011 Request
USFS	8.0	8.0	8.0
DOI	6.0	6.0	6.0
Total	**14.0**	**14.0**	**14.0**

Sources: USDA Forest Service, *Fiscal Year 2011 President's Budget Justification*, http://www.fs.fed.us/publications/budget-2011/fy-2011-usfs-budget-justification.pdf; and U.S. Dept. of the Interior, *Fiscal Year 2011 Interior Budget in Brief*, http://www.doi.gov/budget/2011/11Hilites/BH101.pdf.

Cooperators

The Joint Fire Science Program is implemented substantially through research conducted at federal research facilities, universities, and other scientific institutions. Between 1998 and 2006, the Program has funded 380 research proposals, collaborated with more than 90 colleges and

[28] See http://www.firescience.gov/JFSP_About_JFSP.cfm.

universities, and cooperated with nearly 200 organizations in total.[29] Of the $14.0 million in appropriations for FY2006, 96% went to research projects, and only 4% to administration. In addition, collaborators and cooperators contributed about $8.0 million and substantial in-kind resources to the joint research efforts.

WaterSMART Program

Description and Mission

On February 22, 2010, Secretary Salazar signed Secretarial Order 3297, establishing a WaterSMART Program.[30] DOI aims to pursue a national sustainable water supply by establishing a framework to provide federal leadership and assistance on the efficient use of water, integrating water and energy policies to support the sustainable use of all natural resources, and coordinating the water conservation activities of the various DOI bureaus. The purpose of the program is to secure and stretch water supplies for use by existing and future generations to benefit people, the economy, and the environment, and to identify adaptive measures needed to address climate change and future demands.

S.O 3297 established a WaterSMART Task Force to implement the Program. The chair is the Assistant Secretary for Water and Science; members include the Assistant Secretaries, heads of bureaus, and the Solicitor.

The Administration's 2011 budget proposal includes $72.9 million for the WaterSMART program, or about double the funding for 2010.

	FY2010 Actual ($ in millions)	FY2011 Request ($ in millions)
Bureau of Reclamation	34.6	62.0
USGS WaterSMART Availability/Use Assessments	1.9	10.9
Total	**36.5**	**72.9**

Cooperators

S.O 3297 directs the WaterSMART program to coordinate with the Task Force on Energy and Climate Change to identify the water footprint of various energy technologies, and to work with the Climate Change Response Council, the Climate Science Centers, and the Landscape Conservation Cooperatives to obtain the best available science on the impacts of climate change on water. DOI coordinates the WaterSMART Program with other DOI water sustainability efforts,

[29] http://www.firescience.gov/JFSP_About_JFSP.cfm.

[30] Available at: *206.131.241.18/elips/SO_word/so3297.doc*. "SMART stands for "Sustain and Manage America's Resources for Tomorrow."

including the Bureau of Reclamation's Title XVI, Basin Studies Programs, WaterSMART Grants, and the U.S. Geological Survey's WaterSMART Availability and Use Assessment program.

Federal Agencies

United States Geological Survey

Role in Providing Science for Land Management

Ideally, each federal agency would coordinate and collaborate with agencies having similar or interrelated functions. In this instance, a major goal of USGS is to provide the basic scientific foundation for the adaptive management strategies being pursued by DOI land management agencies (as well as for other federal agencies, state and local governments and others). DOI agencies rely on USGS, to the extent possible, for scientific data and interpretations to inform their land management decisions. Significant interactions between USGS scientists and land managers are increasing, and recent agreements between USGS and other agencies suggest that USGS will be expected to provide research results on climate change processes and impacts, as well as specific data for specific decisions on specific geographic areas.

USGS conducts research in climate change science and maintains monitoring capabilities in water, biology, geology, and geography. To support this work, USGS has a strong history of collecting, maintaining, and serving data sets for water (e.g., National Streamflow Information System), biology (National Biological Information Infrastructure), and geology/geography (National Land Imaging Program). In addition, DOI, and USGS specifically, have chaired the Federal Geographic Data System, which moderates standard setting for geographic information. The data collected and served by USGS programs is used internally and externally for many research and management purposes, including climate change processes and their impacts.

However, the collaboration of a science agency and a land management agency can sometimes be difficult because of competing missions and goals. Land management agencies are charged with developing plans for specific tracts of land within a fixed timeline while complying with the Endangered Species Act, the National Environmental Policy Act (NEPA), etc. USGS conducts long-term scientific research and maintains a number of monitoring networks with information useful in understanding climate change. The land management agency may not be able to wait for completion of a USGS research project, and the USGS scientists or monitoring network may not be able to provide specific information on demand.

It is important that agencies agree on what variables and processes are important to measure and record, what time line or periodicity for data and interpretive reports is useful, and how the information will be made available. In addition, collaboration between agencies sometimes requires a stretching or molding of missions to meet common goals. This stretching is sometimes difficult for agencies that have strong sense of culture. Finally, agency budgets are appropriated for specific programs, and deciding which agency pays for certain functions may be a point of contention among agencies, with the Office of Management and Budget, and in Appropriation Subcommittees.

The scientific information generated by USGS scientists and technicians adheres to a set of fundamental principles called Fundamental Science Practices (FSPs).[31] The FSPs are intended to ensure the scientific reputation of USGS and to apply to all USGS employees and all science activities funded by USGS, including the activities of the programs described below. Thus the scientific integrity of work performed by USGS scientists should be subject to a consistent set of principles and guidelines, such as the procedures for peer review, as well as for release and communication of USGS science activities.

The USGS section of this report describes the following three activities: (1) National Climate Change and Wildlife Science Center the Regional Climate Science Centers; (2) Cooperative Research Units; and (3) Science Centers—Biology and Water disciplines.

National Climate Change and Wildlife Science Center and the Regional Climate Science Centers

USGS was authorized under P.L. 110-161 to establish a National Climate Change and Wildlife Science Center (NCCWSC) as well as regional centers, called Climate Science Centers (CSCs). (See Secretarial Order 3289 section above.)

According to the proposed 5-year strategy, the national office of the NCCWSC would provide leadership and coordination functions, support the center's national advisory board, develop guidance and national standards, facilitate and fund research, promote information sharing and collaboration between the regional centers, and deliver new science results and other information to the conservation community. The regional CSCs would be located in eight regions with "fuzzy" geographic boundaries to address regional differences but allow the centers to work together across boundaries.[32] According to the draft strategic plan, the regional centers would "adapt and evaluate global climate change models to scales that are appropriate for research managers of species and habitats, and facilitate data integration and outreach to collaborators and stake holders."[33] They would also set priorities to support adaptation and adaptive management strategies, help partners define outcomes and endpoints for adaptation strategies, and facilitate and fund research to generate regional-level information.

According to the USGS FY2011 Budget Justifications,[34] three CSCs are to be established in FY2010—in Alaska, the Northwest, and in the Southeast. The FY2011 budget request includes an increase of $8.0 million for two more in FY2011—in the Southwest and the Northcentral regions; and a final three centers are planned for FY2012. The first CSC will be located at the University of Alaska, and the other seven centers will be located at universities that are selected in a competitive process.[35]

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[31] See Fundamental Science Practices: Foundation Policy, at http://www.usgs.gov/usgs-manual/500/502-1.html.

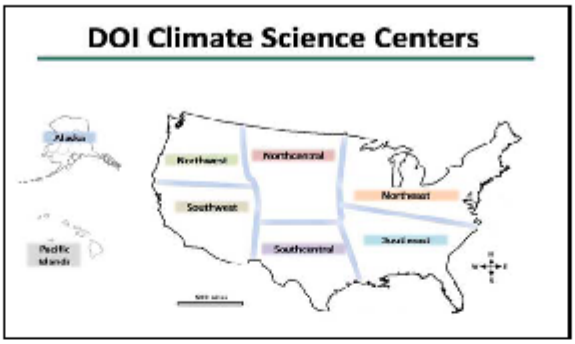
[32] The notion of "fuzzy" boundaries is intended to address climate change and resource management issues that are defined ecologically rather than geographically, according to findings included in a summary report on the NCCWSC. See Ecological Society of America and The Wildlife Society, *USGS National Climate Change and Wildlife Science Center* , Final Report on Outreach & Recommendations, December 2009, http://nccw.usgs.gov/documents/TWS-ClimChgReportFINAL.PDF.

[33] USGS Budget Justifications and Performance Information Fiscal Year 2011, at http://www.usgs.gov/budget/2011/greenbook/FY2011_USGS_Greenbook.pdf.

[34] USGS Budget Justifications and Performance Information Fiscal Year 2011, at http://www.usgs.gov/budget/2011/greenbook/FY2011_USGS_Greenbook.pdf.

[35] David Hayes, Deputy Secretary for the Department of the Interior, E&ETV OnPoint, March 22, 2010, at (continued...)

Figure 2. Climate Science Centers, DOI



Source: http://www.doi.gov/budget/2011/11Hilites/DH011.pdf

In 2009, the NCCWSC held five regional and national stakeholder workshops to gather input on center structure, goals, operations, and science priorities. The workshops led to a draft 5-year strategy.[36] According to the USGS FY2011 Budget, funding was also provided for over a dozen research projects on the development and testing of models of climate effects on flora, fauna, aquatic, and terrestrial habitats.[37] According to one report, over $7.5 million of the $10.0 million in appropriated funds for FY2009 was dedicated to collaborative research.[38] The USGS FY2011 Budget Justifications note, however that the NCCWSC would "move from concept to implementation" by the end of 2012, suggesting that USGS views the centers as work in progress.

Mission

According to the proposed draft strategy, the mission for the NCCWSC is to provide natural resource managers with tools and information to develop and execute strategies to adapt to and mitigate the impacts of climate change. The mission has expanded to include cultural resource managers, as well as natural resource managers.[39] According to the USGS FY2011 Budget, the goal of the CSCs is "to fulfill the congressional request to improve the science capacity for Federal agencies to respond to global warming and enhance science capacity in Federal land management and wildlife agencies."

(...contained)

http://www.eenews.net/tv/2010/03/26/. See also podcast at http://www.doi.gov/news/podcasts/First-Climate-Science-Center-Alaska.cfm.

[36] USGS, *National Climate Change and Wildlife Science Center: a Partnership to Sustain Fish and Wildlife Communities*, Proposed 5-Year Strategy (2009-2014), Executive Summary, July 13, 2009, http://nccw.usgs.gov/documents/NCCWSC_5_year_strategy_ver_7-13-09b.pdf.

[37] USGS Budget Justifications and Performance Information Fiscal Year 2011, p. E-11.

[38] Ecological Society of America and The Wildlife Society, *USGS National Climate Change and Wildlife Science Center* , Final Report on Outreach & Recommendations, December 2009, http://nccw.usgs.gov/documents/TWS-ClimChgReportFINAL.PDF.

[39] USGS Budget Justifications and Performance Information Fiscal Year 2011.

According to the USGS FY2011 Budget Justifications, CSCs are being established under the authority of the NCCGSW, and received $10.0 million in FY2009 and $15.1 million in FY2010. USGS has requested $23.0 million for the program in FY2011, an increase of nearly $8 million compared to FY2010.

Cooperators

According to the USGS FY2011 Budget, the Landscape Conservation Cooperatives (LCCs) are a major partner of the CSCs. (See also "Landscape Conservation Cooperatives" below.) According to DOI, the relationship between the CSCs and the LCCs is that CSCs are "... providing centers for basic climate change science associated with broad regions of the country and the LCCs [are] focusing more on applied science at the landscape level."[40] Further, the CSCs "... will prioritize fundamental science, data and decision-support activities based principally on the needs of the LCCs."[41] In that sense, the LCCs are both cooperators and collaborators for the CSCs and a primary client for the scientific information that the CSCs produce.

USGS partners also include the Forest Service Climate Change Resource Center, NASA, NOAA, EPA, and others. More generally, the FY2011 Budget Justifications states that funds requested for FY2011 would be used to work in partnership with the natural resource management communities to understand high priority science needs, and what is needed to fill the knowledge gaps, and to work with the scientific community to develop information and tools that can inform strategies for responding to climate change.

Cooperative Research Units

Description

Cooperative Research Units (CRUs) aim to leverage cooperative partnerships with federal and state agencies to address mutual scientific needs related to fish and wildlife resources. There are 40 units at universities in 38 states. The program is nearly 50 years old. Originally, CRUs were under FWS until departmental reorganization in the 1990s transferred them first to the short-lived National Biological Service and then to BRD in USGS. Each unit is a partnership among the BRD, a state natural resource agency, a host university, and the Wildlife Management Institute.[42] FWS is the principal federal client of the program and a formal cooperator with the program and each CRU.[43] CRUs work closely with FWS to identify and address information needs required to manage fish and wildlife resources. According to USGS, "individual resources of each cooperator are leveraged to deliver program outcomes that far exceed what any one cooperator could achieve alone."[44]

[40] U.S. Department of the Interior, *Interior's Plan for a Coordinated, Science-Based Response to Climate Change Impacts on our Land, Water, and Wildlife Resources*, http://doi.gov/whatwedo/climate/strategy/upload/Detailed-CSC-LCC-Information.pdf.

[41] Ibid.

[42] The Wildlife Management Institute is a non-profit organization that aims to improve the management of wildlife resources in the United States. Their website is at http://www.wildlifemanagementinstitute.org/.

[43] USGS Budget Justifications and Performance Information Fiscal Year 2011, p. L-47.

[44] USGS Budget Justifications and Performance Information Fiscal Year 2011, p. L-47.

Mission

CRUs have three goals that constitute their mission:

- Maintain a national network of federal, state, and university partnerships for conducting research, education, and technical assistance focused on fish, wildlife, ecology, and natural resources;
- provide a customer-oriented network of expertise for research, teaching, and technical assistance that responds to scientific needs of state and federal resource agencies, including the resource management needs of DOI; and
- conduct graduate education and training of prospective natural resources professionals.

Authorization

The CRU program is authorized under the Cooperative Research Units Act (P.L. 86-686). The Act authorizes the Secretary of the Interior to enter into cooperative agreements with colleges, universities, state wildlife agencies, and non-profit organizations to develop and coordinate research and training programs for conserving fish and wildlife resources. The Act authorizes such sums as may be necessary to carry out the program.

Organization

Federal scientists are stationed at CRUs to help identify natural resource information needs. Approximately 110 federal scientists serve in CRUs and they oversee as many as 600 graduate students. Each CRU has a coordinating committee comprised of federal, state, and university representatives, and a representative from the Wildlife Management Institute. The Committee establishes goals and expectations for the CRU and reviews ongoing and completed work. Concurrence by the coordinating committee is needed for projects to be approved for CRU scientists. There is oversight of CRUs to ensure that research and scientific information disseminated support the goals of USGS and DOI.[45]

Each CRU is jointly owned. USGS provides two to five scientists at each CRU; FWS provides financial support for some research projects as well as access to its facilities; universities provide CRU scientists with graduate faculty appointments, office space, administrative support, and access to university facilities; state agencies provide base funding and logistical support; and the Wildlife Management Institute assists with the coordination of research programs among CRUs.[46]

Recent Funding

The CRU program under USGS received $16.9 million for FY2009, $19.3 million for FY2010, and the FY2011 request is $19.1 million. Each federal dollar appropriated to CRUs is matched by

[45] USGS Budget Justifications and Performance Information Fiscal Year 2011, L-47-L-48.

[46] U.S. Geological Survey, *Draft Strategic Plan for Cooperative Research Units: 2007-2012*, USGS, 2007, pp. 1-3, http://www.coopunits.org/docs/CRU_StratPlan_09May2007.pdf. Hereafter *Strategic Plan*.

roughly three dollars from the other partners. Some of the contributions provided by non-federal stakeholders include equipment, facilities, expertise, and project funding.

Science Centers – Biology and Water Disciplines

Description and Mission

USGS has several science centers throughout the country. Under the Biological Resources Discipline, there are 17 science centers and the Center for Biological Informatics. Under the Water Resources Discipline (WRD), there is a water science center in each state.

Research in BRD science centers addresses a variety of scientific areas, such as aquatic systems (toxic materials and other stressors), botany, ecosystem analysis and modeling, fisheries management, forest management, genetics, zoology, statistical design and analysis, taxonomy and systematics, toxicology, and wildlife habitat evaluation. Each center has its own mission. For example, the National Wildlife Health Center addresses wildlife health, and the Northern Prairie Wildlife Research Center conducts research on grasslands and wetlands. While the mission of most BRD centers concerns their own area or ecosystems, their work may apply to similar ecosystems around the country. BRD science centers are located in Alaska, Hawaii, Washington, Oregon, California, Arizona, Montana, Colorado, Louisiana, Missouri, Wisconsin, Michigan, West Virginia, Maryland, and Florida.[47] BRD science centers collaborate with DOI agencies to conduct research. Individual centers also collaborate with universities, state, tribal, and local institutions to varying degrees.

Water science centers are located in each state, and typically constitute an office within the state office of water resources. Scientists at water science centers collect and organize data on several factors related to water resources management. The centers represent USGS in several water science programs, including the Cooperative Water Program (CWP), a partnership among USGS, and state, tribal, and local governments for collecting and analyzing hydrologic data. Water science centers collect information from stream gages, groundwater observation wells, and water quality monitoring sites for the CWP.[48] WRD science centers collaborate with other federal agencies (both within and outside of DOI), state water agencies, and private stakeholders in a variety of water-related programs.

Water Science centers provide federal resources and share technical and scientific expertise with states and other cooperators. Water science centers are primarily responsible for collecting and analyzing data in a standardized format and implementing the objectives of several WRD programs. These programs include the Cooperative Water Program, programs within the Hydrological Monitoring, Assessments Activity and Research Activity, and the Water Resources Research Act Program. WRD science centers incorporate the mission of the WRD, which is to "provide reliable, impartial, timely information needed to understand the nation's water resources."

[47] Each center's program description and funding can be found in USGS Budget Justifications and Performance Information Fiscal Year 2011, L-41.

[48] The CWP also conducts hydrologic studies across states, standardizes data, helps resolve inter-jurisdictional water disputes, and links stakeholders with the larger network of USGS monitoring sites. The CWP also leverages federal funds with funds from stakeholders to undertake data collection and research. USGS Budget Justifications and Performance Information Fiscal Year 2011, K-47.

Authorization

Since 1879, USGS has studied water availability, water quality, drought, and flood hazards. The WRD is authorized generally under 43 U.S.C. 31, and it establishes USGS's authority to examine resources of the country. BRD science centers are individually authorized under various laws, and have also been created administratively.

Organization

The 17 BRD science centers directors report to the 9 USGS regional executives. Guidance for BRD science centers come from regional executives, three regional directors, and the BRD national office in Virginia. BRD science centers follow annual guidance and strategic directives. Most of the science centers in BRD also have field stations where research is conducted.

There are WRD science centers in every state and in three regional research offices. The state presence was established to conduct a federal inventory of water resources. Science centers are the key operational units of the CWP.

The science center directors report to regional directors and the WRD national office. They also meet with and collaborate with state agencies and local cooperators to determine priorities and strategies for work.[49] In addition to the WRD science centers, there are State Water Resources Research Institutes. These institutes receive grants from USGS to conduct research and education efforts at 54 land grant universities throughout the country.[50] They are authorized under the Water Resources Research Act,[51] and receive $6.5 million in appropriations annually.

Recent Funding

For FY2009, BRD science centers received $103.4 million; for FY2010, $103.6 million; and for FY2011, the request is $103.6 million. BRD science centers do not generally leverage funds from stakeholders or other agencies. There are some exceptions, for example, the Western Fisheries Research Center receives funding from power marketing agencies (e.g., Bonneville Power Administration) to conduct studies.[52]

WRD science centers receive funding through programs in WRD. For example, under the Cooperative Water Program, funding is provided to operate science centers. Funding for WRD science center activities also comes from cooperators, such as other federal agencies, state agencies, and private partners. For example, in the CWP, there is approximately a 70:30 cost-share ratio for funds between the cooperator and USGS.[53]

[49] Personal communication from Ward Stanbitz, USGS Cooperative Program Coordinator, Reston, VA, April 9, 2010.

[50] The program (1) supports research that addresses state and regional water problems; (2) provides technology transfer, and (3) provides for the training of scientists and engineers. Grants under this program must be matched by the universities.

[51] P.L. 98-242, as amended.

[52] Personal communication from Bruce Jones, USGS Chief Scientist for Biology, Reston, VA, April 9, 2010.

[53] Personal communication from Ward Stanbitz, USGS Cooperative Program Coordinator, Reston, VA, April 9, 2010.

Fish and Wildlife Service

With very few exceptions, nearly all parts of FWS are heavy consumers of science. Some parts are also producers of science. In addition to research on the fundamental questions of science in habitat and species management, the agency is a user and producer of basic scientific information, such as collecting long-term monitoring data.

FWS conducts monitoring and inventory in several programs, most notably in refuges and in migratory bird management. Populations of breeding birds have been monitored for decades, and while such data were originally used primarily to set waterfowl hunting quotas, they have proved useful to people studying more complex phenomena such as climate change and drought. Many science consumers in the agency see monitoring information as one of their most important science needs.[54] In addition, the refuge system has conducted inventories and monitoring programs for decades, tracking wildlife populations (including waterfowl especially) and their fluctuations, distributions, etc.

As recently as the FY2009 FWS Budget Justification, such programs were not broken out as separate lines in the budget. That year, FWS stated that the "Wildlife and Habitat Management budget element ... [employs] actions such as the inventory and monitoring of plant and animal populations, ... identifying ... invasive species, ...monitoring air quality, ... and assessing water quality and quantity."[55] The same year, the Migratory Bird Management program) proposed $36.1 million for the Conservation and Monitoring element.[56] In FY2011, FWS proposes adding $8.0 million to Wildlife and Habitat Management for refuges for "building the landscape-scale, long-term inventory and monitoring network that the Service began in 2010."[57] Thus, while the emphasis on a landscape-scale and an interconnected network may have begun in FY2010, inventories and monitoring programs began long before that.

FWS has had a Science Advisor to the Director for more than a decade; the position was added to the formal FWS organizational chart in FY2011, at the same level as an assistant director. Among other duties, the Science Advisor participates in the department-wide biweekly meetings of all agency science advisors. In addition, FWS formed a Service Science Committee in 2005. It consists of four permanent members (the Science Advisor to the Director; the Branch Chief, National Conservation Training Center; the Science Liaison to the International Association of Fish and Wildlife Agencies; and the Science Liaison to USGS). There are nine members who represent both users and producers of scientific information in the agency; they are appointed for staggered three-year terms. There is also a Directorate Oversight Council to oversee the activities of the Committee. The Council is made up of two Regional Directors, two Assistant Directors, and the Science Advisor. Its primary role appears to be advisory for policies and standards, rather than supervisory. The duties of the Committee are to

[54] For example, see U.S. Fish and Wildlife Service, *Conservation in Transition: Leading Change in the 21st Century*, Washington, DC, Jan. 28, 2010, pp. 1-10, http://www.fws.gov/home/feature/2009/pdf/ConsTransitionPublicsmJan2809.pdf.

[55] Fish and Wildlife Service, *Budget Justifications and Performance Information, Fiscal Year 2009*, p. NWR-11.

[56] Ibid., p. MB-1.

[57] Fish and Wildlife Service, *Budget Justifications and Performance Information, Fiscal Year 2011*, p. NWR-11.

> prepare draft policies, procedures, and other work products; monitor science activities and prepare special reports and recommendations; and work closely with Service employees and external partners to promote science excellence in fish and wildlife conservation.[58]

FWS also has a policy on peer review and a science code of ethics. The FWS Scientific Code of Professional Conduct states, among other things, that FWS scientists are to "place reliability and objectivity of scientific activities, reporting, and application of scientific results ahead of personal gain or allegiance to individuals and organizations."[59]

Landscape Conservation Cooperatives

Landscape Conservation Cooperatives began as a concept initiated within FWS. In 2009, DOI identified the LCCs as a useful part of the Climate Change Adaptation Initiative. Sec. 3(c) of S.O. 3289 directed that Interior agencies "work to stimulate the development of a network of collaborative [LCCs]… [to] work interactively with the relevant DOI Climate Science Center(s) and help coordinate adaptation efforts in the region." At the time of the Order, some cooperatives had already been founded. The LCC partners are federal, state, tribal, and local governments as well as private landowners; specific federal partners may vary from region to region. Other than the offices of individual LCC coordinators, an LCC may be a virtual organization, without a physical presence or aggregation of scientific professionals in a specific location.

The mission of an LCC does not appear to be formally stated in the agency's materials, but an FWS description of LCCs states that they are intended to "inform resource management decisions to address landscape-scale stressors including habitat fragmentation, genetic isolation, spread of invasive species, and water scarcity---all of which are accelerated by climate change." And further, they "support adaptive resource management by evaluating conservation strategies, maintaining and sharing information and data, and improving products as new information becomes available."[60] Structurally, each LCC is to have:

- a Steering Committee of executive and management level representatives from partner organizations, which will provide management direction and set priorities;
- an LCC coordinator;
- a science and technology coordinator;
- GIS capacity;
- population modeling capacity;
- monitoring and evaluation capacity; and
- decision analysis expertise.[61]

LCCs are both clients of, and partners with CSCs, the CESU network and the CRUs. Data and information supplied by the LCCs are intended to be available to land managers at all levels of

[58] See http://www.fws.gov/science/ServiceScienceCommittee.html.

[59] The Scientific Code of Professional Conduct is available at http://www.fws.gov/policy/212fw7.pdf.

[60] See http://www.fws.gov/science/SHC/pdf/LCC_Fact_Sheet.pdf.

[61] See http://www.fws.gov/science/SHC/pdf/LCCInfoBull1FormandFunction011610.pdf.

government and the private sector. LCCs are based in, and focus on, a specific geographic region. They include multiple states within their boundaries. (See Figure 3.) Proposed additional funding in the FWS FY2011 Budget is intended to increase the network of LCCs from 9 to 12, with an eventual goal of 21 LCCs. (However, the FWS website gives somewhat different numbers: 16 LCCs are "being developed," of which 10 have operational plans.[62] The source of the discrepancy is unclear.)

Funding for LCCs from FY2009 through FY2011 is difficult to determine because LCCs *per se* are a seemingly new creation first proposed by the Obama Administration for FY2010. Their funding is through the Climate Change Planning and Adaptive Science Capacity within the Resource Management account in FWS. Within the Climate Change program, it appears that all activities are channeled through the LCCs. The FY2010 level was $20.0 million; the FY2011 request is $28.8 million. However, as many FWS documents note, LCCs build upon existing programs, and it should not be assumed that the programs now under the LCC umbrella received no funding before FY2010.

Partners in the LCCs may be regional organizations. The North Atlantic LCC, for example, has four founding partners: the Atlantic Coast Joint Venture, the Eastern Brook Trout Joint Venture, Atlantic Coastal Fish Habitat Partnership, and the Regional Conservation Needs Program. The four founders in turn have various combinations of federal, state, tribal, local, and non-governmental partners. The membership of Atlantic Coast Joint Venture (an organization devoted to bird conservation along the Atlantic flyway), for example, consists of 17 state wildlife agencies, 4 NGOs, and 4 federal agencies (FWS; NPS; FS; and the USGS Patuxent Wildlife Research Center).

With a somewhat vaguely defined mission, and relatively little history, it would be difficult to determine whether LCCs are accomplishing their missions. According to an agency fact sheet,

> All LCCs will perform basic core functions and provide the same general kinds of products and services that will help partners meet shared landscape-scale objectives. Although the roles of LCC members will vary from one LCC to another, depending on their responsibilities, interests, and organizational capabilities, each LCC will be an integral component of the national network, with consistent structure, governance and operations.[63]

Joint Ventures

Joint Ventures for the conservation of migratory birds were created pursuant to the North American Waterfowl Management Plan, signed by the Secretary and the Canadian Minister of the Environment in 1986. Originally focused on waterfowl, they have expanded to include other bird species and entire flyways.[64] They have, according to FWS "formally accepted the responsibility of implementing national or international bird conservation plans within a specific geographic area or for a specific taxonomic group...."[65]

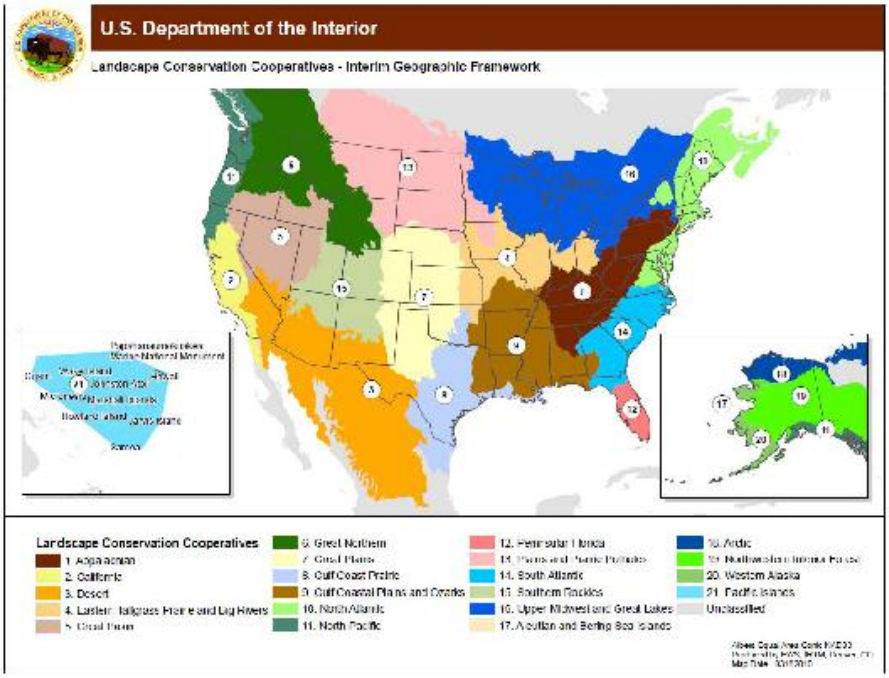
[62] http://www.fws.gov/science/SHC/lcc.html, viewed April 5, 2010. The LCCs with operations plans are named Arctic, California, Great Northern, Great Plains, Gulf Coastal Plains and Ozarks, North Atlantic, North Pacific, Pacific Islands, Plains and Prairie Potholes, and South Atlantic. The others listed are Appalachian, Desert, Gulf Coast Prairie, Peninsular Florida, Upper Midwest and Great Lakes, and Western Alaska.

[63] Available at http://www.fws.gov/science/SHC/pdf/LCCInfoBull1FormandFunction011610.pdf.

[64] For more information on Joint Ventures, see http://www.fws.gov/birdhabitat/JointVentures/index.shtm.

[65] Joint Venture Fact Sheet, available at http://www.fws.gov/birdhabitat/JointVentures/DefineJV.shtm.

Figure 3. Landscape Conservation Cooperatives
Geographic Boundaries



Source: Dept. of the Interior, Fish and Wildlife Service. Available at http://www.fws.gov/science/SHC/lcc.html

Of the 21 current Joint Ventures, 18 are geographically based, while 3 cover one or a few related species. (In addition, Canada has four Joint Ventures of its own.) They are supported within the FWS budget through the Migratory Bird Management Program, with an FY2010 budget of $14.1 million. Joint Ventures have many partners: federal, state, and tribal agencies, local governments, NGOs, and other stakeholders. According to the FWS Division of Bird Habitat Conservation, the goals of a joint venture are:

> biological planning, conservation design, and prioritization;
>
> project development and implementation;
>
> monitoring, evaluation, and applied research activities;
>
> communications and outreach; and
>
> fund-raising for projects and activities.[66]

As the list makes clear, while scientific research, monitoring and related activities are a goal of Joint Ventures, they are part of a larger list of objectives. Joint Ventures may participate in other programs such as LCCs, or be consumers of research produced by CESUs, CRUs, etc.

Fish Habitat Partnerships

FWS also participates in Fish Habitat Partnerships (FHPs), organized under a voluntary program called the National Fish Habitat Action Plan (NFHAP).[67] According to its website, the NFHAP mission is to carry out "a cooperative nationwide program to conserve (protect, restore and enhance) the habitats of the Nation's marine and freshwater fish populations." States, tribes and other stakeholders are members of the various FHPs. FHPs may participate in other programs such as LCCs, or be consumers of research produced by CESUs, CRUs, etc. The FHPs may be based on a geographic region, an ecosystem, or particular species. FWS provides scientific and technical assistance to the FHPs.

The FHPs fund projects, and FWS contributions to projects may be matched as much as three to one for some efforts. FWS participation in FHPs falls under the Fisheries Habitat Assessment and Restoration Program, which was funded at $27.1 million in FY2010. Like the Joint Ventures for birds, the FHPs treat monitoring and scientific research as part of a mission that has several other components. There are currently 17 active partnerships, and 4 partnerships that are in the planning and development stage.

National Park Service

The National Park Service outlines two distinct roles for science in the NPS—to use the best available science in park management (commonly referred to as "Science for Parks"), and to encourage research in parks that benefits society as a whole (referred to as "Parks for Science"). NPS is embarking on an effort to expand the role of science in NPS resource management decision-making. To help lead this effort, a new position, the Science Advisor to the Director, was created in November 2009. The science advisor is located in the Washington, D.C., office and

[66] http://www.fws.gov/birdhabitat/JointVentures/DefineJV.shtm.

[67] For more on the NFHAP, see its website at http://fishhabitat.org/.

does not have additional staff. However, each of the seven regional offices has a chief scientist. The NPS has developed 10 strategic science goals for the agency, among them advancing the role of science within the NPS and developing a state-of-the-art agency science program.[68]

In 2004, a National Parks Science Committee (commissioned by the NPS Advisory Board) submitted a report with recommendations on future directions for science and scientific resource management in the parks. Among the findings were that it is essential for scientific knowledge to be at the base of efforts to preserve ecological resources in the System, and the NPS needs to enhance its current infrastructure and capabilities for conducting inventorying, monitoring, field research, adaptive management, and science education. The committee stated that "each national park should serve as a center of enlightenment, and that the National Park Service should serve as the world's leader in stimulating, synthesizing, and utilizing place-based science."[69]

In 2009, the National Parks Conservation Association (a private conservation organization) convened an independent "National Parks Second Century Commission," chaired by former Senate Majority Leader Howard Baker, Jr. and former Senate Energy and Natural Resources Committee Chairman J. Bennett Johnston, Jr. The commission submitted a report to NPS and the public. One of the recommendations from the commission's science committee was to

> Build a balanced program of research for national parks that can only come from an internally directed research program. The program must center upon in-park, or monitoring program-based, research scientists. The National Park Service science effort should continue to draw heavily on partnerships with academe, and especially USGS, but Congress and [the] National Park Service must also provide adequate funds and National Park Service research positions.[70]

Science in the NPS is conducted by NPS scientists and other professionals, including USGS scientists, university faculty through CESUs and Research Learning Centers, and various other networks, including DOI initiatives (such as the Climate Change Response Council and the Regional Climate Science Centers), cooperative agreements, contracts, and other provisions. A policy on scientific integrity and peer review has been in draft form for about a year and awaits the finalization of an overarching department-wide policy on the same topic.

NPS works with and uses USGS science support staff for many needs; indeed, USGS is an essential partner for NPS science. However, USGS often concentrates on scientific research that can be published in peer-reviewed journals. While the findings of these research studies are useful, the NPS also is responsible for data collection that may not result in publication: collecting inventory and monitoring data, delivering science for decision-making, and educating agency staff and the public. Furthermore, some NPS officials claim that the costs of obtaining scientific services from USGS are often impracticable, encouraging NPS to perform the work in-house or to obtain services elsewhere.[71] Thus, the Science Advisor to the Director aims to move toward an in-house science program to complement USGS work.

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[68] The ten strategic science goals were approved by the NPS Director at a November 29, 2009 National Leadership Council meeting. Available at http://www.npsetirees.org/cnpsc/2010/newly-approved-goals-nps-science-program.

[69] National Park Science Committee Report to the National Park System Advisory Board, March 2004. Page 3. http://www.nature.nps.gov/scienceresearch/ScienceCommitteeReport2ndEdition.pdf.

[70] The National Parks Second Century Commission Science and Natural Resource Committee Report. Page 7. Available at: http://www.nps.gov/yose/naturescience/upload/Second.Century.Science.Report.pdf.

[71] Personal conversations between CRS Analyst Angela Zahniser and several NPS officials.

The Natural Resource Challenge

The Natural Resource Challenge (Challenge) was an initiative which was announced by NPS Director Robert Stanton in 1999 to strengthen natural resource management in the NPS system and to improve the use of science as a management tool.[72] The Challenge, which spanned over seven years, included plans to establish programs and to promote the ideas of "parks for science" and "science for parks." Major scientific components of the Challenge were the Inventory and Monitoring Program, CESUs (described above), and Research Learning Centers. By 2007, $77.6 million had been added to the NPS' base budget. Most of the programs that were authorized as a result of the Challenge remain active today as part of the Service's normal operating funds. The Challenge engineered how science is used and applied in the agency.

Goals of the Natural Resource Challenge were

- to increase inventorying and monitoring capability;
- to provide increased support to programs and projects designed to maintain and restore park natural resources;
- to improve awareness of parks as "natural laboratories" for use by scientists;
- to ensure the public has access to current results of research activities conducted within the parks; and
- to partner with universities, federal and state agencies, and others to implement the Challenge.[73]

Inventory and Monitoring Program

The largest component of the Natural Resource Challenge is the Inventory and Monitoring Program (I&M Program). The purpose of the I&M Program (since 2007 independent of the Challenge) is to collect, organize, and make available natural resource data and to transform data into information through analysis, synthesis, and modeling. The primary goals of the I&M Program are to:

- inventory the natural resources under NPS to determine their nature and status;
- monitor park ecosystems to better understand their dynamic nature and condition and to provide reference points for comparisons with other, altered environments;
- establish natural resource inventory and monitoring as a standard practice throughout the system that transcends traditional program, activity, and funding boundaries;
- integrate natural resource inventory and monitoring information into NPS planning, management, and decision making; and
- share NPS accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives.[74]

The I&M Program provides guidance, funding, and technical assistance for 12 baseline natural resource inventories:

[72] See NPS Press Release, available at http://www.nature.nps.gov/challenge/originalpressrelease.cfm.

[73] Adapted form the National Parks Science Committee Report to the National Park System Advisory Board, March 2004. See http://www.nature.nps.gov/scienceresearch/ScienceCommitteeReport2ndEdition.pdf. Pages 9-10.

[74] NPS Inventory and Monitoring Program website, http://science.nature.nps.gov/im/index.cfm.

Natural Resource Bibliography

Base Cartography Data

Air Quality Data

Air Quality Related Values

Climate Inventory

Geologic Resources Inventory

Soil Resources Inventory

Water Body Location and Classification

Baseline Water Quality Data

Vegetation Inventory

Species Lists

Species Occurrence and Distribution[73]

Organization

The NPS has organized the park units into 32 ecoregional networks with the objective of ensuring data quality, security, longevity and availability. (See **Figure 4**.) Each network supports a core staff who conduct the day-to-day activities of the network and collaborate with staff from other parks to implement monitoring in the parks.

Figure 4. National Park Service Ecoregions.



Source: National Park Service FY2011 Budget Justifications. p. ONPS-17.

[73] Natural Resource Inventories in National Parks website. See http://science.nature.nps.gov/im/inventory/index.cfm.

Research Learning Centers

The "Parks for Science" portion of the Natural Resource Challenge contained several components. The largest component consists of the Research Learning Centers. The concept of Research Learning Centers was first established in the Natural Resource Challenge Action Plan. The Centers (independent of the Challenge program since 2007) have resources based on geography, landscape, culture and history of the area. They are public-private partnerships that involve researchers, universities, educators, and community groups. There are currently 20 Centers, 12 of which are partially funded by the NPS.[76] (See Figure 5.) Funding for each of these twelve centers varies by center.

One of the primary goals of the Centers is to attract non-NPS scientists to conduct research in national parks. These scientists assist park managers by conducting research on prioritized park projects. Additionally, staff at the Centers have the expertise to synthesize the information and transfer it to local communities and electronically to a wider audience.

Figure 5. NPS Research Learning Centers



Source: NPS, available at http://www.nature.nps.gov/learningcenters/map.cfm.

Agenda for Climate Change Response

The NPS coordinates several activities in an effort to respond to climate change. All activities fall under three components: adaptation, mitigation, and communication. In January of 2009, the NPS formed a Climate Change Response Steering Committee, under the directorship of Natural Resources Stewardship and Science. There are approximately eight full time employees who work exclusively on climate change issues. About half are based in Fort Collins, Colorado. The

[76] Available at: http://www.nature.nps.gov/learningcenters/map.cfm.

others are placed where needed. A goal of the steering committee is to complete a long-range strategy and action plan. This strategy is still under review and is not yet available publicly. The committee aims to establish a program for core staff and field-based projects which support the efforts of the three main fields. These climate change response activities all occur within the NPS; however, according to NPS, the activities and projects are communicated with and, when appropriate, coordinated with the DOI Climate Change Response Council.

