Sarasota County/New College of Florida Science Partnership – Second Quarter Fall 2008

Submitted by Dr. Meg Lowman, Director of Environmental Initiatives

Burmese python in local swimming pool, Sarasota County

New College students get a sense of a pythons's length. This individual was found in a garage in Myakka City, Florida.

Sarasota resident, Anne Folsom-Smith gets a first-hand perspective on the size and weight of a Burmese python in Sarasota County.

Meg Lowman <canopymeg@gmail.com>

Monitor Lizard in Sarasota

2 messages

hera <oceanwolf@comcast.net> **Tue, Sep 23, 2008 at 4:39 PM**
To: meg@canopymeg.com

Saw this morning's Herald Tribune article and thought you might be interested in seeing what we caught in our backyard (near the Landings in south Sarasota).

He/she is a little over three feet in length.

Hera

4 attachments

IMG_0617a.JPG
189K

IMG_0618a.JPG
207K

IMG_0619a.JPG
210K

COMING UP ON BAY NEWS 9

What happened to Florida's old voting machines? No one else wanted them. Now see where they ended up! Tonight on Your Evening News.

News > Headlines

Wild lizards have Manatee farmers on edge

Thursday, September 4, 2008

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This Tegu lizard was caught on a Manatee County farm. (slideshow)

MANATEE COUNTY (Bay News 9) -- A lizard, not native to Florida, found in Manatee County could be the start of trouble for farmers.

Farmer Mike Martinez originally thought raccoons were nibbling on his crops.

"They were eating all of my vegetables, so I had to cut back you know," he said.

Martinez caught the culprit in a raccoon trap.

Matthew Hunt with Nuisance Wildlife Relocation was stumped by what he saw.

"I had to look through my encyclopedia on reptiles to try to figure out what he was," he said.

It turns out, the culprit was a Tegu, a lizard that can grow up to four feet long.

"This is my first encounter with a wild Tegu in this area," Hunt said.

Hunt says Florida's tropical climate is well suited for the Argentinean lizard.

"They have such a wide variety of food source they can thrive very well," Hunt said.

The species of lizard can lay up to 32 eggs at a time. Five of them have already been spotted in northeastern Manatee County, so there's the potential to see a lot more.

More about tegu lizards

- Watch the story
- General Info
- Feeding, handling, breeding, & more info
- E-mail TV reporter Jen Anderson

That makes Martinez very nervous.

"That's another problem we're gonna have," he said. "So, we're going to keep an eye on what we see."

The lizards have made sporadic appearances on the farm over the past seven months.

"This is a young adult," Hunt said. "The others were juveniles, so there's probably been a nesting and now they're habitating."

Hunt says in the next couple of years, Manatee County could very well see a surge of these super lizards.

Since the tegu is not native to the area, it is not protected under state law. However, wildlife experts say anyone who spots one should call a professional to remove it. The lizards can bite and scratch. They're also know to use their tail as a whip.

About the Tegu

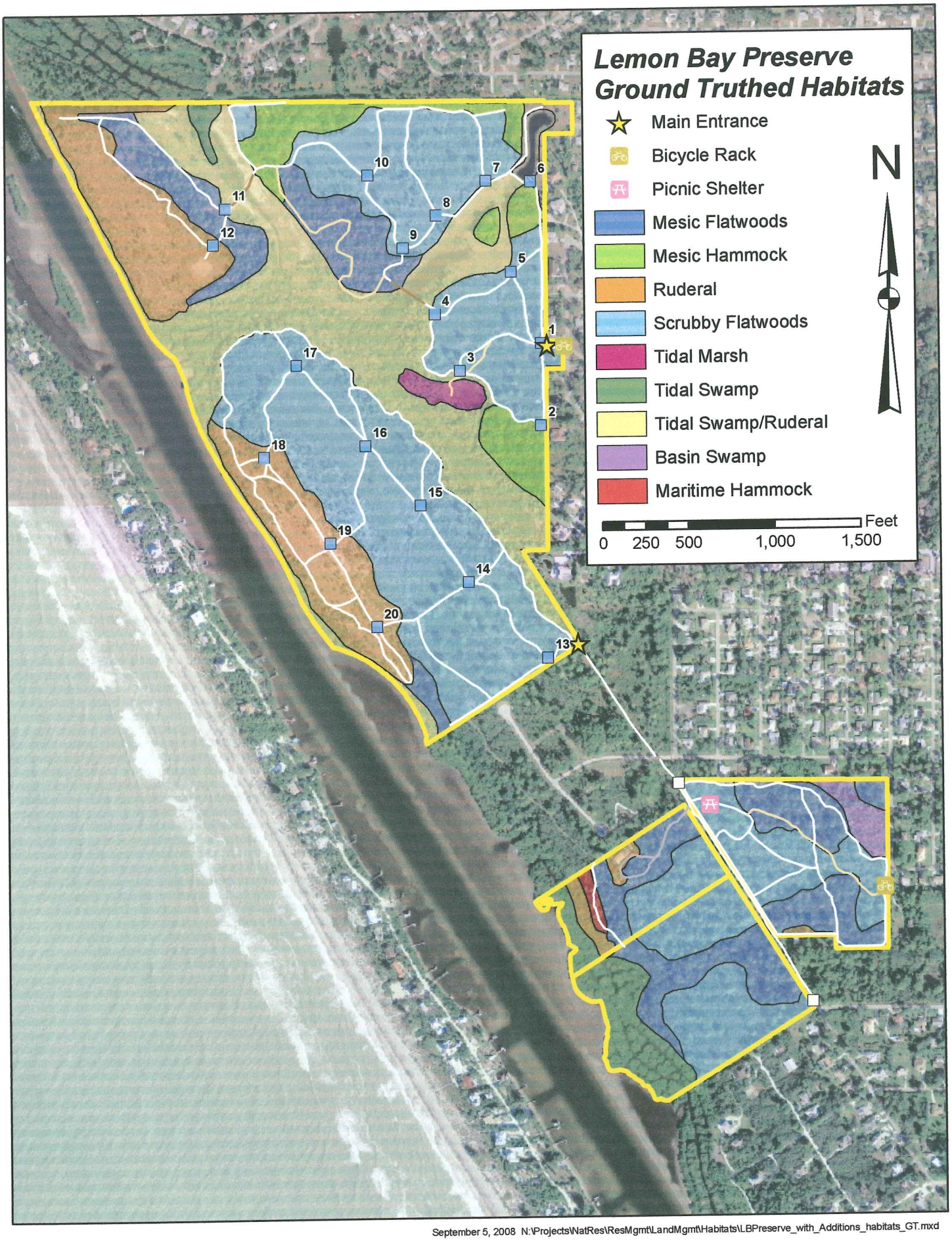
The two most docile and easiest to handle species are the Argentine Black and White Tegu and the Red Tegu.