NPS climate change efforts and activities have been ongoing for several years. However, the activities became more integrated in FY2010, with the appropriation of $10.0 million for NPS climate change activities. New funding for climate change activities in the FY2011 budget was not requested. The NPS will continue to use the funds provided in FY2010 to continue work on projects begun with those funds. NPS plans to direct $0.9 million toward the anticipated DOI Climate Science Centers; nearly $6.1 million toward Landscape Conservation Cooperatives; and $3.0 million for monitoring and data collection activities.

Bureau of Land Management

The Federal Land Policy and Management Act of 1976, commonly called BLM's Organic Act, provides authority for BLM to conduct science on its own or cooperatively. It states that the Secretary of the Interior "may conduct investigations, studies, and experiments, on his own initiative or in cooperation with others, involving the management, protection, development, acquisition, and conveying of the public lands."[77] With regard to BLM land use planning, the law further requires use of "a systematic interdisciplinary approach to achieve integrated consideration of physical, biological, economic, and other sciences."[78] Other laws, regulations, and other directives guide BLM in the conduct of science. For instance, the National Environmental Policy Act (NEPA) directs that agencies use a systematic, interdisciplinary approach to ensure the integrated use of natural and social sciences in planning and decision making which may have an impact on the environment.[79]

BLM has several organizational components to address its science needs. The agency has a Science Advisor, whose primary responsibilities are to recommend science priorities; coordinate science programs with other agencies; and advise BLM leadership on science policy issues, including the integration of science with land use planning and land management. Other organizational components include Regional Science Coordinators and the National Operations Center, Division of Resource Services. This Division is to support other BLM offices by providing physical, biological, and social science assessments; architecture and engineering support; library assistance; mapping science; photo imaging; geographic information systems applications; and publications support.[80]

In 2008, the BLM revised its Science Strategy, first issued in 2000.[81] The Science Strategy discusses the role of science in BLM, sets out a process to identify BLM's science needs,

[77] 43 U.S.C. sec. 1737.

[78] 42 U.S.C. sec. 1712(c)(2).

[79] 42 U.S.C. sec. 4332.

[80] For more information on the National Operations Center, see its website at http://www.blm.gov/nstc/.

[81] For more information on the Science Strategy, see *Bureau of Land Management Science Strategy, 2008*, issued September 2, 2008, on the agency's website at:
(continued...)

addresses how BLM can communicate its science needs to science providers and share results, describes opportunities to conduct science on BLM lands, and suggests an approach to implement the strategy. A draft implementation plan is under internal review.

The Public Lands Foundation (PLF), an organization whose members are predominantly retired employees of the BLM, issued a position statement in 2007. The statement called on BLM to increase its institutional capability and commitment to use science in developing policy, conducting NEPA analyses, and making land management decisions. PLF asserted that BLM needed to make a stronger commitment to implementing its Science Strategy and acquiring the resources to assure science is given appropriate consideration in natural resource management. Other recommendations included reestablishment of a Science Advisory Board to provide independent counsel to the Director on linking policy to science; establishment of a National Operations Center to strengthen the link between science and decision making; and development of guidelines and policies for scientists and managers to foster independent and objective scientific input into policy formulation.[82]

Some PLF recommendations have been adopted by BLM, such as the establishment of the National Operations Center. Other recommendations have not been implemented to date. For instance, the headquarters office has not established an agency-wide code of ethical conduct for scientific research and development, although a draft policy on scientific peer review is currently under internal review. Moreover, BLM's National Landscape Conservation System, comprised of about 27 million acres of specially protected conservation areas, has established guidelines for conducting science on units in the System.[83]

BLM seeks science information and support not only from its own staff but from science providers outside the agency. The agency estimates that over ten years, an average of approximately $13 million in annual research and development funds has gone to outside science providers, with about 75% to federal partners and 25% to non-federal partners. Among the non-federal providers of science are state organizations, non-government organizations, and universities (such as those in the CESU network).[84] The agency claims that there have been substantial savings in obtaining science, technical assistance, and educational information through the CESUs, and that the students and faculty of the participating universities have benefited substantially.[85]

Federal providers of science to BLM include the Forest Service, Agricultural Research Service, and Natural Resources Conservation Service, all within USDA, as well as the National Oceanic and Atmospheric Administration (in the Department of Commerce), the National Science Foundation, and the National Aeronautics and Space Administration. The BLM relies on other

(...continued)

http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources.Par.81244.File.dat/ScienceStrategyWEB%206-09Web.pdf.

[82] See PS-31-07, *The Role of Science in BLM Land Management Decisions*, on the website of the Public Lands Foundation at http://www.publicland.org/.

[83] Information provided by BLM on April 8, 2010.

[84] BLM estimates that over the past 10 years, roughly 10% of its research and development funding for outside science providers has gone to universities in the CESU network. Information provided by BLM on April 1, 2010.

[85] Bureau of Land Management, Instruction Memorandum No. 2007-105, *Designation of State Cooperative Ecosystem Studies Unit Coordinators*, April 17, 2007. For a fuller description of CESUs, see above under "Interagency Committees, Centers, Programs, and Cooperative Units" and the CESU website at http://www.cesu.psu.edu/.

DOI agencies for science expertise. According to BLM, USGS is a major partner and science provider to BLM. BLM contends that the agencies work closely on a wide range and large number of research projects, with major areas involving landscape health, fire management, soil modeling, and wildlife habitat research. Examples of recent USGS research projects conducted in cooperation with BLM include an assessment of livestock grazing across the sagebrush biome; an analysis of fire behavior in blackbrush ecosystems; an estimation of soil and vegetative recovery time from anthropogenic disturbances; and the development of a regional approach to wildlife monitoring related to energy exploration and development in Colorado.[86]

Examples of Science Research Partnerships

According to the agency, the vast majority of BLM science efforts involve research partnerships. A few of the larger efforts are described below.[87]

North Slope Science Initiative (NSSI)

The North Slope Science Initiative (NSSI) was developed by federal, state, and local governments to facilitate and improve collection and dissemination of ecosystem information pertaining to the Alaskan North Slope. Its mission is to improve scientific and regulatory understanding of terrestrial, aquatic, and marine ecosystems for consideration in the context of resource development activities and climate change.

While BLM is the administrative agency, activities of the NSSI are directed by an oversight group whose membership includes federal, state, and borough land managers. A science technical advisory panel advises the oversight group on issues such as the identification and prioritization of inventory, monitoring, and research needs. The panel is to consist of up to 15 scientists and technical experts from varied professions and interests, including the oil and gas industry, subsistence users, Alaska native entities, conservation organizations, and academia.

The NSSI was authorized by the Energy Policy Act of 2005.[88] The appropriation for FY2009 and FY2010 was $1.0 million, and the Administration is seeking level funding for FY2011.

Southern Nevada Agency Partnership (SNAP)

The Southern Nevada Agency Partnership (SNAP) is a partnership of the four major federal land management agencies: BLM, FWS, NPS, and Forest Service. It focuses on the 7 million acres of federal lands in Southern Nevada. The SNAP interagency science and research team is organized to develop and implement an interagency science program to inform decision making regarding natural resources, cultural resources, and human use of federal lands. The program is to create a consistent scientific approach across agency boundaries, as a complement to individual agency science and research activities.

[86] Information provided by BLM on April 8, 2010.

[87] The identification and description of these efforts were provided by BLM on April 8, 2010.

[88] P.L. 109-58, Sec. 348.

While SNAP was established in 1997, the interagency science and research team was created about a decade later. The effort does not have dedicated funding, although grant funding through the Southern Nevada Public Land Management Act has been approved to implement the program.

The four agencies have active partners, such as the Southern Nevada Conservancy, State Historic Preservation Office, and Outside Las Vegas Foundation. The Public Lands Institute at the University of Nevada, Las Vegas has worked with SNAP to facilitate education, outreach, research, and volunteer projects.[89]

National Integrated Land System

The National Integrated Land System (NILS), which is being decommissioned, has been a coordinated effort that has sought to provide cadastral records and land parcel information in a geospatial format for the benefit of both land managers and the public. It has been a joint effort coordinated by BLM and the Forest Service, in partnership with states, counties, and the private sector. The system has provided a means to collect, store, and geographically display a range of land management and survey information, including on federal land ownership, cadastral surveys, land withdrawals, range allotments and pastures, wild horse and burro herds and management areas, rights of way, abandoned mines, energy leasing, and mining claims. The information is available to the public for information, mapping, graphics, and planning through a web-based tool called GeoCommunicator.[90]

BLM records indicate that NILS was established in October, 2001. It never reached full functionality, according to BLM. In 2009, the agency decided to decommission the system due to deficiencies related to the quality and reliability of the data,[91] which contained large, various, and antiquated data sets. The system was unable to recognize and resolve differences among these data. The 2009 decision to decommission NILS followed a gap analysis, which concluded that "[c]onsidering the volume and magnitude of the deficiencies in this GAP Analysis, the team finds no alternative but to retire the system."[92]

While deciding to retire NILS, BLM simultaneously decided to continue the GeoCommunicator so that the public can continue to access the data until a suitable replacement can be found. The agency expanded its data disclaimer on the system's website, which currently includes a statement that "no warranty, expressed or implied, including accuracy, relevancy, timeliness, utility, or completeness of the data and information is made by the BLM...."[93] Further, the agency

[89] Additional information on SNAP is available on the partnership's website at http://www.snap.gov/.

[90] Information on NILS and the GeoCommunicator is available on the BLM website at http://www.blm.gov/wo/st/en/prog/more/nils.html and http://www.blm.gov/nils/GeoComm/documents/NILS_data_themes_public.pdf. The GeoCommunicator has its own website at http://www.geocommunicator.gov/GeoComm/index.shtm.

[91] A report of the National Research Council had concluded in 2007 that while NILS was the closest thing to a coordinated approach to federally managed parcel data, "it remains much more a set of technologies than a source of parcel data." See National Research Council, *National Land Parcel Data: A Vision for the Future*, Washington DC, 2007, p. 3.

[92] Bureau of Land Management, internal memorandum with date stamp of September 18, 2009.

[93] The data disclaimer is on the BLM website at http://www.blm.gov/nils/GeoComm/documents/NILS_data_themes_public.pdf, p. 3.

is pursuing a business case for a new national integrated system, with the hope that newer technologies will make that goal achievable.[94]

The appropriation for NILS was $2.9 million for FY2009 and $3.3 million for FY2010, and the Administration requested $3.4 million for FY2011.[95] According to BLM, monies are being used for decommissioning activities, continuation of the GeoCommunicator, and exploration of a replacement for NILS.

Science Initiatives and Agenda for Climate Change Response

In addition to science research partnerships addressed above, BLM is engaged in a number of science initiatives. BLM now considers these initiatives to be key efforts in the agency's and DOI's climate change strategies. Specifically, BLM includes the three initiatives discussed here — ecoregional assessments; the healthy landscapes program; and the assessment, inventory, and monitoring strategy — as components of its climate change adaption efforts.[96] The BLM recently created a position at the headquarters office for a Climate Change Coordinator, who works in conjunction with the Science Advisor.

In FY2010, BLM received $15.0 million for the Secretary's Climate Change Adaptation Initiative. The FY2010 Budget Justification described how the climate change funds were to be used: "Within priority eco-regions, much of the work will directly benefit Bureau lands within the National Landscape Conservation System (NLCS)."[97]

Of the $15.0 million, $3.0 million will be used to conduct ecoregional assessments, $1.5 million to support the development of adaptation strategies in targeted areas, $3.0 million to collect and store native seed; and $7.5 million to review existing land use plans and use authorizations to reflect the results of the ecoregional assessments, and implement habitat and wildlife restoration and adaptation projects.[98]

It should be noted that, while the funds were appropriated to the Soil, Water, Air (SWA) program, the funds are being applied outside of that program. The SWA program is its own subactivity, and neither the NLCS nor the ecoregional assessment project is part of the SWA subactivity. The FY2011 budget request states: "Funding is provided to these [Climate Change Adaptation] Initiatives through the Soil, Water & Air Program for administrative convenience but is not managed by the Program. The Climate Change Adaptive Initiative will increase ecoregional assessments… ."[99]

The FY2011 BLM Budget Justification states that BLM climate change adaptation initiatives are being coordinated with other DOI bureaus and other partners through LCCs. Elsewhere, the Budget Justification states that the climate change implementation strategy for BLM assumes that

[94] This information was provided by BLM on April 8, 2010.

[95] In the past, some funding for NILS was provided through the Forest Service. The FY2011 FS Budget Justification does not appear to identify an FY2011 request for funding for NILS.

[96] See Bureau of Land Management, *Budget Justifications and Performance Information, Fiscal Year 2011*, p. I-22 – I-24. The identification and description of these efforts were provided by BLM on April 8, 2010.

[97] BLM FY2010 Budget Justifications, page I-7.

[98] DOI budget highlights, available at: http://www.doi.gov/budget/2010/10Hilites/BH007.pdf, p. BH-9.

[99] FY2011 BLM Budget Justifications. See comments section on page IV-28.

DOI agencies "establish a coordinated infrastructure of [LCCs], supported by [CSCs], and an integrated climate monitoring approach." The Administration is seeking $17.5 million for FY2011 for climate change.

Ecoregional Approach for Managing Public Lands

BLM is developing an ecoregional approach for managing public lands to better understand and coordinate responses to complex and widespread challenges that cut across land ownership. Examples of challenges affecting some areas include increasing wildfires, invasive species, energy development, urban growth, and drought. The ecoregional approach has two main components: (1) a rapid ecoregional assessment (REA), which synthesizes existing science regarding resource conditions, trends, and management; and (2) ecoregional direction, which identifies BLM's key management priorities for the public lands within an ecoregion. The goal is for REAs and ecoregional direction to provide the science and management framework in a coordinated manner to address diverse resource values given new land use demands and complex and accelerating environmental changes.

REAs are called "rapid" assessments because they use existing information and generally are completed within 18 months. The assessments are conducted across land ownerships, and their scale is large—ecoregions vary in size from about 11 to 88 million acres. BLM expects that REAs may be helpful to the various landowners in a region. BLM intends to use them to identify and coordinate resource conservation, rehabilitation, and development priorities. For instance, REAs highlight and map areas of high ecological value, including essential wildlife habitats and corridors, and gauge their potential risks from energy development, wildfires, and other disturbances and environmental changes. They also map areas that have high energy development potential, and relatively low ecological value, which could be appropriate for energy development. BLM expects that REAs will serve as a science baseline that can be updated as new information becomes available, to inform conservation and development planning and decision making over the long term.

According to BLM, the REAs are being developed within DOI's emerging framework for addressing climate change, which includes establishment of Climate Science Centers and Landscape Conservation Cooperatives. For instance, the REAs initiated in 2010 and 2011 will establish baseline information, inform the development of adaptive management strategies, and identify indicators to monitor effectiveness of land management in six LCCs. BLM anticipates that future landscape-scale assessments will likely be conducted or sponsored by the LCCs.

BLM expects to use the REAs to prepare, in cooperation with partners and stakeholders, broad-scale management direction for the public lands within an ecoregion. This ecoregional direction will identify priority areas for resource conservation and development, and is to be coordinated and implemented through the BLM's field office organization, land use planning process, and budget process. In 2010, the BLM and its partners will prepare ecoregional direction for four ecoregions that have completed pilot REAs: the Northern Great Basin, Wyoming Basin, Chihuahuan Desert, and Alaska's North Slope. REAs will be initiated in 2010 for the following seven ecoregions: the Mojave Desert, Sonoran Desert, Central Great Basin, Northwestern Great Plains, Middle Rockies, Colorado Plateau, and Seward-Nulato in Alaska.

Funding for the ecoregional assessments is being provided through funding to BLM for climate change adaptation. Total funding for climate change adaptation in FY2010 was $15.0 million, and the Administration is seeking $17.5 million for FY2011 (see previous section.)[100]

Healthy Landscapes

Through the Healthy Landscapes program, BLM conducts restoration activities in areas where assessments have been done to guide these activities. The program began in 2007 in six areas to increase land productivity and health, through a landscape based restoration and conservation program focused on native plant and animal communities. A focus is maintenance of habitats to preclude the need to list species under the Endangered Species Act. In the past, many healthy landscape projects restored or improved habitat for sage grouse, whose habitat spans 11 western states. Land restoration efforts are accomplished through interagency coordination with other federal and state agencies.

Funding for the program is estimated at $8.0 million for FY2009 and FY2010, and the Administration is seeking the same level for FY2011.

Assessment, Inventory, and Monitoring (AIM) Strategy

BLM continues to develop an Assessment, Inventory and Monitoring (AIM) Strategy to establish an integrated and standardized data collection, retrieval, and assessment process that will provide data that is consistent and comparable over time, and that can be readily accessed and shared. The goal is to provide BLM and its partners with information to understand resource conditions and opportunities, and develop effective adaptive management strategies. The strategy is intended in part to foster BLM efforts to address climate impacts. A draft Strategy is currently under internal review.

The AIM Strategy has specific components and objectives. The assessment is intended in part to synthesize existing data and science to produce landscape-level ecoregional assessments, as discussed above. The inventory involves identifying priority inventories for continued use and proposals for additional data sets. The monitoring involves the development of a digital data library for vegetation monitoring data; establishing an agency wide field monitoring system for data collection that is based on key attributes of ecosystem sustainability, such as soil/site stability; indentifying performance indicators to monitor sensitive wildlife populations and habitats; and increasing the BLM's capability to use remotely sensed data to detect change and document land treatments.

FY2009 and FY2010 funding for the AIM Strategy is estimated at $2.0 million, and the Administration is seeking the same level of funding for FY2011. BLM has been directing this level of funding towards the development of this strategy since 2005.

[100] Funding for climate change activities in FY2009 is not identified in the FY2011 BLM Budget Justification.

Forest Service

The Forest Service tries to use science-based management for producing outputs from, accommodating uses on, and sustaining the ecosystems of the national forests. The science used in planning and managing the national forests can come from any source, but much of the scientific information is from the Research branch of the USFS. The USFS Chief does not have a "science advisor," but there is a Deputy Chief for Research and Development who reports to the Chief and is responsible for overseeing the work and funding of USFS Research.

Description and Purpose

The USFS Research branch conducts scientific research for land and resource protection, management, use, and restoration. It currently focuses on seven program areas: (1) wildland fire and fuels; (2) invasive species; (3) recreation; (4) resource management and use; (5) water, air, and soils; (6) wildlife and fish; and (7) inventory and monitoring. The goal is to provide information useful to land managers—substantially, but not exclusively USFS managers—for protecting lands from fire, insects and diseases, and invasive species; for managing resources (e.g., timber, water, wildlife) and uses (e.g., recreation, livestock grazing); and for restoring lands that have been affected by natural or man-made events (e.g., post-fire rehabilitation, slope stabilization and landslide recovery, invasive species eradication).

In addition, USFS Research conducts a forest inventory and analysis (FIA) program. FIA provides up-to-date information about timber and biomass on federal, state, and private forestlands in each state. The information collected is coordinated with the state forestry agencies to assure that all relevant data are gathered. Others (e.g., forest industry firms) can also collaborate, but they must fund the collection of any additional information requested. Originally, FIA conducted field surveys using fixed forest plots once a decade in each state. Now, the data are updated annually, with periodic field checks to assure the accuracy of the updates.

Authorization

USFS Research began in 1876 with funding in U.S. Department of Agriculture (USDA) appropriations for a forestry agent to "study and report on forest supplies and conditions."[101] In 1881, a Division of Forestry was established in USDA to continue studies of forest conditions and to provide technical assistance to forest landowners.[102] Thus, research has been a centerpiece for USDA forestry for 135 years, since before the national forests were created.

Formal legislative authorization of USFS was initially enacted in 1928, in a statute commonly known as the McSweeney-McNary Act (45 Stat. 699). This authorization was repealed and replaced with updated direction in the Forest and Rangeland Renewable Resources Research Act of 1978.[103] This act authorizes five areas of research: (1) management (e.g., for managing, reproducing, and growing vegetation on forests and rangelands); (2) environment (e.g., for understanding and managing the air, water, and soil of forests and rangelands); (3) protection

[101] Harold K. Steen, *The U.S. Forest Service: A History* (Seattle: Univ. of Washington Press, 1976), p. 13.

[102] The USFS was created in 1905, when the forest reserves and the Forestry Division of the General Land Office of DOI were transferred to USDA and merged with what had become the USDA Bureau of Forestry to create the USFS.

[103] P.L. 95-307; 16 U.S.C. §§1641-1647.

(e.g., for protecting vegetation and other resources, including threatened and endangered flora and fauna); (4) utilization (e.g., for improving the harvest, production, and marketing of wood-based products); and (5) assessment (e.g., for developing and applying scientific knowledge and technology for surveying and analyzing forest and rangeland resources). The act requires a system of experiment stations and areas, research laboratories, and other facilities, and authorizes the USFS to accept gifts, donations, and bequests to support the research efforts. The act also authorizes cooperation with public and private agencies, institutions, universities, and organizations, as well as with businesses and individuals, including acceptance of contributions for joint research efforts. The act authorizes competitive research grants. The Secretary is directed to avoid duplicative efforts, and to balance long-term versus short-term research and basic versus applied research.

Organization

USFS Research is a separate branch of the agency, and has been identified separately since at least 1911.[104] USFS Research is basically organized regionally into six stations, as shown in **Figure 6**:

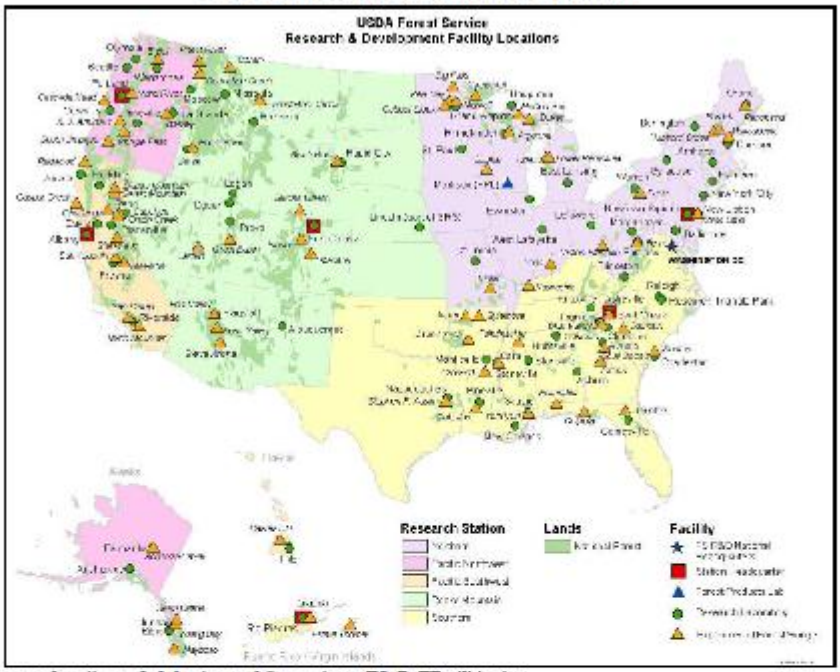
- the Northern Research Station, headquartered in Newton Square, PA;
- the Southern Research Station, headquartered in Asheville, NC;
- the Rocky Mountain Research Station, headquartered in Ft. Collins, CO;
- the Pacific Northwest Research Station, headquartered in Portland, OR;
- the Pacific Southwest Research Station, headquartered in Albany, CA; and
- the International Institute of Tropical Forestry, headquartered in San Juan, PR.

In addition, the USFS has three fire sciences labs, generally associated with the regional research stations, and the Forest Products Lab in Madison, WI.

The USFS Research branch includes more than 2,000 research scientists and support staff working in hundreds of research work units across the country. These work units include 80 experimental forests in 32 states, plus Puerto Rico and the Virgin Islands, as well as a multitude of research facilities, commonly located on or adjacent to university campuses. USFS researchers often collaborate with university faculty in their endeavors.

[104] See Henry S. Graves, *Report of the Forester for 1911*, U.S.GPO, 1912.

Figure 6. Forest Service Research Stations



Source: http://www.fs.fed.us/research/images/maps/FS_RnDFacilities.jpg

Funding

The USFS Research branch is funded in its own separate line item in the annual appropriations acts. The USFS has been included as a related agency in the annual Interior, Environment, and Related Agencies Appropriations Acts since 1955. Recent funding is shown in **Table 4**.

Table 4. USFS Research Funding, FY2009-FY2011

	FY2009 Actual	FY2010 Estimate	FY2011 Request
USFS Research	$296.4 million	$312.0 million	$304.4 million

Source: USDA Forest Service, *Fiscal Year 2011 President's Budget Justification*, http://www.fs.fed.us/publications/budget-2011/fy-2011-usfs-budget-justification.pdf.

Cooperators

As noted above, USFS Research is authorized to cooperate with other federal, state, and local governmental agencies, with public and private institutions, universities, and organizations, and with businesses, nonprofit organizations, and individuals. The agency can accept gifts, grants, and contributions for its own research and for joint research with any cooperators. Also as noted, many of the research work units are co-located at universities, promoting cooperative and joint

research efforts between USFS researchers and academicians. While much of the applied USFS research (in contrast to basic science research) is aimed at providing information useful for federal land managers, the research results (including publications) are often applicable to other land managers in the United States and elsewhere.

Discussion

The four FLMs and USGS have greatly expanded their emphasis on science and particularly on global climate change in recent years. The sudden growth can lead to overlap, duplication, and gaps. In addition, what appears to be growth may be simply repackaging. We conclude, within the time and resource constraints, that some overlap or duplication is illusory due to similar names or confusing agency or program histories. Second, the relationship among some programs is unclear, as their missions and structures seem similar. Third, the differing cultures and missions of the agencies lead to differing views on science needs. Fourth, CRS could not fully assess duplication or gaps in the time available. Fifth, the fact that some programs are in their infancy would by itself make an assessment difficult. Constraints on reducing any duplication or gaps could be statutory, budgetary, or cultural. Each point is reviewed below. (See **Table 3**.)

First, the duplication and overlap may be somewhat less than it appears because pre-existing Committees, Initiatives, Programs and Projects are renamed, moved from one agency to another, or have added new missions. Here is a selection of repackaged or renamed programs:

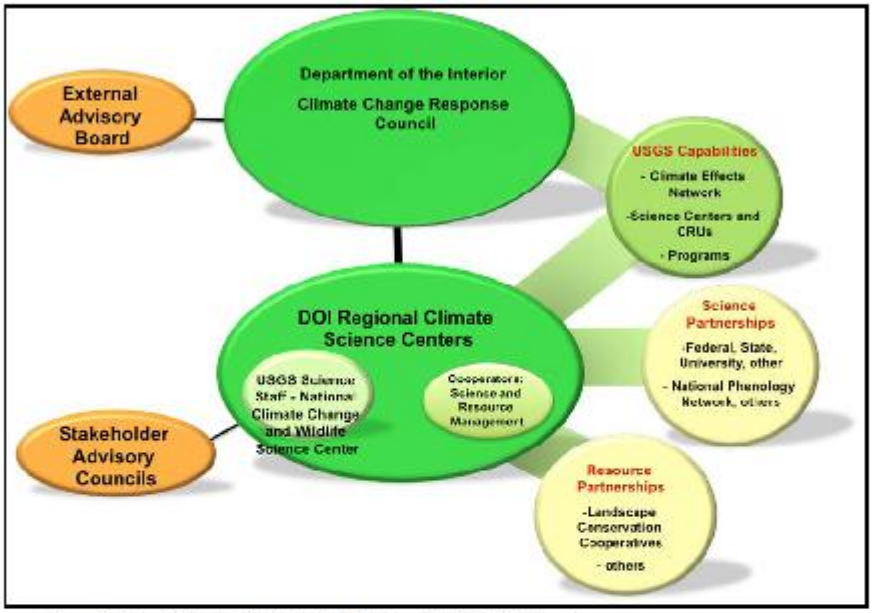
- The Landscape Conservation Cooperatives, seemingly created under S.O. 3289, in fact existed well before 2009. Their foundation is in FWS, but the Order gave them a role in the whole department as well as maintaining their role in cooperating with many outside entities.
- The Cooperative Research Units, a program begun 50 years ago, moved from FWS to the National Biological Service to BRD in USGS in the 1990s. The FWS remains their primary client.
- The National Climate Change and Wildlife Science Centers were renamed Regional Climate Change Response Centers in S.O. 3289. They were renamed again five months later as DOI Climate Science Centers in S.O. 3289A1.
- Regional Climate Science Centers were also once known as Regional Climate Change Response Centers, which were also once known as Regional Climate Science Hubs.
- The CESUs and the CRUs have many features in common and may be located in the same universities or have many of the same partners.
- Science Advisors are found at the Departmental and agency level. (In DOI, not only are Science Advisors found in the agencies discussed here, but also in other DOI agencies.)

Second, the relationship among the various programs at times is not clear. Without making any claim on whether any program does duplicate or overlap with any other, an objective observer could still find DOI's organizational structure for Climate Change Governance, as illustrated in **Figure 7**, to be confusing. There may indeed be little duplication among the structures. But the diagramed structure would at least require coordination to prevent duplication. If the complicated

structure embodied in **Figure 7** is accurate, the various partners may spend considerable amounts of time in meetings and project development preventing duplication.

Figure 7. Climate Change Adaptation Governance

Department of the Interior



Source: Dept. of the Interior. Budget Highlights, p. DH-12. Available at http://www.doi.gov/budget/2011/11Hilites/DH011.pdf

Third, during the course of this research, CRS analysts noted that agency officials at each of the agencies expressed different fundamental cultures as well as missions. Different policies, practices, and emphases on apparently similar programs has led to institutionalized views of the role of science and its application to decision-making. These somewhat intangible cultural ideologies play a role in how science is generally regarded in the agencies. Furthermore, these differences may contribute to the frequency or intensity with which USGS science services are employed.

Fourth, with the time and resources available, CRS could not fully assess duplication or gaps. However, the missions of the CRUs, the LCCs, the CESUs, and the CSCs and others appear to overlap very considerably. Examples include:

- The Water Resource Science Centers overlap in their missions with the Regional Climate Science Centers.
- The LCC mission overlaps with that of the National Climate Change and Wildlife Science Centers.
- The CESUs and the CRUs appear to have very similar missions.

Other examples involve some of the smaller partnerships.

CRS was not able determine if the agencies are avoiding the "stovepiping" that historically has been an issue for land management agencies.

Moreover, some programs appear to be virtual, rather than physical. The LCCs, at least so far, appear to be an information sharing network, and barring each LCC's coordinator, some may have no physical presence anywhere. If so, their ties to the Climate Science Centers would probably need to be strong, in order to generate the increased flow of information and ideas that would often be brought by daily contact if they were in the same physical setting.

Finally, many of these programs are either in their infancy or else in the first stages of reorganization. Results are not likely to be robust from a very young program. Moreover, organizations evolve, and might settle over time into their own niches, avoiding what now looks like duplication – or they might not.

Overall, our analysis found that some programs simply changed names (multiple times in some cases), or moved from one agency or part of an agency to another, so some apparent duplications are actually the same entity with sequentially different names. But we also discovered multiple programs that appeared to have strongly overlapping missions; these programs might require cooperative efforts to avoid overlaps. If actual overlapping functions were to be consolidated, statutory changes might be required, or be as simple as housing similar programs near each other.

Comparison with Secretary's Priorities

As noted above (see "Secretarial Priorities"), the Secretary has expressed great interest in the role of science at DOI, particularly regarding climate change. However, the priorities we have found tend to be general, and their success is correspondingly difficult to measure. There is clearly more scientific research being carried out, and more cross-cutting committees, councils, etc., are being formed than we were able to identify. If the attendees at these committees and councils rank high enough in their respective organizations to make substantive decisions or set measurable goals, they may be able to avoid duplication and fill in gaps in agency research. If however the principals delegate lower-ranking officials to attend repeatedly in their absence (a likely occurrence as the number of such bodies increases), then the committees and councils lose their authority, and may waste the time of those who circulate to these meetings.

One type of committee appeared to be absent: a committee within DOI or an interdepartmental committee that could review the many committees, initiatives, etc., and would be authorized to make the case if restructuring were needed for greater efficiency. Even if some committees or initiatives were created in statute, recommendations for mergers could still be made. For example, the CESUs, the CRUs, and the LCCs were created under different authorities, and might not be able to be merged formally as a result. But any overlap could be noted, and an attempt made to house them in the same facilities or on the same campuses in their ecoregions.

The Secretary's priorities do not directly address one cause of the proliferation of science programs: the tension between providing high quality scientific research through USGS, and the FLM need for not only high quality science but also more basic inventory and monitoring data. This feeling of periodic or frequent mismatches between USGS standards and internal science needs was voiced repeatedly to the authors, even as FLM managers acknowledged the quality of USGS science. As long as there is even a perception of a mismatch, there will likely be a desire

among science consumers to develop their own expertise. The Secretary has noted his desire to integrate science and management within DOI. Yet where agencies disagree or experience a culture clash, there appears to be no resolution short of an appeal to the Secretary. A working-level mechanism that could be tasked with avoiding duplications, overlaps, gaps, and policy disagreements was not found. Even if such a mechanism did not have decision-making authority, it could make recommendations for a resolution.[105]

Unanswered Questions

As we have noted, in the time available, and lacking investigative powers, we find several questions that we could not answer. As you requested, we present them here for your consideration. If you wish to pursue them or to use them to form the basis of requests to CRS or other entities such as the Government Accountability Office, we would be happy to work with you to develop the questions further.

- Beyond those described above, what other committees, initiatives, programs, or projects exist to serve the research needs, especially regarding global climate change, for the four FLMs?
- If DOI were to consolidate any existing programs (e.g., CESUs, CSCs, CRUs, and LCCs), what changes in statute would be required?
- Further, can any of the practical purposes of consolidation be accomplished simply by co-locating these institutions, either on the same campus, in the same building, or the same general area?
- In the last five years, one measure of real increases (as opposed to repackaging pre-existing programs) in scientific effort might be increases in several parameters, such as the number of federal scientists in these agencies; the number of collaborating universities, or the number of undergraduate and graduate students trained in the programs. How have these measures changed?
- Why did DOI choose to create the new DOI climate change science centers rather than use the existing CESU's (which are already established and work with over 13 federal agencies and 200 universities and serve many of the same roles and functions)?
- Given that the agencies have different missions, priorities, and different data standards and policies, is there an efficient way to implement a DOI-wide resource data system while maintaining the highest quality of applied science (rather than reverting to the least common denominator) so that the data can be extracted, shared, and compared among agencies?
- Given that the agencies have different missions, uses and applications for science data, different funding mechanisms, and different priorities for collecting and applying science data, is it even practical to try to standardize data inventorying collection methodologies so that data can be shared and managed across agencies within the DOI?

[105] It is also possible that some council does have the authority to resolve such differences, but that the authority was not clear in agency documents available to CRS.

- Is it practical to ensure that the nature and role of USGS services to the other DOI agencies are defined in writing, either through policy, memoranda or otherwise?
- Does DOI have any plans to consolidate some climate change research programs to improve efficiency? If not, does it plan to review the range of programs with an eye to efficiency?
- Each of the five agencies considered in this review has received funding for climate change, research and adaptation. In addition, other DOI agencies have also received funding. What is the connection between the Secretary's goals and the specific amounts received by each agency?
- One of the most readily measurable of the Secretary's goals is that DOI will identify areas in the United States that are most vulnerable climate change. Further, DOI is expected to begin implementing comprehensive adaptation strategies by 2012. To meet such goal, one might expect that vulnerable areas would already begin to be identified. Have any especially vulnerable areas begun to be named?

Table 3. Principal Climate Change Research Programs in Five Federal Agencies

Program	Principle Agency	Cooperating Agencies & Organizations	Year Created	Authority	Funding FY2010	Mission
DOI Task Force on Energy and Climate Change	DOI	All DOI agencies	2009	S.O. 3285	Funding through participating agencies; amount not identifiable	To establish a DOI-wide approach for renewable energy on federal lands, including those on the Outer Continental Shelf.
Cooperative Ecosystem Studies Units	DOI	NPS, FWS, BLM, USGS, BOR, MMS, FS, NRCS, NOAA, DOD, COE, NASA, universities	1998	P.L. 105-391	Varies with unit; through contributions from cooperating agencies	To provide timely, authoritative scientific information to resource managers; to support professional development of federal scientists; and to benefit university faculty and students.
Climate Change Response Council	DOI	All of DOI	2009	S.O. 3289	Through DOI General Administration; not identifiable	To coordinate a Department-wide strategy to increase scientific understanding and develop tools to address the impacts of climate change on natural and cultural resources.
Joint Fire Science Program	DOI & USDA-FS	BLM, FWS, NPS, BIA, USGS	1998	P.L. 105-83	$14.0 million	To provide research, via competitive grants, for fire and fuel managers.
WaterSMART Program	DOI/BOR	USGS, LCCs	2010	S.O. 3297	$36.5 million	To secure and stretch water supplies to benefit people, the economy, and the environment
National Climate Change and Wildlife Center (and Regional Climate Science Centers)	DOI, USGS	DOI LCCs, FS, NASA, NOAA, EPA, states, tribes, NGOs	2007	P.L. 110-161 S.O. 3289	$15.1 million	To provide natural resource managers with the tools and information they need to develop and execute strategies for successfully adapting to and mitigating the impacts of climate change.
Cooperative Research Units	USGS (BRD)	FWS, State natural resource agencies, host universities, Wildlife Management Institute	1960	P.L. 86-686	$19.3 million	Network conducts research, education on fish, wildlife, ecology, and natural resources; provides expertise for scientific needs for resource management by state and federal agencies; supports relevant graduate education and training.

Program	Principle Agency	Cooperating Agencies & Organizations	Year Created	Authority	Funding FY2010	Mission
Science Centers	USGS (BRD)	Other DOI agencies, universities, state, and local institutions (varies with center)	Various years	Funded via contributions from USGS and other cooperators; varies from center to center	$103.6 million	Varies with individual center.
Water Resources Science Centers	USGS (WRD)	Other federal agencies (in and out of DOI), state water agencies, and private stakeholders	Various years	43 U.S.C. 31	Unknown: from various water resources programs under USGS and from cooperators.	To collect and analyze data for Cooperative Water Program, Hydrological Monitoring, Assessments Activity and Research Activity, and Water Resources Research Act Program.
Landscape Conservation Cooperatives	DOI, FWS	USGS, BOR, BLM, NPS, FS, states, tribes, local governments, non-governmental groups	2009 (but with predecessors)	S.O. 3289	~$20.0 million	To inform managers on landscape-scale stressors (habitat fragmentation, genetic isolation, spread of invasive species, and water scarcity, all accelerated by climate change) and to evaluate conservation strategies, maintain and share information and data, and improve products with newly available information.
Joint Ventures	FWS	DOI agencies, FS, states, tribes, local governments, NGOs	1986	North American Waterfowl Management Plan (U.S.-Canada Agreement)	$14.1 million	To implement national or international bird conservation plans within a specific geographic area or for a specific taxonomic group (with general acceptance in the bird conservation community for such responsibility).
Fish Habitat Partnerships	FWS (as participant in voluntary organization)	States, tribes, other stakeholders	Chartered in 2006	N.A.	FWS portion is part of Fisheries Habitat Assessment and Restoration Program, funded at $27.1 million	To carry out a cooperative nationwide program to conserve (protect, restore and enhance) the habitats of the nation's marine and freshwater fish populations.

Program	Principle Agency	Cooperating Agencies & Organizations	Year Created	Authority	Funding FY2010	Mission
Research Learning Centers	NPS	Public/private partnership; researchers; universities; community groups	1999	Created by the Natural Resource Challenge	Each of the 12 units funded by NPS are also partially funded by partners; funding for each Center varies	To attract non-NPS scientists to conduct research in parks; results help park managers in making science-based decisions.
Climate Change Response activities	NPS	DOI Energy and Climate Change Task Force, Climate Change Response Council	2009	--	$10.0 million in FY2010. No request for FY2011	To respond to climate change through mitigation, adaptation, and communication with a program for core staff and field-based projects.
North Slope Science Initiative	BLM	Other federal agencies, Alaskan & local governments, Native corporation	2005	P.L. 109-58, Sec. 348	$1.0 million	To improve scientific and regulatory understanding of terrestrial, aquatic, and marine ecosystems for consideration in the context of resource development activities and climate change.
Southern Nevada Agency Partnership	BLM	FWS, NPS, FS, private organizations	1997	Established administratively as Service First Initiative[a]	N.A.[b]	To coordinate protection, conservation, and use of public lands of southern Nevada.
National Integrated Land System	BLM	FS, states, counties, and private sector	2001; being decommis-sioned	OMB Circular A-16	$3.3 million	To provide cadastral records and land parcel information in a geospatial format for land managers and the public.
USFS Research	USFS	not applicable	1876	16 U.S.C. 1641-1647	$312.0 million	R&D for land managers on wildfire & fuels, invasive species, recreation, resource management & use, water/air/soils, wildlife & fish, inventory & monitoring

Source: Created by CRS from many agency documents; see text for each entry.

Notes: See Appendix A for acronyms; N.A. = Not Available.

a. For information on Service First, see Forest Service website at http://www.fs.fed.us/servicefirst/.

b. Receives grant funding through Southern Nevada Public Land Management Act. Most recent grant, in 2009, was $0.6 million.

Appendix A. Directory of Acronyms

AIM	Assessment, Inventory, and Monitoring Strategy
BLM	Bureau of Land Management
BRD	Biological Research Discipline
CCRC	Climate Change Response Center
CESU	Cooperative Ecosystem Studies Unit
CIPPs	Committees, Initiatives, Programs, and Projects
CRU	Cooperative Research Unit
CSC	Climate Science Center, once known as Climate Change Response Center
CWP	Cooperative Water Program
DOI	Department of the Interior
EPA	Environmental Protection Agency
FHP	Fish Habitat Partnerships
FIA	Forest Inventory and Analysis
FLM	Federal Land Management Agency
FLPMA	Federal Land Policy and Management Act of 1976
FS	Forest Service
FSP	Fundamental Science Practices
FY	Fiscal Year
JFSP	Joint Fire Science Program
LCC	Landscape Conservation Cooperative
FS	Forest Service
FWS	Fish and Wildlife Service
NASA	National Aeronautics and Space Administration
NBS	National Biological Service
NCCWSC	National Climate Change and Wildlife Science Center
NEPA	National Environmental Policy Act
NFHAP	National Fish Habitat Action Plan
NGO	Non-Governmental Organization
NILS	The National Integrated Land System
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRC	National Research Council

NSSI	North Slope Science Initiative
PLF	Public Lands Foundation
REA	Rapid Ecoregional Assessment
SNAP	Southern Nevada Agency Partnership
S.O.	Secretarial Order
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WRD	Water Resources Discipline

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South Atlantic Landscape Conservation Cooperative

U.S. Fish & Wildlife Service

South Atlantic Landscape Conservation Cooperative

Development and Operations Plan

December 2009



USFWS/Garry Tucker

Acknowledgements

While a number of individuals within several agencies and organizations were involved in pulling this plan together, the plan does not have the benefit of the multitude of individuals whose contributions will be instrumental to the success of the South Atlantic LCC. Thus, this plan is expected to undergo substantial improvements as the larger community engages in the cooperative.

A core writing team consisting of Bob Ford (USFWS, Regional Science Coordinator), Joe DeVivo (US National Park Service, Southeast Regional Office), Amy Keister (USFWS, Lower Mississippi Joint Venture Office, on detail to SALCC), John Stanton (USFWS, Migratory Birds), Doug Newcomb (USFWS, Ecological Services, Raleigh, NC, Field Office) and Wilson Laney (USFWS, South Atlantic Fisheries Coordinator), prepared the original draft of this document. Sonya Jones and the scientists working on the Southeast Pilot Project (USGS) contributed text and reviewed portions of this document. Mike Harris (Georgia Wildlife Resources Division) provided comments and worked with other states in the LCC.

Additional materials and text were provided by members of the USFWS internal SALCC Advisory Team, Regional Office staff, and other field staff including Pete Campbell (USFWS, Ecological Services, Raleigh, NC, Field Office), Craig Watson (USFWS, Atlantic Coast Joint Venture), Raye Nilius (USFWS, South Carolina Lowcountry Refuges Complex), Bill Uihlein and Catherine Rideout (USFWS, Gulf Coastal Plain and Ozarks LCC), Andrew Milliken, Tim Jones, and Randy Dettmers (USFWS, North Atlantic LCC), Jeff Fleming (USFWS, Southeast Region, Assistant Regional Director-External Affairs), Stacy Shelton (USFWS, External Affairs) and Jackie Parrish (USFWS, Southeast Region, Assistant Regional Director-Budget and Administration).

The Interagency Scoping Team for the South Atlantic LCC had only a brief opportunity to review this document, but will be the group that continues to modify and grow the SALCC plan and concept until a Steering Committee and Coordinator are in place.

We thank those who had the opportunity to review and comment on short notice, including Laurel Barnhill (South Carolina Dept of Natural Resources), Mike Harris (GA WRD), Tom Eason (Florida Fish and Wildlife Conservation Commission), Emily Greene (Atlantic Coastal Fish Habitat Partnership), Scott Robinson (Southeastern Aquatic Resources Partnership), Mary Long (U.S. Forest Service), and Ashton Drew (North Carolina State University). We anticipate further review of this document as it evolves.

Introduction

The South Atlantic Landscape Conservation Cooperative is one of 22 cooperatives proposed earlier this year by the U.S. Department of Interior to address unprecedented conservation challenges, headlined by climate change.

Landscape Conservation Cooperatives are envisioned as broad-based partnerships that will provide the science necessary to undertake strategic conservation efforts across large geographic areas. A coordinated network of these LCCs across the United States are the most effective way to address major environmental and human-related factors that limit fish and wildlife populations. The science provided by these partnerships will:

- Inform biological planning and conservation design;
- Help direct assumption-driven research and monitoring; and
- Ensure future conservation decisions are made in an adaptive management framework.

U.S. Department of Interior (DOI) agencies have committed financial and staff resources to make the South Atlantic LCC (SALCC) functional in 2010:

- The U.S. Fish and Wildlife Service (Service) will hire a full-time LCC coordinator in late winter, another position to be determined by LCC need, and provide dedicated staff support for other LCC needs, such as spatial analysis. The Service will also support core science projects that will be useful to all partners involved in the LCC.
- The U.S. Geological Survey (USGS) has committed to develop and continue southeastern regional science products via the Southeastern Pilot Project, and to also provide a science position in the South Atlantic.
- The National Park Service (NPS) has resources at hand to further science capacity and provide leadership for information management in the SALCC as well.
- Other DOI Bureaus, including Mineral Management Services, Office of Surface Mining, and Bureau of Indian Affairs, are exploring avenues for coordination with the Service's Southeast Region.

In addition, states and universities in the SALCC are exploring ideas for in-kind support, ranging from species climate change sensitivity assessments to GIS technology to sharing office space and staff expertise.

To date, the concept of such a dynamic partnership in the South Atlantic generally has been well received in the Southeastern U.S. and the South Atlantic region. Many organizations and existing partnerships recognize the need for coordinated efforts across multiple ecological scales to provide the science needed to act on traditional and new stresses to natural resources, while ensuring sustainable landscapes for our economy and standard of living.

The Service also is taking the lead in establishing LCCs covering the entire Eastern Seaboard (North Atlantic, South Atlantic, Peninsular Florida LCCs) and the Gulf of Mexico coast (Peninsular Florida and Gulf Coastal Plain and Ozarks). Furthermore, discussions have begun between the southeast and southwest regions of the Service to initiate a cooperative that includes the Texas and Louisiana coasts. This geography is among the most sensitive in the world to sea level rise, salt water intrusion, and storm surge from accelerated climate change. The interaction among these LCCs is extremely important, and is demonstrated in parts of this plan.

The LCC Challenge: Changing the Business of Conservation So Society Can Meet Unprecedented Demands

One of the grandest achievements of U.S. society has been its public policies and investment in treasured landscapes where citizens are invited to experience natural wonders by fishing, hiking, boating, touring, hunting, bird watching – or simply star-gazing. Moreover, we are learning that an investment in a healthy landscape, represented by both public and private lands, is a sound investment in our economic future, health, and well-being.

And yet society's progress has meant increased pressures on the natural resources we depend on and desire to protect. Climate change, above all other stresses, threatens to remake landscapes and extinguish species. No longer is it sufficient to protect and manage only pieces of a complex ecosystem. Climate change requires us to reconsider every aspect of organizational and program operations and performance.

The conservation community understands that it cannot face these challenges by simply repeating past successes. A fundamental shift is taking place that's evolved over two decades. The catalysts are advancements in conservation and decision theory, as well as the new spatial planning capabilities and tools which are outgrowths of the global digital revolution.

Landscape Conservation Cooperatives embody this changing conservation business model. The name itself explains how:

- *Landscape* - LCC boundaries are not intended to be barriers to conservation, but should ensure complete spatial coverage while avoiding costly duplications. The LCC also should provide common ground for the intense level of coordination required to sustain ecological systems, processes and species.
- *Conservation* - The LCC will enable conservation partners to apply a conservation planning logic and science-based adaptive management process, which the Service calls Strategic Habitat Conservation (SHC). SHC integrates biological planning, conservation design, conservation delivery, outcome-based monitoring, and assumption-driven research as an iterative whole. The framework will continue to be refined and improved through the partnerships that comprise the national network of LCCs.
- *Cooperatives* - Coordination can no longer be our goal. We must recognize the need for working beyond our boundaries and accept interdependency as an organizing principle.

The South Atlantic Landscape Conservation Cooperative's Proposed Geographic Area

The SALCC's proposed boundary is an ecologically diverse region in the southeastern United States that covers portions of six states and encompasses approximately 89 million acres.

The boundary was created by a joint USGS and Service team based on Bird Conservation Regions (BCR) that were modified to consider the needs of aquatic and terrestrial species. The SALCC geographic area is comprised of portions

of the Piedmont and Southeastern Coastal Plain BCRs, as well as the Atlantic Ocean from the shore to the seaward extent of U.S. Territorial waters 200 miles offshore. For a more detailed description of the SALCC boundary including various ecoregions, land cover, and land use maps, see end of document.

The SALCC includes five ecoregions: the Middle Atlantic Coastal Plain, Southern Coastal Plain, Southeastern Plains, the Piedmont, and the Blue Ridge.

Middle Atlantic Coastal Plain

The Middle Atlantic Coastal Plain spans approximately 14 million acres and includes coastal areas in Virginia, North Carolina, and South Carolina. This ecoregion is characterized by low elevation flat plains, which contain swamps, marshes, and estuaries. The historic land cover, dominated by longleaf pine, has largely been converted to loblolly and shortleaf pine.

Southern Coastal Plain

The Southern Coastal Plain spans approximately 13 million acres and includes coastal areas in South Carolina, Georgia and Florida. This heterogeneous region includes barrier islands, lagoons, marshes, swampy lowlands, wetlands and numerous lakes. The historic land cover, a variety of forest communities including longleaf pine, slash pine, pond pine, beech, sweetgum, southern magnolia, white oak, and laurel oak, has largely been converted to slash and loblolly pine, oak-gum-cypress forest in low lying areas, pastures, and urban centers.

Southeastern Plains

The Southeastern Plains spans approximately 26 million acres and includes portions of Virginia, North Carolina, South Carolina, Georgia, and Florida. This ecoregion is characterized by irregular plains. This historic land cover, dominated by longleaf pine, now includes cropland, pasture, and woodlands.

Piedmont

The Piedmont spans approximately 35 million acres and includes portions of Virginia, North Carolina, South Carolina, Georgia, and Alabama. This transitional area between the Appalachian Mountains to the northwest and the coastal plains to the southeast is characterized by moderately dissected plains and hills. The historic land cover, dominated by oak-hickory-pine and Southern mixed forest, has been largely cleared for agriculture and is now rapidly converting to urban and suburban communities.

Blue Ridge

The SALCC will cover only a small portion (approximately 250,000 acres) of the Blue Ridge ecoregion in Virginia and North Carolina. This area is on the northwestern edge of the SALCC. It is likely that the Appalachian LCC will provide the lead for this ecoregion. The SALCC will need to coordinate closely with all bordering LCCs to ensure a seamless approach to biological planning and conservation design.

Southeastern Outer Continental Shelf

This SALCC is adjacent to the Southeastern Outer Continental Shelf and shares many biotic and abiotic features, and can be classified into the Virginian and Carolinian marine ecoregions. In an area offshore of Cape Hatteras on the Southeastern Outer Continental shelf, two major Atlantic currents mix forming a very rich marine environment. Large mats of *Sargassum* form surface reefs and concentrate rare and endangered seabirds, marine mammals, marine turtles and fish. The site is important commercial and sport fishing area, as well. Within the southeastern U.S., this subunit has the greatest diversity of seabirds and marine mammals, and probably the greatest density of tropical seabirds.

Starting Point

The SALCC is an extension of existing, powerful and fully functioning partnerships comprised of federal and state agencies and conservation non-governmental organizations. The two principal ones are the Atlantic Coast Joint Venture, which covers the full extent of the SALCC, and the Service's Eastern North Carolina-Southeastern Virginia Strategic Habitat Conservation Team, which covers the northern portion of the SALCC.

Eastern North Carolina-Southeastern Virginia Strategic Habitat Conservation Team (ENC-SEVA SHC Team)

The SALCC has its roots in a national, cross-programmatic initiative launched by Service leaders in June 2004 to develop a landscape-level approach to conservation. The ENC-SEVA SHC Team developed the proposal to establish the SALCC, and remains a strong leader.

Atlantic Coast Joint Venture (ACJV)

The ACJV is a partnership of federal, regional and state agencies and organizations focused on the conservation of habitat for native birds in the Atlantic Flyway region of the United States from Maine south to Puerto Rico, including all the states in the North Atlantic, South Atlantic and South Florida LCCs. The ACJV Management Board met December 3- 4, 2009 and agreed to collaborate in broader strategic habitat conservation approaches for all wildlife and fish species. The Management Board will provide a leadership role for tying together the conservation science and conservation delivery of the three Atlantic Coast LCCs.

The joint venture will continue to develop biological planning, conservation design, monitoring and research projects throughout the joint venture area. Its partners and staff are willing to play a lead role in helping to establish LCCs in the South Atlantic as well as the North Atlantic, South Florida, Great Lakes and the Caribbean by building on existing ACJV projects and partnerships including a number of science projects that can serve as initial priorities for the LCCs.

Working with Partners

The SALCC scoping team is in place with a number of partners. In addition to the Service, they include representatives from the USGS, NPS, the U.S. Forest Service, Southeastern Association of Fish and Wildlife Agencies' members Georgia, Florida, North and South Carolina and Virginia, the Atlantic Coast Joint Venture, the Southeastern Aquatic Resources Partnership, and the Atlantic Coastal Fish Habitat Partenrship. Ultimately, top-level representatives from these partner organizations will form the Steering Committee to provide management direction and set the priorities for the SALCC.

The Southeast Natural Resources Leadership Group (SENRLG)[1] helped develop the idea for the South Atlantic Landscape Conservation Cooperative in 2008, then provided conceptual support for the proposal at their January 2009 meeting in Florida.

For southeastern states, an open session about LCCs and climate change was hosted by the Georgia Department of Natural Resources at the 2009 Southeastern Association of Fish and Wildlife Agencies (SEAFWA) meeting

1 SNERGL consists of senior regional administrators from the Department of Defense, U.S. Army Corps of Engineers, U.S. Geological Survey, National Park Service, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Agency, Federal Highway Administration, U.S. Forest Service, Environmental Protection Agency, and the Tennessee Valley Authority.

in Atlanta. State wildlife agency directors and other state and federal biologists attended the meeting, such as, Florida Fish and Wildlife Conservation Commission; Georgia Department of Natural Resources; South Carolina

Department of Natural Resources; and the Southeast Aquatic Resources Partnership. Georgia wildlife biologists and the Service received feedback from the meeting, and there was strong conceptual endorsement of continuing development of the LCC. In concert with this meeting, the Service's Southeast Regional Director held individual conversations with each State Wildlife Director to strengthen the concept of LCCs.

Future discussions will be held with all partners to ascertain the role(s) which they are willing to play in the SALCC. In the interim, we include herein the roles which we envision could be played by some of the partners which have to date been contacted.

In addition, the Service's Southeastern Regional Directorate provided resources in 2008 to assign temporary staff to start partnership and science development. As a result, two teams were developed in the South Atlantic Region to guide and support the formation of the SALCC. The first team is advisory and internal to the Service, and has been networking with partners. The second is the SALCC Interagency Scoping Team[2], which will:

- Provide input and guidance on hiring an LCC coordinator;
- Provide input into choosing a location for core staff, which has now been proposed for Raleigh, North Carolina;
- Consider possible office locations for other staff throughout the LCC geography;
- For the development of a Steering Committee, consider size, participating agencies and organizations, rotation of members, and, possibly, draft a preliminary vision and role of the Steering Committee to better identify partners;
- Review and comment on this preliminary draft plan for the SALCC.

The Scoping Team may also provide suggestions for the expenditure of funds in the short term, with thoughts about a long-term process for expenditure of funds.

Current and Potential Partner Roles

Department of Interior

- U.S. Fish and Wildlife Service (Service)

  The Service is providing leadership and overall coordination, and will contribute to science support, inventory, monitoring, and conservation delivery in the SALCC. The Service will dedicate additional resources as determined by the LCC, including for example, spatial analysis. The Service has led development of this plan, provided the coordination to form an internal advisory team for the SALCC, and provided leadership to date for the Interagency Scoping Team for the SALCC.

  The Service has a significant land base consisting of 32 national wildlife refuges in the South Atlantic area. Furthermore, in fiscal year 2010, the Service will provide the resources necessary for an SALCC Coordinator and a science position. The Service has coordinated with USGS and NPS staff in the region to ensure the development of shared vision and objectives.

- U.S. Geological Survey (USGS)

  The USGS is leading the effort in the southeastern U.S. to provide the necessary science tools for land managers and planners to address climate change. The USGS, in close partnership with the Service, developed the Southeast Pilot Project, which provides a series of coordinated research products ranging from downscaled climate change predictions to coastal sea level rise threats to terrestrial and aquatic modeling n the South Atlantic and East Gulf Coast Plain regions. The USGS led the development of a plan and vision for the Southeast Regional Climate Impact Response Center (the "Regional Hub") and helped define the conceptual relationship between the regional center and the LCCs.

- National Park Service (NPS)

  NPS's Southeast Coast Inventory and Monitoring Network (SECN) has been monitoring the natural resources of parks within the SALCC since 2005. The Network's program began in 2001 with initial funding to conduct baseline biological inventories. The SECN has selected and begun monitoring of 25 Vital Signs, or indicators of ecosystem health. Monitoring methodologies and data management strategies will be shared among LCC partners. Beginning in 2010, the SECN will receive additional base funding to augment its existing monitoring program to assess climate change impacts on park resources in coastal areas. The new monies to be programmed for climate change monitoring are intended to be applied within the context of the SALCC.

  The NPS has a significant land base in the SALCC, including 17 national seashores, historic sites, and recreation areas.

- Other Bureaus

  Other DOI bureaus have been exploring avenues for coordination, including the Minerals Management Service, Office of Surface Mining, and the Bureau of Indian Affairs.

Other Partners

- States and the Southeastern Association of State Wildlife Agencies (SEAFWA)

  States that are active in the SALCC will provide essential and foundational support both as individual states and as a collective of states that share priorities through their State Wildlife Action Plans or Comprehensive Wildlife Conservation Plans. The State Wildlife Action Plans were completed in 2005 with input from the public and partners in each state. These plans provide a comprehensive assessment of wildlife conservation needs in each state including identification of species of greatest conservation need, habitats that support these species, problems affecting the

2 Members of the Interagency Scoping Team include Joe DeVivo (NPS), Brock Carmichael (South Carolina Department of Natural Resources), Laural Barnhill (SCDNR), Sonya Jones (USGS), Brian Branciforte (Florida Fish and Wildlife Conservation Commission), David Whitehurst (Virginia Department of Game and Inland Fisheries), Jason Bulluck (Virginia Department of Conservation and Recreation), Craig Watson (ACJV, USFWS), Mike Harris (Georgia Wildlife Resources Division), Mary Long (USFS), Gordon Meyers (North Carolina Wildlife Resources Commission), Dr. Thomas Eason (Florida Fish and Wildlife Conservation Commission), Roger Pugliese (South Atlantic Fishery Management Council), Scott Robinson (Southeastern Aquatic Resources Partnership), Pat Campfield (Atlantic States Marine Fisheries Commission), Emile Greene (Atlantic Coastal Fish Habitat Partnership), Dean Carpenter (Albemarle Pamlico National Estuary Program). Staff support: Bob Ford, Amy Keister, Pete Campbell, and Wilson Laney (USFWS).

species and habitats, identification of research needs, conservation actions to address identified needs and plans for monitoring effectiveness of conservation actions and species and habitats.

These states are exploring methods through which to contribute to the LCC for projects that address shared interstate wildlife priorities. For example, states are well positioned to contribute to sustainable landscape-type projects that will require good habitat maps for modeling. They have extensive data and could share in updating GIS databases in regard to public lands, management status, and potential climate change sensitivity. States also could share in implementation of monitoring programs for a variety of species in a coordinated system. States may also be able to share in funding to update habitat maps through the Southeastern ReGap Project. Existing multistate projects have been initiated based on common needs and on-going partnerships.

Other state contributions -- such as expressed by the state natural heritage program support in Virginia and, as expressed by Florida in its state conservation planning efforts -- will be integrated into the LCC conservation planning and design process over time.

In addition, SEAFWA continues to offer opportunities for an exchange of ideas about the future of conservation and the role of states, as well as providing opportunity for specific reports and feedback.

- Atlantic Coast Joint Venture (ACJV)

  Joint venture staff and partners are already working on various aspects of biological planning, conservation design, monitoring and research for migratory birds in this area. They will also help guide funding to high priorities identified by the LCC through major grant programs including the North American Wetlands Conservation Act and National Coastal Wetlands Conservation Grants.

- Federal Fishery Management Councils

  Nationwide, eight Federal Fishery Management Councils develop fishery management plans to manage fishery resources within waters 3 miles to 200 miles offshore. Two of those are within the SALCC, the Mid-Atlantic and South Atlantic Fishery Management Councils (MAFMC, SAFMC). A formal request for the Council to designate a member of the SALCC Scoping Team was submitted on November 20, 2009. The Council will benefit the SALCC through continued monitoring and assessing of fish stocks in the south Atlantic, as well as through their continued actions with regard to ecosystem-based fishery management. The SALCC will benefit the Council through the provision of biological planning and conservation design services.

- National Fish Habitat Partnerships (NFHP)

  The National Fish Habitat Action Plan is an unprecedented attempt to address an unseen crisis for fish nationwide: loss and degradation of their watery homes. A key component of the plan is to establish Fish Habitat Partnerships which operate in defined areas and are eligible for federal funding. There are currently two Fish Habitat Partnerships whose designated work areas overlap the geographic boundary of the SALCC, the Southeast Aquatic Resources Partnership (SARP), and the Atlantic Coastal Fish Habitat Partnership (ACFHP). The coordinators of both partnerships have been invited to serve as members of the Scoping Team.

- Partners in Amphibian and Reptile Conservation (PARC)

  PARC is an inclusive partnership dedicated to the conservation of the herpetofauna (i.e. reptiles and amphibians) and their habitats. Membership includes representatives from state and federal agencies, conservation organizations, museums, pet trade industry, nature centers, zoos, energy industry, universities, herpetological organizations, research laboratories, forest industries, and environmental consultants. PARC will be able to serve as a focal point for herpetofaunal planning and conservation efforts.

- Partners in Flight (PIF)

  PIF was launched in 1990 in response to growing concerns about declines in the populations of many land bird species, and to emphasize the conservation of birds not covered under existing initiatives. The central premise of PIF is in close alignment to SALCC: Resources of public and private organizations in North and South America must be combined, coordinated and increased in order to achieve success in conserving bird populations. PIF is anticipated to be a key partner in bird conservation within the SALCC.

- Southeast Regional Partnership for Planning and Sustainability (SERPPAS)

  In 2005, state environmental and natural resource officials from across the southeast partnered with the Department of Defense and other federal agencies to form SERPPAS to prevent encroachment around military lands, encourage compatible resource-use decisions, and improve coordination among regions, states, communities, and military services. The region covered by SERPPAS includes the states of North Carolina, South Carolina, Georgia, Alabama, and Florida. Given that all SALCC states except Virginia participate in SERPPAS, we anticipate it will be an important partner in SALCC.

Priority Species and Habitats

The South Atlantic LCC includes a tremendous diversity of ecosystems that include tidal river and estuarine ecosystems, barrier islands, near-shore marine habitats, vast intertidal marshes, blackwater river systems, the pocosin and Carolina Bay wetlands which host carnivorous plants, baldcypress swamps, live oak maritime forests, longleaf pine savannas, dunes of the Coastal Plain, oak–hickory forests, bottomland forests, prairies, glades, barrens of the Piedmont and continental interior, and the springs and extensive cave systems of limestone areas.

Because of diverse environments and long evolutionary isolation, a number of groups reach continental high points of species richness in the Southeast, making the region one of the richest areas in the temperate zone, surpassed only by eastern Asia. Groups that have their highest North American diversities in the Southeast include amphibians, fishes, mollusks, aquatic insects, and crayfishes throughout the region; salamanders, land snails, fungi, and plants in the southern Appalachians; and carnivorous plants on the Coastal Plain.

The six states within the SALCC, as noted earlier, have each prepared State Wildlife Action Plans that identify

priority species also known as species of greatest conservation need. These plans also identified priority habitats but classification systems varied among the states. The Service's Southeast Region also is working to identify priority species and habitats.

In the interim, for the purposes of this planning exercise, we have identified representative habitats and system drivers present in the SALCC; this list is not intended to be comprehensive (Table 1), and some representative species of management concern; this list is not intended to be comprehensive (Table 2).

It is anticipated that this list will be refined as the steering committee/ partnership formalizes. Species and habitats identified in the State Wildlife Action Plans are an obvious starting point but additional species and habitats could be included. The ACJV through South Atlantic Migratory Bird Initiative (SAMBI) has identified priority bird species and habitats through the vast SAMBI partnership. Additionally, through the Designing Sustainable Landscapes project, surrogate species for the major habitat types for birds has gone through a Structured Decision Making process to refine the list of priority bird species to be modeled. The Steering Committee may use a similar process of SDM to determine priority species in other taxa.

Anticipated Conservation Delivery Mechanisms Related to Priority Species and Habitats

Background

The core staff of the LCC will focus on the development of science driven decision support tools, so that cooperators in the LCC can have a common and useful tool for making decisions about delivering the most effective conservation through ecosystem restoration, habitat management, and policy shifts. A myriad of opportunities exist for delivering conservation on the ground and in policy, and each opportunity can uniquely serve the needs of any particular project. We provide examples of a new, non-traditional approach to habitat restoration in partnership with industry and others, as well as traditional conservation delivery programs in the text below.

Cutting-edge tools

Carbon sequestration partnerships with industry and others represent new opportunities for the SALCC. Carbon sequestration allows industry to offset their carbon footprint by mitigating their carbon emissions with replacement of native vegetation in locations that provide the most effective conservation of wildlife.

Pocosins

Pocosins are unique wetlands, also known as southeastern shrub bogs. These peatlands typically have a thick underlying layer of peat soils (Histosols) that act as a chemical sponge over geologic time, locking-up metals, carbon, and nutrients in vegetation and the deepening soil layer. Inundation of hundreds of thousands of acres of low-lying pocosins east of Pocosin Lakes from sea level rise is anticipated; conversion of thousands of acres of low pocosin to

Table 1. Potential priority species, habitats and system drivers found within the South Atlantic LCC.

Species and Assemblages	Habitats and Systems	Ecosystem Drivers and Threats
Carnivorous Plants	Bottomland and Floodplain Forests	Fire Suppression
Freshwater and Diadromous Fishes	Glades, Barrens, and Prairies	Altered Hydrology and Water Quality
Reptiles and Amphibians	Longleaf Pines and Southeastern Pinelands	Loss of Upland old-growth forests
Birds	Carolina Bays	Land Use Conversion and Development
Bats	Pocosins	Climate Change
Black Bear	Atlantic White-Cedar Swamps	Non-indigenous species
Small Mammals	Barrier Island Communities and Maritime Forests	Harvest
White-Tailed Deer	Rivers and Streams	Environmental Contaminants
Marine Mammals	Caves	Natural Disturbances
Shorebirds and Seabirds	Estuaries	Coastal urban development and sea level rise
Marine Reptiles (Turtles)	Oceans	Rising temperatures, sea level rise, and other climate change impacts on nesting beaches
Shorebirds, Seabirds, Marsh Birds, Wading Birds	Salt Marshes and Wetlands	Sea level rise and other climate change impacts, coastal urban development, and nutrient runoff

Table 2. Representative species of management concern to LCC partners

Fish
American Shad
Blueback Herring
Lionfish
Robust Redhorse

Mammals
Northern Right Whale
White-Tailed Deer
Black Bear
Southeastern Beach Mice (all subspecies)
Indiana Bat

Reptiles and Amphibians
Gopher Tortoise
Loggerhead, Green, Leatherback, and Kemp's Ridley Sea Turtles
Eastern Diamondback Rattlesnake

Plants
Venus Flytrap
Red Bay
Sea Beach Amaranth

Birds
Red Cockaded Woodpecker
Swainson's Warbler

Invertebrates
Freshwater Mussels
Green Mussel
Palamedes Swallowtail
Carolina Heelsplitter
St. Franci Satyr

marsh in and near Pocosin Lakes is likely. Restoring hydrology in the peatlands stops the loss of peat soils while allowing soil generation and biomass accumulation to resume. Over time, this results in increasing elevation of previously drained pocosins. Restoring peatlands, like those on the Albemarle-Pamlico peninsula, provides an adaptive mechanism to sea level rise. The re-accumulation of soil also helps mitigate the impacts of flooding and storm events while improving water quality, wildlife and vegetation. A 10,000 acre tract is proposed for restoration, using carbon sequestration partnerships, near Pocosin Lakes NWR. The project also will sequester an estimated annualized average of 10.8 metric tons of CO_2 equivalent per acre per year.

Tidal marsh

In the United States, carbon stored in tidal salt marsh soils comprises 1-2% of its total carbon sink. Each molecule of carbon dioxide sequestered in tidal marsh soils and their tropical equivalents, mangrove swamps, probably has greater value than that stored in any other natural ecosystem due to the lack of production of other greenhouse gases. In the southern coastal region of North America, for example, the net primary production of these ecosystems averages approximately 8000 g m^{-2} yr^{-1}.

Tidal marshes also exhibit low rates of organic matter decomposition, because the anaerobic decomposers of these oxygen-depleted environments operate at slower rates than do their aerobic counterparts of terrestrial environments. Thus, it can readily be appreciated that as seas rise and encroach upon the land, rates of carbon sequestration in coastal marsh soils rise right along with them. A carbon sequestration habitat restoration project in tidal marsh near Waccamaw NWR is under development with the Service.

Traditional tools

As the SALCC partnership matures, we expect that the SALCC will design appropriate landscape-level approaches for priority species and/or their habitats, and designs will be provided to the partners with the most effective delivery mechanisms and programs for their implementation.

For aquatic species and habitats, these include:

- Restoration of water quality through maintenance of riparian corridors;
- Implementation of best management practices on agricultural, industrial forest and urban landscapes
- Wetlands protection, conservation and restoration;
- Special designations such as Primary Nursery Area (PNA), Habitat Area of Particular Concern (HAPC), Essential Fish Habitat (EFH), and Critical Habitat designation;
- Habitat Conservation Plan (HCP) development;
- Enhancement and establishment of native aquatic vegetation;
- Captive propagation and release;
- Reconnecting fragmented habitats through barrier removal or provision of fishways; and
- Development of fishery management plans.

For terrestrial ecosystems, these include:

- Acquistion of significant habitats;
- Forest restoration through carbon sequestration;
- Restoration of riparian corridors; and
- Best management practices which promote habitat and species diversity in urban, agricultural and industrial forest habitats.

Developing Capacity to Support the Science Needs of the SALCC

Many projects in this section are partially or fully funded by LCC partners, including the Service's 2010 appropriation. However, exact budget balance and needs remaining for these projects are still under development.

Southeastern U.S. Projects with Regional Context for LCCs

Southeastern Regional Climate Change Response Center

The USGS National Climate Change and Wildlife Science Center (NCCWSC) was authorized by Congress in the FY 2008 Omnibus Budget Act to help resource management agencies anticipate and adapt to climate change impacts to fish, wildlife, and their habitats. With the release of Secretarial Order 3289 on September 14, 2009, the mandate of the NCCWSC was increased to address climate change-related impacts on the full array of DOI resources. Furthermore, the NCCWSC's planned network of eight Regional Climate Science Hubs was designated as DOI Regional Climate Change Response Centers. These Centers will work with a variety of partners to provide natural resource managers with tools and information that will help them anticipate and adapt conservation planning to climate change. The forecasting products produced by these regional Centers will enable fish, wildlife, and land managers to design suitable adaptive management approaches for their programs.

The SE Pilot Project was designed to demonstrate how a Regional Center could function to develop the science needed by resource managers. This project will begin to develop regional downscaled climate models, land cover change products, regional ecological models, regional watershed models, a web-based portal for information exchange, and other science tools. Models and data produced by the SE Pilot Project will be used in a collaborative process between USGS, LCCs, state and federal partners, NGOs and academia to produce science at appropriate scales to answer resource management questions.

Estimated funding: Over $1.3M for FY2009 and $1.2M for FY 2010; at the time of this writing, this USGS funding is anticipated to be in place, and will provide support to several projects listed below.

Downscaling Global Circulation Models for Southeastern Application to Conservation

A Geodata Portal will be created to support the regional Climate Change Response Center and LCCs. The portal will be a web-delivered computer application for discovery, selection, extraction, processing, quality control, and formatting of spatio-temporal data for ecosystem modeling applications. The purpose is to bring modelers, data providers, and resource managers together in a common framework. The initial version will support users in assessing the impacts of climate change on ecosystems in the Southeast Region, with the intent of eventually supporting national studies. The initial version also will support web-based access to climate change data in point form and gridded form, and support the loose coupling of models developed for the SE Pilot Project.

Estimated cost of enhancements: $150,000 is needed above the USGS support listed above, the Service has provided funds for this project as well.

Policy linkages between science and land conservation and management programs

We need to pursue conservation at landscape scales as a science-based, socially-driven endeavor. Doing so will require that we lay before the public transparent, science-based assessments of population and habitat sustainability, and engage the public in non-regulatory forums in finding conservation solutions that will lead to socially viable populations of fish and wildlife. This initiative will link conservation science to conservation delivery via effective policy and incentive programs.

Cost: $80,000

The Development of Tools for the SALCC Conservation Community

Designing Sustainable Landscapes in the Southeastern United States

A high priority project which would benefit multiple partners in the SALCC area is the expansion of the Designing Sustainable Landscapes Pilot Project for bird populations in the Eastern U.S. The pilot project, which is scheduled to be completed in 2010, focuses on bird species in the Southeastern Coastal Plain portion of the SALCC area. The overall objective of the pilot is to develop a consistent methodology and to enhance the capacity of states, joint ventures and other partners to assess and design sustainable landscape conservation for birds and other wildlife in the eastern United States.

Expanding this project includes the development of core landscape projection datasets for the Piedmont Region including projections of climate change, urbanization, ecosystem disturbance processes, and land cover dynamics. It will also include expanding the stakeholder-driven process to identify priority species and evaluate available science to create species-habitat relationship models.

Estimated project cost: an additional $174,000 is needed to support this project.

Information Management

As part of the SALCC's effort to improve natural resource conservation through greater reliance on scientific knowledge, a primary role of the LCC is to collect, organize, and make available natural resource data and to contribute to each partner's institutional knowledge by facilitating the transformation of data into information through analysis, synthesis, and modeling. To meet these objectives, the SALCC will develop a decision support system that effectively stores, maintains, analyzes, and distributes the data, information and products of scientific work conducted by each partner agency. Thus, a foundation of the SALCC program is the strong emphasis placed on data and information management, particularly during the initial period of program development.

A pilot project to develop linkages and partnerships is proposed for fiscal year 2010 called Integrated Nesting Shorebird and Sea Turtle Data Management System. Working with partners at NPS, states, national wildlife refuges and others, the SALCC would develop a single data management system capable of managing and reporting out nesting shorebird and sea turtle data. The system would be based on existing efforts and would be designed to allow all partner agencies to efficiently enter, access, analyze, and report target species data at the local to landscape level for research, management, and planning for the conservation of priority species across multiple LCCs.

Estimated Project Cost: $180,000

Water Availability for Ecological Needs

This component of the SE Pilot Project will develop information and modeling approaches to help resource managers assess potential effects of climate change on biological resources. The specific focus of this research is on aquatic biota, especially freshwater fishes and mussels, and on improving our ability to answer questions concerning how species are likely to respond to climate-induced hydrologic change.

Estimated Cost: Most of this project is supported by USGS, an additional $40,000 is needed.

Identifying Coastal Habitats at Risk – Gulf and South Atlantic Coasts

In partnership with the Gulf Coastal Plain and Ozarks LCC, the South Atlantic LCC will support science tools that assess sea level rise impacts on the Gulf Coast. The South Atlantic and Gulf of Mexico coastal regions are prone to high rates of coastal erosion and flood disasters associated with hurricanes. Subsidence in some parts of the southeastern coastal plain serves to amplify the vulnerability of communities, infrastructure, and natural resources to storm surge flooding. The southeastern region ranks highest in the number of U.S. billion dollar weather-related disasters and flood insurance claims. The Gulf of Mexico coastal zone is already experiencing some of the highest rates of coastal erosion and wetland loss in the world. The high vulnerability of this low-lying coastal zone to land loss and flooding is generally attributed to the combined effects of human development activity, sea-level rise, hurricanes and other tropical storms, and a natural physical setting that is sensitive to subtle changes in the balance of marine, coastal, and onshore processes.

This project is currently supported through the USGS SE Pilot Project for coastal zones of Mississippi and Alabama, which are in the Gulf Coastal Plain and Ozarks LCC. As part of a cooperative effort between LCCs, the South Atlantic LCC will explore opportunities to continue this project into panhandle Florida, and extend past the mouth of the ACF basin. This will provide geographic and scientific continuity between the Gulf Coastal Plain and Ozarks LCC and the South Atlantic LCC for the water availability project and the coastal mapping project. Furthermore, the Service will ensure consistency with the emerging LCC for the Texas and Louisiana coasts.

Estimated cost: an additional $135,000 to add panhandle Florida to Gulf Coast Assessment and $300,000 to add SALCC to Mid and North Atlantic sea-level rise modeling for marshes.

Template for Strategic Habitat Conservation (SHC) implementation plan to meet Waterbird Management Needs within Atlantic and Mississippi Flyways

In partnership with LCCs across the eastern U.S, the South Atlantic LCC will implement an integrated waterbird monitoring and management program to inform decision makers and resource managers in an adaptive management context. Improved resource contributions toward waterfowl, shorebirds and waterbirds may be realized by this cross-scale integration of management actions across multiple spatial scales from the Flyway scale down to local wetland management sites.

Presently, little coordination occurs among management sites, resulting in many disparate efforts that may not meet all waterbird needs at the appropriate spatial or temporal scales. Additionally, management decisions are often made in the absence of supporting monitoring information. The application of consistent monitoring protocols across spatial scales that informs management decisions will increase the collective contribution of

wetland management actions to meet waterbird habitat needs.

Estimated costs: $150,000

Staff Capacity

Conservation efforts to address unprecedented threats will require new organizational core competencies that interact with existing capacity. While competencies have to be considered at the level of the individual, competencies must also be considered at the organizational level. The needed competencies flow from the demands of society on the conservation community:

- Competence in assessing and predicting population and habitat sustainability within ecologically definable units;
- Competence in spatially depicting goals and objectives that reflect measurable biological outcomes; and
- Competence in assessing and characterizing the environmental sensitivity of landscapes to species and populations.

Resources are available within DOI Bureaus to start development of the core competencies that can complement and build upon efforts of existing capacity. For the South Atlantic, the Service start-up costs in fiscal year 2010 is estimated at $540,000. This includes salary for an LCC coordinator, a FWS science coordinator, a part time, contract administrative assistant, as well as office space, two vehicles and computer support. Negotiations are underway for partnership sharing of these costs, such as office space. Increased capacity from USGS is tentatively for one scientist to be established in the region, with possible costs similar to the above estimates.

LCC Coordinator
This position has three primary components: oversight of conservation science development for the LCC, partnership development and support, and developing and implementing appropriate multi-organizational conservation strategies.

Costs: Approximately $150,000 for salary support, plus additional support for office space, vehicle, computer and other needs. The LCC partnership may provide additional support for some needs, such as office space.

Science Technology Coordinator
This position is responsible for coordinating science for the full spectrum of priority aquatic and terrestrial species, including population-habitat modeling, simulation modeling, development of decision support tools, monitoring, and research. This position's primary responsibilities will be to prepare proposals, secure funding, and oversee and implement projects to develop relevant models and decision support tools needed to formulate objectives and priority actions, and to continually test the assumptions behind them.

Costs: Approximately $150,000 for salary support, plus additional support for office space, vehicle, computer and other needs. The LCC partnership may provide additional support for some needs, such as office space.

Science (USGS)
The USGS has committed to establishing science positions in LCCs across the nation. For the South Atlantic LCC, the science coordinator would develop a science program and specific research projects in support of LCC needs, as defined by the LCC core staff and LCC Steering Committee. We envision that this position would be different from the Service's science function, in that the USGS scientist would conduct active research, whereas the Service's science position would help develop, coordinate, and disseminate priority science needs and results.

During FY 2010, the USGS, the Service and other conservation will identify key conservation issues related to potential landscape change and needs associated with implementation of the first eight LCCs. Assessment of needs at the level of individual LCCs, and identification of challenges common to multiple LCCs (requiring larger joint efforts), are both important.