Additionally, a new variety has been recently introduced, called the Blue Tegu due to the tendency of males to become bright blue color upon maturity.

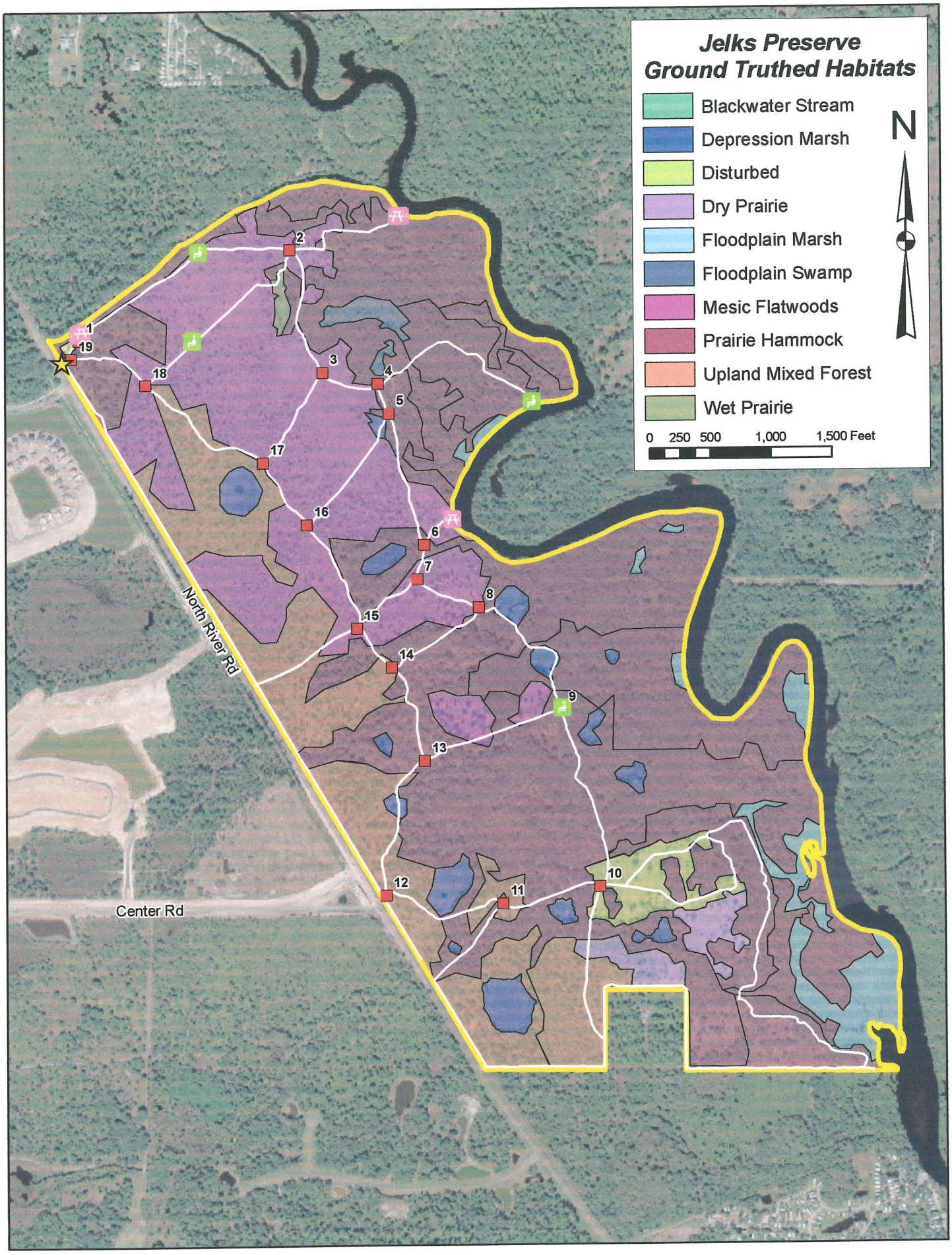
These variations grow to 2.5 to 4 feet and have a pleasant nature. Tegus are also one of the most intelligent lizards known.

In captivity, a healthy tegus' diet should consist of mice/pinkies, crickets, and assorted fruits and vegetables.

The above information is from Wikipedia.



September 5, 2008 N:\Projects\NatRes\ResMgmt\LandMgmt\Habitats\LBPreserve_with_Additions_habitats_GT.mxd


Jelks Preserve
Ground Truthed Habitats
Blackwater Stream
Depression Marsh
Disturbed
Dry Prairie
Floodplain Marsh
Floodplain Swamp
Mesic Flatwoods
Prairie Hammock
Upland Mixed Forest
Wet Prairie
N
0 250 500 1,000 1,500 Feet
North River Rd
Center Rd
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