Costs: under development

Science (NPS)
New monies to be programmed for climate change monitoring are intended to be applied within the context of the SALCC.

Costs: under development

Spatial Analyst
The Service will dedicate staff time to spatial analysis needs of the LCC until such time that the LCC is prepared to create such a position.

Out-year postions (all SALCC partners)
Out-year needs include the following possible positions. Gaining this expertise, as well as definition of other needs within the LCC, will be an ongoing, high priority function of the LCC Steering Committee. The Service will provide additional resources and support as the LCC determines its highest priority needs.

- Fisheries/Aquatics Scientist
- Ecosystem Simulation Modeler
- Population-Habitat Modeler
- Hydrologist
- Coastal/Marine Fisheries Scientist

Top Science Needs Exceeding the Initial Regional Allocation for Science Capacity in the SALCC

The implementation of specific, thematic research can help managers and land planners understand impacts on natural landscapes in the SALCC. Habitat impacts are driven by a variety of factors, including climate change and sea level rise, increased urban development, the spread of invasive species, and the ongoing cumulative impact associated with fragmentation of wildlife corridors. As an example, habitats in the coastal plain are increasingly impacted by rapid urban development. Coastal habitats that are influenced by the tides are subject to losses due to accelerated coastal erosion, submergence of barrier islands and low-lying coastal habitats, dissection of salt marsh due to sea level rise, impacts on coastal dune formations following extreme storm events, and the conversion of freshwater marshes and wetlands due to saltwater intrusion.

An array of research is needed to develop models and monitoring protocols to evaluate the potential effects of climate change and sea level rise on wildlife populations and habitats. Results and recommendations would be used to facilitate management decisions to minimize or mitigate impacts both on local and regional scales. The ability to identify changes in habitats across the landscape over time will help land managers address the impacts with strategies that are holistic in nature, on a landscape scale, with a view toward ensuring that migration corridors remain intact, protected landscapes for high priority species continue function, and viable ecosystems are in place and protected for Federal Trust species.

The following research needs are not listed in priority order.

U.S. Fish & Wildlife Service

Examples of Research Needs

Hydrological Conditions

More understanding is needed of ground water variations and change over time throughout the SALCC. The establishment of a network of wells and surface water level data loggers that can be tracked by individual stations for immediate use as well as by a regional team will produce consistent baseline data that can be evaluated over time. This data can also lead to the development of predictive hydrological models for a variety of important habitats in the SALCC including interior wetland swamps such as Okefenokee NWR's 396,000 acres and other important habitats that are greatly affected by groundwater. Additional data that would be collected would include changes in rainfall quantities, periodicity of rainfall, considering the topography, evaporation, and evapotranspiration.

Estimated cost: GW real time well installation $11,000

Yearly O&M costs $6,000 – these cost include QA/QC, real-time dissemination of the data and archival of the data.

Hierarchical Landscape Models for Endemic Unionid Mussels: Building Strategic Habitat Conservation Tools for Mussel Recovery in the South Atlantic Landscape Conservation Cooperative.

The Southeast is a hotspot of mussel biodiversity, but an integrated approach is urgently needed to effectively conserve endangered mussel species. Key habitat where extant populations are found must be protected, but it is also crucial to prioritize restoration areas and identify additional suitable habitat for population augmentations.

Estimated Costs: $365,000

Longleaf Pine Ecosystems

One of the most important habitats in the SALCC and the Gulf Coastal Plain and Ozarks LCC is the longleaf pine ecosystems. Red-cockaded woodpecker, gopher tortoise, indigo snake, and Bachman's Sparrow are some of the high priority species that occur in longleaf pine forest habitats. Management is currently geared toward faster-growing tree species. However, studies are needed to identify the tolerance levels of soil moisture. A better understanding of genetic differences among longleaf pine will help conservation delivery.

Estimated cost for start and linkages of these projects: $150,000

Population Status for 4 Threatened and Endangered Freshwater Mussels in the Ochlockonee River Basin

A key component to recover freshwater mussel species is to determine population size, rates of recruitment, survival, growth, and fecundity that constitute a viable population and evaluate these demographics to determine the long-term population viability of each species. Currently, little information on these parameters exists for four listed mussels in the Ochlockonee River Basin. It is especially important to know the population size so that mortality can be evaluated. This study will provide a baseline for developing and evaluating a comprehensive monitoring program for the seven listed mussels in the Northeast Gulf of Mexico watersheds.

Estimated Cost: $120,000

Develop Historic Rate of Change Models for Coastal Barrier Islands

Using historic aerial photography and a sequence of spatially explicit GIS data sets, this project will reveal changes over time in shorelines and in terrestrial, intertidal, and beach ecosystems. From this, we can develop rate-of-change models to inform land managers of the quantity and quality of habitat changes that have occurred and are expected to occur.

Estimated Cost: $250,000

Improve Land Managers Access to Current Body of Science

For the SALCC geographic area identify the literature and data locations across natural resource disciplines (i.e., geology, ecology, biological, down-scaled and more refined climate and sea level rise models) and synthesize the information in a way that land managers can better understand the natural processes that will inform their management decisions and identify information gaps which can be used to target needed applied research.

Estimated Cost: $10,000

SALCC Inventory and Monitoring System

In close cooperation with the Inventory and Monitoring Programs of the NPS and the National Wildlife Refuge System, design a scientifically based inventory and monitoring protocols for use by partners in the SALCC. Baseline species surveys are needed to identify the locations of suites of species and to match those species with habitats that are vulnerable to the impacts of climate change and other challenges.

Estimated Project Cost: $200,000

Carbon Sequestration Studies

This project represents the first step in a cross-country partnership devoted to understanding carbon sequestration rates in tidal freshwater swamps and marshes. It is designed to determine rates of carbon sequestration in managed and tidal freshwater marshes in the Waccamaw National Wildlife Refuge, Georgetown, SC. This three-year project will be funded through an agreement between the U.S. Fish and Wildlife Service and the USGS California Water Science Center.

Budget Request: $150,000

Expansion of Blueback Herring and American Shad Habitat Models for Use in NALCC and SALCC.

Habitat models for these two species are currently under development as part of the ENC-SEVA SHC Team's ongoing SHC project in the Roanoke-Tar-Neuse-Cape Fear river basins in southeastern Virginia and eastern North Carolina. This project would entail modifying these two models for use throughout the US east coast range of these two species. Both species are currently in a depleted status throughout much of their range (see Limburg et al. 2007, Limburg and Waldman 2009). Both species are under ASMFC management and their management plans are the subject of recent extensive modifications designed to begin restoration of their populations, which were once of immense ecological, economic and cultural significance throughout the NALCC and SALCC.

Total Estimated Project Cost: under development

Climate Change Impacts of Forest Dynamics

Studies are needed to determine the effects of a changing climate on forests and the species that depend upon them. Changes in weather patterns and temperatures could change forest fuel patterns, species composition, and volume. Of equal importance is an understanding of how alterations in weather patterns will impact prescribed fire as a management strategy in forest communities.

Estimated Cost: $50,000

Assessment of Habitat of the Flatwoods Salamander

This is a long-term project on the Flintrock Perserve in Florida to boost populations of the flatwoods salamander

and Red-cockaded woodpeckers, two umbrella species that encompass the entire pine upland/isolated wetland mosaic. The ecological importance of the preserve is centered upon water quality, upland conservation and Threatened and Endangered species recovery.

Estimated Cost: $380,000

Assess health and status of Bottomland Hardwood Forests in the South Atlantic

Bottomland hardwood forests are an important ecosystem sustainability and resilience, a well as critical fish and wildlife habitat. In the South Atlantic coastal zones, bottomland hardwood forests are being stressed by salt water intrusion as well as storm surge events, making the health of bottomland forest further inland even more important to sustain.

Estimated Cost: $60,000

Demonstrate how to manage flow for the benefit of ecological systems and human needs.

Estuarine Instream Flow Requirements - Freshwater from the South Atlantic Coastal Plain rivers help support the greatest extent and highest quality estuaries of the North Atlantic Ocean. The amount and timing of freshwater inflows regulate the salinity interface and are key to the health of these productive ecosystems, yet the flow requirements are undefined.

Research question: Research is needed to determine the relationships between altered freshwater hydrologic regime and estuarine ecosystem conditions to inform and support development of state instream flow standards for these critical areas.

Research question: The dams on the eight major drainages in this region reduce the range of water level fluctuation as well as alter the seasonality of flow. Research is needed to determine the flows required to support the natural assemblage of plants and animals of these riverine ecosystems.

Research question: If these large systems are to be manipulated to improve hydrologic regimes, research is needed to determine how these ecosystems respond to restoration of flows after more than 50 years of altered conditions.

Research question: Information is needed as to how freshwater resources of the South Atlantic Coastal Plain will likely be impacted by climate change.

Estimated Cost: under development

Characterizing basic units of conservation

The most basic level of conservation is the population. Populations are used as a critical metric in many local and national conservation plans (e.g., The Strategic Habitat Conservation plan), as well as in key pieces of legislation, such as the Endangered Species Act. Therefore it is important to have a firm understanding of the number of populations dispersed across the landscape and the extent to which they interact. Science support needs are as follows:

The goal of this study is to develop a GIS-based approach for explicitly mapping patterns of genetic divergence and diversity for multiple terrestrial and aquatic species. Using this approach, we will analyze mitochondrial DNA datasets from vertebrate and invertebrate species in both North and South Atlantic ecoregions for phylogeographic breaks and high intrapopulation diversity. The result will be an evolutionary framework for the Atlantic within which patterns of genetic diversity can be analyzed in the context of historical processes, future evolutionary potential and current reserve design. This multi-species genetic landscape will be able to pinpoint biogeographic hotspots where interpopulation and intrapopulation genetic divergence, connectivity, and/or diversity are consistently high.

Comparisons genetic connectivity for estuarine species. We seek to integrate genetic, ecological, and life history data to assess larval recruitment and genetic connectivity for various aquatic species inhabiting estuaries from North Carolina to Florida. This work will provide for an understanding of patterns of recruitment and connectivity in estuarine ecosystems and serve as a necessary base-line data for predicting the fate of these populations under climate change scenarios.

Estimated cost: under development

Distribution and Habitat Use of Keystone Species, including northern right whales, in the SALCC Nearshore Atlantic Ocean

This project would entail expanding the mission of the existing Cooperative Winter Tagging Cruise (Cruise) to include surveying northern right and other large whale distribution and habitat use during January-February in the nearshore Atlantic Ocean off NC and VA. The Cruise is an existing partnership which tags species managed by the Atlantic States Marine Fisheries Commission (Atlantic sturgeon, striped bass, horseshoe crab, red drum) and managed jointly by ASMFC and the Mid-Atlantic Fishery Management Council (spiny dogfish, summer flounder). The northern right and other species of large whales (fin, humpback) annually migrate along the Atlantic coast, using the Atlantic Seaway pathway described elsewhere in this plan. The National Marine Fisheries Service Large Whale Take Reduction Team (ALWTRT), Mid- and South-Atlantic Sub Group, at their last meeting in April, 2009, identified a need for data on northern right whale distribution and habitat use in the mid-Atlantic (Red Munden, North Carolina Division of Marine Fisheries, Morehead City, NC and Diane Borggaard, National Marine Fisheries Service, Northeast Regional Office, personal communication to RWL; also see ALWTRT 2009; online on the NOAA-NMFS web site at the following location: http://www.nero.noaa.gov/whaletrp/trt/meetings/ALWTRT%20Meeting%20Summary.April.2009.pdf). We envision that collaborating researchers (possibly Dr. Doug Nowacek, Duke University Marine Laboratory, but we haven't been able to contact him yet) would deploy pop-up acoustic monitors during the Cruise to detect whale vocalizations, as well as conducting a visual survey from the research vessel. Monitors could be retrieved at the end of the Cruise, having been deployed for a multi-week (two weeks, longer if additional ship time could be secured) period. This project would fill a gap between existing surveys in the northeast, and south Atlantic.

Total Estimated Project Cost: under development

Anticipated Successes in 2010

Partnership and staff development

We expect to have a fully functional Steering Committee, which represents non-government organizations, industry, universities, an dfederal and state governments, in place that guides the conservation science and priority conservation delivery mechanisms in the South Atlantic. To manage against – and with – threats caused by accelerating climate change, we expect the Steering Committee to embrace new challenges in conservation for the 21st Century. That likely will mean acquiring new technologies in information management and spatial analysis and developing non-traditional expertise in core staff,

such as conservation biology and land-use policy. We expect members of this Steering Committee to be leaders in the conservation effort in the South Atlantic, and reach out to traditional and non-traditional partners in the LCC for the use and development of science products and conservation delivery.

Biological Foundation

The basic elements of conservation depend on a biologist's knowledge of species, species-habitat relationships and ecosystem function. Based on high priority needs expressed in this proposal, we expect substantial progress and success in learning more about the life history traits of high priority species in the South Atlantic, including those off shore. The biological planning work for birds in the South Atlantic Coastal Plain will be expanded to the Southern Piedmont by partners working through the Atlantic Coast Joint Venture and South Atlantic Migratory Bird Initiative in preparation for conservation design work in that area. Furthermore, we expect the development of a process with stakeholders in the LCC model that determines species sensitivity to different climate change scenarios (part of the Designing Sustainable Landscapes project).

Conservation Design

The development of tools to design conservation and sustainable landscapes will happen at multiple spatial scales. We expect to have success in the development of downscaled General Circulation Models, and the easy access to that information by scientists, for us in the LCCs. We expect successful and significant progress in the development of models that help us predict and manage for coastal vulnerability with climate change on the Gulf Coast side of the SALCC. We expect the completion of spatial analysis for the coastal zone of the South Atlantic (part of the Designing Sustainable Landscapes project).

Conservation Delivery

We expect the start of a successful model demonstration of conservation delivery in the restoration of a 10,000 acre tract of pocosin wetlands in North Carolina using carbon sequestration as the restoration/conservation delivery tool. This project is in partnership with industry and others who need to offset their carbon footprint, and are willing to do so by the restoration of this high priority tract of pocosin wetlands. The FWS will manage strictly for wildlife and ecological benefit, while industry can mitigate carbon emissions.

Inventory and Monitoring

We expect the establishment and integration of an Inventory and Monitoring Program by the FWS National Wildlife Refuge System, and we expect to demonstrate success in integration with the NPS and the USGS in survey methods, objectives, and data compatibility. We expect to complete initial steps on the Atlantic Flyway Integrated Waterbird Management and Monitoring Project including model development and testing and protocol development.

Assumption-Driven Research

The development of research priorities that are driven by the assumptions we make in modeling and management requires time to consider the effectiveness of those models and management decisions. While the SALCC will support several integrated research projects, many of which are designed to test basic assumptions, we expect our success in this year to be the development of a process by which we can thoroughly tease out the most important assumptions in models and management.

Information sharing and Adaptive Management

We expect a successful demonstration project that integrates the data of NPS, FWS, USGS, states and others to examine sea turtle nd shorebird response to accelerating beach erosion. By way of this project, we hope to establish the basis for long term linkages among data and to establish a process of information management that can feed into management decisions at several spatial scales.

Unique Characteristics of the SALCC

The SALCC supports numerous unique habitats and species which occur nowhere else on the planet; provides unique ecosystem functions which are vital for sustaining migratory species of avifauna, anadromous and pelagic fish, marine mammals and sea turtles; and is subject to intense demographic pressure from a burgeoning human population and climate-change induced sea level rise, more so than many other parts of North America. The SALCC may perhaps best be identified from an ecosystem services perspective as hosting two significant migratory pathways for charismatic fauna: one for avifauna (primarily shorebirds and waterfowl), the Atlantic Flyway; and the other for nearshore marine fauna (marine mammals, sea turtles, and anadromous and pelagic fish), which may be characterized as the Atlantic Seaway, and includes the Gulf Stream.

Habitats within the SALCC support species traveling in the vast migration pathway known as the Atlantic Flyway. In the southern portion of the Atlantic Flyway the route narrows considerably in the five coastal states that comprise the SALCC; Virginia, North Carolina, South Carolina, Georgia, and Florida. It is this narrowing of the route that effectively concentrates and increases the number of birds and other species found in any one location in the SALCC.

Large concentrations of waterfowl, shorebirds, neotropical migrants, and raptors, along with some species of bats, dragonflies, and butterflies use this pathway during migration events. Of those groups, shorebirds are in greatest decline. At least half of all coastally migrating shorebirds have declined by at least 39%. They face threats from pollution, over-fishing, and warming sea temperatures caused by climate change, as well as threats at island and coastal nesting sites. Sea level rise caused by accelerating climate change will inundate shoreline habitats.

The SALCC encompasses a rich tapestry of landscapes and seascapes in North Carolina, South Carolina, east central Alabama, Georgia, northern Florida, and Southern Virginia that support a diversity of species. Many endangered, threatened, and declining species are dependent upon these habitats, including the loggerhead sea turtle, wood stork, red-cockaded woodpecker, and piping plover. The SALCC's coastal and estuarine habitats support crab, shrimp, and oyster industries, while the region's abundant wetlands and forests sustain small and large game species, recreational fisheries, and a diversity of unique and rare habitats of national and international importance.

Mature southern pine forests, including the longleaf pine ecosystem are home for many species of eastern forest birds that are currently suffering consistent and troubling declines. Red-cockaded Woodpecker, Brown-headed Nuthatch, and Bachman's Sparrow, year-round residents of mature southern pine forests, are especially impacted. Many eastern forest birds are suffering consistent and troubling declines, including neotropical migrants that require large blocks of intact forest, such as

the Kentucky Warbler, Wood Thrush, and Eastern Wood-Pewee. Likewise, species dependent on disturbed or early successional forest or natural disturbance (including pine barrens) such as the Golden-winged Warbler, Whip-poor-will, Prairie Warbler, Eastern Towhee, and Field Sparrow, and popular game species such as Northern Bobwhite and American Woodcock are at risk.

The SALCC's contribution to entire populations of migratory birds, bats, and butterflies not only affects species diversity in the U.S., it also affects species diversity in Canada and other countries because the U.S. shares many bird species with other countries along the pathway.

The SALCC is also known for a second vital species migration corridor, which we proposed to name the Atlantic Seaway. The marine portion of the SALCC, from the beach to 200 miles offshore, includes both pelagic and nearshore migration routes off the Atlantic Coast, and many of the species that use this route rely upon the SALCC's salt marsh, estuarine systems, coastal wetlands, and other habitats along that oceanic pathway for food, resting, and breeding. The SALCC's great expanses of salt marsh along the Atlantic Coast are known as some of the most productive ecosystems on earth. Salt marsh habitats provide a source of food for estuarine species as well as for the pelagic species that migrate along the off-shore corridor of the Atlantic Ocean. Salt marsh ecosystems with their rich tidal creeks and diverse estuaries also support the crab, shrimp, and oyster industries, and commercial fisheries, along with the birds, fish, and turtles that migrate along the coast each year.

The exclusively oceanic pelagic route extends from Labrador and Nova Scotia to the Lesser Antilles, and on to the mainland of South America. The pelagic migration paths are traveled by thousands of water birds and shore birds, marine mammals (bottlenose dolphins, humpback whales, northern right whales), bluefin tuna, dolphin-fish, wahoo, yellowfin tuna, swordfish, Atlantic sturgeon, migratory striped bass, spiny dogfish, weakfish, and the loggerhead and leatherback sea turtles.

In addition to these two unique migratory pathways, the SALCC also hosts numerous endemic species and habitats which are again restricted to it alone. These include numerous plants, insects, amphibians, reptiles and fish.

Additional LCC Support from the Southeast Region in FY 2010

The FWS has taken a strong lead to start development of LCCs that cover the entire eastern seaboard (North Atlantic, South Atlantic, Peninsular Florida LCCs) as well as much of the Gulf of Mexico coastal (Penisular Florida and Gulf Coastal Plain and Ozarks). This geography is among the most sensitive in the world to sea level rise, salt water intrusion, and storm surge from accelerated climate change. The interaction among these LCCs is extremely important, and is demonstrated in parts of this plan.

Gulf Coastal Plain and Ozarks LCC

The Southeast Region of the FWS will support the start up functions of the Gulf Coastal Plain and Ozarks LCC in federal fiscal year 2010, in strong partnership with members of the Lower Mississippi Valley, East Gulf Coastal Plain, and Central Hardwoods Joint Venture Management Boards. FWS Regions 2 and 3 will be heavily engaged as well. The Lower Mississippi Valley Joint Venture Board agreed to provide a strong leadership role in the development of the LCC. A concept plan, to be drafted at the same time as this plan (December 2009) is complete and develops actions for 2010 LCC development. Please see that plan for details.

Peninsular Florida LCC

The southeast region of the FWS will support the development of the Peninsular Florida in federal fiscal year 2010, in strong partnership with the NPS, USGS, the state of Florida and others. The development of the Peninsular Florida plan will be developed by early spring 2010, and a staff will be provided on detail for the LCC to begin a higher level of conservation planning and to initiate or sustain high priority science projects.

Cooperation with the North Atlantic LCC

A portion of the SALCC lies in southern Virginia, part of the Northeast Region, and the Northeast Region has resource program offices operating there. The two regions already coordinate on topics of mutual concern through the Atlantic Coast Joint Venture and Atlantic Coastal Fish Habitat Partnership, whose boundaries include both the NALCC and SALCC areas. These partnerships can serve as conduits for coordination between the two LCCs. The Northeast Region has offered to continue to provide significant support to these program offices in the SALCC in a coordinated effort to most effectively and efficiently conserve migratory birds and other trust resources common to these congruent geographic areas.

Cooperation with the Appalachian LCC

Although the South Atlantic LCC is targeted for full implementation in 2010, the Southeast Region also has great interest in initiating an LCC for the Appalachian area. The Northeast Region will be the lead for the Appalachian LCC and will coordinate closely with the Southeast and Midwest Regions on the development of this LCC. With existing partnerships, projects, and Service offices moving forward with landscape scale planning, this LCC has the opportunity to start immediately to build biological planning and conservation design capacity that complements existing efforts, host partner meetings, and develop contracts in FY 2010.

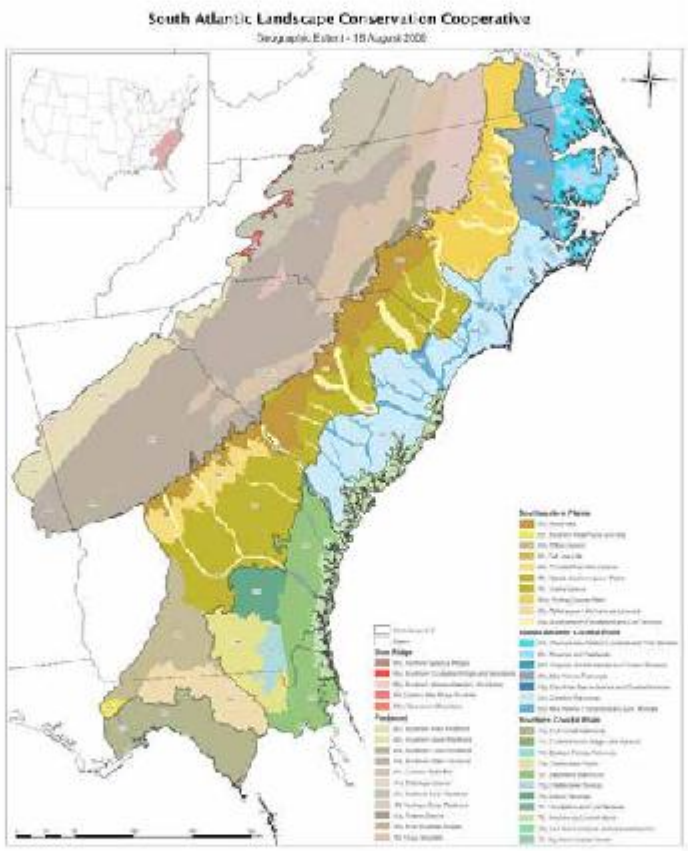
More formal conversations will be scheduled later in 2010, including key contacts from the Service and partners in all three Service regions overlapping the Appalachian LCC area.

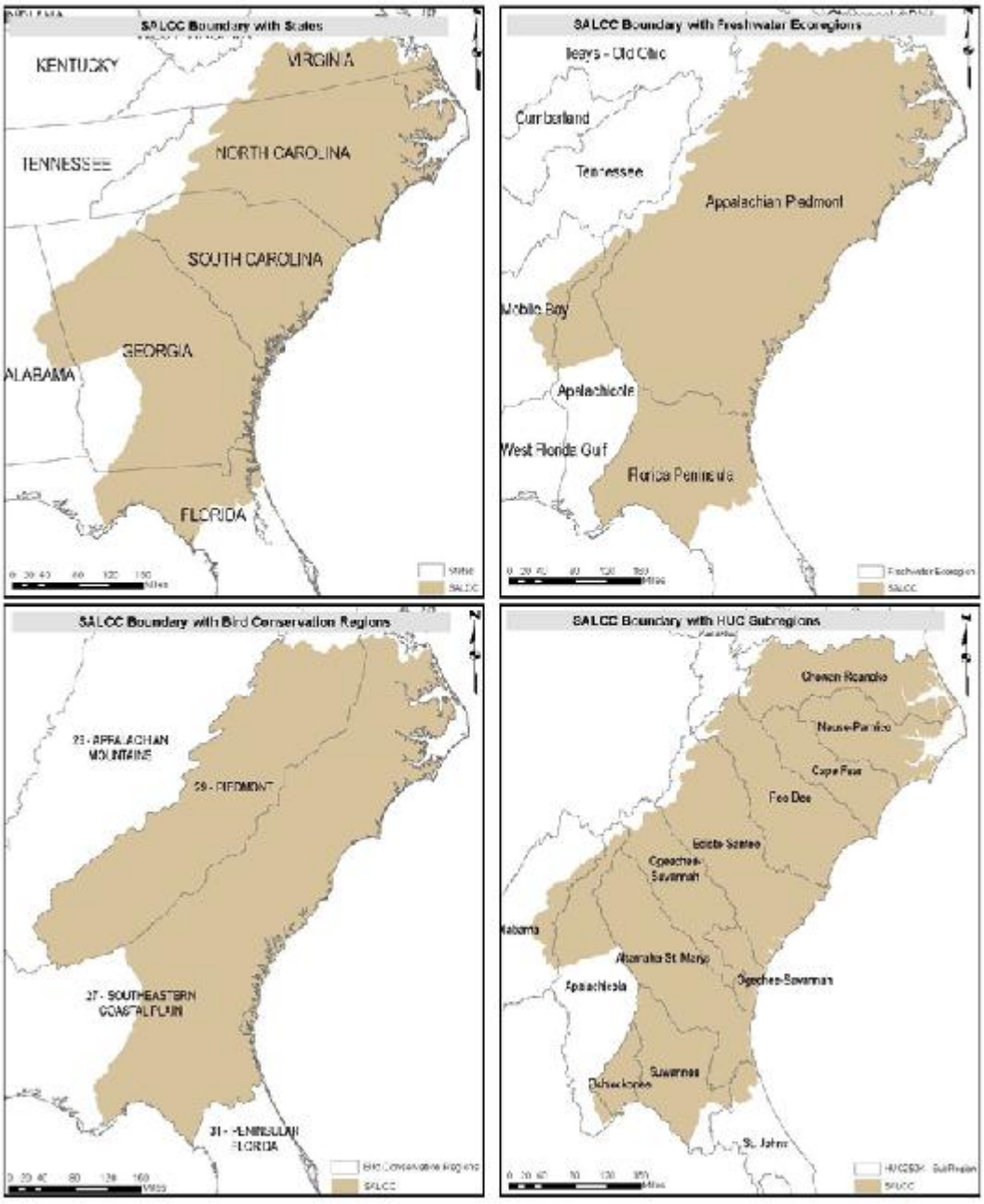
Conservation Lands in the SALCC





SE GAP Terrestrial Ecological System	Acres
Evergreen Plantations or Managed Pine (can include dense successional regrowth)	12,773,963
Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier	8,967,658
Pasture/Hay	8,593,966
Row Crop	8,314,236
Developed Open Space	5,016,924
Atlantic Coastal Plain Upland Longleaf Pine Woodland	4,552,839
Other - Herbaceous	4,372,056
Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest	2,392,710
Successional Shrub/Scrub (Other)	2,287,624
Atlantic Coastal Plain Small Blackwater River Floodplain Forest	2,168,984
Low Intensity Developed	2,120,380
Clearcut - Grassland/Herbaceous	1,817,020
Atlantic Coastal Plain Blackwater Stream Floodplain Forest - Forest Modifier	1,709,835
Atlantic Coastal Plain Peatland Pocosin	1,495,203
Open Water (Fresh)	1,444,622
Southern Piedmont Mesic Forest	1,399,041
Southern Piedmont Dry Oak-(Pine) Forest - Loblolly Pine Modifier	1,361,653
Atlantic Coastal Plain Small Brownwater River Floodplain Forest	1,236,144
Southern Piedmont Dry Oak-(Pine) Forest - Mixed Modifier	1,229,181
Successional Shrub/Scrub (Clear Cut)	1,041,155


South Atlantic Landscape Conservation Cooperative


SALCC Boundary with States
KENTUCKY
VIRGINIA
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
ALABAMA
FLORIDA
SALCC Boundary with Freshwater Ecoregions
Ilegys - Old Citric
Cumberland
Tennessee
Appalachian Piedmont
Mobile Bay
Apalachicola
West Florida Gulf
Florida Peninsula
SALCC Boundary with Bird Conservation Regions
28 - APPALACHIAN MOUNTAINS
29 - PIEDMONT
27 - SOUTHEASTERN COASTAL PLAIN
31 - PENINSULAR FLORIDA
SALCC Boundary with HUC Subregions
Chowan-Roanoke
Neuse-Pamlico
Cape Fear
Pee Dee
Edisto-Santee
Ogeechee-Savannah
Alabama
Altamaha-St Marys
Ogeechee-Savannah
Apalachicola
Suwannee
St. Johns



National Wildlife Refuge Inventory and Monitoring Program

USGS Southeast Regional Assessment Program

USGS
science for a changing world

Regional Climate Change—Science in the Southeast

"Management decisions made in response to climate change impacts must be informed by science and require that scientists work in tandem with those managers who are confronting climate change impacts and evaluating options to respond to such impacts."

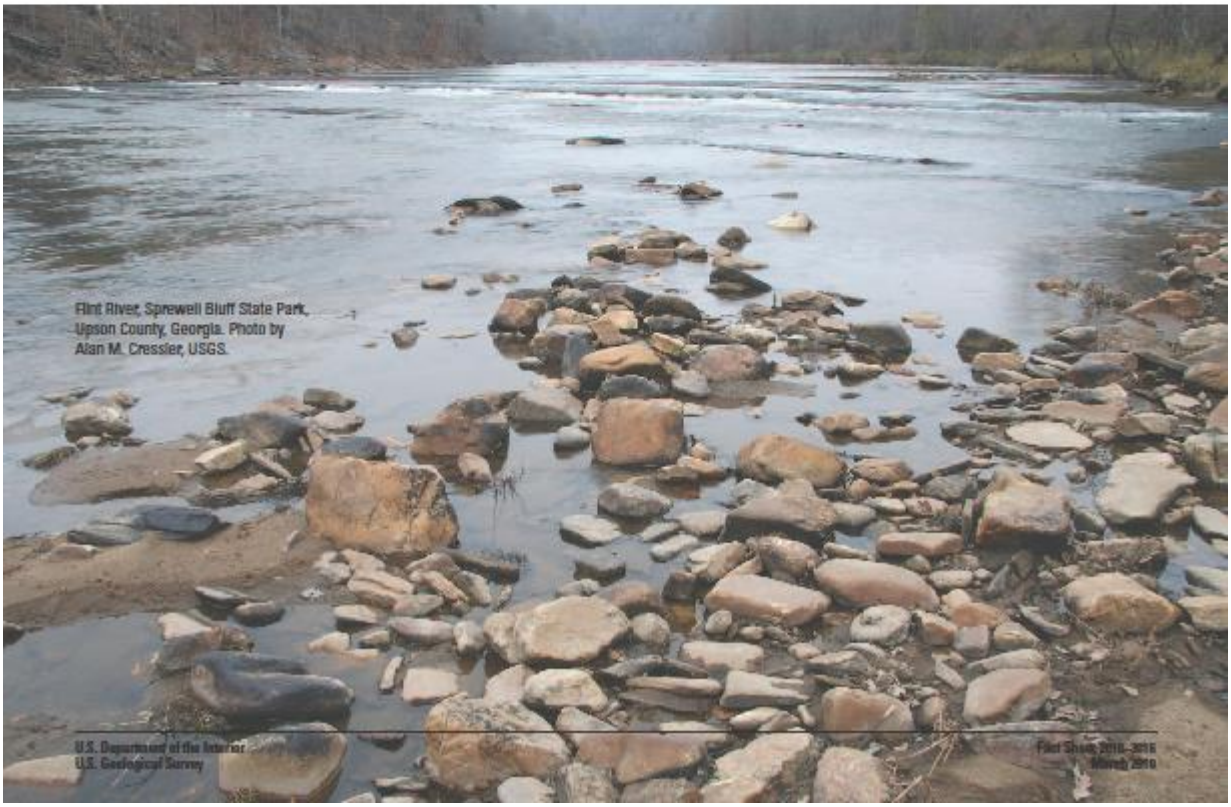
—Secretary of the Interior Ken Salazar, Secretarial Order 3289 s 3b

Department of Interior Regional Climate Science Centers

Resource managers are at the forefront of a new era of management. They must consider the potential impacts of climate change on the Nation's resources and proactively develop strategies for dealing with those impacts on plants, animals, and ecosystems. This requires rigorous, scientific understanding of environmental change.

The role of the U.S. Geological Survey (USGS) in this effort is to analyze climate-change data and develop tools for assessing how changing conditions are likely to impact resources. This information will assist Federal, State, local, and tribal partners manage resources strategically. The 2008 Omnibus Budget Act and Secretarial Order 3289 established a new network of eight Department of Interior Regional Climate Science Centers to provide technical support for resource managers.

The Southeast Regional Assessment Project (SERAP) is the first regional assessment to be funded by the USGS National Climate Change and Wildlife Science Center (*http://nccwsc.usgs.gov/*). The USGS is working closely with the developing Department of Interior Landscape Conservation Cooperatives to ensure that the project will meet the needs of resource managers in the Southeast. In addition, the U.S. Fish and Wildlife Service is providing resources to the SERAP to expand the scope of the project.



Flint River, Sprewell Bluff State Park, Upson County, Georgia. Photo by Alan M. Cressler, USGS.

U.S. Department of the Interior
U.S. Geological Survey

Regional Assessments

The regional focus of the Climate Science Centers is key to providing science that is useful to resource managers. Regional assessments are a link between the planetary focus of the general circulation models (GCMs) and landscape-level dynamics that affect local resources. Regional models can analyze the interaction of global changes with local topography and ecosystems. This allows scientists to more precisely pinpoint factors driving change and to determine how these changes affect resources.











Red-cockaded woodpecker and brown-headed nuthatch photos courtesy of Will Stuart. Other photos by USGS.





Southeast Regional Assessment Project

SERAP will convert a suite of global models into regional climate projections and develop landscape change datasets that can be used to project the likely changes to the Southeast's climate and ecosystems. By concurrently downscaling global models while developing change-assessment tools for resource managers, SERAP teams can determine the best approaches for coupling models and effectively provide useful decision-making tools for assessing the impacts of climate change.

Downscaling

The USGS is deploying state-of-the science statistics to identify the parameters in global models that are most likely to affect the Southeast region's climate and local landscape dynamics. Decision makers will be provided with information about low-probability, high-impact climate extremes. The downscaled models then can be used by other SERAP research teams to conduct their assessments of regional change.

Relative Sea-Level Rise

To estimate local rates of sea-level rise along the Southeast's Gulf Coast, the USGS is factoring in parameters to represent local processes that affect land-surface elevation and other types of ecosystem changes. The team will design new tools for decision makers to visualize and assess change in coastal regions where a combination of inundation, land loss, and habitat change already is occurring and is expected to continue.

Inferring Changes to Habitat

The USGS is integrating models of urbanization and vegetation dynamics with the regional climate models to assess how landscape change could impact priority species. Models for North American land birds, for example, can predict locations where responses to climate change are most likely to occur, expressing results in terms of species persistence to help resource managers understand the long-term sustainability of bird populations. The basic modeling techniques can be applied later to other taxonomic groups.

Streams and Aquatic Habitat

Aquatic habitat is sensitive to streamflow, so the USGS is assessing how climate change can affect land cover and flow in river systems. The project team will experiment with a variety of resolutions for linking hydrology and land-cover data for analyzing streams in the Apalachicola–Chattahoochee–Flint watershed to improve the ability to detect and project the condition of aquatic habitats. Decision makers will be consulted to determine priority species so that species-specific models can be developed and used to assess the vulnerability of fishes and mussels to climate change.

Optimizing Conservation

The USGS will work with stakeholders and managers across the Southeast to identify and assess landscape-level strategies for conserving multiple species. These strategies will incorporate predictions from downscaled climate models, sea-level rise, and changes to aquatic and terrestrial habitats.

Data Dissemination

The USGS is creating a Web-based data platform to readily share data and results from the SERAP. The platform also will host a comprehensive data library of high-resolution climate change projections for the continental United States that take into account a range of predictions.

Future Directions

The USGS continues to work closely with partners to identify further scientific-information needs and to design relevant decision-support tools to address these needs.

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USGS National Climate Change and Wildlife Science Center

USGS
science for a changing world

National Climate Change and Wildlife Science Center

Delivering Science to Help the Nation's Fish, Wildlife, and Ecosystems Cope with Climate Change

The earth's climate, including changes in temperature, weather patterns, and precipitation, will likely result in significant effects on our nation's fish and wildlife resources now and in the future. Relatively little scientific information exists on which to base management strategies to help fish and wildlife adapt to climate change. The **U.S. Geological Survey** (USGS) is meeting this challenge through the **National Climate Change and Wildlife Science Center** (NCCWSC) and the Center's partnerships with the Department of the Interior's Climate Science Centers.

The Center was established by Congress in 2008 to help deliver scientific and technical information to help natural resource managers cope with a changing climate.

Working in partnership with both resource managers and scientists at national, regional, and landscape levels, including Interior's eight Climate Science Centers and federal, tribal, state, local, university, NGO, and other partners, the NCCWSC will:

- ***Forecast fish and wildlife population and habitat changes in response to climate change.***
- ***Assess the vulnerability and risk of species and habitats to climate change.***
- ***Link models of physical climate change (such as temperature and precipitation) with models that predict ecological, habitat, and population responses.***
- ***Develop standardized approaches to monitoring and help link existing monitoring efforts to climate and ecological or biological response models.***

The Center is a partnership-oriented institution. It works closely with natural resource agencies and scientists inside and outside government to gather the information and build the tools managers need to help fish and wildlife and their habitats and ecosystems adapt to climate change. Such interactions at national, regional, and landscape levels ensure that NCCWSC's science is focused on key priorities – as defined by managers – and is delivered to users effectively.

Regionally Focused: The Center will work closely with eight Department of the Interior (DOI) Regional Climate Science Centers, to be established over the next three years. These regional centers will address the science and information needs of a full range of natural and cultural resource managers. Funds and scientific staff from multiple Interior Department bureaus (e.g., USGS, National Park Service, Bureau of Reclamation, Fish and Wildlife Service) will be pooled to support and leverage these centers. Centers in Alaska, the Northwest and Southeast will be established in 2010, with additional centers added in 2011 and 2012 as resources permit.



Regional Climate Science Centers will be housed at host institutions with substantial climate change expertise and partnerships. Expected benefits from the host institutions include access to supercomputing capability as well as, for universities, faculty and graduate student expertise. Each CSC will also have a regional science-management advisory committee, which will establish the Center's strategic priorities and will work closely with the Department's Landscape Conservation Cooperatives to ensure strong links to management needs and applications.

Regional Climate Science Centers will work closely with the emerging network of Landscape Conservation Cooperatives (LCCs). LCCs are management-science partnerships that inform integrated resource management actions addressing climate change and other stressors within and across landscapes. They will link science and conservation delivery. LCCs are true cooperatives, formed and directed by land, water, wildlife and cultural resource managers and interested public and private organizations. Federal, state, tribal, local government and non-governmental management organizations are all invited as partners in their development. Each LCC will be directed by a steering committee representing partners working in that region. LCCs will also be represented on the partnership advisory committees for each CSC. See *http://doi.gov/whatwedo/climate/strategy/index.cfm*

Working with both the Climate Science Centers and the Landscape Conservation Cooperatives, NCCWSC staff and funding will produce regional ecological and biological response models

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for priority species and habitats, and provide access to fundamental climate change science related to the development of effective and measurable adaptation activities for fish, wildlife and their habitats. About three-fourths of NCCWSC funding at the CSCs will be dedicated to scientific activities.