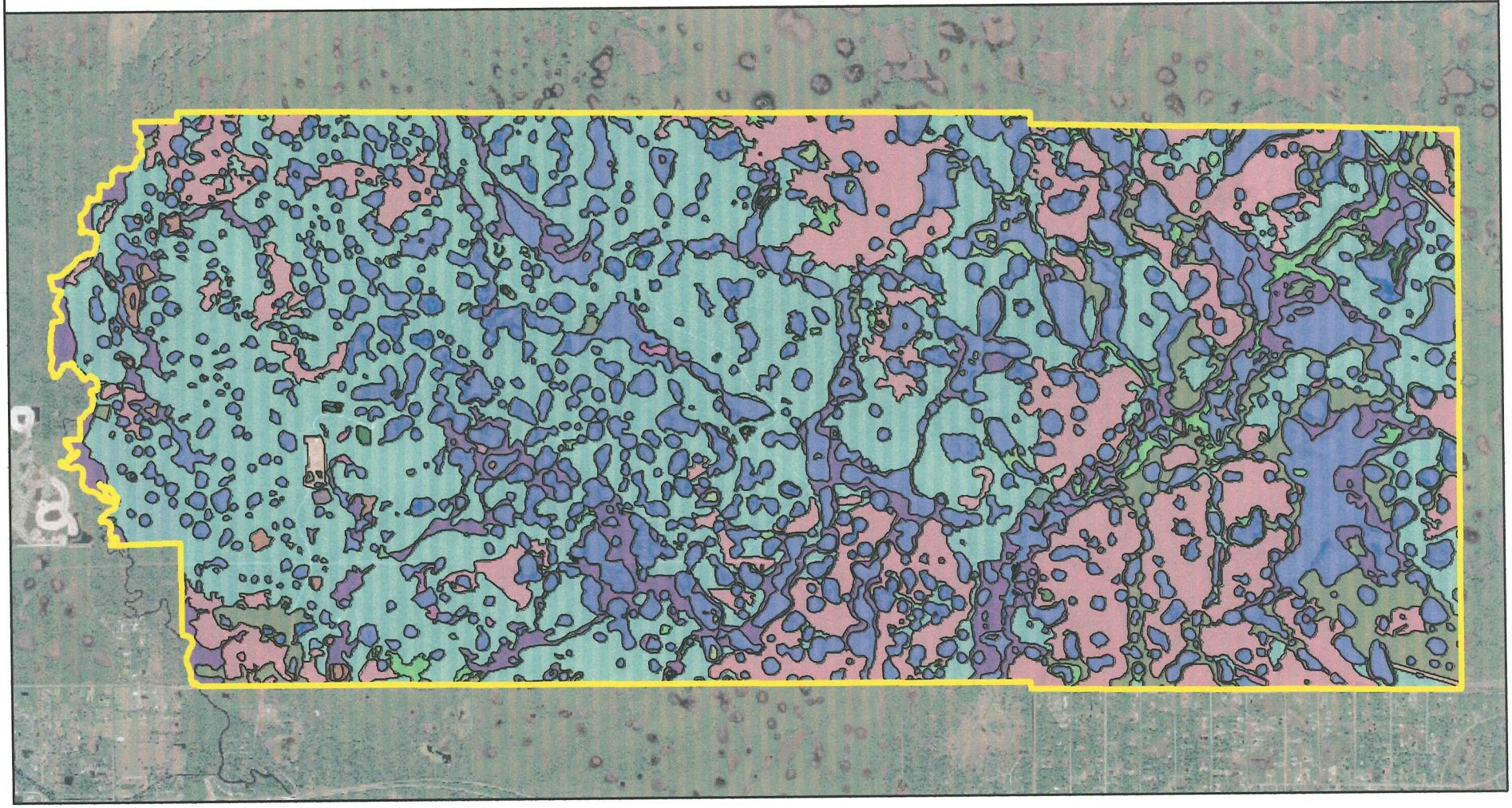
T. Mabry Carlton, Jr. Memorial Reserve - Habitats

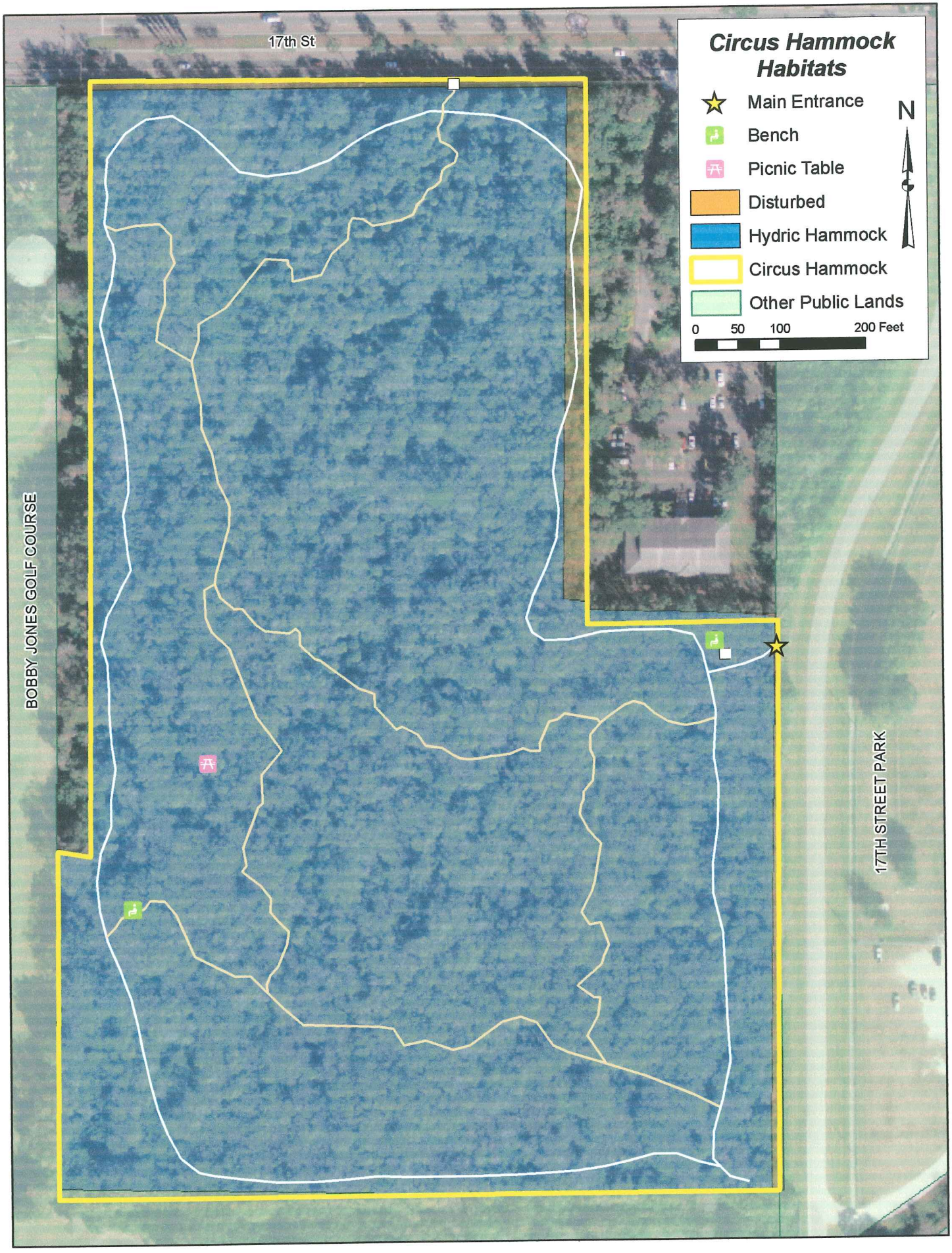
Feet
0 2,500 5,000 10,000 15,000

N

- BAY SWAMPS
- CROPLAND AND PASTURELAND
- CYPRESS
- DISTURBED LAND
- EMERGENT AQUATIC VEGETATION
- FRESHWATER MARSHES
- HARDWOOD CONIFER MIXED
- MIXED RANGELAND
- PINE FLATWOODS
- RESERVOIRS
- SHRUB AND BRUSHLAND
- STREAM AND LAKE SWAMPS (BOTTOMLAND)
- STREAMS AND WATERWAYS
- UPLAND CONIFEROUS FOREST
- UTILITIES
- WET PRAIRIES
- WETLAND CONIFEROUS FORESTS
- WETLAND FORESTED MIXED

Data Source: SWFWMD




17th St
BOBBY JONES GOLF COURSE
17TH STREET PARK
Circus Hammock Habitats
Main Entrance
Bench
Picnic Table
Disturbed
Hydric Hammock
Circus Hammock
Other Public Lands
N
0 50 100 200 Feet

Appendix 9.