The National Climate Change and Wildlife Science Center will include a small science staff located at USGS headquarters in Reston, Virginia. These staff foster national partnerships and identify and meet national or multi-regional science needs. They will convene a national advisory committee, with both management and science expertise, to guide the Center's overall direction.

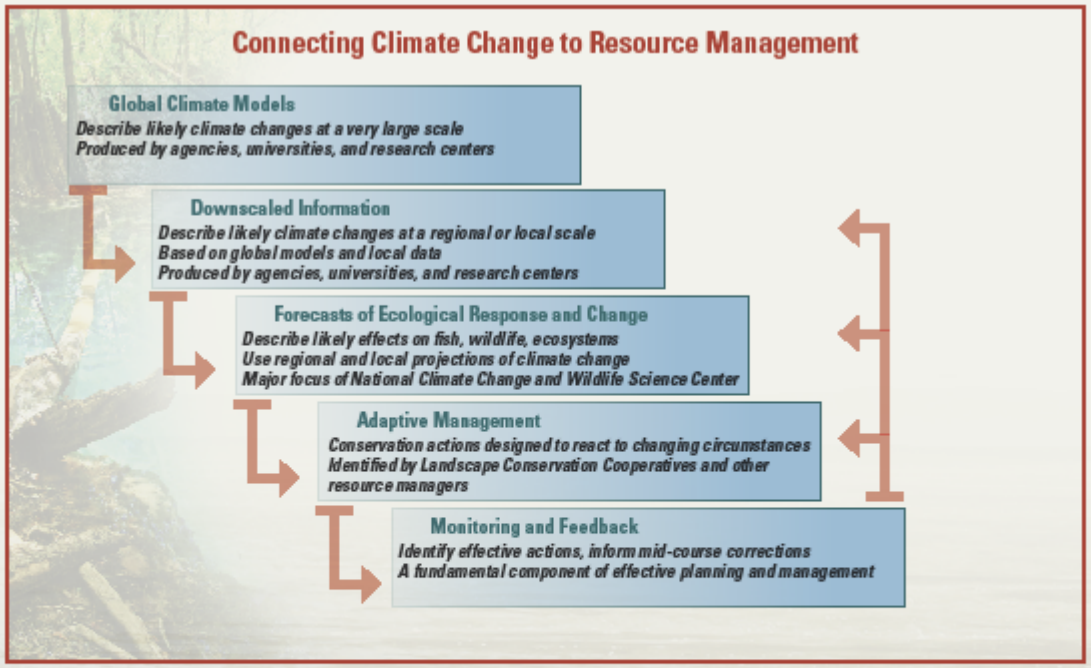
Climate Science in the Southeast: A Pilot Project

The effects of climate change will vary by region and even by landscape. Because of this, natural resource managers need solid scientific information that can help them more precisely pinpoint factors driving changes and to determine how those changes affect important resources.

The southeastern U.S. is home to an exceptionally rich diversity of ecosystems, plants, and animals. Yet the region is already experience a warming and drier climate, which is expected to intensify over the next few decades. Some species are likely to be extirpated, while others will expand or decline in range or abundance. Climate change effects on the environmental conditions necessary to sustain or increase fish and wildlife populations will be important to decision makers challenged with balancing other land uses, including agriculture, forestry, freshwater allocations, and transportation.

Scientists from multiple agencies and institutions in the Southeast are already hard at work converting global models into regional climate projections for the Southeast Regional Assessment Project. Their ultimate goal is to develop climatic and landscape change datasets that can be used to project climate change impacts on priority plants, animals, and ecosystems. Researchers are already designing change assessment tools so that resource managers can determine the best approaches for sustaining trust species and their habitats in the face of climate change. Additionally, scientists are also creating new tools for decision-makers to assess change in coastal regions where a combination of inundation, land loss, and habitat change is expected to occur.

Contact: *Doug Beard, Interim Director (dbeard@usgs.gov) or Robin O'Malley, Policy and Partnership Coordinator (romalley@usgs.gov)*



The National Climate Change and Wildlife Science Center (NCCWSC) will work closely with DOI Climate Science Centers and Landscape Conservation Cooperatives to integrate scientific information and apply it to conservation challenges raised by the Earth's changing climate

Governor's South Atlantic Alliance



Governors' South Atlantic Alliance Priority Issues

- Healthy Ecosystems
- Working Waterfronts
- Clean Coastal and Ocean Waters
- Disaster-Resilient Communities

Background

Florida, Georgia, South Carolina and North Carolina share a rich array of ocean and coastal resources that provide economic, environmental and social benefits for the citizens of each state. Recognizing the critical importance of protecting these valuable resources, the Governors of North Carolina, South Carolina, Georgia, and Florida signed a Partnership Agreement in May 2009 establishing the Governors' South Atlantic Alliance. The mission of the Alliance is to significantly increase regional collaboration among the four states, with support from federal agencies, universities, regional organizations, NGOs, private businesses and the public as partners, to sustain and enhance the region's coastal and ocean resources for the betterment of its citizenry. The initial focus areas addressed by the Alliance are:

Healthy Ecosystems

The South Atlantic supports a diverse array of coastal and marine environments vital to the ecological and economic stability and sustainability of the Southeast. The Alliance will undertake activities to:

- enhance and support ecosystem-based management for the biological resources of the region;
- improve ecosystem structure and function by developing and applying sound scientific data to support habitat conservation, enhancement, and restoration;
- increase understanding of the scope and scale of the region's human and natural resources; and
- develop communication networks, research frameworks, and outreach/education initiatives.

Working Waterfronts

Working waterfronts include water-dependent facilities and related shore-side infrastructure offering access or support for a wide variety of public, business, recreation, and commercial uses. Challenges facing waterfront users include declining water quality, loss of public access and traditional uses, population growth, and threats from climate change. The Alliance will undertake activities to:

- sustain and enhance robust waterfront cultural traditions, commerce, and uses of public trust; and
- integrate coastal and land use planning tools to balance new development, historic uses, port expansion, and sustained resources for the future.

Clean Coastal and Ocean Waters

Significant impacts to water quality and coastal ecosystem health are predicted as a result of population growth and land use change, increasing urbanization, point and non-point source pollution, and climate change. The Alliance will undertake activities to:

- enable coastal managers and decision-makers to predict, prevent, enforce, respond, and mitigate ecosystem and human health impacts; and
- provide consistent data through integrated coastal and ocean observing and monitoring system.

Disaster-Resilient Communities

Both episodic (e.g., hurricanes) and chronic (e.g., sea level rise) impacts from weather and climate change are major concerns. These phenomena threaten public safety, property, and infrastructure in coastal and watershed communities, as well as multi-billion dollar tourism and fishing industries. The Alliance will undertake activities to:

- enhance understanding of ocean and weather dynamics, including short-term coastal hazards and long-term climate change; and
- share best practices to minimize losses and accelerate recovery, while implementing new and more effective coastal and land use strategies to minimize future risk.

For more information, contact Chris Russo, South Atlantic Executive Planning Group, (919) 715-4169

The Governors' South Atlantic Alliance: A Call To Action Framework

A Call to Action

Florida, Georgia, South Carolina and North Carolina share an extraordinarily rich array of ocean and coastal resources that provide enormous economic, environmental and social benefits for each state. However, those resources face significant and growing stress. Pollution, declining fishery resources, degraded coastal habitats, vulnerability to natural hazards and rapid population growth and development are primary examples of serious challenges to the sustainability of coastal resources in the region. Furthermore, the similarity of issues and habitats plus the connectivity of ocean resources such as coastal watersheds, fisheries and ocean currents across state jurisdictions calls for collective action. For instance, many coastal watersheds involve multiple states, while fish populations migrate seasonally throughout the four-state region.

Recently, two national ocean commissions and the President's United States Ocean Action Plan called for meaningful collaboration at all levels of ocean and coastal research and actions to restore and maintain our ocean resources. Several major regional alliances (e.g., West Coast, Gulf of Mexico, and Northeast) have been established and have successfully leveraged resources to meet common goals. This regional alliance framework is in response to that collective call for action.

Regional Context

Changes in economics, culture, environmental quality, resource use and growth have occurred in the Southeast at an accelerated pace. The resulting pressures placed on the Southeast's natural, environmental, economic, and cultural resources, as well as national defense are increasing exponentially on a regional scale. The complexity of multiple and interdependent resource issues undergoing rapid change creates new challenges and an urgent need for new responses. Our growing understanding of the relationship of humans with the marine environment is leading us to explore new ecosystem-based approaches to coastal management that engages multiple state jurisdictions. The urgency of the situation calls for developing coordinated regional actions by the states in conjunction with supporting partners and leveraging multiple resources to help address critical issues in sustaining our coastal and ocean ecosystems.

Improved coordination among state governments and effective engagement of federal and local governments, academia and coastal and ocean stakeholders is critical to this effort. An integrated regional action is needed to guide research, planning, and management activities that address critical ocean and coastal issues facing all four states. In the following sections, we outline the framework and basis for a regional alliance among the four states, including a structure and process for stakeholders' involvement. Through this alliance, we seek to advance the member states' mutual interests in initial priority South Atlantic coastal and marine issue areas needing attention and action while jointly engaging federal agencies and regional constituencies on significant regional coastal and ocean issues that warrant their support.

Governors' South Atlantic Alliance Framework Continued

The South Atlantic Alliance



The South Atlantic Alliance (Alliance) will complement existing regional arrangements. Most importantly, the Alliance will serve as a conduit for collectively finding, acting on, and regionally implementing science-based actions to sustain the coastal and ocean ecosystems. The Alliance will provide a method for more efficiently and effectively balancing and sustaining ecological capacity, economic vitality, quality of life, public safety and national security mission requirements. The Alliance will provide a partnership of state leaders, supported by federal and local governments, with private and public assistance.

South Atlantic Regional Priority Issues

The following initial priority issues have been identified as being timely and of mutual importance to the sustainability of the South Atlantic region's resources. None of these issues are limited by state boundaries.

Healthy Ecosystems

The South Atlantic supports a diverse array of coastal, estuarine, nearshore and offshore ecosystems, including seagrass beds, wetlands and marshes, mangroves, barrier islands, sand dunes, coral reefs and other "live bottom" formations, maritime forests, streams and rivers. These ecosystems provide ecological and economic benefits including improved water quality, nurseries for fish, wildlife habitat, hurricane and flood buffers, erosion prevention, stabilized shorelines, tourism, jobs, recreation, and support for national defense and homeland security activities. The ecosystems include a range of recreationally and commercially important species, and federally and state protected species. Further, many species and habitats are facing a variety of threats including invasive non-native species, habitat alterations, fishing pressures, population growth in coastal areas, climate change and degraded water quality. Most importantly, all of these pressures are linked.

There are opportunities to enhance and support ecosystem-based management efforts within the region. The objective of these efforts is to improve ecosystem structure and function; improve economic, social and cultural benefits from resources; and improve biological, economic, and cultural diversity in the South Atlantic region. Achieving these goals requires a more thorough understanding of the scope, scale and distribution of resources within the region. Less than five percent of the coastal ocean region of the southeastern United States has been mapped. A significant need exists for standardized, integrated, and accessible spatial and temporal data for the management of coastal marine resources in our region. The Alliance will enhance collaboration necessary to address region-wide ecosystem issues.

Working Waterfronts

Working waterfronts require direct access to coastal public trust waters and submerged lands. The term, working waterfronts, includes water-dependent facilities and related shore-side

infrastructure that offer access or support facilities for recreation, commerce, research, and other public uses including military operations (Coast Guard, Navy, etc.). Examples of these facilities include: seafood harvesters and processors; public wet and dry marinas; boat construction and repair facilities; recreational fishing facilities, including fishing piers and for-hire vessel operations; aquaculture facilities; marine transportation (e.g., ferries and cruise ships) and ports for seaborne commerce. It is important to address these issues in a timely manner because there are limited remaining areas suitable as working waterfronts.

Working waterfronts face a number of challenges and high among them is the future of our ports and other water access points. Growth, environmental degradation and displacement are some of the issues facing traditional working waterfront communities. Homeland security requires better control of our coastal facilities both for protection as well as for military operations. Finally, climate change and associated environmental factors such as storm intensity and sea-level changes are emerging issues.

While the southeastern United States is one of the least developed in the nation, according to the Census Bureau, our four southeastern states contain one-third of the nation's 100 fastest-growing counties. The projected percent change in population from 2000 to 2030 in North Carolina, South Carolina, Georgia and Florida is an increase of 51.9 percent, 28.3 percent, 46.8 percent, and 79.5 percent, respectively. Much of the growth is concentrated in coastal counties, and is outpacing our ability to understand, react, and plan for changes in environmental, social, and economic conditions. Sustaining robust waterfront cultural traditions, commerce, adequate access and use of public trust waters, and infrastructure in the face of this growth is crucial.

Major port complexes in the South Atlantic are of vital economic importance to the nation's vast international trade and the region's link to global commerce. Ships are increasing in size, requiring deeper and wider channels. Competition for vital water frontage will increase as the number of larger and faster vessels calling on regional ports increases.

Other water dependent businesses (e.g., recreational and commercial fishing, diving, eco-tours, and water sports) as well as national defense readiness needs are threatened by the conversion of working waterfronts to private residences, condominiums, and marinas. The increase in these waterfront usages results in additional impervious surfaces, and the resulting stormwater runoff causes further degradation of water quality. Coastal and land use planning tools, effective incentives to preserve and enhance the region's coastal waterfront heritage and protect access to the public trust resources of the South Atlantic are examples of such tools. The Alliance will strive to more effectively manage these changes, by striking a balance among new development, historic uses, port expansion, and sustaining resources for the future.

Clean Coastal and Ocean Waters

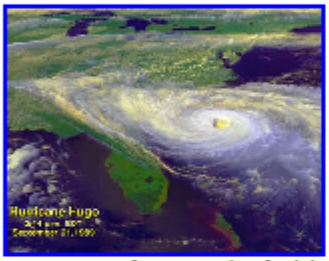
Significant impacts to estuarine water quality and coastal ecosystem health are predicted as a result of increasing coastal urbanization. Growth and development are already placing enormous pressures on coastal resources and the adjacent coastal ocean. At the same time, climate change is influencing salinity levels, saltwater intrusion and rise in ocean levels. Both point and non-point discharges from land-based and atmospheric sources are affecting our ground water, rivers, estuaries and the oceans' water column.

Governors' South Atlantic Alliance Framework Continued

Impacts are also evidenced by the increased number of advisories and closures caused by high bacteria levels and harmful algal blooms implicated in fish kills and human health dangers. Variable loads of sediment, nutrients, and pollutants interact with the coastal ocean to influence processes. The Alliance will view the impacts in a state and regional context to enhance managers' ability to effectively target prevention, enforcement, response, mitigation activities, and integrate coastal and ocean observing systems in the South Atlantic.

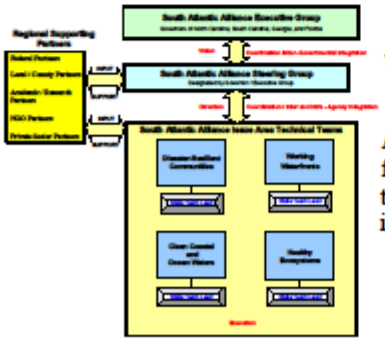
Disaster-Resilient Communities

Both short-term and long-term changes in weather and climate are major concerns in the southeastern United States. These changes threaten our coastal communities, a multi-billion dollar tourism industry, coastal and watershed development and infrastructure, and local fishing industries. There is a solid history of cooperation among state and private responders in times of emergency. Building upon that, we can share best practices as we prepare for the next emergency to minimize losses and accelerate recovery. Coastal storms account for 71 percent of recent U.S. disaster losses annually. Each event costs roughly $500 million. Hurricanes Hugo, Andrew, Rita, Isabel and Wilma have reinforced the need for the region to better prepare our communities through risk reduction and damage prevention, mitigation, response, and recovery strategies.



Understanding our vulnerability to, and the impacts of, storms and climate change will enable coastal and natural resource managers and community decision-makers to adapt their management strategies, improve planning and preparedness, and develop mitigation strategies to address impacts to public safety, shoreline change, coastal infrastructure, habitat loss, and species migration and natural resources. Emergency responders and community planners must also develop and implement new strategies to minimize risk to property and industries located in our coastal counties. Long-term climate change and accelerated sea level rise have also emerged as important issues for our region. The Alliance will work to greatly enhance our understanding of ocean and weather dynamics and improve prediction, observation and forecasting capabilities.

Alliance Framework and Outcomes



The Alliance organization will function based on rules that optimize the ability to develop and sustain an effective working relationship among the partners to identify and seize opportunities for mutual gain. The Alliance structure and framework will provide the foundation for key outcomes supporting the vitality of the region in a balanced manner. Furthermore, it is our intent that the Alliance will provide:

- An organizational structure and forum for collaboration, coordination and a clearing house for information supporting cooperative activities and coastal and ocean decision making;

Governors' South Atlantic Alliance Framework Continued

- Regional sustainability of resources that supports individual state requirements;
- Better regional alignment of decisions resulting in mutual mission accomplishment;
- Cooperative planning and leveraging of resources to produce multiple state and regional benefits;
- Integrated research, observation and mapping of the South Atlantic region leading to common and coordinated data and information to enhance science-based decision making;
- Integrated solutions that benefit all systems' requirements (i.e., ecosystems, economic systems, and national defense systems) at state, federal and local levels; and
- Increase the level of awareness of policymakers and the public to the challenges facing the South Atlantic region.

CLIMATE CHANGE SCENARIO TRAINING
Preparing for an Uncertain Future
National Park Service Climate Change Response Program

STATEMENT OF NEED:
Land managers need skill in understanding and using conceptual as well as quantitative tools when planning for the uncertainty of climate change. Scenario Planning has been identified as a valuable long-range planning tool for uncertain and potentially highly consequential changing conditions but there is little expertise currently available to facilitate or apply this approach within the NPS or the Department of the Interior.

STRATEGY:
A series of training workshops will be held to educate and train managers, resource specialists, scientists, educators, and planners in the structured Scenario Planning process. By building knowledge of how to apply this tool to various decision environments, the NPS will collaborate with others to increase our capacity for choosing the most appropriate response actions that will be most effective across a range of potential futures or that promote desired outcomes.

Background:
Resource management decisions must be based on future expectations. Climate change is generally expected to bring highly consequential and unprecedented changes, but specific future conditions are very difficult to accurately predict. Scenario planning offers a tool for developing a structured, science-based decision-making framework in the face of an uncertain future. Climate change scenario planning involves exploring qualitative as well as quantitative models in order to envision future outcomes under a variety of different decisions, policies, or societal pathways.

Scenario planning has been explored within the National Park Service as a long-range planning tool for incorporating climate change into a range of park management processes and documents, including General Management Plans and Resource Stewardship Strategies. Major benefits of this approach are:

- identification of key uncertainties
- incorporation of alternative perspectives into conservation planning
- improved capacity for adaptive management to promote resource sustainability

Since 2007, the National Park Service has held three workshops exploring five different case studies. Efforts engage a range of federal, academic, and private partners to explore approaches that are tailored to management relevant questions regarding the future of natural and cultural resources. A formal interview process has been established to survey previous participants in order to learn and build from these efforts as we initiate the next series of workshops designed to train NPS staff and partners in the scenario planning process.

Training Approach:
From October 2010 to February 2011, the Climate Change Response Program is taking the next step in building capacity for using Scenario Planning by partnering with the Global Business Network to host three training workshops. The workshops will give NPS and other agency staff and partners an overall understanding of the Scenario Planning process as it applies to protected area management and climate change adaptation. Course participants will:

- Gain an overall understanding of the Scenario Planning process as it is applied to protected area management and climate change,
- Walk through the scenario building process for two landscape-scale case studies per workshop,
- Develop climate drivers, uncertainties and impacts utilizing bioregional peer-reviewed information available from the NPS Climate Change Response Program,
- Create scenarios and narratives for the future using the framework and process learned in the course, and
- Begin a dialogue about how this process can inform future planning at the park level for better management decision making.

Workshops:

Great Lakes and Atlantic Coast Workshop
Duluth, MN, October 5 - 7, 2010
Thirty workshop participants will apply the Scenario Planning framework to two case studies in the Great Lakes and Atlantic Coast bio-regions. Participants will use major climate drivers, such as warming temperatures, changing precipitation patterns, and sea level rise to identify highly consequential and uncertain impacts like altered vegetation patterns, increased temperature and salinity in wetland, coastal, and shoreline environments to create narratives that can guide management options under several possible futures.

Urban Landscapes & Eastern Forests Workshop
Shepherdstown, WV, December 7 – 9, 2010
A workshop utilizing case studies in Urban Landscapes and Eastern Forests bio-regions will host thirty participants at the National Conservation Training Center to examine climate drivers, uncertainties, and impacts on these landscapes with a special emphasis on how climate change will impact cultural and historic resources and landscapes in an urban setting.

Western Mountains, Pacific Islands, and Arid Lands Workshop
Denver, CO, February 8 – 10, 2011
Forty-five workshop participants will consider climate change across three diverse case studies. Participants will explore drivers such as reduced snowpack and changing precipitation and streamflow patterns to envision the uncertainty and significance of impacts to western mountains, arid lands and Pacific island systems. Special emphasis will be placed on the integration of cultural and natural resource issues and their joint protection.

Partner: Global Business Network, http://www.gbn.com

More Information:

Visit http://www.nps.gov/climatechange/adaptationplanning.cfm for additional materials on the NPS approach to climate change scenario planning.

DOI Employees: To register for a course, visit DOI Learn and search for 'Climate Change Scenario Training.' Please register at least 2 months prior to each class. There is no tuition for this course; travel cost is paid by participant.

For information on these courses, contact:
October workshop: Shelly_Clubb@nps.gov
December workshop: Melanie_Wood@nps.gov
February workshop: Patrick_Malone@nps.gov

Appendix C. SECN Organizational Chart

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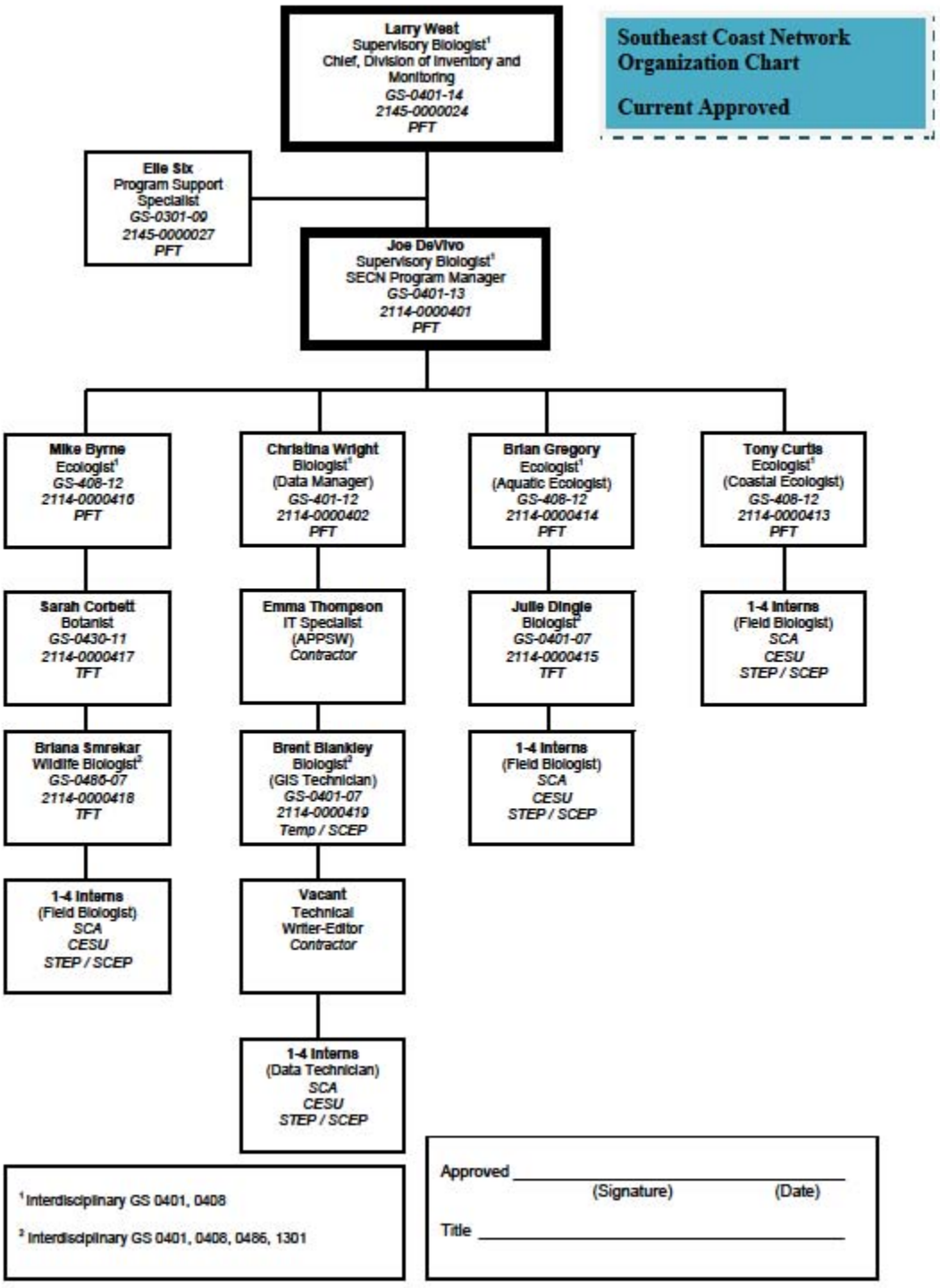
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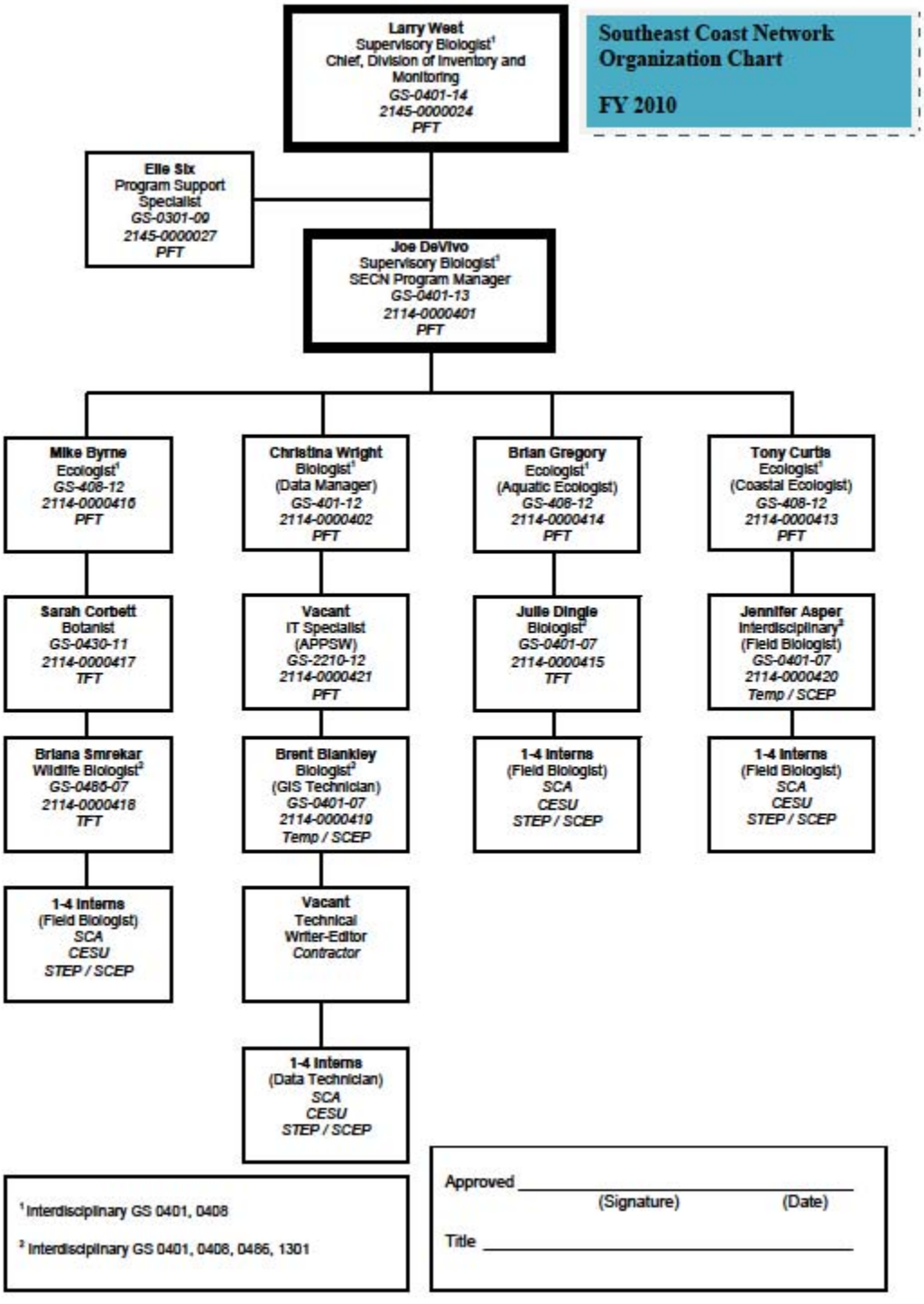
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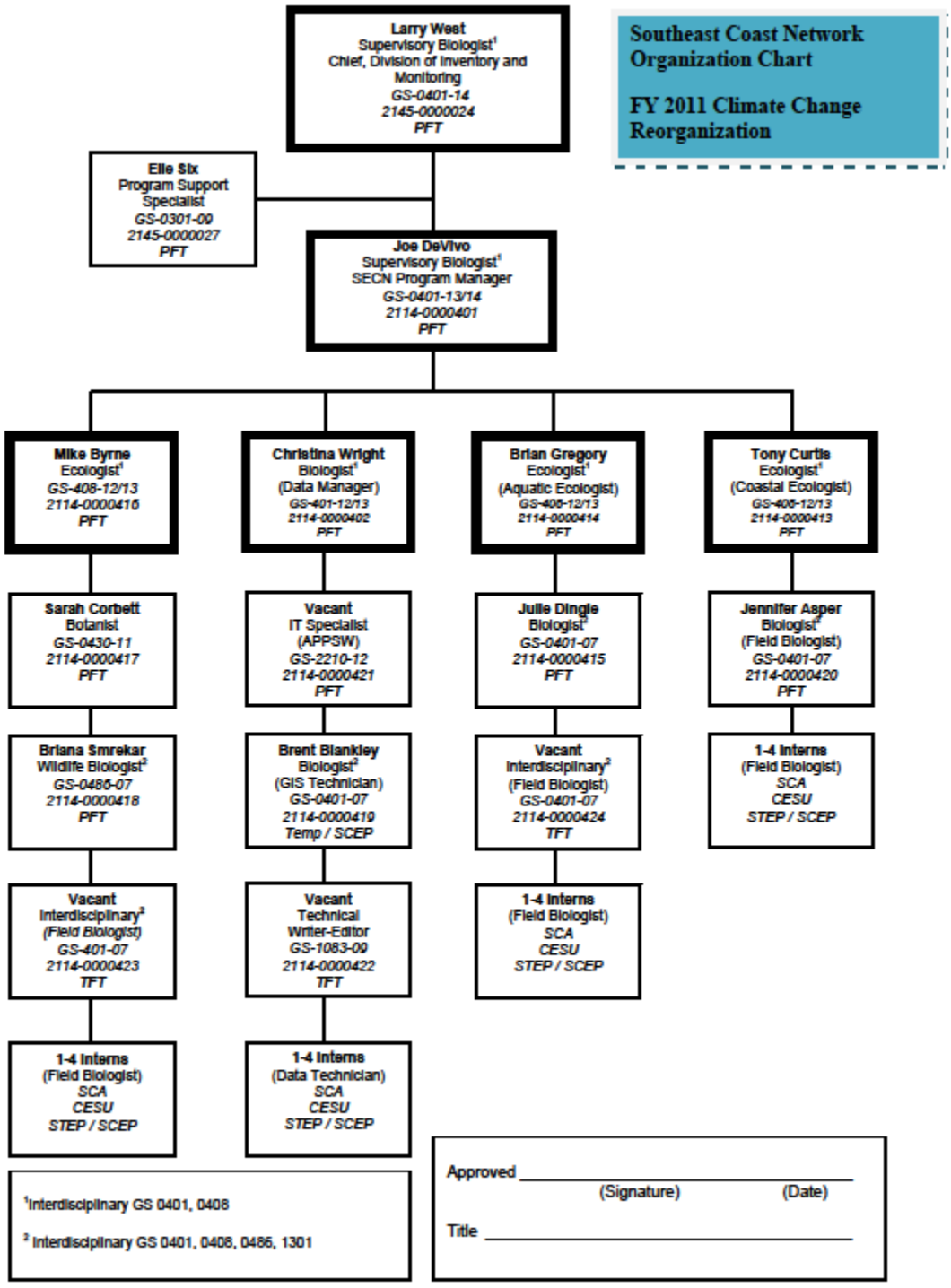
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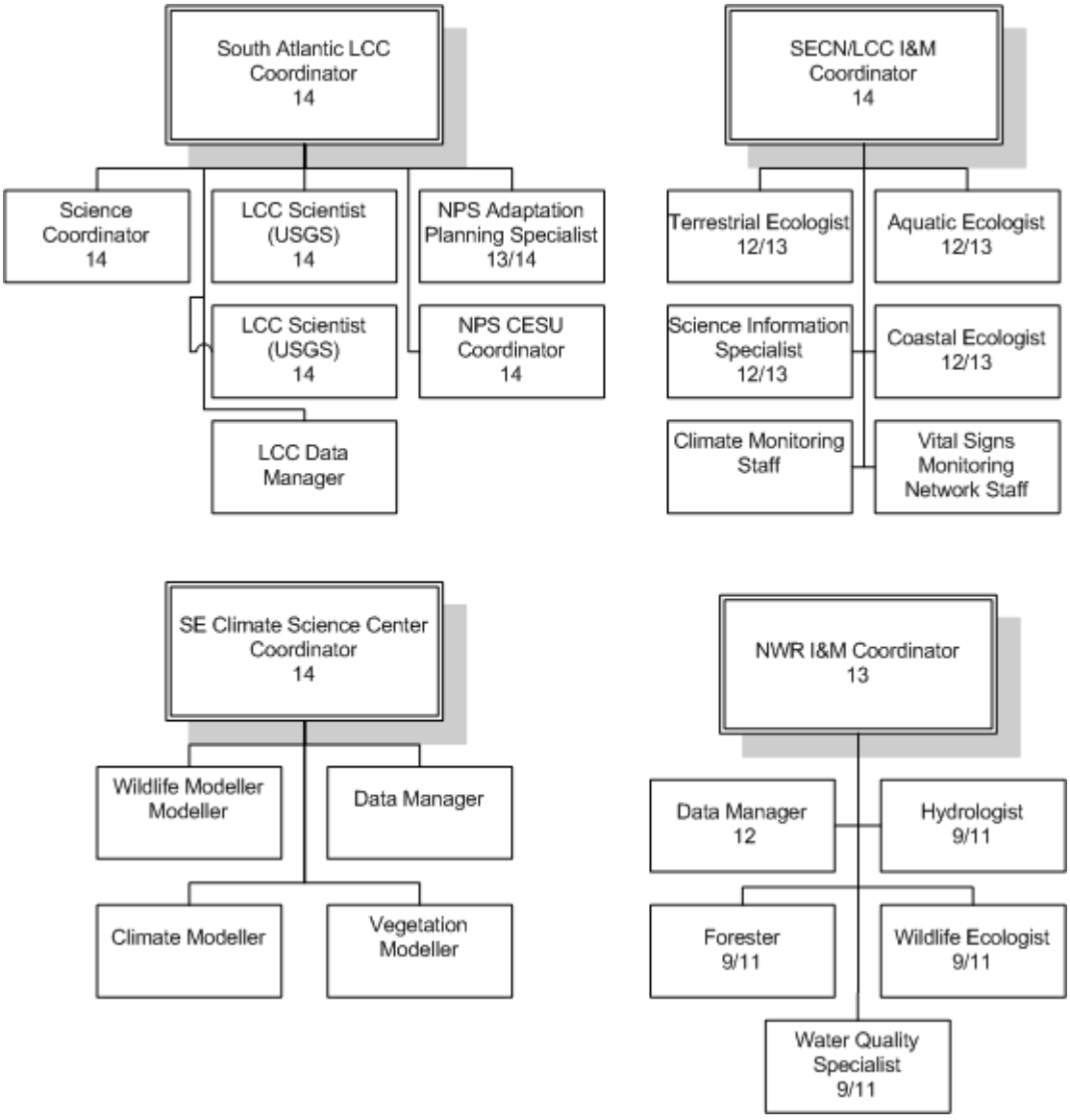
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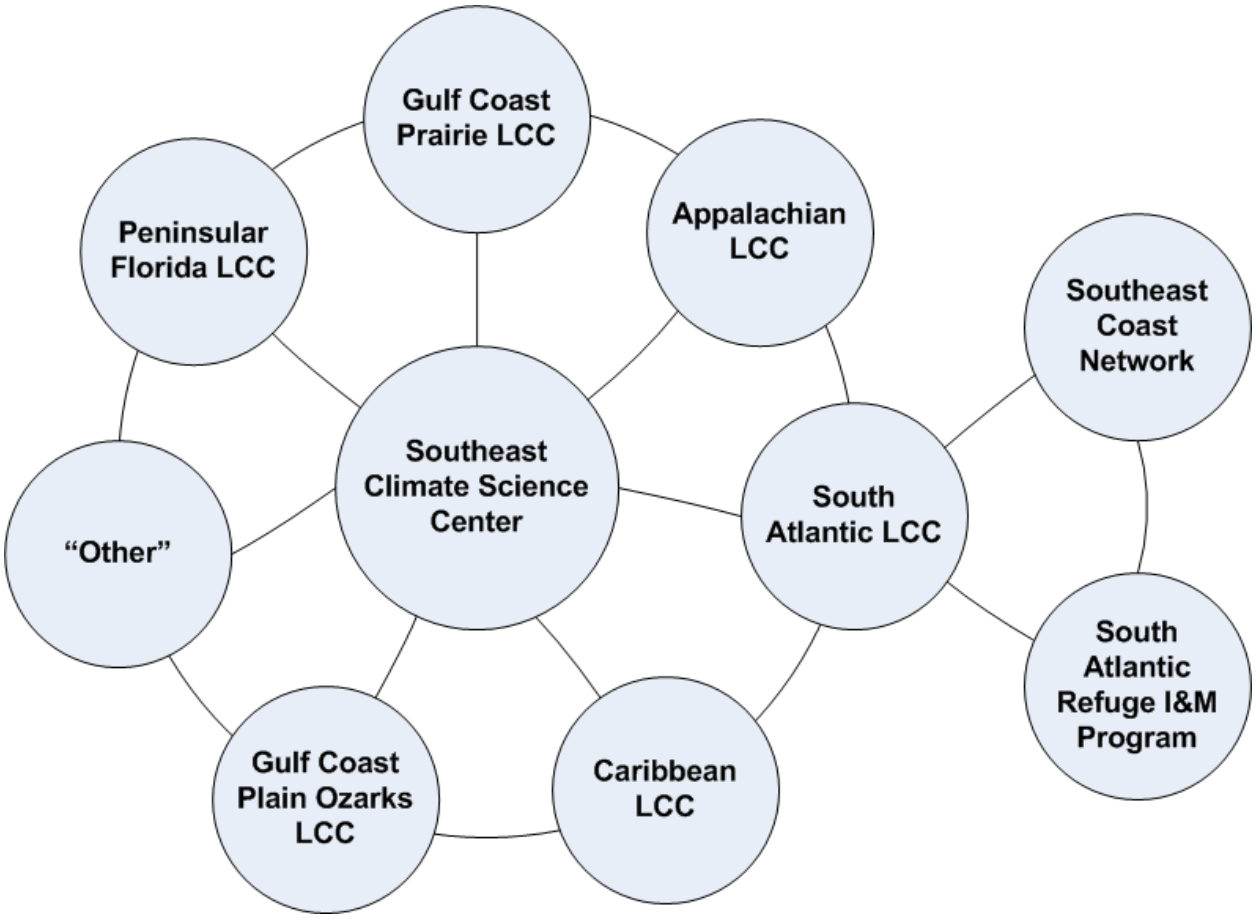
Proposed FY 2011 Organizational Chart



DOI Climate Science Programs



Network of DOI Climate Science programs with operational purview within the Southeast



Appendix D. Climate Change Policies

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Federal Register

Thursday,
October 8, 2009

Part VII

The President

Executive Order 13514—Federal Leadership in Environmental, Energy, and Economic Performance

Federal Register
Vol. 74, No. 194
Thursday, October 8, 2009

Presidential Documents

Title3—

The President

Executive Order 13514 of October 5, 2009

Federal Leadership in Environmental, Energy, and Economic Performance

By the authority vested in me as President by the Constitution and the laws of the United States of America, and to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas emissions a priority for Federal agencies, it is hereby ordered as follows:

Section 1. *Policy.* In order to create a clean energy economy that will increase our Nation's prosperity, promote energy security, protect the interests of taxpayers, and safeguard the health of our environment, the Federal Government must lead by example. It is therefore the policy of the United States that Federal agencies shall increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution; leverage agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services; design, construct, maintain, and operate high performance sustainable buildings in sustainable locations; strengthen the vitality and livability of the communities in which Federal facilities are located; and inform Federal employees about and involve them in the achievement of these goals.