The role of low soil moisture in mitigation of water and carbon exchange at a Bahia grass (*Paspalum notatum*) pasture in central Florida

Smithsonian Environmental Research Center

Rosvel Bracho[1], David Sumner[2], Thomas Powell[3], Ross Hinkle[4], and Bert Drake[3]

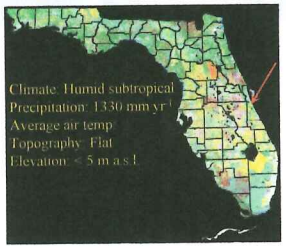
[1] National Research Council, Washington DC; [2] U.S. Geological Survey, Altamonte Springs, FL; [3] Smithsonian Environmental Research Center, Edgewater MD; [4] Dynamac Corp., Kennedy Space Center, FL

December 2004

Introduction:

Seasonality in soil moisture coupled with plant development are important controlling factors regulating ecosystem level water and carbon exchange. Evapotranspiration (Et) and ecosystem carbon exchange are tightly related. Et is controlled by environmental factors as soil moisture (θ) and available energy (R_a), and also by biological factors as leaf area index (LAI) and the surface conductance (g_s). The net ecosystem carbon exchange (NEE) is the difference between two large fluxes, photosynthesis and respiration, and the dominant process determines whether an ecosystem is a carbon sink or source. Moreover, the magnitude of photosynthesis and respiration changes in response to θ and the leaf area development. We present results of three years of water and one year of CO_2 exchange measurements over a pasture in central Florida.

Study site:

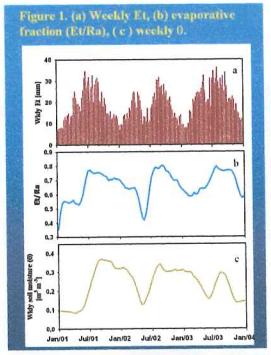


Species: Bahia grass (*Paspalum notatum*)
Sandy soils
Eddy flux measurements :
H_2O: June 2000 – Feb 2004
CO_2: Feb 2003 – Feb 2004

Acknowledgements: We are grateful to the National Research Council, U. S. Geological Survey, Department of Energy and Smithsonian Institution for funding and support We also wish to thank Dynamac Corporation. Duda & Sons Farm and St. Johns River Watershed Management District for their support .

Results:

WATER



Annual Et:
2001: 973 mm yr^{-1}
2002: 939 mm yr^{-1}
2003: 1100 mm yr^{-1}

Annual Et was 64% to 74% of precipitation.

Et (Fig. 1a) shows a seasonal trend with maximum values during the summer of each year (wet season).

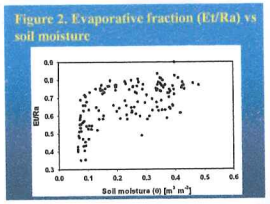
Maximum **weekly Et** was > 30 mm at maximum soil moisture .

The evaporative fraction (Et/R_n), (Fig. 1b) tracked θ.

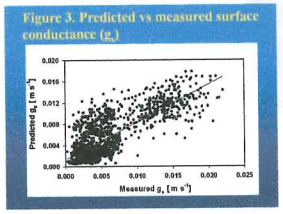
When θ > 0.2, (Fig. 1c) over 80% of R_n was used to evaporate water.

Et/R_n decreased to 0.3 when soil moisture reached minimum values indicating that the available energy was mainly dissipated by sensible heat.

Annually, Et was the major energy dissipating component.



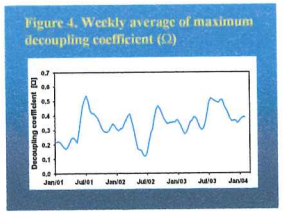
Soil moisture (θ) influenced the evaporative fraction (Et/Ra). Et/Ra reached maximum around 0.8 for θ > 0.15 $m^3\ m^{-3}$ (Fig. 2). Below this critical value Et/Ra declined sharply to a value of 0.3 at minimum θ. Et/Ra declined from values > 0.7 to 0.3 while θ declined from 0.15 to 0.08.



The soil moisture, θ, was the main environmental control over surface conductance g_s.

A model in the form:
$g_s = g_{smax} f(Ra) f(VPD) f(\theta)$
where g_{smax} is maximum g_s
VPD= vapor pressure deficit
explained 61% of the variability in g_s. (P<0.0001).
(Fig. 3)

The available soil moisture function alone explained 53% of the variability in gs (P<0.0001)



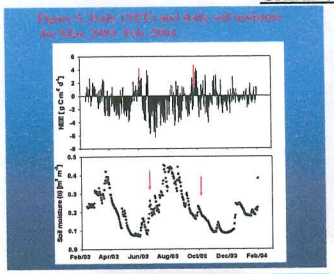
The decoupling coefficient (Ω) was used to determine the magnitude of surface conductance (g_s) control over Et (Figure 4).

When Ω approaches 1 Et is predominantly driven by Ra. As Ω approaches to zero, g_s impose an increasingly stronger control on Et.

Over this pasture, g_s was the dominant biological control over Et when θ was below 0.1.

At high θ (>0.2) Et was controlled by a combination of g_s and Ra.

CARBON



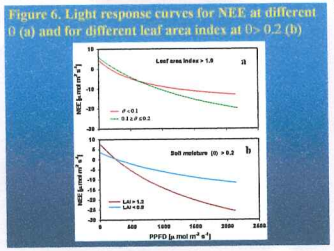
Annual carbon accumulation was 264 g C m^{-2} yr^{-1} for March 2003 – Feb. 2004.

Most of the carbon gain occurred during the spring and summer, when photosynthetic rates increased with LAI while ecosystem respiration stayed at a stable rate with relatively stable air and soil temperature.

The maximum daily net ecosystem carbon exchange (NEE) was -6.2 g C m^{-2} (Fig. 5a) and occurred during the summer when θ > 0.15 (Fig. 5b).

Carbon uptake was lowest when θ < 0.1.

A considerable amount of C was flushed out of this system after heavy rain events that were preceded by prolonged dry period because rewetting of the soil flushed out CO_2 (red arrows).