It is further the policy of the United States that to achieve these goals and support their respective missions, agencies shall prioritize actions based on a full accounting of both economic and social benefits and costs and shall drive continuous improvement by annually evaluating performance, extending or expanding projects that have net benefits, and reassessing or discontinuing under-performing projects.

Finally, it is also the policy of the United States that agencies' efforts and outcomes in implementing this order shall be transparent and that agencies shall therefore disclose results associated with the actions taken pursuant to this order on publicly available Federal websites.

Sec. 2. *Goals for Agencies.* In implementing the policy set forth in section 1 of this order, and preparing and implementing the Strategic Sustainability Performance Plan called for in section 8 of this order, the head of each agency shall:

(a) within 90 days of the date of this order, establish and report to the Chair of the Council on Environmental Quality (CEQ Chair) and the Director of the Office of Management and Budget (OMB Director) a percentage reduction target for agency-wide reductions of scope 1 and 2 greenhouse gas emissions in absolute terms by fiscal year 2020, relative to a fiscal year 2008 baseline of the agency's scope 1 and 2 greenhouse gas emissions. Where appropriate, the target shall exclude direct emissions from excluded vehicles and equipment and from electric power produced and sold commercially to other parties in the course of regular business. This target shall be subject to review and approval by the CEQ Chair in consultation with the OMB Director under section 5 of this order. In establishing the target, the agency head shall consider reductions associated with:

(i) reducing energy intensity in agency buildings;

(ii) increasing agency use of renewable energy and implementing renewable energy generation projects on agency property; and
(iii) reducing the use of fossil fuels by:
(A) using low greenhouse gas emitting vehicles including alternative fuel vehicles;
(B) optimizing the number of vehicles in the agency fleet; and
(C) reducing, if the agency operates a fleet of at least 20 motor vehicles, the agency fleet's total consumption of petroleum products by a minimum of 2 percent annually through the end of fiscal year 2020, relative to a baseline of fiscal year 2005;

(b) within 240 days of the date of this order and concurrent with submission of the Strategic Sustainability Performance Plan as described in section 8 of this order, establish and report to the CEQ Chair and the OMB Director a percentage reduction target for reducing agency-wide scope 3 greenhouse gas emissions in absolute terms by fiscal year 2020, relative to a fiscal year 2008 baseline of agency scope 3 emissions. This target shall be subject to review and approval by the CEQ Chair in consultation with the OMB Director under section 5 of this order. In establishing the target, the agency head shall consider reductions associated with:
(i) pursuing opportunities with vendors and contractors to address and incorporate incentives to reduce greenhouse gas emissions (such as changes to manufacturing, utility or delivery services, modes of transportation used, or other changes in supply chain activities);
(ii) implementing strategies and accommodations for transit, travel, training, and conferencing that actively support lower-carbon commuting and travel by agency staff;
(iii) greenhouse gas emission reductions associated with pursuing other relevant goals in this section; and
(iv) developing and implementing innovative policies and practices to address scope 3 greenhouse gas emissions unique to agency operations;

(c) establish and report to the CEQ Chair and OMB Director a comprehensive inventory of absolute greenhouse gas emissions, including scope 1, scope 2, and specified scope 3 emissions (i) within 15 months of the date of this order for fiscal year 2010, and (ii) thereafter, annually at the end of January, for the preceding fiscal year.

(d) improve water use efficiency and management by:
(i) reducing potable water consumption intensity by 2 percent annually through fiscal year 2020, or 26 percent by the end of fiscal year 2020, relative to a baseline of the agency's water consumption in fiscal year 2007, by implementing water management strategies including water-efficient and low-flow fixtures and efficient cooling towers;
(ii) reducing agency industrial, landscaping, and agricultural water consumption by 2 percent annually or 20 percent by the end of fiscal year 2020 relative to a baseline of the agency's industrial, landscaping, and agricultural water consumption in fiscal year 2010;
(iii) consistent with State law, identifying, promoting, and implementing water reuse strategies that reduce potable water consumption; and
(iv) implementing and achieving the objectives identified in the stormwater management guidance referenced in section 14 of this order;

(e) promote pollution prevention and eliminate waste by:
(i) minimizing the generation of waste and pollutants through source reduction;
(ii) diverting at least 50 percent of non-hazardous solid waste, excluding construction and demolition debris, by the end of fiscal year 2015;
(iii) diverting at least 50 percent of construction and demolition materials and debris by the end of fiscal year 2015;
(iv) reducing printing paper use and acquiring uncoated printing and writing paper containing at least 30 percent postconsumer fiber;

(v) reducing and minimizing the quantity of toxic and hazardous chemicals and materials acquired, used, or disposed of;
(vi) increasing diversion of compostable and organic material from the waste stream;
(vii) implementing integrated pest management and other appropriate landscape management practices;
(viii) increasing agency use of acceptable alternative chemicals and processes in keeping with the agency's procurement policies;
(ix) decreasing agency use of chemicals where such decrease will assist the agency in achieving greenhouse gas emission reduction targets under section 2(a) and (b) of this order; and
(x) reporting in accordance with the requirements of sections 301 through 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C. 11001 *et seq.*);

(f) advance regional and local integrated planning by:

(i) participating in regional transportation planning and recognizing existing community transportation infrastructure;
(ii) aligning Federal policies to increase the effectiveness of local planning for energy choices such as locally generated renewable energy;
(iii) ensuring that planning for new Federal facilities or new leases includes consideration of sites that are pedestrian friendly, near existing employment centers, and accessible to public transit, and emphasizes existing central cities and, in rural communities, existing or planned town centers;
(iv) identifying and analyzing impacts from energy usage and alternative energy sources in all Environmental Impact Statements and Environmental Assessments for proposals for new or expanded Federal facilities under the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 *et seq.*); and
(v) coordinating with regional programs for Federal, State, tribal, and local ecosystem, watershed, and environmental management;

(g) implement high performance sustainable Federal building design, construction, operation and management, maintenance, and deconstruction including by:

(i) beginning in 2020 and thereafter, ensuring that all new Federal buildings that enter the planning process are designed to achieve zero-net-energy by 2030;
(ii) ensuring that all new construction, major renovation, or repair and alteration of Federal buildings complies with the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings*, (Guiding Principles);
(iii) ensuring that at least 15 percent of the agency's existing buildings (above 5,000 gross square feet) and building leases (above 5,000 gross square feet) meet the Guiding Principles by fiscal year 2015 and that the agency makes annual progress toward 100-percent conformance with the Guiding Principles for its building inventory;
(iv) pursuing cost-effective, innovative strategies, such as highly reflective and vegetated roofs, to minimize consumption of energy, water, and materials;
(v) managing existing building systems to reduce the consumption of energy, water, and materials, and identifying alternatives to renovation that reduce existing assets' deferred maintenance costs;
(vi) when adding assets to the agency's real property inventory, identifying opportunities to consolidate and dispose of existing assets, optimize the performance of the agency's real-property portfolio, and reduce associated environmental impacts; and
(vii) ensuring that rehabilitation of federally owned historic buildings utilizes best practices and technologies in retrofitting to promote long-term viability of the buildings;

(h) advance sustainable acquisition to ensure that 95 percent of new contract actions including task and delivery orders, for products and services with the exception of acquisition of weapon systems, are energy-

efficient (Energy Star or Federal Energy Management Program (FEMP) designated), water-efficient, biobased, environmentally preferable (e.g., Electronic Product Environmental Assessment Tool (EPEAT) certified), non-ozone depleting, contain recycled content, or are non-toxic or less-toxic alternatives, where such products and services meet agency performance requirements;

(i) promote electronics stewardship, in particular by:

(i) ensuring procurement preference for EPEAT-registered electronic products;

(ii) establishing and implementing policies to enable power management, duplex printing, and other energy-efficient or environmentally preferable features on all eligible agency electronic products;

(iii) employing environmentally sound practices with respect to the agency's disposition of all agency excess or surplus electronic products;

(iv) ensuring the procurement of Energy Star and FEMP designated electronic equipment;

(v) implementing best management practices for energy-efficient management of servers and Federal data centers; and

(j) sustain environmental management, including by:

(i) continuing implementation of formal environmental management systems at all appropriate organizational levels; and

(ii) ensuring these formal systems are appropriately implemented and maintained to achieve the performance necessary to meet the goals of this order.

Sec. 3. *Steering Committee on Federal Sustainability.* The OMB Director and the CEQ Chair shall:

(a) establish an interagency Steering Committee (Steering Committee) on Federal Sustainability composed of the Federal Environmental Executive, designated under section 6 of Executive Order 13423 of January 24, 2007, and Agency Senior Sustainability Officers, designated under section 7 of this order, and that shall:

(i) serve in the dual capacity of the Steering Committee on Strengthening FederalEnvironmental, Energy, and Transportation Management designated by the CEQ Chair pursuant to section 4 of Executive Order 13423;

(ii) advise the OMB Director and the CEQ Chair on implementation of this order;

(iii) facilitate the implementation of each agency's Strategic Sustainability Performance Plan; and

(iv) share information and promote progress towards the goals of this order;

(b) enlist the support of other organizations within the Federal Government to assist the Steering Committee in addressing the goals of this order;

(c) establish and disband, as appropriate, interagency subcommittees of the Steering Committee, to assist the Steering Committee in carrying out its responsibilities;

(d) determine appropriate Federal actions to achieve the policy of section 1 and the goals of section 2 of this order;

(e) ensure that Federal agencies are held accountable for conformance with the requirements of this order; and

(f) in coordination with the Department of Energy's Federal Energy Management Program and the Office of the Federal Environmental Executive designated under section 6 of Executive Order 13423, provide guidance and assistance to facilitate the development of agency targets for greenhouse gas emission reductions required under subsections 2(a) and (b) of this order.

Sec. 4. *Additional Duties of the Director of the Office of Management and Budget.* In addition to the duties of the OMB Director specified elsewhere in this order, the OMB Director shall:

(a) review and approve each agency's multi-year Strategic Sustainability Performance Plan under section 8 of this order and each update of the Plan. The Director shall, where feasible, review each agency's Plan concurrently with OMB's review and evaluation of the agency's budget request;

(b) prepare scorecards providing periodic evaluation of Federal agency performance in implementing this order and publish scorecard results on a publicly available website; and

(c) approve and issue instructions to the heads of agencies concerning budget and appropriations matters relating to implementation of this order.

Sec. 5. *Additional Duties of the Chair of the Council on Environmental Quality.* In addition to the duties of the CEQ Chair specified elsewhere in this order, the CEQ Chair shall:

(a) issue guidance for greenhouse gas accounting and reporting required under section 2 of this order;

(b) issue instructions to implement this order, in addition to instructions within the authority of the OMB Director to issue under subsection 4(c) of this order;

(c) review and approve each agency's targets, in consultation with the OMB Director, for agency-wide reductions of greenhouse gas emissions under section 2 of this order;

(d) prepare, in coordination with the OMB Director, streamlined reporting metrics to determine each agency's progress under section 2 of this order;

(e) review and evaluate each agency's multi-year Strategic Sustainability Performance Plan under section 8 of this order and each update of the Plan;

(f) assess agency progress toward achieving the goals and policies of this order, and provide its assessment of the agency's progress to the OMB Director;

(g) within 120 days of the date of this order, provide the President with an aggregate Federal Government-wide target for reducing scope 1 and 2 greenhouse gas emissions in absolute terms by fiscal year 2020 relative to a fiscal year 2008 baseline;

(h) within 270 days of the date of this order, provide the President with an aggregate Federal Government-wide target for reducing scope 3 greenhouse gas emissions in absolute terms by fiscal year 2020 relative to a fiscal year 2008 baseline;

(i) establish and disband, as appropriate, interagency working groups to provide recommendations to the CEQ for areas of Federal agency operational and managerial improvement associated with the goals of this order; and

(j) administer the Presidential leadership awards program, established under subsection 4(c) of Executive Order 13423, to recognize exceptional and outstanding agency performance with respect to achieving the goals of this order and to recognize extraordinary innovation, technologies, and practices employed to achieve the goals of this order.

Sec. 6. *Duties of the Federal Environmental Executive.* The Federal Environmental Executive designated by the President to head the Office of the Federal Environmental Executive, pursuant to section 6 of Executive Order 13423, shall:

(a) identify strategies and tools to assist Federal implementation efforts under this order, including through the sharing of best practices from successful Federal sustainability efforts; and

(b) monitor and advise the CEQ Chair and the OMB Director on the agencies' implementation of this order and their progress in achieving the order's policies and goals.

Sec. 7. *Agency Senior Sustainability Officers.* (a) Within 30 days of the date of this order, the head of each agency shall designate from among

the agency's senior management officials a Senior Sustainability Officer who shall be accountable for agency conformance with the requirements of this order; and shall report such designation to the OMB Director and the CEQ Chair.

(b) The Senior Sustainability Officer for each agency shall perform the functions of the senior agency official designated by the head of each agency pursuant to section 3(d)(i) of Executive Order 13423 and shall be responsible for:

(i) preparing the targets for agency-wide reductions and the inventory of greenhouse gas emissions required under subsections 2(a), (b), and (c) of this order;

(ii) within 240 days of the date of this order, and annually thereafter, preparing and submitting to the CEQ Chair and the OMB Director, for their review and approval, a multi-year Strategic Sustainability Performance Plan (Sustainability Plan or Plan) as described in section 8 of this order;

(iii) preparing and implementing the approved Plan in coordination with appropriate offices and organizations within the agency including the General Counsel, Chief Information Officer, Chief Acquisition Officer, Chief Financial Officer, and Senior Real Property Officers, and in coordination with other agency plans, policies, and activities;

(iv) monitoring the agency's performance and progress in implementing the Plan, and reporting the performance and progress to the CEQ Chair and the OMB Director, on such schedule and in such format as the Chair and the Director may require; and

(v) reporting annually to the head of the agency on the adequacy and effectiveness of the agency's Plan in implementing this order.

Sec. 8. *Agency Strategic Sustainability Performance Plan.* Each agency shall develop, implement, and annually update an integrated Strategic Sustainability Performance Plan that will prioritize agency actions based on lifecycle return on investment. Each agency Plan and update shall be subject to approval by the OMB Director under section 4 of this order. With respect to the period beginning in fiscal year 2011 and continuing through the end of fiscal year 2021, each agency Plan shall:

(a) include a policy statement committing the agency to compliance with environmental and energy statutes, regulations, and Executive Orders;

(b) achieve the sustainability goals and targets, including greenhouse gas reduction targets, established under section 2 of this order;

(c) be integrated into the agency's strategic planning and budget process, including the agency's strategic plan under section 3 of the Government Performance and Results Act of 1993, as amended (5 U.S.C. 306);

(d) identify agency activities, policies, plans, procedures, and practices that are relevant to the agency's implementation of this order, and where necessary, provide for development and implementation of new or revised policies, plans, procedures, and practices;

(e) identify specific agency goals, a schedule, milestones, and approaches for achieving results, and quantifiable metrics for agency implementation of this order;

(f) take into consideration environmental measures as well as economic and social benefits and costs in evaluating projects and activities based on lifecycle return on investment;

(g) outline planned actions to provide information about agency progress and performance with respect to achieving the goals of this order on a publicly available Federal website;

(h) incorporate actions for achieving progress metrics identified by the OMB Director and the CEQ Chair;

(i) evaluate agency climate-change risks and vulnerabilities to manage the effects of climate change on the agency's operations and mission in both the short and long term; and

(j) identify in annual updates opportunities for improvement and evaluation of past performance in order to extend or expand projects that have net lifecycle benefits, and reassess or discontinue under-performing projects.

Sec. 9. *Recommendations for Greenhouse Gas Accounting and Reporting.* The Department of Energy, through its Federal Energy Management Program, and in coordination with the Environmental Protection Agency, the Department of Defense, the General Services Administration, the Department of the Interior, the Department of Commerce, and other agencies as appropriate, shall:

(a) within 180 days of the date of this order develop and provide to the CEQ Chair recommended Federal greenhouse gas reporting and accounting procedures for agencies to use in carrying out their obligations under subsections 2(a), (b), and (c) of this order, including procedures that will ensure that agencies:

(i) accurately and consistently quantify and account for greenhouse gas emissions from all scope 1, 2, and 3 sources, using accepted greenhouse gas accounting and reporting principles, and identify appropriate opportunities to revise the fiscal year 2008 baseline to address significant changes in factors affecting agency emissions such as reorganization and improvements in accuracy of data collection and estimation procedures or other major changes that would otherwise render the initial baseline information unsuitable;

(ii) consider past Federal agency efforts to reduce greenhouse gas emissions; and

(iii) consider and account for sequestration and emissions of greenhouse gases resulting from Federal land management practices;

(b) within 1 year of the date of this order, to ensure consistent and accurate reporting under this section, provide electronic accounting and reporting capability for the Federal greenhouse gas reporting procedures developed under subsection (a) of this section, and to the extent practicable, ensure compatibility between this capability and existing Federal agency reporting systems; and

(c) every 3 years from the date of the CEQ Chair's issuance of the initial version of the reporting guidance, and as otherwise necessary, develop and provide recommendations to the CEQ Chair for revised Federal greenhouse gas reporting procedures for agencies to use in implementing subsections 2(a), (b), and (c) of this order.

Sec. 10. *Recommendations for Sustainable Locations for Federal Facilities.* Within 180 days of the date of this order, the Department of Transportation, in accordance with its Sustainable Partnership Agreement with the Department of Housing and Urban Development and the Environmental Protection Agency, and in coordination with the General Services Administration, the Department of Homeland Security, the Department of Defense, and other agencies as appropriate, shall:

(a) review existing policies and practices associated with site selection for Federal facilities; and

(b) provide recommendations to the CEQ Chair regarding sustainable location strategies for consideration in Sustainability Plans. The recommendations shall be consistent with principles of sustainable development including prioritizing central business district and rural town center locations, prioritizing sites well served by transit, including site design elements that ensure safe and convenient pedestrian access, consideration of transit access and proximity to housing affordable to a wide range of Federal employees, adaptive reuse or renovation of buildings, avoidance of development of sensitive land resources, and evaluation of parking management strategies.

Sec. 11. *Recommendations for Federal Local Transportation Logistics.* Within 180 days of the date of this order, the General Services Administration, in coordination with the Department of Transportation, the Department of

the Treasury, the Department of Energy, the Office of Personnel Management, and other agencies as appropriate, shall review current policies and practices associated with use of public transportation by Federal personnel, Federal shuttle bus and vehicle transportation routes supported by multiple Federal agencies, and use of alternative fuel vehicles in Federal shuttle bus fleets, and shall provide recommendations to the CEQ Chair on how these policies and practices could be revised to support the implementation of this order and the achievement of its policies and goals.

Sec. 12. *Guidance for Federal Fleet Management.* Within 180 days of the date of this order, the Department of Energy, in coordination with the General Services Administration, shall issue guidance on Federal fleet management that addresses the acquisition of alternative fuel vehicles and use of alternative fuels; the use of biodiesel blends in diesel vehicles; the acquisition of electric vehicles for appropriate functions; improvement of fleet fuel economy; the optimizing of fleets to the agency mission; petroleum reduction strategies, such as the acquisition of low greenhouse gas emitting vehicles and the reduction of vehicle miles traveled; and the installation of renewable fuel pumps at Federal fleet fueling centers.

Sec. 13. *Recommendations for Vendor and Contractor Emissions.* Within 180 days of the date of this order, the General Services Administration, in coordination with the Department of Defense, the Environmental Protection Agency, and other agencies as appropriate, shall review and provide recommendations to the CEQ Chair and the Administrator of OMB's Office of Federal Procurement Policy regarding the feasibility of working with the Federal vendor and contractor community to provide information that will assist Federal agencies in tracking and reducing scope 3 greenhouse gas emissions related to the supply of products and services to the Government. These recommendations should consider the potential impacts on the procurement process, and the Federal vendor and contractor community including small businesses and other socioeconomic procurement programs. Recommendations should also explore the feasibility of:

(a) requiring vendors and contractors to register with a voluntary registry or organization for reporting greenhouse gas emissions;

(b) requiring contractors, as part of a new or revised registration under the Central Contractor Registration or other tracking system, to develop and make available its greenhouse gas inventory and description of efforts to mitigate greenhouse gas emissions;

(c) using Federal Government purchasing preferences or other incentives for products manufactured using processes that minimize greenhouse gas emissions; and

(d) other options for encouraging sustainable practices and reducing greenhouse gas emissions.

Sec. 14. *Stormwater Guidance for Federal Facilities.* Within 60 days of the date of this order, the Environmental Protection Agency, in coordination with other Federal agencies as appropriate, shall issue guidance on the implementation of section 438 of the Energy Independence and Security Act of 2007 (42 U.S.C. 17094).

Sec. 15. *Regional Coordination.* Within 180 days of the date of this order, the Federal Environmental Executive shall develop and implement a regional implementation plan to support the goals of this order taking into account energy and environmental priorities of particular regions of the United States.

Sec. 16. *Agency Roles in Support of Federal Adaptation Strategy.* In addition to other roles and responsibilities of agencies with respect to environmental leadership as specified in this order, the agencies shall participate actively in the interagency Climate Change Adaptation Task Force, which is already engaged in developing the domestic and international dimensions of a U.S. strategy for adaptation to climate change, and shall develop approaches through which the policies and practices of the agencies can be made compatible with and reinforce that strategy. Within 1 year of the date of

this order the CEQ Chair shall provide to the President, following consultation with the agencies and the Climate Change Adaptation Task Force, as appropriate, a progress report on agency actions in support of the national adaptation strategy and recommendations for any further such measures as the CEQ Chair may deem necessary.

Sec. 17. *Limitations.* (a) This order shall apply to an agency with respect to the activities, personnel, resources, and facilities of the agency that are located within the United States. The head of an agency may provide that this order shall apply in whole or in part with respect to the activities, personnel, resources, and facilities of the agency that are not located within the United States, if the head of the agency determines that such application is in the interest of the United States.

(b) The head of an agency shall manage activities, personnel, resources, and facilities of the agency that are not located within the United States, and with respect to which the head of the agency has not made a determination under subsection (a) of this section, in a manner consistent with the policy set forth in section 1 of this order to the extent the head of the agency determines practicable.

Sec. 18. *Exemption Authority.*

(a) The Director of National Intelligence may exempt an intelligence activity of the United States, and related personnel, resources, and facilities, from the provisions of this order, other than this subsection and section 20, to the extent the Director determines necessary to protect intelligence sources and methods from unauthorized disclosure.

(b) The head of an agency may exempt law enforcement activities of that agency, and related personnel, resources, and facilities, from the provisions of this order, other than this subsection and section 20, to the extent the head of an agency determines necessary to protect undercover operations from unauthorized disclosure.

(c) (i) The head of an agency may exempt law enforcement, protective, emergency response, or military tactical vehicle fleets of that agency from the provisions of this order, other than this subsection and section 20.

(ii) Heads of agencies shall manage fleets to which paragraph (i) of this subsection refers in a manner consistent with the policy set forth in section 1 of this order to the extent they determine practicable.

(d) The head of an agency may exempt particular agency activities and facilities from the provisions of this order, other than this subsection and section 20, where it is in the interest of national security. If the head of an agency issues an exemption under this section, the agency must notify the CEQ Chair in writing within 30 days of issuance of the exemption under this subsection. To the maximum extent practicable, and without compromising national security, each agency shall strive to comply with the purposes, goals, and implementation steps in this order.

(e) The head of an agency may submit to the President, through the CEQ Chair, a request for an exemption of an agency activity, and related personnel, resources, and facilities, from this order.

Sec. 19. *Definitions.* As used in this order:

(a) "absolute greenhouse gas emissions" means total greenhouse gas emissions without normalization for activity levels and includes any allowable consideration of sequestration;

(b) "agency" means an executive agency as defined in section 105 of title 5, United States Code, excluding the Government Accountability Office;

(c) "alternative fuel vehicle" means vehicles defined by section 301 of the Energy Policy Act of 1992, as amended (42 U.S.C. 13211), and otherwise includes electric fueled vehicles, hybrid electric vehicles, plug-in hybrid electric vehicles, dedicated alternative fuel vehicles, dual fueled alternative

fuel vehicles, qualified fuel cell motor vehicles, advanced lean burn technology motor vehicles, self-propelled vehicles such as bicycles and any other alternative fuel vehicles that are defined by statute;

(d) "construction and demolition materials and debris" means materials and debris generated during construction, renovation, demolition, or dismantling of all structures and buildings and associated infrastructure;

(e) "divert" and "diverting" means redirecting materials that might otherwise be placed in the waste stream to recycling or recovery, excluding diversion to waste-to-energy facilities;

(f) "energy intensity" means energy consumption per square foot of building space, including industrial or laboratory facilities;

(g) "environmental" means environmental aspects of internal agency operations and activities, including those aspects related to energy and transportation functions;

(h) "excluded vehicles and equipment" means any vehicle, vessel, aircraft, or non-road equipment owned or operated by an agency of the Federal Government that is used in:

(i) combat support, combat service support, tactical or relief operations, or training for such operations;

(ii) Federal law enforcement (including protective service and investigation);

(iii) emergency response (including fire and rescue); or

(iv) spaceflight vehicles (including associated ground-support equipment);

(i) "greenhouse gases" means carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride;

(j) "renewable energy" means energy produced by solar, wind, biomass, landfill gas, ocean (including tidal, wave, current, and thermal), geothermal, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project;

(k) "scope 1, 2, and 3" mean;

(i) scope 1: direct greenhouse gas emissions from sources that are owned or controlled by the Federal agency;

(ii) scope 2: direct greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency; and

(iii) scope 3: greenhouse gas emissions from sources not owned or directly controlled by a Federal agency but related to agency activities such as vendor supply chains, delivery services, and employee travel and commuting;

(l) "sustainability" and "sustainable" mean to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations;

(m) "United States" means the fifty States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, and the Northern Mariana Islands, and associated territorial waters and airspace;

(n) "water consumption intensity" means water consumption per square foot of building space; and

(o) "zero-net-energy building" means a building that is designed, constructed, and operated to require a greatly reduced quantity of energy to operate, meet the balance of energy needs from sources of energy that do not produce greenhouse gases, and therefore result in no net emissions of greenhouse gases and be economically viable.

Sec. 20. *General Provisions.*

(a) This order shall be implemented in a manner consistent with applicable law and subject to the availability of appropriations.

(b) Nothing in this order shall be construed to impair or otherwise affect the functions of the OMB Director relating to budgetary, administrative, or legislative proposals.

(c) This order is intended only to improve the internal management of the Federal Government and is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.



THE WHITE HOUSE,
Washington, October 5, 2009.

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Secretarial Order 3289. Addressing the Impacts of Climate Change on America's Water, Land and Other Natural and Cultural Resources

THE SECRETARY OF THE INTERIOR

WASHINGTON

ORDER NO. 3289

Subject: Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources

Sec. 1 **Purpose and Background.** Secretarial Order No. 3285, issued on March 11, 2009, made production and transmission of renewable energy on public lands a priority for the Department. This Order establishes a Department-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages. This Order replaces Secretarial Order No. 3226, Amendment No. 1, issued on January 16, 2009, and reinstates the provisions of Secretarial Order No. 3226, issued on January 19, 2001.

To fulfill our nation's vision for a clean energy economy, Interior is now managing America's public lands and oceans not just for balanced oil, natural gas, and coal development, but also – for the first time ever – to promote environmentally responsible renewable energy development. Sun, wind, biomass, and geothermal energy from our public and tribal lands is creating new jobs and will power millions of American homes and electric vehicles.

The Department is also taking the lead in protecting our country's water, land, fish and wildlife, and cultural heritage and tribal lands and resources from the dramatic effects of climate change that are already occurring – from the Arctic to the Everglades. The realities of climate change require us to change how we manage the land, water, fish and wildlife, and cultural heritage and tribal lands and resources we oversee. For example:

- New water management imperatives associated with climate change may require restoration of natural systems and construction of new infrastructure to reduce new flood risks or to capture early run-off.
- Strategies to address sea level rise may require acquisition of upland habitat and creation of wetlands and other natural filters and barriers to protect against sea level rise and storm surges. It may be necessary to relocate certain iconic and culturally historic structures.
- Shifting wildlife and habitat populations may require investments in new wildlife corridors.
- New invasions of exotic species and new wildland fire threats due to longer fire seasons and more severe droughts will require innovation and more effective ways of managing the Department's resources.

The Department of the Interior, with its 67,000 employees and scientific and resource management expertise, is responsible for helping protect the nation from the impacts of climate change. In particular the Department must:

- Adapt its water management strategies to address the possibility of shrinking water supplies and more frequent and extended droughts to continue to supply drinking water to more than 31 million people and irrigation water to 140,000 farmers.
- Wisely manage millions of acres of parks, refuges and other public lands, and prudently exercise its shared responsibility for managing the 1.7 billion acres of the U.S. outer continental shelf.
- Conserve and manage fish and wildlife resources, including over 800 native migratory bird species and nearly 2,000 federally listed threatened and endangered species.
- Protect cultural and archaeological resources and iconic structures that may be affected by climate change.
- Address the impacts of climate change on American Indians and Alaska Natives, for whom the Department holds trust responsibilities on behalf of the Federal government.
- Continue to provide state-of-the art science to better understand the impacts of climate change and to develop science-based adaptive management strategies for natural and cultural resource managers.
- Continue its work to quantify the amount of carbon stored in our forests, wetlands, and grasslands, identifying areas where carbon dioxide can be safely stored underground, and ways to reduce the Department's carbon footprint.

Sec. 2 **Authority**. This Order is issued under the authority of Section 2 of Reorganization Plan No. 3 of 1950 (64 Stat. 1262), as amended.

Sec. 3 **Coordinating the Department's Response to Climate Change Impacts on Our Resources**. This Order establishes a *Climate Change Response Council* within the Office of the Secretary that will execute a coordinated Department-wide strategy to increase scientific understanding of and development of effective adaptive management tools to address the impacts of climate change on our natural and cultural resources. The Climate Change Response Council will be composed of the Secretary (Chair), Deputy Secretary (Vice-Chair), Counselor to the Secretary (Vice-Chair), Assistant Secretaries, Bureau Directors and the Solicitor. The Council will help coordinate activities within and among the Department's agencies and bureaus to develop and implement an integrated strategy for responding to climate change impacts involving the resources managed by the Department. The Department's Climate Change Response Council will also coordinate its climate change activities with all relevant Federal Departments and agencies including, but not limited to, the Council on Environmental Quality, the Office of Energy and Climate Change, the Office of Science and Technology Policy, the National Science and Technology Council, the Department of Agriculture, the Department of Commerce, the Department of Defense, and the Environmental Protection Agency.

The Climate Change Response Council will implement Department-specific climate change activities through the following mechanisms:

(a) Climate Change Response Planning Requirements. Each bureau and office of the Department must consider and analyze potential climate change impacts when undertaking long-

range planning exercises, setting priorities for scientific research and investigations, developing multi-year management plans, and making major decisions regarding potential use of resources under the Department's purview. These requirements were set forth in Secretarial Order No. 3226, and remain in effect. The organizational changes made by this Order will enable the bureaus and agencies to fulfill these planning requirements.

(b) DOI Regional Climate Change Response Centers. Management decisions made in response to climate change impacts must be informed by science and require that scientists work in tandem with those managers who are confronting climate change impacts and evaluating options to respond to such impacts. Pursuant to P.L. 110-161, the United States Geological Survey (USGS) has been developing regional science centers to provide climate change impact data and analysis geared to the needs of fish and wildlife managers as they develop adaptation strategies in response to climate change. These centers are currently known as "regional hubs" of the National Climate Change and Wildlife Science Center, and are being developed in close collaboration with Interior agencies and other federal, state, university, and non-governmental partners.

The Climate Change Response Council will work with USGS and other Department bureaus to rename these regional science centers as Regional Climate Change Response Centers and broaden their mandate to encompass other climate-change-related impacts on Departmental resources. These eight Response Centers will synthesize and integrate climate change impact data and develop tools that the Department's managers and partners can use when managing the Department's land, water, fish and wildlife, and cultural heritage resources.

(c) Landscape Conservation Cooperatives. Given the broad impacts of climate change, management responses to such impacts must be coordinated on a landscape-level basis. For example, wildlife migration and related needs for new wildlife corridors, the spread of invasive species and wildfire risks, typically will extend beyond the borders of National Wildlife Refuges, BLM lands, or National Parks. Additionally, some bureau responsibilities (e.g., Fish and Wildlife Service migratory bird and threatened and endangered species responsibilities) extend nationally and globally. Because of the unprecedented scope of affected landscapes, Interior bureaus and agencies must work together, and with other federal, state, tribal and local governments, and private landowner partners, to develop landscape-level strategies for understanding and responding to climate change impacts. Interior bureaus and agencies, guided by the Climate Response Council, will work to stimulate the development of a network of collaborative "Landscape Conservation Cooperatives." These cooperatives, which already have been formed in some regions, will work interactively with the relevant DOI Regional Climate Change Response Center(s) and help coordinate adaptation efforts in the region.

Sec. 4 **Additional Departmental Action to Mitigate Climate Change.** In accordance with Secretarial Order No. 3285, the Department has prioritized development of renewable energy on public lands and offshore waters to reduce our dependence on foreign oil and to reduce greenhouse gas pollution. This Order establishes two additional projects to mitigate climate change: the DOI Carbon Storage Project, and the DOI Carbon Footprint Project. Additional mitigation projects will be encouraged and supported by the Climate Change Response Council.

(a) The DOI Carbon Storage Project. This project is being implemented under P.L. 110-140, "The Energy Independence and Security Act of 2007," which gives the Department statutory responsibility to develop carbon sequestration methodologies for geological (i.e., underground) and biological (e.g., forests and rangelands) carbon storage. The USGS has the lead in administering the Carbon Storage Project, but will work closely with other bureaus and agencies in the Department and external partners to enhance carbon storage in geologic formations and in plants and soils in a manner consistent with the Department's responsibility to provide comprehensive, long-term stewardship of its resources. The DOI Carbon Storage Project is vital for successful domestic and global geological and biological carbon sequestration efforts.

(b) The DOI Carbon Footprint Project. The project will develop a unified greenhouse gas emission reduction program, including setting a baseline and reduction goal for the Department's greenhouse gas emissions and energy use. The Assistant Secretary for Policy, Management and Budget will have the lead in administering the DOI Carbon Footprint Project, with the cooperation of all of the Department's agencies and bureaus.

Sec. 5 **American Indians and Alaska Natives.** Climate change may disproportionately affect tribes and their lands because they are heavily dependent on their natural resources for economic and cultural identity. As the Department has the primary trust responsibility for the Federal government for American Indians, Alaska Natives, and tribal lands and resources, the Department will ensure consistent and in-depth government-to-government consultation with tribes and Alaska Natives on the Department's climate change initiatives. Tribal values are critical to determining what is to be protected, why, and how to protect the interests of their communities. The Department will support the use of the best available science, including traditional ecological knowledge, in formulating policy pertaining to climate change. The Department will also support substantive participation by tribes in deliberations on climate-related mechanisms, agreements, rules, and regulations.

Sec. 6 **Implementation.** The Deputy Secretary is responsible for ensuring implementation of all aspects of this Order. This responsibility may be delegated as appropriate. This Order does not alter or affect any existing duty or authority of individual bureaus.

Sec. 7 **Effective Date.** This Order is effective immediately and will remain in effect until its provisions are converted to the Departmental Manual or until it is amended, superseded, or revoked, whichever occurs first.

Ken Salazar
Secretary of the Interior

Date: SEP 14 2009

Interior's Plan for a Coordinated, Science-Based Response to Climate Change Impacts on our Land, Water, and Wildlife Resources

U.S. Department of the Interior

INTERIOR'S PLAN FOR A COORDINATED, SCIENCE-BASED RESPONSE TO CLIMATE CHANGE IMPACTS ON OUR LAND, WATER, and WILDLIFE RESOURCES

SUMMARY

Climate change is driving rapid and broad changes in the global ecosystem, which are documented in extensive scientific literature. These include increasing temperatures; varying precipitation; rising sea levels; and acidifying oceans. These changes, in turn, are impacting local environments and economies. Sea level rise puts landscapes important to humans and wildlife at risk; variations in precipitation affect water resource availability for humans and natural systems; temperature changes affect terrestrial and aquatic systems, species distributions and interactions; these same forces will also pose threats to our Nation's cultural traditions and resources. Accomplishing conservation goals in a changing climate will be more challenging and complex than ever before. Success will require building integrated capacities, forging shared goals, and people working together to define and implement conservation strategies large and bold enough to meet these challenges.

As the primary land, water and wildlife manager for the nation, the U.S. Department of the Interior has an obligation to address the impacts that climate change is having on America's resources by developing integrated adaptation and mitigation strategies. In recognition of this responsibility, Secretary Salazar signed a Secretarial Order (No. 3289) on September 14, 2009, entitled, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources." **That Order established a *Climate Change Response Council*, chaired by the Secretary, which is coordinating activities within and across the bureaus to develop and implement an integrated strategy for climate change response by the Department.** Working at the landscape, regional, and national scales through the establishment of ***DOI Climate Science Centers (CSCs)*** **and** ***Landscape Conservation Cooperatives (LCCs),*** the Department is defining and implementing a vision that integrates DOI science and management expertise with that of our partners, providing information and best management practices available to support strategic adaptation and mitigation efforts on both public and private lands across the U.S. and internationally.

This vision supports individual bureau missions while, at the same time, creating synergies with other DOI agencies and both governmental and non-governmental partners to implement integrated climate change science, adaptation, and mitigation strategies across broad landscapes. DOI bureaus will be pooling resources to support and leverage the joint work of CSCs and LCCs. Project-level funding and implementation, and regulatory, management, and policy decisions will continue to be the responsibility of each bureau and partner, in accordance with their mission-related responsibilities.

In implementing this vision we will bring significant new capabilities to the table for DOI land, fish, wildlife, water, marine, tribal, and cultural heritage managers, as well as for our federal, state, local, Tribal, NGO, and private landowner partners. These new resources include:

- *Climate Change Impact Science*: Regional Climate Science Centers and Landscape Conservation Cooperatives will conduct and communicate research and monitoring, improving our understanding and forecasting of climate change impacts and vulnerabilities. They will support strategic decisions in response to those vulnerabilities, with CSCs providing centers for basic climate change science associated with broad regions of the country and LCCs focusing more on applied science at the landscape level.

- *Data Integration and Dissemination:* This effort will support the integration of our nation's scientific database, improving availability and dissemination of climate change impact and vulnerability information, and access and decision-support to scientists, resource managers, decision makers, and the general public through www.data.gov and other appropriate mechanisms.

- *Enabling Science-Based Adaptation Strategies:* By providing integrated scientific and technical capacities to support cultural and natural resource managers, they will be able to design and implement strategic and adaptive responses to changing climate.

As explained in more detail below, these new approaches form the foundational elements for the Climate Science Centers that DOI is establishing on a regional basis around the country, and for Landscape Conservation Cooperatives -- geographically-based cooperatives in which DOI bureaus will work with other agencies and outside partners to expand the understanding of climate change and how it is interacting with other forces to alter natural and cultural resources, and to facilitate strategic responses.

DOI Climate Science Centers (CSCs): "Delivering Fundamental Climate Impact Science to Resource Managers on a Regional Basis"

The Department of the Interior operates a National Climate Change and Wildlife Center at the headquarters of the United States Geological Service. In accordance with Secretarial Order No. 3289, the Department is expanding the scope and geographic reach of its climate science efforts by establishing, in addition, eight regional Climate Science Centers that will provide scientific information, tools and techniques that land, water, wildlife and cultural resource managers and other interested parties can apply to anticipate, monitor and adapt to climate and ecologically-driven responses at regional-to-local scales.

CSCs will deliver basic climate change impact science to Landscape Conservation Cooperatives within their respective regions, including physical and biological research, ecological forecasting, and multi-scale modeling. These Climate Science Centers will prioritize fundamental science, data and decision-support activities based principally on the needs of the LCCs, including climate change impacts on natural and cultural resources and adaptive management and other decision support tools for managers. By way of example, the regional CSCs will work with (and sometimes generate) downscaled climate models, providing derivative models and tools that link physical forcing factors with biological,

hydrological, physical, ecological, and cultural resource response variables. Centers also will develop response models and projections for priority ecosystems, species, habitats, and other natural and cultural resources; this will generally be done at regional levels and then collaboratively developed with LCCs for specific applications.