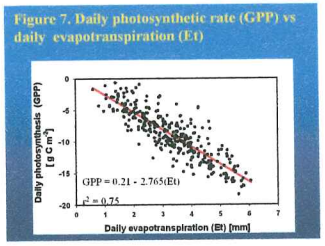
Light saturation of NEE appeared to occur at PPFD values around 1000 μ mol m^{-2} s^{-1} when θ was below 0.1 $m^3\ m^{-3}$ and LAI > 1.0 (summer time water stress) (Figure 6a, red line) or when θ was > 0.2 but LAI < 0.8 (winter time) (Figure 6b, blue line).

Light saturation of NEE was not apparent when θ was > 0.1 and LAI > 1.) (occurred in the summer time) (Figura 6a, green line and 6b brown line).

Table 1. Maximum NEE rate (Amax), quantum yield (q) and respiration rate (Re) at different θ and leaf area index (LAI).

θ	LAI	A_{max}	q	Re	r^2
< 0.15	> 1.0	-23.9	-0.031	4.66	0.74
> 0.15		-48.5	-0.025	5.91	0.83
> 0.15	> 1.2	-61.2	-0.035	7.86	0.93
	< 0.8	-29.5	-0.015	3.53	0.74

Calculated maximum NEE(A_{max}) and respiration rate (Re) increased with θ when LAI > 1.0 (Table 1)
At θ > 0.15 but different LAI, Amax and Re increased with LAI.



Et explained 75% of the variability in daily photosynthesis (GPP) (Fig. 7). The linear relationship between GPP and Et shows a water use efficiency of 2.76 g C per mm of water evaporated.

Conclusions:

- Soil moisture was the main variable controlling water and carbon exchange in this ecosystem.
- An analysis of the decoupling coefficient, Ω, indicates that in this system, Et is strongly controlled by gs at low θ and a combination of g_s and energy input controlled Et at high θ.
- Changes in θ explained most of the variability in g_s.
- On the annual basis the ecosystem was a carbon sink.
- High carbon uptake occurred at high LAI, however, LAI is constrained by soil moisture when it drops below 0.1.

Ap

Common Birds of Myakka River State Park

Forest Hayes and Michael Dexter

Created for Ornithology class at New College of Florida with Professor Meg Lowman (www.canopymeg.com)

New College of Florida — The Honors College

Tree Foundation — Tree Research, Exploration & Education

Wood Stork

Mycteria americana

Habitat: Common resident of Florida swamps, ponds, and coastal shallows.
Identification: Large curved dusky colored bill. Bald, gray and black head. Black tail and flight feathers visible during flight. Black legs, orange feet.

Snowy Egret

Egretta thula

Habitat: Common throughout various wetland and marsh habitats, year round resident of Florida.
Identification: Small white heron with slender black bill and yellow eyes. Black legs and bright yellow feet.

Great Egret

Ardea alba

Habitat: Year-round resident common throughout Florida's wetlands.
Identification: Large white wading heron with a long straight yellow bill and long solid black legs. Much larger than the snowy egret.

Great Blue Heron

Ardea herodias

Habitat: Common throughout Florida near bodies of water.
Identification: Blue-gray in color, black stripe running from the yellowish bill, above the eyes, and through the crest.

Tricolored Heron

Egretta tricolor

Habitat: Commonly found in salt marshes and swamps on the Atlantic and Gulf Coasts, less common inland.
Identification: White belly and foreneck, upper is mostly dark blue. Long, slender bill.

Little Blue Heron

Egretta caerula

Habitat: Common throughout Florida, found in ponds, lakes and marshes.
Identification: Slate blue body, head and neck dark purple, legs and feet dull green. Juvenile white, distinguishable by its two-toned bill.

Green Heron

Butordies virescens

Habitat: Year-round resident, common in salt marshes, and mangrove swamps.
Identification: Small heron with short legs. Greenish blue back and chestnut throat. Crown is dark green, chest streaked with white.

White Ibis

Eudocimus albus

Habitat: Year-round resident, common in coastal marshes, swamps and mangroves, and inland marshes.
Identification: White plumage with pink facial skin, long two-toned curved bill. Black wing tips visible in flight.

Glossy Ibis

Plegadis falcinellus

Habitat: Year-round resident, occurs in both salt and freshwater marshes.
Identification: Appears dull gray at a distance. Up close plumage appears chestnut collored with green patches. Legs are gray, the bill is a single color.

Limpkin

Aramus guarauna

Habitat: Year-round Florida resident in swamps and wetlands.
Identification: Chocolate brown plumage, densely streaked with white. Large bill, curved slightly downward. Legs and webless feet are a dull green.

Appendix 10

Roseate Spoonbill

Platalea ajaja

Habitat: Common along the southern coasts of Florida, casual inland.

Identification: Spoon-shaped bill, pink feathers with red highlights. Adults have pink legs. Juvenile has more subdued colors, and dusky yellow legs.

Sandhill Crane

Grus canadensis

Habitat: Florida resident, found in marshes and dry fields.

Identification: Very large, gray body, red crown, and white chin. Juvenile lacks red on head, has a gray-brown throat, and irregular molting patterns.

Red-winged Blackbird

Agelaius phoeniceus

Habitat: Widespread thoughout the US, found in marshes, fields, and woodlands.

Identification: Male distinguished by bright red and yellow patches on wings. Female is dark brown, with a heavily streaked chest.

Northern Cardinal

Cardinalis cardinalis

Habitat: Inhabits woodlands, swamps, and suburban gardens in the eastern US.

Identification: Male is bright red, with a black face and red beak. Females and juveniles are more buffy colored, with subtle tinges of red .

Boat-tailed Grackle

Quiscalus major

Habitat: Year-round resident, inhabits marshes, and inland lakes and streams.

Identification: Large grackle with a fan shaped tail. Adult male is a glossy blue. Females and juveniles are brown with dark wings and tail.

Anhinga

Anhinga anhinga

Habitat: Rivers and lakes.

Identification: Often seen drying wings. White streaked wings, straight bill. Males have black necks, females and juveniles have buffy colored necks.

Double-crested Cormorant

Phalacrocorax auritus

Habitat: Commonly found along coasts, lakes, and rivers.

Identification: Dark gray brown plumage. Large bill, curved at the end. Legs and webless feet are dull green. Throat is cream-colored.

Mottled Duck

Anas fulvigula

Habitat: Florida year-round resident, common in coastal marshes.

Identification: Dark brown overall, with lighter face and neck. Blue-green patch is sometimes visible on the wing.

Pied-billed Grebe

Podilymbus podiceps

Habitat: Marshes and lakes.

Identification: Brown overall, with a light throat in winter. In summer has a black ring around the bill and a black chin. Juvenile resembles winter adult, with more pronounced white on face.

Common Moorhen

Gallinula chloropus

Habitat: Freshwater marshes, ponds and rivers.

Identification: Prominant red forehead shield, with a yellow tipped beak. Head and neck are black. White flank with yellow legs and feet.

Pileated Woodpecker

Dryocopus pileatus

Habitat: Dense mature forests and wooded areas.

Identification: Lage woodpecker, black body when perched. White chin, dark bill, red crest. White visible on wings when in flight.

Black Vulture

Coragyps atratus

Habitat: Common in open country as well as human settlements.

Identification: White wing tips visable while in flight. Black head and white legs and feet distinguish the black vulture from the turkey vulture.

Turkey Vulture

Cathartes aura

Habitat: Widespread in various habitats throughout the United States.

Identification: Red skin on head, silvery flight feathers along the length of the wing visible and wings form a V shape during flight.

Red -shouldered Hawk

Buteo lineatus

Habitat: Year-round resident, found in mixed woodlands and near water.

Identification: Reddish shoulders, white streaked chest. Beak is two tones with a black tip. Gray head and fan shaped tail.

Bald Eagle

Haliaeetus pelagicus

Habitat: Found arround lakes and rivers where food is abundant.

Identification: Large eagle, adult has a yellow beak, and white head and tail. Juveniles are overall dark with a dark beak, and lack white head and tail.

Photos by
Forest Hayes and John Hayes

Agreement for Professional Services between Sarasota County and New College
Quarterly Report August - October 2008
Dr. Meg Lowman, Director of Environmental Initiatives, NCF 30 Oct 2008

1. **Assess and Quantify Infestation of Sarasota County by Non-indigenous, Nuisance Reptiles** – Due to the urgent nature of this invasion, this issue remains a priority for the SC/NCF Scope of Services. Invasive reptiles currently cost billions of dollars for regional, national and international entities. The key economic and ecological management tool is early management and control; so this issue was the major focus of summer research and services as follows:

   a. **Formation of a local working team** – Kenya Leonard, Lowman, Dexter, Hayes, and Jerris Foote met regularly over the summer to determine priorities and issues to assist the County in management of invasive herps. The County staff team of Leonard and Juris asked the NCF/SC partnership to work on the following priorities: 1. determine reproductive seasonality; 2. assess diet and its variability; 3. quantify ecological impacts; 4. obtain "best predictions" for species' potential to spread; and 5. obtain "best practices" for eradication.

   b. **Student internships** - Two student interns (Michael Dexter and Forest Hayes) were hired by Dr. Lowman to work fulltime on invasive python, Nile monitor, and iguana sightings. The students spent most of their time "ground-truthing" reports from citizens who called into the County hotline claiming they had an invasive reptile on their property. From this information, the distribution of the four major invasives was mapped and confirmed. In addition, the students created a master list of peer-reviewed publications on invasive reptiles from the scientific literature, as a tool for County management staff and for creating future "best practices" using available data. New College (in conjunction with the Necropsy team at Mote and University of Tampa biologists) is currently analyzing stomach contents to determine what the iguanas are eating.

   c. **Invasive Species Workshop** - Lowman networked throughout the state and country to identify best practices in other regions for invasive reptiles. As a result, New College hosted a workshop on invasive reptiles, bringing in a team of biologists and environmental managers from around Florida and beyond. (See attached list). This workshop included a field trip to view local invasive reptiles, a dinner for County government leadership and scientists, and an all-day workshop at New College on September 22. A full agenda of speakers/contacts, and videos of the presentations are available (www.basecampsarasota.org) , thanks to funding from the Economic Development Corporation. This online archive will facilitate County leaders to utilize the data and scientific information for creating management plans based on sound science.. Approximately 45 statewide government and scientific employees attended, with the ultimate goal to

assist Sarasota County to immediately engage in best practices for the new invasions of pythons, monitors, and iguanas.

d. **Literature Review** – Lowman, Hayes and Dexter compiled the most current literature from local, state, national and international case studies on invasive reptiles to circulate to County employees who need to know answers about this topic. (CD enclosed).

e. **National invasive species best practices** – Lowman attended the Ecological Society of America annual meetings in Milwaukee, WI, where two critical sessions were presented on invasive species, in hopes to engaging other experts to provide advice to Sarasota County. Of note, no scientists presented on Invasive Reptiles, allegedly because their invasions are relatively recent as compared to plants and birds which were the focus of all presentations. But discussions generated great interest in future projects and research opportunities for invasive ecologists to work in Florida, if facilities and field sites were available.

f. **Public education about invasive reptiles** - At the request of the County invasive species staff, a series of public education articles was written and published by Lowman in the Sarasota Herald Tribune. Five articles were published over a 3-month period, and each article repeated the County Invasive Reptile telephone hotline number, asking citizens to call in with any sightings. (Of note, the publications spiked the numbers of calls on the Invasive Species hotline, indicating that public education is critical for effective management.) In addition, the local news stations and newspapers covered the Invasive Reptile Workshop. (see attached emails and articles)

g. **Field guides** – A set of visual keys to identify invasive reptiles and also their signatures (footprints and tail marks in the sand) will be created and placed on the web site, www.basecampsarasota.org. Lowman will publicize this in the newspaper upon completion, so citizens can confirm correct IDs of reptiles sighted around the region.

h. **Web site** – Although the bricks and mortar version of Base Camp Sarasota is on hold due to economic constraints, a virtual field station has been launched with the creation of a web site. The Invasive Reptile Workshop represents the first official conference hosted by Base Camp Sarasota, whereby scientific professionals came together in Sarasota County to assist in solving a ecological management issue. The talks, contacts, and literature from the Workshop are available on www.basecampsarasota.org

i. **Policy recommendations** – A series of recommendations, including a synthesis of the current scientific knowledge of Sarasota County's invasive reptiles, is forthcoming next quarter.