The science priorities and activities at Climate Science Centers will be driven principally by input from the associated LCCs, but also other partnerships. Working closely with LCC staff, the CSCs will help develop adaptive management approaches, develop statistically sound sampling programs and processes to monitor and manage climate change effects. Centers also will work with LCCs to define measurable resource outcomes and endpoints for adaptive management applications which, in turn, will help CSCs refine models and outputs. CSCs will also facilitate and fund research advancing the science of climate impact and resource modeling, and investigating underlying mechanisms that drive the responses of specific resources.

Climate Science Centers will be based at host institutions with substantial climate change science expertise and partnerships. Centers will include staff from multiple partners, perhaps including LCC staff and will include a cadre of scientists as well as information specialists.

Landscape Conservation Cooperatives (LCCs): The On-the-Ground Applied Science and Adaptive Management Arm

Landscape Conservation Cooperatives are management-science partnerships that inform integrated resource management actions addressing climate change and other stressors within and across landscapes. They will link science and conservation delivery. Each LCC functions within a specific landscape, but it also will be part of a national, and ultimately, international network. LCCs are true cooperatives, formed and directed by land, water, wildlife and cultural resource managers and interested public and private organizations. Federal, state, tribal, local government and non-governmental management organizations are all invited as partners in their development. Each LCC will be directed by a steering committee representing partners working in that region.

The Secretary's Climate Change Response Council will promote collaboration among LCCs and develop mechanisms for data and information management, the setting of national priorities, and ensuring consistency and prevent duplication of effort among the national network of LCCs.

Organization and Focus of LCCs. LCCs are self-directed partnerships. They provide a structure to define objectives, develop spatially-explicit strategies, and provide scientific and technical decision support to inform natural and cultural resource management across terrestrial, aquatic, coastal and marine ecosystems. The core of an LCC will be a scientific and technical staff with an applied resource management focus. That staff and capacity will be directed by a Steering Committee, consisting of resource management representatives from governmental entities (federal, state, tribal and local) and non-governmental organizations who are prepared to contribute to the joint effort.

Role of the Department of the Interior and its Federal Partners: Interior bureaus will seek to catalyze LCC development by contributing scientific and technical capacities, and inspiring a critical mass of partners to contribute their expertise and capacities and array around shared landscape-scale resource management objectives. Bureaus will support LCCs by providing a structure for integrating natural and cultural resource management and climate impact response, and pooling resources so that

LCCs will have the capability to address issues that extend across the missions of all supporting bureaus and agencies.

The Department's climate change vision and capacities, including LCCs and CSCs, will enable each of DOI's bureaus to work together, and with partners, to implement an integrated Department-wide climate change science, adaptation, and mitigation strategy that supports their individual mission responsibilities. Project-level funding and implementation, and management and regulatory decisions will continue to be the responsibility of each bureau and partner. Entities outside the Department (e.g., States, the U.S. Forest Service; EPA; NOAA) are encouraged to participate in LCCs as conservation partners and as providers of fundamental and applied scientific information and/or financial support. In this way, LCCs will aggregate capacity, creating synergies, and avoiding duplication and competition between organizations.

ADDITIONAL BACKGROUND

Landscape Conservation Cooperatives and Climate Science Centers: Interrelationship and Roles in Climate Change Science and Adaptation. The Department of the Interior considers the Climate Science Centers (CSCs) and Landscape Conservation Cooperatives (LCCs) as cornerstones to an integrated approach to climate change science and adaptation. CSCs and LCCs have distinct science and resource management roles, but also share complementary capacities and capabilities.

LCCs: As explained above, LCCs are management-science partnerships that will inform integrated resource management actions to address climate change and other stressors across landscapes. They link science and conservation delivery. One key function will be to help partners develop spatially-explicit resource management goals and, working with Climate Science Centers, provide scientific decision support, including information needed to identify adaptation strategies for dealing with anticipated climate change impacts. LCC staff will also assist partners in integrating status and trends data with effectiveness monitoring and applying science-based monitoring programs to determine if resource goals are being met, evaluate and adapt management goals and strategies, and work with CSC staff to reduce key uncertainties and improve the next round of forecasts. LCCs will coordinate data identification and synthesis closely with Climate Science Centers, the National Climate Change and Wildlife Science Center, and other scientific organizations. The Department of the Interior has committed to a unified monitoring and data management effort that will promote state of the art data integration procedures to facilitate data sharing.

LCCs will include staff from multiple partners. Core staffing will include an LCC Coordinator and LCC Science Coordinator. Depending on the availability of resources from Climate Science Centers and other organizations, other key LCC capacities may include landscape and population modelers, geographers and GIS specialists, terrestrial and aquatic ecologists, cultural resource specialists, quantitative fish and wildlife biologists, hydrologists, outreach specialists and other technical and decision-support staff to provide the scientific, technical and training capabilities to understand, apply, and adapt models and tools for specific landscapes, resources, and strategies. The USGS has committed to providing co-located scientists to supply some of these capacities and focus on LCC science needs. It is envisioned that core LCC staff will be located at an LCC partner facility, with other staff networked from remote locations.

CSCs: As mentioned above, CSCs will deliver basic climate change impact science to all Landscape Conservation Cooperatives (LCCs) within their respective regions; they will prioritize fundamental science, data and decision-support activities based principally on the needs of the LCCs, including climate change impacts on natural and cultural resources and adaptive management and other decision support tools for managers. They will partner with and help facilitate the coordination of fundamental climate science capabilities and monitoring activities across their regions of responsibility, including federal (e.g., climate science being performed by the USGS, NPS, FWS, BoR, MMS, BLM, BIA, OSM, NOAA, and USDA), university, tribal, state, local government, and NGO partners. CSCs will synthesize, integrate, and communicate existing climate change impact data gathered by the Department and external partners, and identify gaps in this data. CSCs will provide education opportunities for the public and stakeholders about the impacts of climate change, adaptive management strategies, and sustainability and environmental leadership.

Each CSC will employ, or affiliate with, DOI scientists performing fundamental climate change research (e.g., research scientists, climate modelers and field biologists), data managers, and decision support analysts located within the region. These scientists, data managers, and decision support analysts will

have a wide range of expertise in terms of climate change impacts and the adaptive management of DOI resources. They either will be physically located at a CSC or virtually co-located with a CSC. CSCs will also rely upon or collaborate with partnerships with other federal scientists (e.g. NOAA, USDA, and EPA scientists) as well as state, university, NGO and tribal scientists.

Roles and Responsibilities Concept Table. This represents lead roles only, and does not imply exclusive involvement in any given activity. The list is not inclusive of every potential activity at an LCC or CSC.

	LCC Lead	Shared	CSC Lead
Partnerships			
Initiate science partnerships; bringing groups to the table			X
Initiate resource partnerships; bringing groups to the table	X		
Develop resource goals and desired resource outcomes	X		
Help define resource outcomes and endpoints that can be measured and used to refine future efforts		X	
Articulate priority science needs for specific resource goals/outcomes	X		
Support priority science needs		X	
Science Development and Delivery			
Determine specific model outputs and endpoints needed to address the specific science questions and priorities (determine feasibility)		X	
Evaluate whether needed forecast/model/information already exists			X
Work with or develop downscaled climate data and models to generate output variables for specific resource questions			X
Develop ecological and other resource models, linking underlying drivers with factors that can be forecast and modeled			X
Develop new data and tools for forecasting large-scale natural, physical, and ecological conditions under different climate scenarios			X
Provide large-scale information, forecasts, models, and tools to the LCCs			X
Science Application			
Apply down-scaled models and other information to generate spatially-explicit options and adaptation strategies	X		
Assess species and habitat vulnerabilities		X	

Determine where to conduct on-the-ground activities to accomplish specific goals	X		
Monitoring			
Develop science-based monitoring strategies that can link resulting data back to models, for refinement		X	
Help partners design and implement science-based monitoring programs to determine if resource goals are met, and to refine future modeling	X		
Use monitoring results to refine future model and forecasting efforts		X	

Director's Memo to NLC and All Superintendents. National Park Service Role in Implementing DOI Climate Change Response Initiative through Landscape Conservation Cooperatives and Climate Science Centers

United States Department of the Interior

NATIONAL PARK SERVICE
1849 C Street, N.W.
Washington, D.C. 20240

IN REPLY REFER TO

N16 (2306)

MAY 2 6 2011

Memorandum

To: National Leadership Council, All Superintendents

From: Director

Subject: National Park Service Role in Implementing DOI Climate Change Response Initiative through Landscape Conservation Cooperatives and Climate Science Centers

Likely the largest issue to confront modern civilization, climate change is an unprecedented challenge to the management of national parks and other protected areas. The Secretary of the Interior announced a plan for science-management partnerships to facilitate understanding and response to climate change impacts on our land, water, wildlife, and cultural heritage resources. Secretarial Order 3289 (September 14, 2009) establishes a network of Landscape Conservation Cooperatives (LCCs), and Climate Science Centers (CSCs) as described in "Interior's Plan for a Coordinated, Science-Based Response To Climate Change Impacts on Our Land, Water, and Wildlife Resources" (Attachment 1). These partnerships are a new concept for land management and science. This memorandum describes the role that the National Park Service will play in the establishment and evolution of these important partnerships. Additional information regarding the LCC's and the CSCs is available at:
http://www.doi.gov/whatsnew/climate_strategy/index.cfm

Broad Partnerships
Although the LCCs and CSCs originate within the Department of the Interior, both are intended to achieve broader partnerships with other federal departments/agencies and others, including state, local, Tribal, non-governmental organizations, and private landowners who wish to participate. For increased efficiency and synergy in addressing climate change challenges, DOI bureaus and partners will unite expertise, resources, and other capabilities to support the cooperative work of CSCs and LCCs. In accordance with their missions, agency and partner participants in CSCs and LCCs will retain responsibility for regulatory, management, and policy decisions, while working together to respond to climate change across large landscapes.

Landscape Conservation Cooperatives
Envisioned as management-science partnerships to develop alternative climate change response strategies across ecological regions or landscapes, LCCs will facilitate integrated, place-based resource conservation approaches at scales that are relevant to managers. While the organizational structure of LCCs will encompass broad ecoregions, specific activities and products developed through the partnerships will support landscape-level response, such as

adapting to sea level rise in coastal parks, maintaining biodiversity within and across ecosystems, or enhancing connectivity for species migration and range shifts. LCC responsibilities include cultural and natural resources and are not intended to serve the primary mission interests of any particular bureau or agency. Rather, LCCs provide a structure to address management issues and climate impacts that affect a diversity of stakeholders across a broad array of ecosystems and resource types. LCCs will function to facilitate development of multi-jurisdictional resource conservation goals, identify data and research needs, and coordinate closely with climate service providers and scientific organizations.

Climate Science Centers

To support the science-management partnerships working in the LCCs, scientists of the CSCs will deliver basic climate change science relevant to their respective regions, including physical and biological research, ecological forecasting, and multi-scale modeling. The CSCs will provide fundamental science, data and decision-support activities based principally on the needs of the LCCs, including climate change impacts on natural and cultural resources and adaptive management and other decision support tools for managers. Examples may include downscaled climate models, projections for priority ecosystems, habitats, or cultural or traditional heritage resources, or other specific applications needed by the LCC partners.

NPS FY2010 Activities in LCCs and CSCs

In FY2010, the NPS will establish new Landscape Adaptation Coordinator positions in the Great Northern, North Atlantic, South Atlantic, and Pacific Islands LCCs. These positions will be located at or near existing NPS organizational networks (e.g., Inventory and Monitoring networks, Cooperative Ecosystems Studies Units, and Research Learning Centers) to leverage current capabilities for promoting adaptation response strategies. Additionally, the NPS will place two scientists in the CSCs – one each in Alaska and the Pacific Northwest. Over time, the NPS and other LCC partners may provide additional core staffing to support work of the LCCs.

The NPS is committed to help shape, support and implement the vision for the LCCs and CSCs as described by Secretary Salazar. The organizational structure, governance and function of the LCCs and CSCs will continue to evolve over the coming year, and within these, the NPS will work with our partners to develop comprehensive, integrated strategies that protect resources in a way we could not do by working alone. We will support and participate with the LCCs and CSCs to develop scientific products for managers, including evaluation and application of vulnerability and risk assessment methodologies, scenario development, decision support tools and adaptation planning. From these partnerships we will derive knowledge and cooperative landscape approaches to integrate into local planning at the park unit level, and information to share with park visitors and the public as we work to educate the public and protect parks into the future.

Attachment 1. Interior's Plan for a Coordinated, Science-Based Response to Climate Change Impacts on Our Land, Water, and Wildlife Resources

Inventory & Monitoring Program FY 2010 Guidance for Climate Change Activities, November 18, 2009 Latest Developments

I&M Program's Role in FY 2010 Climate Change Activities
November 18, 2009 Latest Developments

There continues to be a flurry of activity related to addressing climate change impacts. DOI Secretary Salazar has identified Climate Change Response and Youth as two major priority areas, and there have been numerous meetings among DOI and bureau leaders and budget staff trying to develop the vision and work out some of the details about how the DOI bureaus will work together to meet the significant challenges ahead.

The NPS received $10 Million in FY 2010 for the Climate Change Response Program. The details of how these funds will be allocated are still being worked out (e.g., the National Leadership Council is meeting this week, and climate change is the major topic), but the funds will be available for park competitive projects through the SCC; funding of 5 CESU and other positions in regions; funding for vulnerability assessments and scenario planning; adaptation coordination with the DOI Landscape Conservation Cooperatives (LCCs) that are being set up; development of a template for park cc adaptation plans; SCA or other interns; details and permanent positions at the national level; and funding to build upon existing monitoring and to strengthen interagency monitoring coordination.

The US Fish and Wildlife Service is getting a large funding increase to build an I&M Program for the National Wildlife Refuge System, and to address climate change issues through eight interagency LCCs that they are funding this year. We have had a series of meetings with FWS leaders, and our I&M Program will be working very closely with the FWS on inventories, monitoring, and possibly teaming up with us on the IRMA data system development. The FWS has decided to base their new national I&M program staff in Fort Collins, possibly on the third floor of our building, so that we can work together. They've provided a lot of information on their climate change website: http://www.fws.gov/home/climatechange/

Meanwhile, the USGS is receiving a lot of new money and is figuring out how to coordinate with NPS, FWS, BLM, and other agencies and States inside and external to DOI, but they are still in the process of hiring key staff to lead the efforts. Our needs for climate model downscaling, vulnerability assessments, scenario planning, data synthesis and modeling, climate change monitoring, and other needs overlap considerably with the needs of other agencies and States, so everyone is trying to figure out how to coordinate all of this across agency and funding boundaries, and waiting to see how the Regional CC Response Centers and LCCs develop.

The latest vision of the LCCs (Landscape Conservation Cooperative) is that they are interagency science and technical support teams that "provide scientific and technical support for landscape-scale conservation in an adaptive management framework, by supporting scientific assessment, conservation design, prioritizing and coordinating research, and designing inventory and monitoring programs." Basically, they are a lot like our I&M Networks: a group of scientists, data managers, GIS specialists, various "ologists" working together to produce reports, GIS products, models, and expertise to inform land management and planning. This year, the FWS plans to fund and hire a bunch of people for the following 8 LCCs:

- Arctic Plains and Mountains (Alaska)
- Pacific Islands (Hawaii and the western Pacific)
- California
- Great Northern
- Plains and Prairie Potholes
- Southern Great Plains
- North Atlantic
- South Atlantic

A map showing the proposed LCC areas for the lower 48, and the convex hulls for our I&M networks that are associated with six of these LCCs, is available at (128 kb .pdf file):
http://www1.nrintra.nps.gov/im/docs/DOI-Framework_NetworkHulls_CONUS_20091117.pdf

As part of the NPS Climate Change Response Program, we will be providing monitoring funding this year to six groups of parks that fall within four "high vulnerability to climate change effects" thematic areas, for the purpose of enhancing and building on the existing monitoring being done by the I&M networks. The six groups of parks are:

- High Latitude parks in Alaska
- Pacific Island parks (enable the PACN to contribute to the Pacific Island LCC)
- High-elevation parks in the ROMN, GRYN, and UCBN networks
- Atlantic Coastal parks in the NETN, NCBN, and NCRN networks (contribute to the North Atlantic LCC, but emphasis on coastal and marine parks)
- Atlantic Coastal parks in the SECN (contribute to the South Atlantic LCC, with emphasis on the coastal and marine parks and interagency collaboration)
- Southwest Desert parks in the SODN, CHDN, and MOJN networks (the NPS will take the lead initially on the Desert LCC since the FWS is not funding the Desert LCC this year).

Each of these six groups of parks this year will hold meetings and conference calls and work with partners to develop a work plan describing how the monitoring funding in FY 2011 and beyond will be used to enhance the existing monitoring. The description of what the networks involved in these "thematic areas" need to do was described in the September 15 update:
http://www1.nrintra.nps.gov/im/docs/CC_Monitoring_Update_15-Sep-2009.pdf

As explained in the September 15 update, our long-term strategy (it may take us multiple years, as it did with the 32 networks) is to provide additional funding for climate change monitoring for all parks with significant natural resources. However, we will start with the subset of parks that fall into one of the groups listed above. Multiple I&M networks will be involved in each of the high-vulnerability "thematic areas", and not all parks in a particular network will be included.

A major role of the I&M Program and the 32 I&M networks is to "put science into the hands of managers and planners". Most of the vital signs being monitored by the I&M networks are relevant to tracking and responding to rapid climate change. The data sets that we have already compiled and organized, as well as inventory data and the landscape-scale datasets generated by the NPScape Project, will make an important contribution to the LCCs and the DOI's efforts to respond to climate change impacts. By continuing to do what we are already doing, all 32 I&M networks and the national program staff will be contributing to the climate change response. Much of the NPS capacity for science, data analysis, and modeling currently resides within the I&M Program.

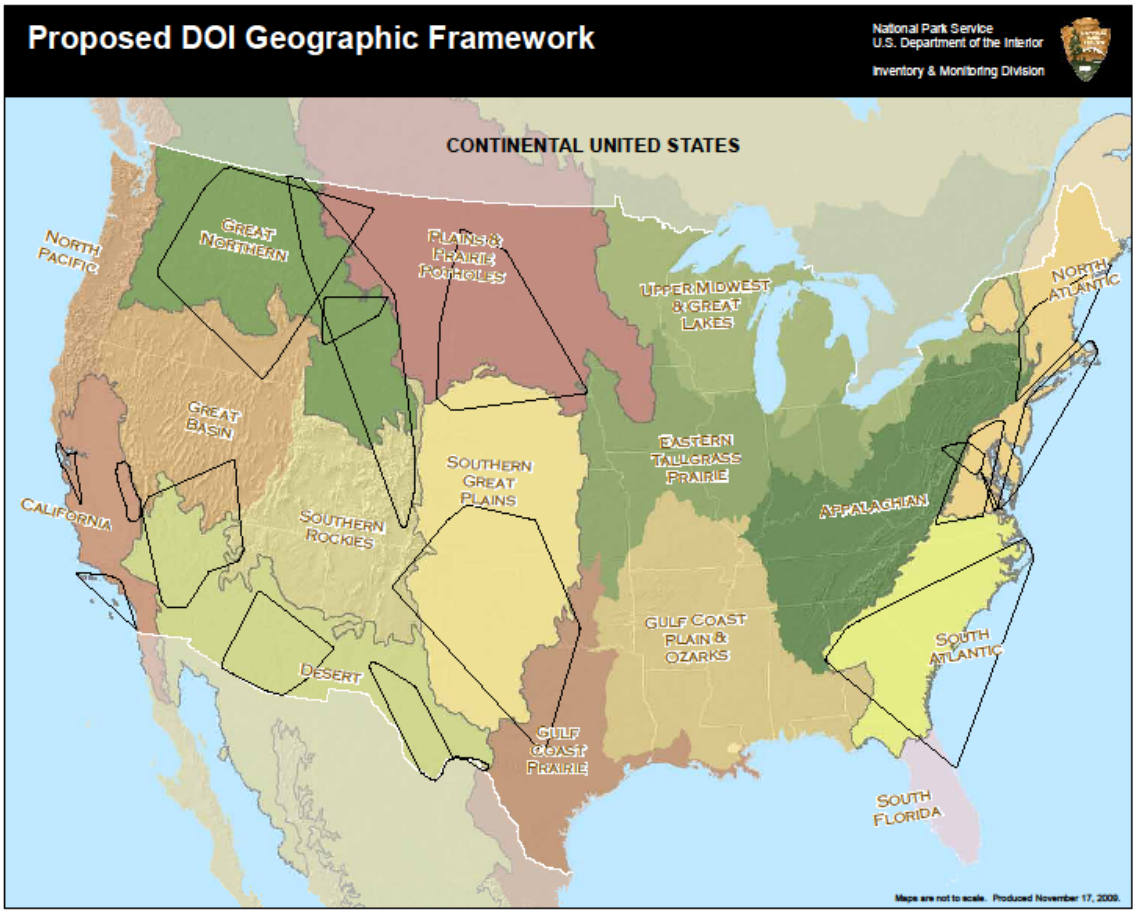
Several other Noteworthy Items:

- We're still on track to deliver the datasets and documents generated by the NPScape Project to all 32 networks by Christmas, as described in the Sept. 15 update. Peter Budde is the project lead.
- Associated with a DOI Youth initiative, we have requested 160 technicians (approximately 5 for each of the 32 networks). These might be SCA interns or 6-month seasonals or something else; we don't have any details, but there's actually a chance that this could happen in FY 2011 or 12.
- Gary Machlis, the new Science Advisor to the Director, is beginning to develop a major Science initiative for the NPS for the FY 2012 budget. This would be a major budget initiative, on par or larger than the Natural Resource Challenge, that he will develop by May 2010 to get it into the

FY 2012 budget request. The I&M Program and the Climate Change Response Program will be major factors in whatever is developed.

- We are doing the contracting paperwork to hold an I&M Program meeting during one of the four weeks in March 2010. We have identified five cities, and we have to go through the competitive contracting process before we know which week and where the meeting will be. Lisa Garrett is leading the organizing committee, and they are using the results of the survey that we sent out, asking people what their priorities are, as the basis for organizing the meeting. We're expecting somewhere around 300 people to attend. There is a lot of interest from the FWS and USGS and other agencies to attend.
- We are contributing to a research solicitation that would involve NASA, FWS, NPS, USGS, and possibly the National Science Foundation to develop forecasting tools to project the impact of a changing climate on populations, species, and ecosystems. The research proposals would need to include NPS scientists or data managers from I&M or other programs.

Proposed DOI Geographic Framework for Landscape Conservation Cooperatives and I&M Networks Funded to Conduct climate change Monitoring



Inventory & Monitoring Program's Role in FY 2010 Change Activities, September 15, 2009 Latest Developments

I&M Program's Role in FY 2010 Climate Change Activities
September 15, 2009 Latest Developments

Background Information:

There is a flurry of activity right now related to addressing climate change impacts. The Dept. of Interior has identified the response to rapid climate change as a top priority, and the DOI and Congressional committees are greatly emphasizing the need to closely coordinate the response across agencies within and external to the DOI. Secretary Salazar has issued a Secretarial Order (http://www.doi.gov/climatechange/SecOrder3289.pdf), announcing among other things eight Regional Climate Change Response Centers and a series of Landscape Conservation Cooperatives (LCCs). There is a lot of uncertainty in how the NPS and other agencies will coordinate all of this, but this update will present some highlights based on what we know.

The FY 2010 NPS budget may provide $8 Million (House version) or $10 Million (Senate version) or none of the above for a NPS Climate Change Response Program. Funding may be available in FY 2010 for park competitive projects through the SCC; funding of 5 CESU and other positions in regions; funding for vulnerability assessments and scenario planning; bioregional adaptation coordination; development of a template for park cc adaptation plans; SCA or other interns; details and permanent positions at the national level; and funding to build upon existing monitoring and to strengthen interagency monitoring coordination.

All of this needs to be coordinated within the NPS and with other agencies, and much of it is still fuzzy as we wait for decisions on budgets, a new NPS Director, and further "guidance from above". The US Fish and Wildlife Service is getting a large funding increase to build an I&M Program and to address climate change, and they will be hiring a lot of new people. We have had a series of meetings with FWS leaders, and they are interested in working closely with us on inventories, monitoring, and possibly teaming up with us on the IRMA data system development. The FWS may possibly rent space in our building in Fort Collins so that we can co-locate our national I&M staff. Meanwhile, the USGS is receiving a lot of new money and is figuring out how to coordinate with NPS, FWS, BLM, and other agencies and States inside and external to DOI. Our needs for climate model downscaling, vulnerability assessments, scenario planning, data synthesis and modeling, climate change monitoring, and other needs overlap considerably with the needs of other agencies and States, so everyone is trying to figure out how to coordinate all of this across agency and funding boundaries, and waiting to see how the Regional CC Response Centers develop.

The LCCs (Landscape Conservation Cooperative) are seen as conservation-science "joint venture" partnerships between the FWS, NPS, USGS, and other federal agencies, states, tribes, NGOs, universities, and other entities. They provide science support to managers and partnerships responsible for developing and implementing conservation strategies at landscape scales, with an emphasis on biological planning and conservation design; and the acquisition of biological and spatial data, research and related activities. The FWS and USGS worked together on a "National Geographical Framework" to divide North America into 22 geographic areas as the basis for locating interagency LCCs and other science and management activities. See: http://nrpcsharepoint/climatechange/Science/Climate%20Domains%20and%20Regional%20Boundaries/FWS_National_Geographic_Framework_081709.pdf. The LCCs in Hawaii and the Northern Rockies seem to be the furthest along in getting organized. A map of our I&M networks within this "National Geographical Framework" for the continental U.S. is available:

http://nrpcsharepoint/climatechange/Science/Climate%20Domains%20and%20Regional%20Boundaries/Networks_FWS_CONUS_150dpi.pdf.

The term "climate change adaptation" that you're hearing a lot about includes most of what the NPS does as part of managing parks "unimpaired for future generations". The catch-phrase is "Conserving and restoring natural landscapes is good for global health". The following are examples of CC adaptation measures:

- Preserving ecosystem services (e.g., clean and abundant water supply, clean air, pollination, critical nutrient cycling, cultural heritage, recreational services);
- Preserving biodiversity (including genetic diversity) so that species can adapt to climate change;
- Reducing other environmental stressors that interact with global warming (e.g., invasive species, habitat destruction, disease, over-fishing, pollution);
- Providing science-based information to educators, visitors, partners, and the general public.

Climate Change Monitoring and the Role of the I&M Networks:

All 32 I&M Networks, plus the national office staff, will be actively involved in FY 2010 to assist parks and the NPS with planning, decision-making, and science communication efforts related to rapid climate change.

All 32 I&M networks and staff from the national office will provide data and expertise for various landscape-level modeling efforts, interagency workshops, vulnerability assessments, scenario planning, etc. Much of the NPS capacity for science, data analysis, and modeling currently resides within the I&M Program.

All 32 networks are already collecting and organizing cc-relevant data. The inventory data sets will be an important contribution to the DOI response to addressing climate change. Our soils and vegetation inventory data and maps are the most accurate in the nation for calculating current and potential carbon storage. The GIS products, species lists and other biodiversity data, water quality and National Hydrography Datasets (NHD), air quality data, and especially the weather and climate data we have collected and organized, will be important data sources.

Most of the vital signs being monitored by the I&M networks are relevant to tracking and responding to rapid climate change. However, when priorities were established and vital signs were selected based on management and ecological significance and other considerations such as interagency opportunities for leveraging and cost-sharing, we did not know as much about likely climate change impacts, and many of the interagency opportunities that now exist did not exist at the time that the monitoring design was finalized. We need to dust off and revisit the conceptual models and the list of high-priority vital signs that were and were not selected with our new "climate change knowledge" and climate change emphasis to see what we need to add, change, or supplement.

Funding will be provided this year to selected networks to build upon the existing monitoring by (a) adding additional vital signs, or (b) increasing sample sizes or frequency of sampling, or (c) modifying protocols to better coordinate with monitoring by other agencies, or (d) increasing our capacity to contribute to climate change response through data synthesis, modeling, and science communication efforts. Examples of previously identified, high-priority indicators that may be added or monitored more frequently or intensively are: Glacial Features and Processes (net mass balance, permafrost extent, snow water chemistry); Groundwater Dynamics (depth to

groundwater); Landscape Dynamics (shoreline change, erosion, fire and fuel dynamics); Phenology (time of first flowering, length of growing season); high elevation sites using the interagency GLORIA protocols; and vulnerable species (pika, amphibians, certain bird species). For an update on I&M phenological monitoring activities and the USA-NPN, see http://science.nature.nps.gov/im/monitor/docs/NPN-NPS_info_opportunities_Sept_09.pdf.

In his testimony to Congress, Jon Jarvis stated that "national park units can serve as the proverbial canary in the coal mine, a place where we can monitor and document ecosystem change without many of the stressors that are found on other public lands."

Data discovery and data sharing among agencies and partners for planning and modeling is the key to the significant interagency response needed to address climate change impacts, and the NPS is currently the leader within the DOI on this. The data already collected and organized by the 32 networks, plus the data developed and compiled and processed by the national I&M office for NPScape and other projects, plus the data and information that will be available through the IRMA project and http://nrinfo portal this year, will be a major contribution to the vulnerability assessments, scenario planning, and various modeling efforts to be done this year by the NPS and other agencies.

We are accelerating the development of the IRMA (Integrated Resource Management Applications) system to improve our ability to share, translate, and apply climate change research, monitoring, and modeling results within the NPS and with other agencies and organizations. By spring 2010, the Identity Management and role-based security system will be in place for our NRInfo data and information portal, which will allow us to integrate and share data with other agencies and the scientific community while protecting sensitive data. We have already built and demonstrated data-exchange modules that allow us to share data between the NPS and the U.S. Fish and Wildlife Service (ECOS database) and U.S. Dept. Agriculture (USDA Plants database).

By Christmas 2009, the NPScape project will deliver to more than 270 parks a series of DVDs that contain a large number of digital data sets, landcover and other remotely-sensed data, maps, charts, graphs, and tables at multiple scales that will be an important data source used in adaption planning and various modeling efforts (see attached list of "Data Sets that we have available"and http://nrpcsharepoint/im/landscape/Data%20mgmt/NPScape_Data_Access.pdf

The NPScape project has begun packaging data sets, maps, and analyzed data for the Northern Rocky Mountains and Hawaii interagency Landscape Conservation Cooperative (LCC) efforts. Packaging and delivery of data for other LCCs along the Atlantic Coast, Alaska, and Desert Southwest parks will be next in line. These data, including land cover data, land conservation status, roads, housing density, etc. will be used by NPS and other agencies for modeling and conservation and adaptation planning activities this year. We planned ahead and are way ahead of the game on this.

We have met with the USFWS and USGS and are exploring opportunities for working closely together on the development of data systems using service-oriented architecture and building upon the services and other building blocks that we've developed.

The I&M Program has established two new positions to help us coordinate climate-change related monitoring within the NPS and with other agencies.

Dr. Shawn Carter is the new NPS Climate Change Monitoring Coordinator based in Washington DC. Shawn will serve as the immediate point of contact to USFWS, USGS, NOAA, NASA, BLM, and other bureaus for ongoing NPS climate monitoring and for data/information exchange activities and partnership development. He also serves as the Washington Office liaison for the I&M Program to coordinate with other directorates and divisions, and is responsible for establishing and maintaining interagency monitoring collaborations, responding to immediate information requests by senior NPS and department officials, and coordinating NPS inventory and monitoring within the overall DOI Climate Change program.

Dr. John Gross is the new I&M Climate Change Ecologist, and will focus on park- and network-based climate- and management-related monitoring, data synthesis, and modeling among the 32 NPS I&M networks and other natural resource disciplines (e.g., air, water, oceans, and biology). John is a member of the Climate Change Response Program Steering Committee (CCRP) and is Chair of the CCRP Science Working Group. John will coordinate and lead projects to synthesize, translate, and disseminate monitoring and other data to NPS managers and stakeholders; share NPS data and expertise with others; support and participate in adaptation and scenario planning workshops; and develop guidance and standards for NPS climate monitoring and information products.

We will be hiring a new GS-12 ecologist in Fort Collins to backfill John's previous position. The new ecologist will become the point person on NPScape (currently being led by Peter Budde) and will be involved in data synthesis and modeling work plus lots of other duties.

In FY 2010, I&M staff from the national office and selected I&M networks, along with staff from other NRPC divisions and other agencies and universities, will build upon existing monitoring by the NPS and others in parks that fall into four high-vulnerability categories: high elevation, high latitude, coastal/marine, and arid lands. The long-term strategy is to provide funding to all parks that are likely to have significant climate-related impacts, but the initial priority and focus will be given to these four vulnerability "thematic areas", and to "fully fund groups of parks as we go" as was done with the funding strategy for the 32 I&M networks.

Here's what we've told Congress and DOI to justify the funding increases: "Initial priority for building upon existing monitoring and strengthening interagency monitoring coordination would be given to the 184 parks that fall into one of the four categories of high-vulnerability to climate change effects: high elevation, high latitude, coastal/marine, or arid lands. Initial focus will be on parks in the Alaska region (all parks, including Denali, Glacier Bay, and Gates of the Arctic); Northern Rockies (including Rocky Mountain NP, Glacier NP, and Yellowstone NP); Atlantic coastal and barrier island parks from mid-Florida to Massachusetts (21 parks, including Assateague NS, Cape Cod NS, and Cape Hatteras NS); Desert Southwest (23 Sonoran, Mojave, and Chihuahuan Desert parks including Joshua Tree NP, Saguaro NP, and Big Bend NP); and the Pacific Islands (11 parks, including Hawaii Volcanoes NP, Haleakala NP, and Koloko-Honokohau NHP)."

Each of these "thematic areas" will receive some start-up funding in FY 2010 to get organized, hold workshops, organize and synthesize data, evaluate monitoring done by other agencies and partnership opportunities, etc., that will lead to the development of a work plan for how the additional "permanent" funding will be allocated over the long-term to build upon existing monitoring done by the I&M networks, parks, or other agencies.

The long-term strategy (it may take us multiple years, as it did with the 32 networks) is to provide additional funding for climate change monitoring for all parks with significant natural resources. However, we need to start with a subset of parks that fall into one or more of the four high-vulnerability categories. Multiple I&M networks will be involved in each of these four "thematic areas", and not all parks in a particular network will be included. Park and network managers and scientists from "highly vulnerable" parks not included in the list above will be invited to the initial scoping meetings and should determine their highest priorities and partnership opportunities, even though it may take several years to get additional funding to actually implement the additional monitoring in their parks.

Before September 30, 2010, staff from multiple I&M networks working within each thematic area above will need to develop a detailed work plan that will describe how the target funding level of $400,000 per year will be allocated to get the greatest benefit from the increased funding. It is expected that the allocation and use of the funds in FY 2010 as people are getting organized and the work plan is being developed, will be different from the allocation and use of the funds as described in the work plan. For example, funds in FY 2010 might be used to bring someone in on a detail or through a university agreement; travel and other costs associated with workshops; contracts or agreements for analysis and synthesis of existing data, or for protocol modification; or a short-term interagency agreement. The work plan that is developed during the first year will explain in detail how the additional funding will be used long-term to build upon existing monitoring by us and others, and it might include expenses for personnel (e.g., seasonals, technicians, SCA interns, or university agreements), long-term interagency agreements, equipment, or data analysis and reporting support. The work plan will determine how the additional funding will be allocated in FY 2011 and beyond.

This exercise will make everyone realize that we need to work at an interagency, landscape scale and have much better coordination across agencies. The climate change crisis is pushing agencies to work together in ways that we've never been able to make happen before. "A crisis is a terrible thing to waste".

Example of the vision for how we will prioritize and build upon NPS and interagency monitoring for parks within each of these "high vulnerability" thematic areas, using the group of parks along the Atlantic coast as an example (Note: Alaska has already had some interagency meetings and is further ahead, and their approach will probably be different):

In early 2010, an interagency workshop will be held that includes park managers, scientists, planners, and subject-matter experts from the NPS as well as other federal agencies, states, and universities.

The focus is building upon/augmenting existing monitoring, but in the process there will be a lot of learning by managers and scientists, and a lot of interagency coordination and person-to-person interagency interaction and partnership building.

Potential invitees would include Charley Roman, Cliff McCreedy, Rebecca Beavers, Jeff Cross; superintendents and resource chiefs from Atlantic coastal parks; regional scientists and planners from NER, NCR, SER; scientists and data managers from the I&M networks that have parks along the Atlantic coast; managers from FWS refuges; scientists and key people from EPA, NOAA, USGS, FWS, and States that we could partner with. Dr. Joe DeVivo has volunteered to start organizing the first workshop. A lot of work needs to be done prior to the interagency workshop to organize and summarize existing information and various options to be evaluated,

so some of the first-year funding might be used to bring someone in on a detail or through a university agreement or contract or some other means of backfilling a position.

Step 1: What are the key questions that our managers are asking and what are their key data needs for addressing the predicted impacts of climate change (sea level rise, changes in precipitation and temperature, vegetation changes, etc.)? Think about our "canary in the coal mine" role, and the need to communicate our results to park visitors and the public, "for it is the broader public that will decide the fate of the resources". Is there something that we should be monitoring or analyzing and reporting on relative to climate change effects on park natural resources, that would be particularly informative to our key audiences and/or the general public?

Step 2: What data are we already collecting, or some other agency is collecting, that will address these data needs and questions?

Step 3: Based on the difference between Steps 2 and 1, what are the gaps? What can we do in a consistent way across agencies to fill the most critical gaps? Are there some interagency monitoring efforts, such as the National Phenology Network or monitoring done by NOAA or the EPA, that we should contribute to?

Step 4: After combining Steps 1, 2, 3, and assuming a target $$ amount of $400,000 per year (for years 2 through "forever", once we receive full funding for each group) to build upon the existing monitoring that is being done by us and others, where do we get the biggest bang for the buck? Do we need to adjust any of our monitoring protocols or locations to better connect to what other agencies are doing and to be more strategic in an interagency way? Do we need to add certain vital signs, or increase the sample size (e.g., may need more SET sediment elevation tables to monitor sedimentation rates and salt marsh dynamics), or do certain monitoring more often (e.g., every year instead of every 5 years).

Before the end of FY 2010, the group would develop a detailed work plan that would describe how the funding would be allocated. Steve Fancy would organize a peer review panel that would evaluate the work plan to ensure that the proposed work meets minimum I&M Program standards for protocols, data management, and routine analysis and reporting of data. The approved work plan would then be used to determine how to allocate funding in future years among I&M networks or to interagency partnerships.

Subsequent work would include vulnerability analyses and scenario planning for specific parks, and the development of adaptation plans for specific parks based on all of these preliminary efforts.