2. **Provide Services as Climate Change Advisor to the County's Sustainability Initiatives**

   a. **Local working group** – Lowman is working with Lee Hayes Byron to identify priorities for County with regard to climate change policy and actions.

   b. **Carbon sink assessments for Florida and for Sarasota County as a Florida-wide Model** – Lowman worked with State CFO, Alex Sink, submitting a line item in the recently passed energy budget in Tallahassee that will fund a quantified study of Florida vegetation as carbon sinks. An RFP will circulate at the end of November from the DEP and Forestry offices in Tallahassee, requesting the best national carbon modeling team to undertake this state contract to measure the capacity of Florida vegetation to sequester carbon. In addition, the nationally-acclaimed group from the Heinz Center for Science, Economics, and the Environment will create a model study of Sarasota County first, with a detailed assessment of local vegetation in terms of its potential for carbon storage. County staff and NCF scientists met with the Heinz team, who spent time in the field making observations of local vegetation for this project. The carbon team has three levels of detail (at incremental costs, see attached). Lowman's partnership budget at New College will fund Level One, and the County is determining if they can contribute extra to bring the survey to Level Two.

   c. **State climate change policy-making** – Lowman continues as Science Advisor for Climate Change to CFO Alex Sink in Tallahassee, facilitating the sharing of information from state level to Sarasota County level. As part of Governor Crist's Adaptation Team, she has shared the initiatives of the ADP (Adaptation Planning Framework) that is forthcoming as a statewide action. (See Draft document attached). Senator Mike Bennett is working with Lowman to insure that the carbon model funding in the recent budget is identified and utilized as pledged.

   d. **Collection of local vegetation data for carbon modeling** – Three New College ecology students are working on literature searches to collate the pertinent scientific data about local vegetation that is required for an accurate carbon assessment. A timeline for data completion is scheduled for end-November, with completion of the carbon model for Sarasota County forthcoming in early spring. Belinda Perry and Lee Hayes Byron provided input to the important plant species that require quantifying for the models. Of note, the carbon modeling team were amazed (and horrified) at the level of damage by wild boars to soils in the Myakka watershed, creating a significant loss of carbon into the atmosphere that will require careful input to make the Sarasota County carbon models accurate. (see attached documents illustrating the carbon modeling process).

3. **Review of Designation of "Environmentally Sensitive"** – Lowman met with Belinda Perry and with Albert Joerger to get an update and assignments with regard to this review process. Joerger felt that no issues were pertinent or pending, since the process currently involved purchasing a relatively small number of properties. Perry made a request for a literature search to find peer-reviewed scientific articles about ecological restoration of local Florida pasturelands, because she had identified this subject as a gap in the applied management strategies for the County. Admittedly, an exhaustive search, including requests to the Disney Wilderness Preserve and also to Archbold Field Station, provided only one (incomplete) study (see attached). This topic is obviously a priority if (in future) opportunities arise to dedicate ecological research in Sarasota County through a field station or a long-term university partnership.

4. **Provide Advisory Services Relative to State Wildlife Management Plans**

The invasive reptiles and climate change issues were prioritized over and above this item.

5. **Provide Recommendations and Supportive Science for Land Management Practices** – Lowman wrote a section about invasive species for the HCP.

6. **Conduct Public Outreach and Education Activities**

September 6 - Ecology walk - Red Bug Slough
September 21 – The ecology of invasive reptiles - Blind Pass
October 5 – Exploring the Florida forest canopy – Myakka
November 1 – A wet and wonderful world - Carlton Reserve

Brochure created and printed by New College ecology students: Common Birds of Myakka River State Park (see attached)

Sarasota Herald Tribune – invasive species series began July 28.

APPENDIX:

1. Program and list of scientists at the Invasive Reptile Workshop
2. CD - literature review on invasive reptiles
3. Public education outreach articles in Sarasota Herald Tribune (and selected examples of follow-up emails from the public)
4. Data sheets for invasive reptile monitoring programs and gut analyses
5. Three tiers of carbon modeling proposed by Heinz team
6. Vegetation maps used as basis for carbon models
7. Press release – example of ecosystem-scale work that Heinz Center is undertaking to assist communities adapt and mitigate against climate change impacts
8. Florida ADP (Adaptation Planning Framework) draft document
9. The (sole) vegetation study about restoration of SW Florida pasturelands
10. Student-created brochure on birds in Myakka

Appendix 1 – Schedule of Invasive Reptile Workshop and list of participants

CD of invasive reptile publications

Invasive Reptile Workshop - Monday September 22 2008

New College of Florida – Cook Hall Music Room on the Bayfront campus
5800 Bayshore Road Sarasota 34243

SUNDAY AGENDA Blind
2 – 5 PM Field Trip to Stump pass for iguanas with trapper George Cera. Meet in parking lot of Stump Pass at 2 PM (directions and information from Forest Hayes on 352 226-1266). Group will caravan to Meg's dinner at 5:00 PM.
6 PM - Dinner at Meg's home on Sunday 21 September – 4762 Watermark Lane, Turtle Rock in Palmer Ranch, south Sarasota County). All are welcome!

MONDAY AGENDA (apologies if the wrong speaker is bolded)
9:30 AM – Coffee and posters and herp displays

10:00 AM – Opening Introduction – The invasion ecology of large reptiles in South Florida – Defining a new battleground **Meg Lowman**, New College

10:15 – Sarasota County – Management challenges of invasive herps
Kenya Leonard, Sarasota County Environmental Services

10:30 – Cooperative research and education for control of Burmese pythons in Greater Everglades ecosystems Michael R. Rochford, Michael S. Cherkiss, Matthew L. Brien, Skip Snow, Kenneth Rice, Michael E. Dorcas, Alexander Wolf, Brian Greeves, Laurie Wilkins, Gordon Rodda, Robert Reed, **Kristen Hart** (US Geological Survey), and Frank Mazzotti

11:00 Nonindigeneous amphibians and reptiles in Florida: defining the invasion process and identifying continuous pathways. **Kenneth L. Krysko** (University of Florida Museum of Natural History), Joseph Burgess, Kevin M. Enge, Louis A. Somma, Michael R. Rochford, Stuart V. Nielson, and Jennifer L. Stabile

11:30 Preliminary data on the Argentine black and white tegu (Tupinambis merianea) in central Florida – Bernard Kaiser, Larry Connor, Ross Dickerson, **Kevin Enge** (Florida Fish and Wildlife Conservation Commission), Scott Hardin, Kenneth Krysko, and Catherine Smith

12:00 Are invasive fishes causing the collapse of Florida's native semi-aquatic herpetofauna? **Steve Godley**, Biological Research Associates

12:30 - Lunch

1:30 Reptile Trapping Techniques – Challenges and Frustrations George Cera, SW Florida trapper

1:45 How far can they go? Exotic in NE Florida Joseph Burgess, Guana Tolomato Matanzas National Estuarine Research Reserve

2:00 Exploring potential management strategies for invasive Cuban treefrogs and coquis **Steve Johnson** and Monica McGarrity, University of Florida

2:30 What, why, and what does it all mean? **Kevin Enge**, Florida Fish and Wildlife Conservation Commission

3:00 – 3:15 Coffee

3:15 – 3:30 Is there a role for invasive journalists in the exotic species problem? Public education as a solution **Leslie Anthony**, author of Snakebit