Data Sets that we have available:

Land Cover
Enhanced NLCD 1992
NLCD 1992
NLCD 2001
NLCD Change Product
NLCD Impervious Surface
NLCD Tree Canopy
Historic Natural Fire Regime
LandFire - all products
Land cover diversity (Simpson's)
NatureServe Ecological Systems
GAP/ReGAP
Land cover characteristics
Forest fragmentation
Morphological pattern metrics
Forest cover types
Converted and natural landcover

Landform
DEM - 10, 30, and 120 meter
Slope and aspect
Depth to bedrock
Sand, silt, clay fractions
Crop capability
Geology

Climate
Precipitation
Temperature (min/max, variability)
Growing season days
NDVI
Sea surface temperature

Transportation
Roads (Multiple data sources)
Railroads (U.S. and Canada)
National Waterways

Population
Nightime lights (1992/93, 2000)
Populated places
U.S. cities
U.S. urban areas
1990, 2000 Census, block group
Population projections by county
SEDAC census grids
Housing density (1940-2040)
Inventoried roadless area
Agriculture census by county
Water use by county
Conservation risk index
Wildland Urban Interface

Boundaries
Omernick Ecoregions (and CEC)
Bailey Ecoregions
Physiographic Provinces
UNEP Large Marine Ecosystems
States
Counties
NPS Units (with various buffers)
NPS Vital Sign Networks
Protected Areas Boundaries
Federal Lands
National Wilderness Preservation System
Continental Divide
NCDC Climate Divisions
NEON Domains

Hydrology
Hydrologic Units (4, 6, 8, 12-digit)
NHD (med and high resolution)
Impoundments
Aquifers
Ground water climate response network
Sea ice (North America)

Office of Inventory, Monitoring, and Evaluation
Natural Resource Program Center

Appendix E. Conceptual Ecosystem Models

Page

Conceptual Model 2

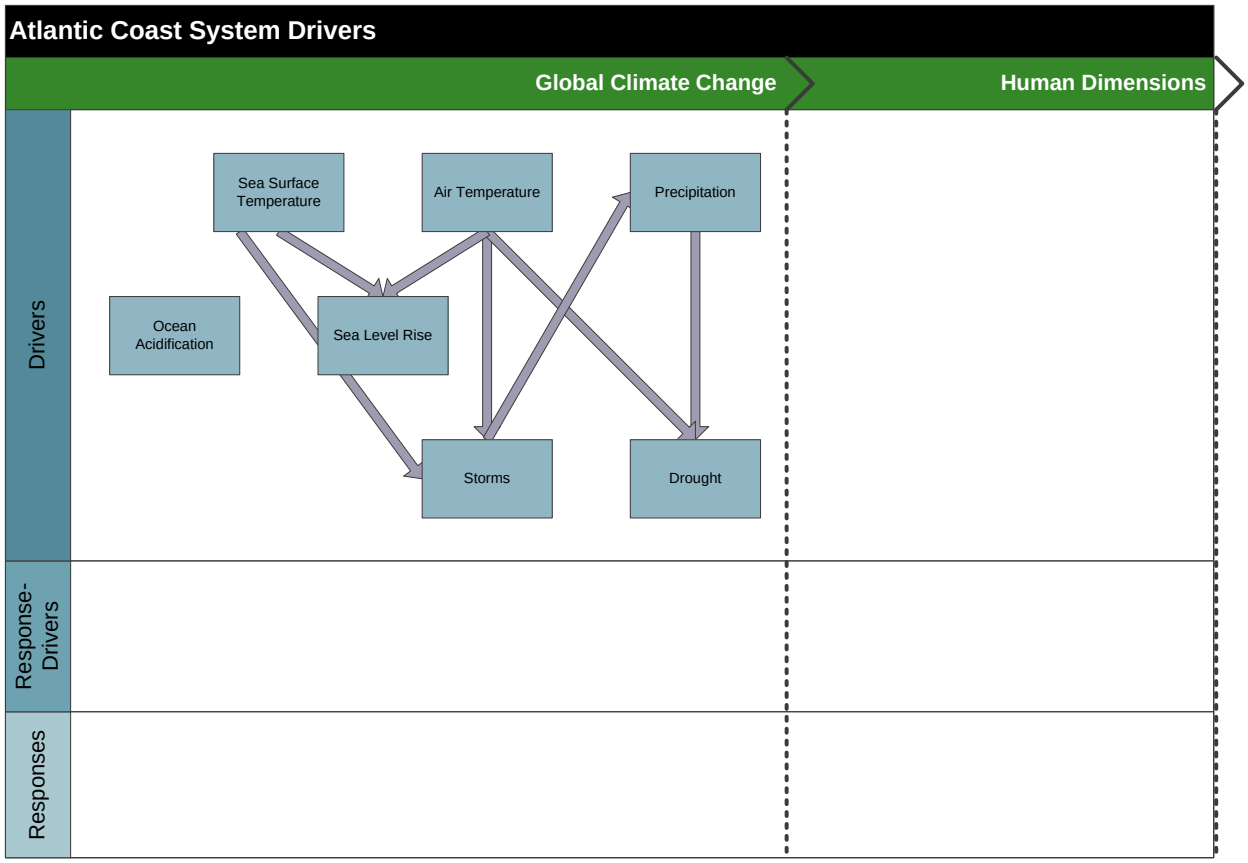
Drivers 9

National Park Service

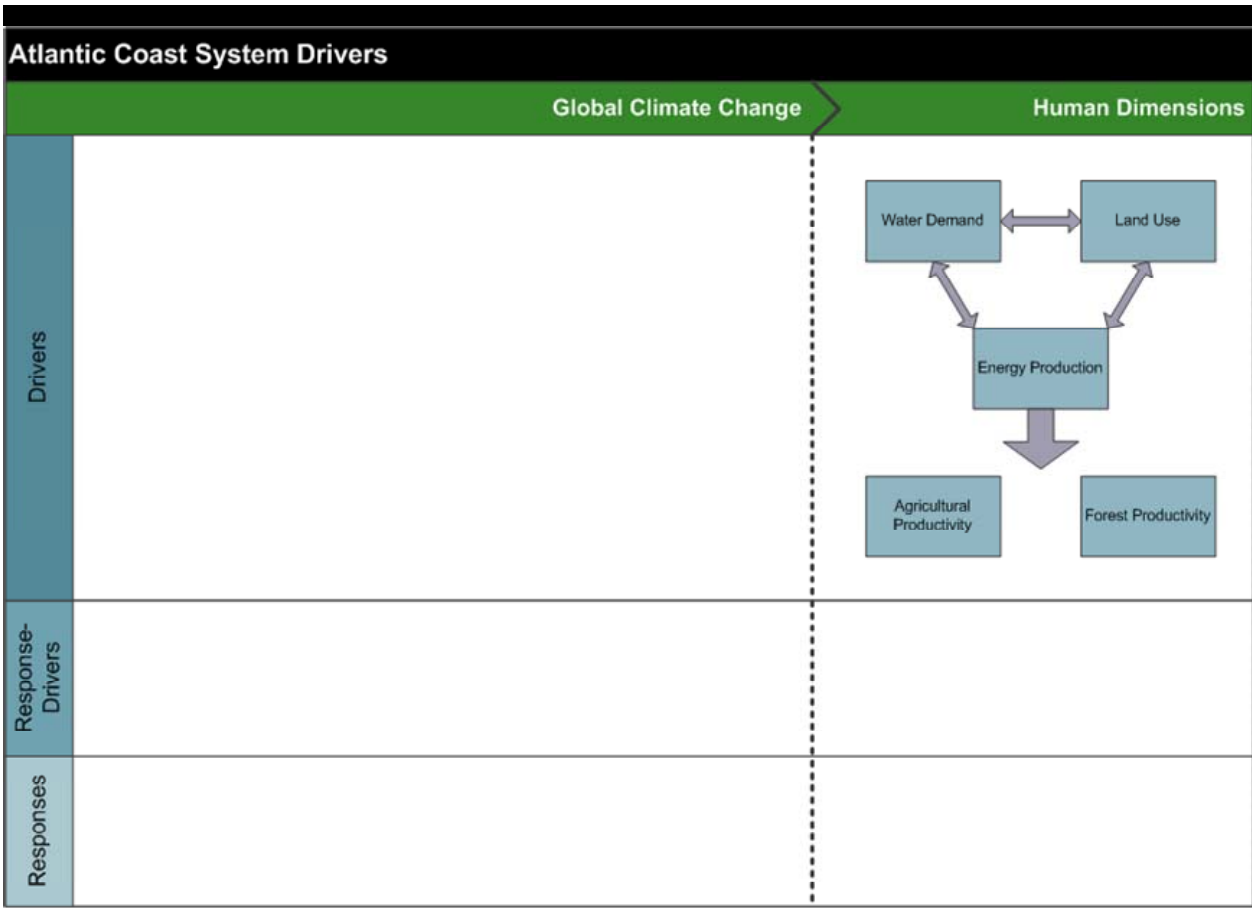
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Conceptual Model

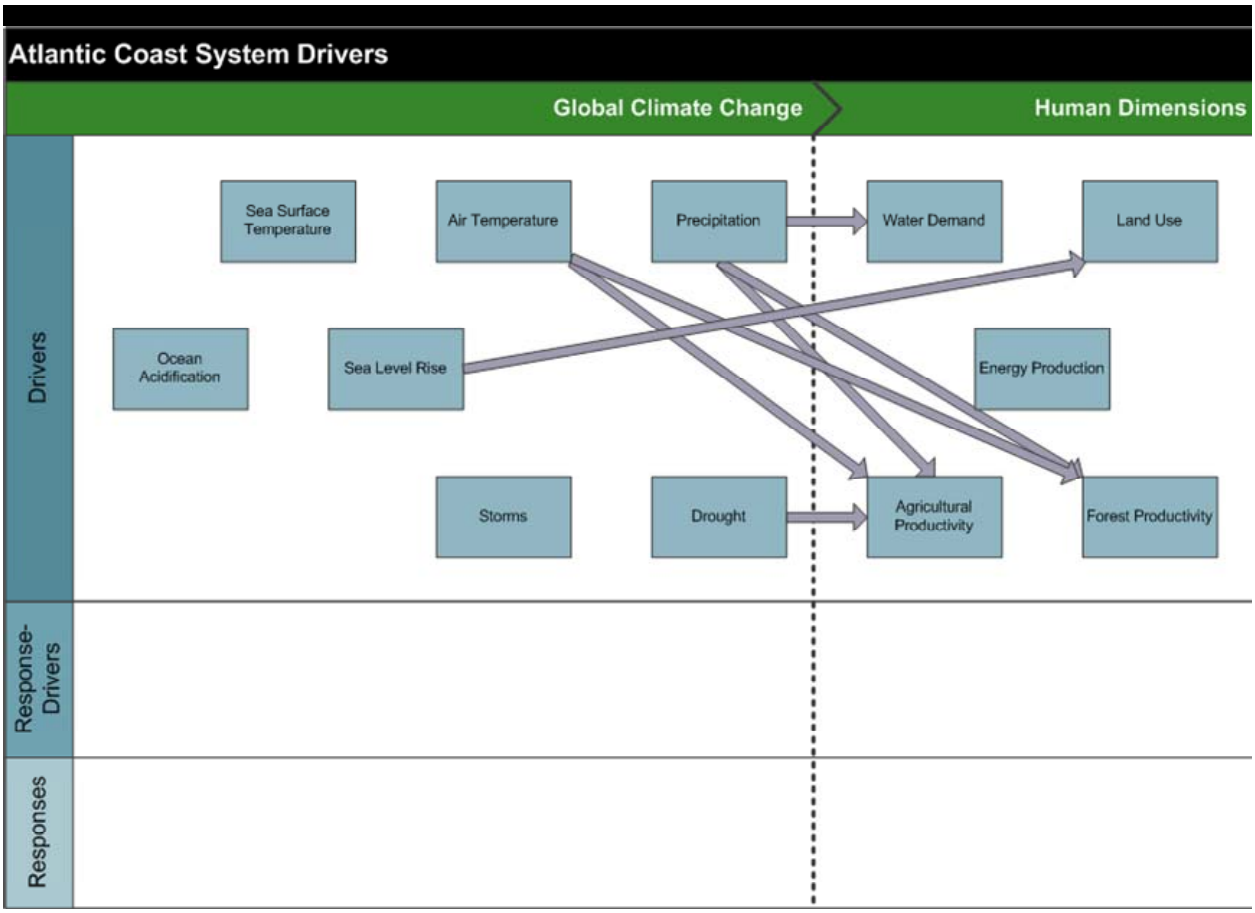
- Systems will be driven by both climate change and human-driven factors
- Relative impact of either is location-dependent
- Need to consider both for scenario planning



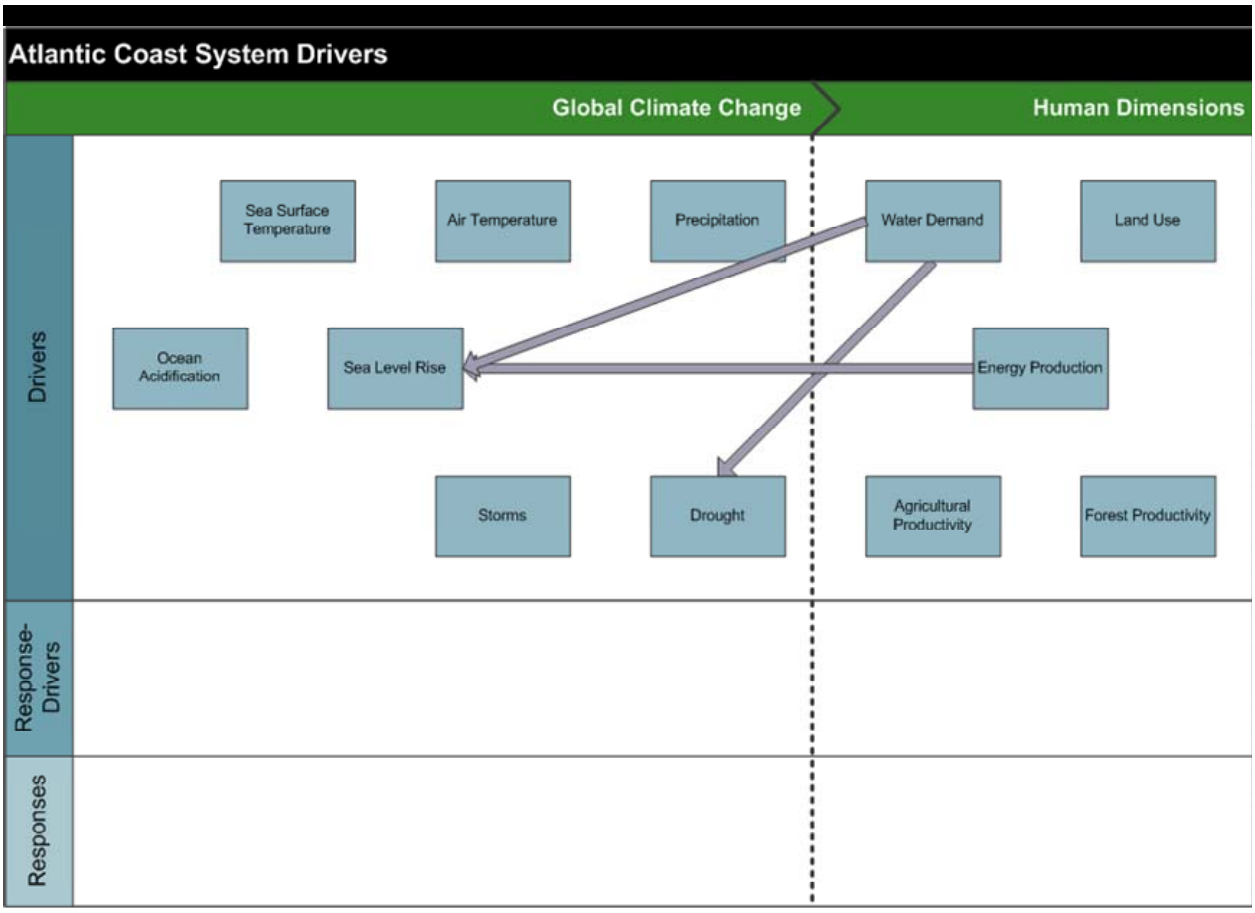
If you just look at climate change, there are seven key drivers that will shape ecosystem response. Important to realize that these are in fact causally linked.



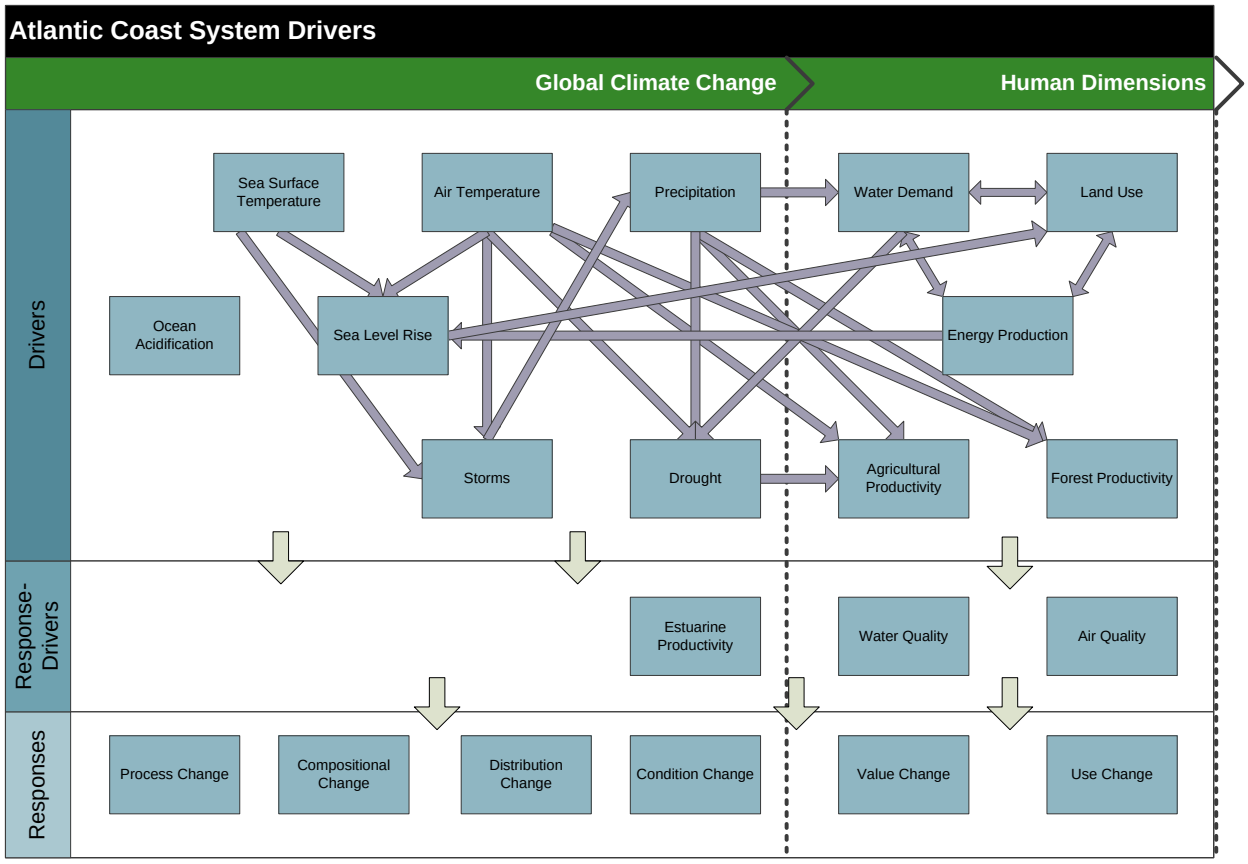
The Atlantic Coast landscape is already being shaped (and is projected to continue to be shaped) by other significant system drivers related to the distribution, intensity, and types of human uses. During the next century we expect to see significant changes in urbanization (increases), energy production (increase in amount and types), and water demand, with these three drivers being very tightly linked. Changes in land use and water availability will also likely affect forest/crop productivity within the coastal zone and watersheds upstream.



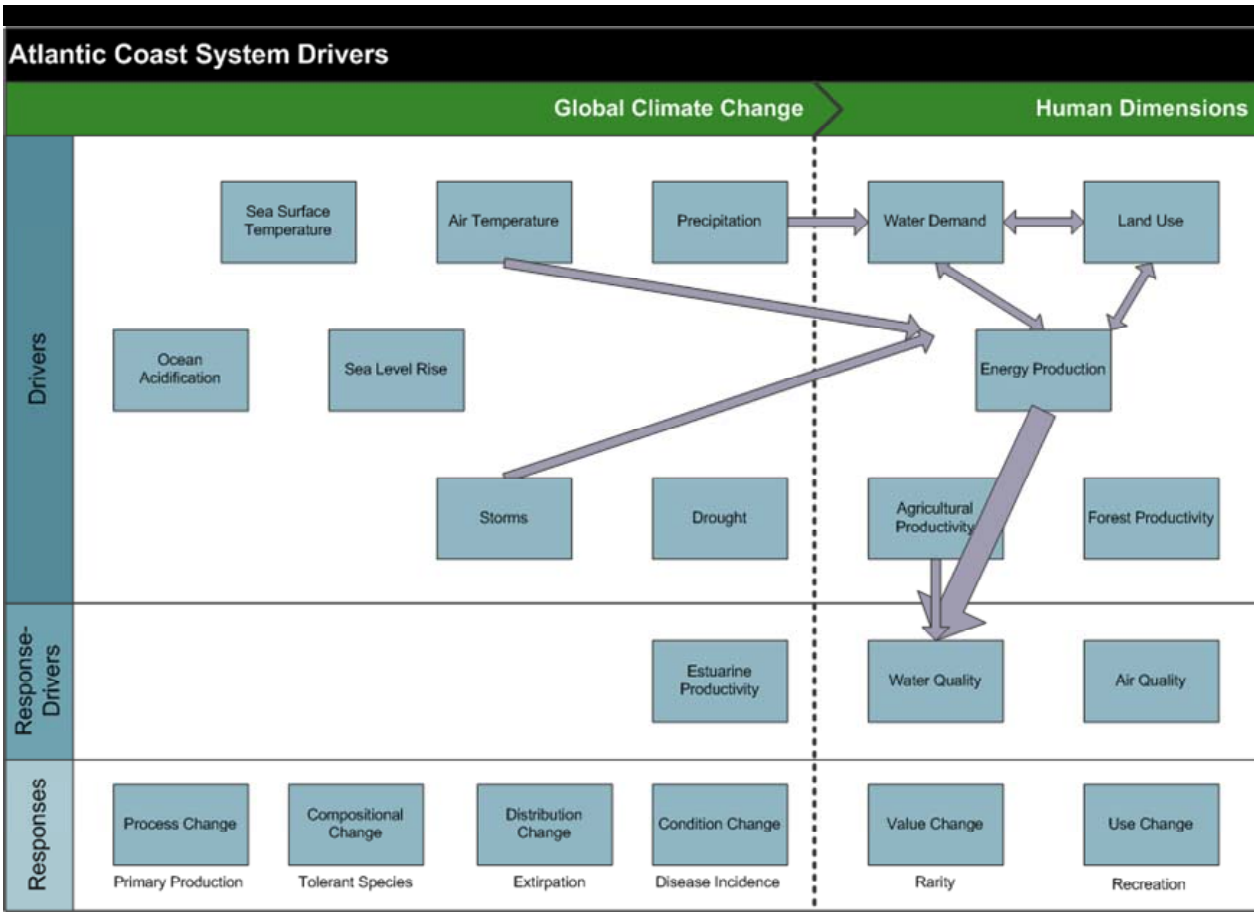
Climate change and human dimensions drivers are linked. GCC drivers can have direct and indirect effects



Linkages go both ways; with notable examples regionally of water and energy sectors affecting relative sea level rise as well as (potentially) exacerbating drought effects.



It's a mess! But we have to consider GCC within the context of the human landscape because they are tightly linked.



Linkage of drivers implies that impacts are also linked. For example, thermal pollution of rivers is driven both by climate change (temperature and amount of water entering the system) and human dimensions through use (water extraction and return) as well as changes to flow (percolation vs. overland flow across impervious surface). The relative importance drivers and responses will largely be scale-dependent, and management of the responses must address all relevant drivers.

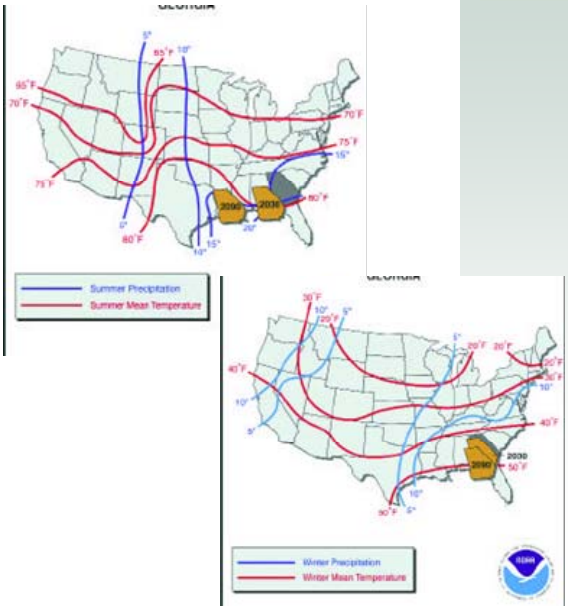
National Park Service

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Air Temperature

- Increasing everywhere
- Will accelerate

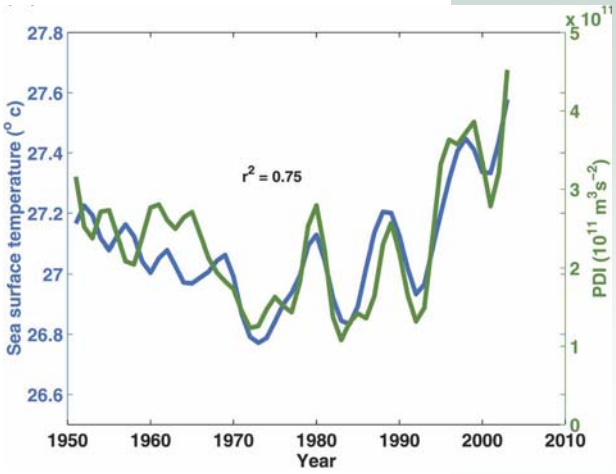
Region and Season	TIME STEP					
	2010-2039 (2020)		2040-2069 (2050)		2070-2099 (2080)	
	Median	Range	Median	Range	Median	Range
WESTERN U.S.						
DJF	1.6	0.5-2.4	2.3	1.0-4.2	4.1	2.0-7.6
MAM	1.4	0.5-1.9	2.5	1.1-4.1	3.8	1.0-7.6
JJA	1.8	0.8-2.6	2.8	1.7-5.2	4.2	2.8-9.1
SON	1.3	0.5-2.1	2.8	1.4-4.6	3.9	1.6-8.0
CENTRAL U.S.						
DJF	1.6	0.0-2.6	3.0	1.2-4.5	4.2	1.9-7.9
MAM	1.8	0.5-2.8	2.9	1.2-5.1	4.4	1.9-8.0
JJA	1.8	0.9-2.2	3.0	1.5-5.4	4.4	1.9-8.5
SON	1.3	0.4-2.3	2.8	1.2-5.0	4.1	1.8-8.8
EASTERN U.S.						
DJF	1.8	0.4-2.6	2.6	1.4-5.8	4.6	2.2-10.2
MAM	1.7	0.6-3.2	2.7	1.4-6.0	4.4	1.9-9.6
JJA	1.6	0.8-1.9	2.8	1.4-5.5	4.2	1.8-8.6
SON	1.5	0.6-2.3	2.8	1.4-5.4	4.0	1.8-9.0



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Sea Surface Temperature

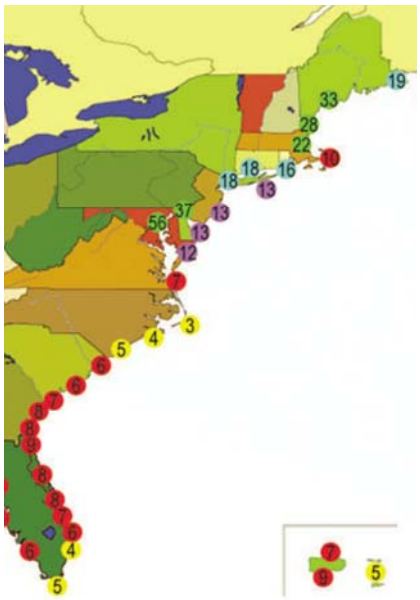
- Generally warming with decadal variability
- Warming faster in northern latitudes
- Drives storm patterns



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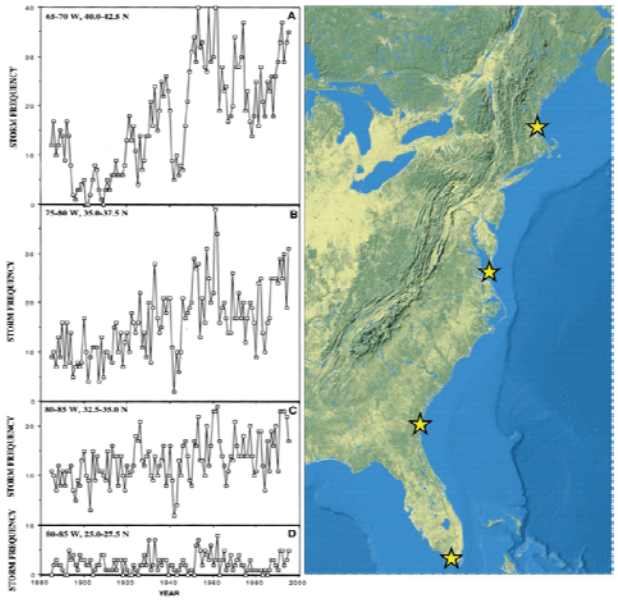
Storm Events

- Current return rate of CAT I storms ranges from 3 to 33 years.
- Highest frequency in Outer Banks and South Florida



Storm Events

- Rate is increasing
- Increasing with latitude



Relative Sea Level

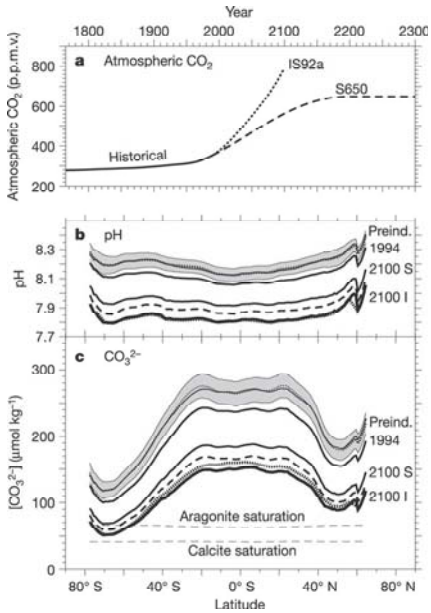
- 0-3 mm/y (green)
  - S. Florida
  - New England
  - Most of South Atlantic
- 3-6 mm/y (yellow)
  - Charleston
  - Mid Atlantic
- 6-9 mm/y (orange)
  - Chesapeake Bay



Relative SL is currently rising coast-wide. Rising faster in mid-atlantic (especially Chesapeake) area. Primarily driven by air temperature (leading to both more ice melting and thermal expansion) as well as land subsidance (combination of natural and anthropogenic causes).

Ocean Acidification

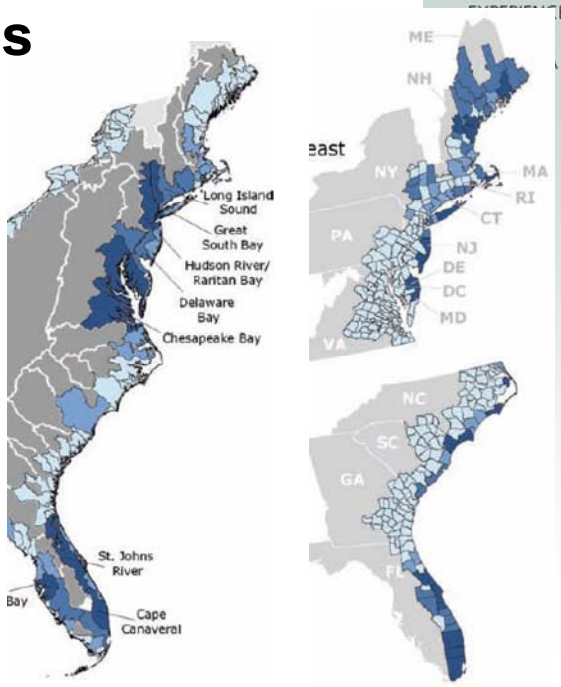
- Acidification increases southward
- CO_3^{2-} Driven by atmospheric carbon (not temperature)



a, Atmospheric CO2 used to force 13 OCMIP models over the industrial period ('Historical') and for two future scenarios: IS92a ('I' in b and c) and S650 ('S' in b and c). b, c, Increases in atmospheric CO2 lead to reductions in surface ocean pH (b) and surface ocean [CO32 -] (c). Results are given as global zonal averages for the 1994 data and the preindustrial ('Preind.') ocean. The latter were obtained by subtracting data-based anthropogenic DIC (ref. 17) (solid line in grey-shaded area), as well as by subtracting model-based anthropogenic DIC (OCMIP median, dotted line in grey-shaded area; OCMIP range, grey shading). Future results for the year 2100 come from the 1994 data plus the simulated DIC perturbations for the two scenarios; results are also shown for the year 2300 with S650 (thick dashed line). The small effect of future climate change simulated by the IPSL climate–carbon model is added as a perturbation to IS92a in the year 2100 (thick dotted line); two other climate–carbon models, PIUB-Bern and Commonwealth Scientific and Industrial Research Organisation (CSIRO), show similar results (Fig. 3a). The thin dashed lines indicating the [CO32 -] for sea water in equilibrium with aragonite and calcite are nearly flat, revealing weak temperature sensitivity.

Human Populations

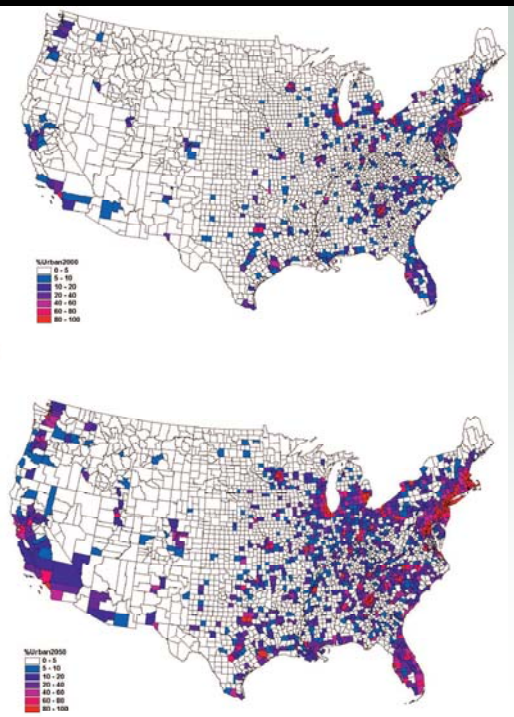
- 1980-2000
- Largest rates of increase in FL, Mid Atlantic
- Seasonal home densities greatest in New England and South Florida



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Land Use

- Urbanization projected to continue (thru 2050).
- RI, NJ, MA, CT will be >50% urban.
- FL to have highest urbanization rate
- Pattern not even across landscape



Land use change will be driven by both climate and anthropogenic forces. Land will be converted based on gain/loss of ag and forest productivity. Urban areas will grow and get more "impervious." Region-wide changes will affect systems on coast.

Figure from Nowak, D. J., and J. T. Walton. 2005. Projected urban growh (2000-2050) and its estimated impact on the US Forest Resource. Journal of Forestry 383-389.

National Park Service

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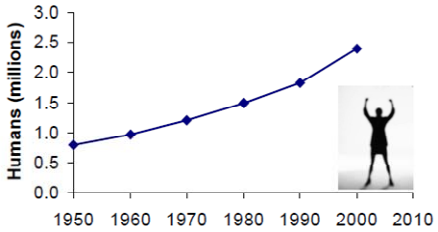
Changes in the Altamaha River Watershed

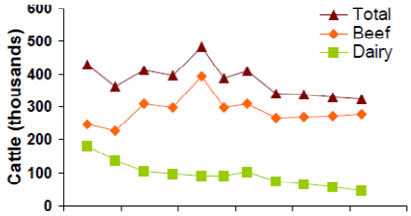


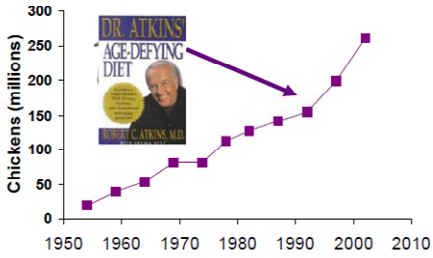
Increase in human population

No overall change in cattle

Increase in chickens!





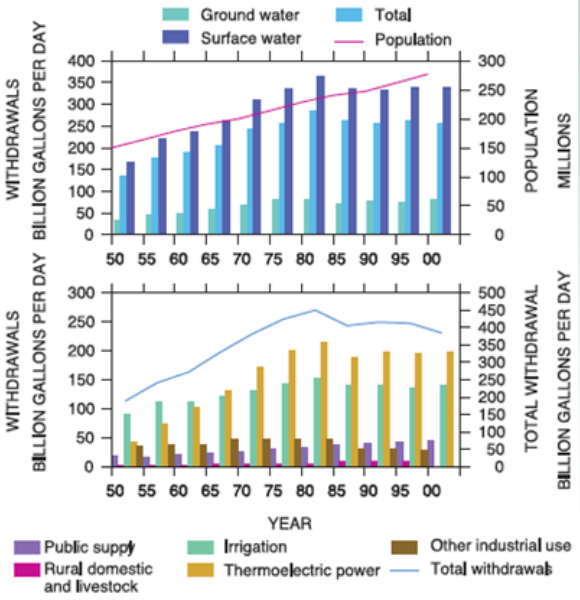


Agricultural land uses in the Southeast include more than crops; animal husbandry, particularly high-density chicken facilities, produce large quantities of nutrient inputs to water systems within the southern landscape. Economic-driven shifts among agricultural sectors might include shifts from plant- to animal-focused production.

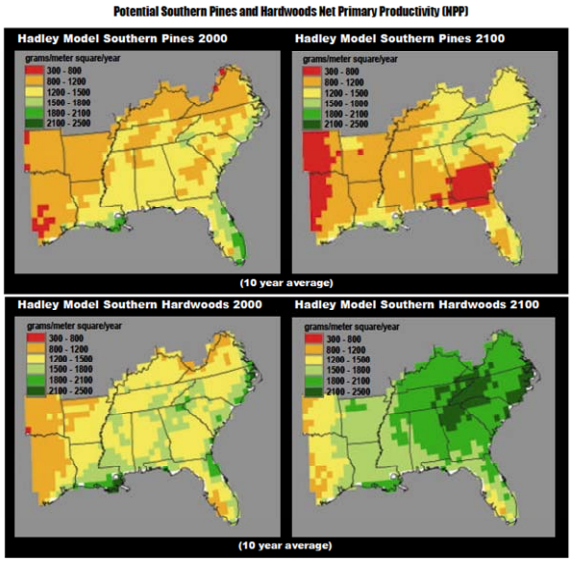
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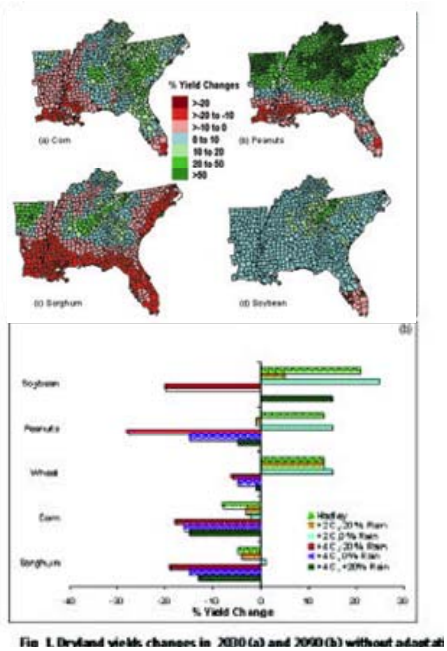
Water Demand

- Use correlated with population increases
- Surface water largest source
- Power generation and agriculture largest use sector
- Already history of water and power shortages



Forestry & Agriculture

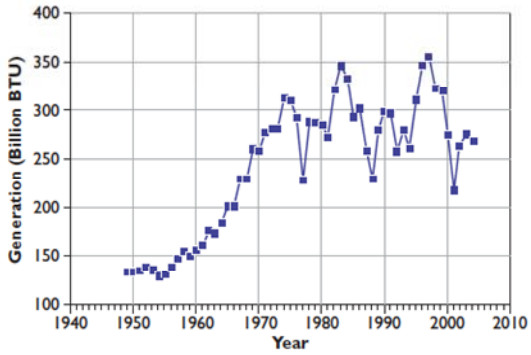




Pine productivity projected to decline. Hardwood productivity projected to increase. Variability in productivity of various crops throughout the Southeast. The result is a predicted change in the types and distribution of vegetation cover across the landscape, when considered in conjunction with land use change can have significant effects on wildlife habitat.

Energy Production

- Hydropower (below) near capacity but highly variable
- Both production and infrastructure impacts
- Demand projected to increase



Energy Impact Supplies		Climate Impact Mechanisms
Fossil Fuels (86%)	Coal (22%)	Cooling water quantity and quality (T), cooling efficiency (T, W, H), erosion in surface mining
	Natural Gas (23%)	Cooling water quantity and quality (T), cooling efficiency (T, W, H), disruptions of off-shore extraction (E)
	Petroleum (40%)	Cooling water quantity and quality, cooling efficiency (T, W, H), disruptions of off-shore extraction and transport (E)
	Liquified Natural Gas (1%)	Disruptions of import operations (E)
Nuclear (8%)		Cooling water quantity and quality (T), cooling efficiency (T, W, H)
Renewables (6%)	Hydropower	Water availability and quality, temperature-related stresses, operational modification from extreme weather (floods/droughts), (T, E)
	Biomass	
	• Wood and forest products	Possible short-term impacts from timber kills or long-term impacts from timber kills and changes in tree growth rates (T, P, H, E, carbon dioxide levels)
	• Waste (municipal solid waste, landfill gas, etc.)	n/a
	• Agricultural resources (including derived biofuels)	Changes in food crop residue and dedicated energy crop growth rates (T, P, E, H, carbon dioxide levels)
	Wind	Wind resource changes (intensity and duration), damage from extreme weather
	Solar	Insolation changes (clouds), damage from extreme weather
	Geothermal	Cooling efficiency for air-cooled geothermal (T)

(Source: EIA, 2004)

Just about every portion of the energy sector is impacted by climate change. Most sectors require water in varying degrees

Summary

Driver	General Trend
Air Temp	Increasing
Precipitation	Increasing
Sea Level	Increasing, with notable local/ regional hotspots
Ocean Acidification	Increasing
SST	Increasing
Drought	Increased risk
Storms	Stronger, changes in frequency uncertain
Human Population	Regionally Variable
Water Demand	Increasing demand, Decreasing availability
Land Use	Increasing urbanization
Ag & Forestry	Decrease overall, change in production
Energy Production	Increasing demand

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