3:30 – 4:00 Paradise lost: the status of introduced amphibian and reptile management in Florida **Todd Campbell**, University of Tampa

4:00 – 5:00 Discussion – Where to go from here? Group discussion led by Meg, Kenya, Kristen, Kenney and Todd

Other demonstrations:

Jeff Norris, Nuisance Wildlife Removal

Justin Matthew
Matthew Wildlife Rehabilitation, Sarasota FL

Invasive Herpetology Workshop
September 22, 2008
New College of Florida, College Hall Music Room

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Appendix 3 – Public education outreach articles on invasive reptiles, and examples of public responses

INTRODUCTIONS GONE BAD

July 28 2008

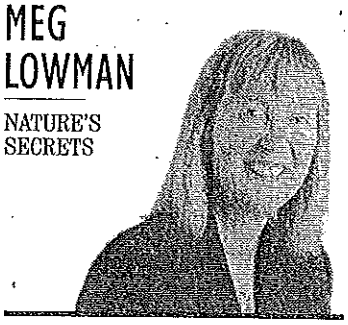
Alien invasions cost us millions

A good gardener doesn't sling mud.

— **Joan Ehrenfield** (Rutgers University professor, in reference to encourage gardeners to plant natives, not aliens)

MEG LOWMAN

NATURE'S SECRETS



In 1932, cane toads (Bufo marinus) were introduced into Australia by the agricultural industry to control an infestation of grubs on sugar cane. The hasty decision to introduce an alien species onto this island continent proved disastrous.

First, the cane toads simply did not eat the grubs, and so control efforts were ineffective. Second, the toad populations exploded, thriving in almost any conceivable habitat from streams to garages to gardens to roadsides. And third, native Australian animals (and pets) that attempted to eat the toads were poisoned and usually killed outright.

Today, over 300 million toads thrive in the "lucky country" from the original dozen or so. The ratio of toads to Australians is 10-to-1!

Millions of dollars are spent annually in control efforts, without much success. Numerous native species, including freshwater crocodiles, Tasmanian devils and many birds, are threatened by cane toads. And worst of all, there is no end in sight to slow the invasion of these aggressive, fast-reproducing and highly toxic critters.

Similar scenarios exist in the United States, where more than 7,000 plant and animal aliens have invaded our shores. (Some scientists argue that a more appropriate term for invasive species is "introduced," which may eliminate some of the emotions from the issue.)

Regardless of terminology, the economics of species introductions undoubtedly incurs emotional responses, with the cost of escaped alien plants from American gardens estimated at over $35 billion a year.

Yet some gardeners continue to plant aliens such as English ivy, periwinkle and Japanese honeysuckle, and many botanical gardens and nurseries continue to sell non-native plants. Australian pine, kudzu and Brazilian pepper, introduced with good intentions, pets or as garden or aquarium plants, for recreational fishing, or for agriculture. An increasing number arrive accidentally, such as zebra mussels that hitchhiked in the ballast water discharge of ships into the Great Lakes. Stories of invasive species read like good science fiction — except they are truth, not fiction!

In hindsight, most invasions were preventable. Many species were intentionally introduced for profit, and others as attempts to control other invaders. The sale of pythons, aquarium plants and iguanas is big business, but often their owners release them into the wild through a combination of carelessness and helplessness. As a consequence, U.S. taxpayers pay over $160 billion a year for invasive species control.

In addition, the indirect costs are enormous. For example, water supplies may become contaminated by insecticides, gypsy moth outbreaks create real estate devaluation, and homeowners devote increasing amounts of time and money fighting fire ants, termites and kudzu.

A growing number of responsible organizations, policymakers and citizens are beginning to advocate policies for invasive species. In 2001, representatives from nurseries and botanical gardens met to develop codes of ethics, discouraging the planting or sale of any non-native plants.

In Florida, the Department of Environmental Protection has created a statewide network of working groups to manage invasive plants on public lands. However, many invasive species experts advocate that an effective national center for the management of inva-

When alien species replace natives, they usually alter the habitat to benefit their own survival, leading to a decline in the health of the natural ecosystem. This provides challenging research issues for ecologists, but it also creates ethical questions: Should introduced creatures be encouraged, at the expense of native ones? What are the rights of native species, or introduced pests? And should we invest billions of dollars in an attempt to retain the integrity of ecosystems that humans inevitably degrade?

One of the largest invasive populations is livestock (sheep, cattle, pigs, goats) that wreak havoc on millions of acres throughout the world — yet we tolerate and even encourage their breeding. On the other hand, invasive brown snakes on Guam led to the extinction of nine of its 13 native bird species. Should policies allow some species to run amok at the expense of others?

As scientists continue to discover the value of nature's secrets — ecosystem benefits like clean water, production of oxygen and carbon storage — invasive species pose a major threat to our health and economy.

■ **Next installment:** Invasive Species in Sarasota County — Did you know a 12-foot python was found approximately 6 miles east of Myakka River State Park? Nature's Secrets will talk about the challenges of alien species in local ecosystems.

Margaret Lowman is director of Environmental Initiatives at New College of Florida. On the Web: www.canopymeg.com

CAN YOU SAY 'PARTHENOGENESIS'?

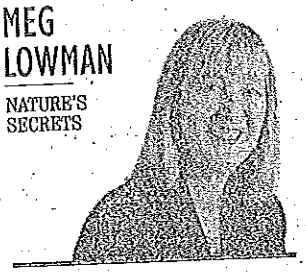
11 Aug, 2008

Pythons uncoil across Florida

"We really need to be addressing the spread of these pythons. They're capable of surviving anywhere in Florida, they're capable of incredible movement — and in a relatively short period."

Frank Mazzotti, University of Florida, Institute of Food and Agricultural Sciences

MEG LOWMAN
NATURE'S SECRETS



The Burmese python has been reported to reproduce by parthenogenesis. In layman's terms, this means that a lone female can give birth to young in the absence of a conventional entanglement with a male. This astounding feat suggests that pythons, one of Florida's newest introduced species, could also become our most successful, rapid and expensive invasion.

If you are involved in real estate, tourism or agriculture in Florida, then here is a word you need to know: partheno-genesis. "Partheno-what?" most citizens will likely respond.

Oxford Dictionary's definition cites, "development of an egg without fertilization." Usually restricted to technical literature about honeybees, earthworms and a few species of lizards, this hard-to-pronounce jargon is becoming a buzzword in South Florida regional government and land-management circles.

A recent invasive species to South Florida, the Burmese python (Python molurus bivittatus) has been reported in the scientific literature to reproduce by parthenogenesis. In layman's terms, this means that a lone female can give birth to young in the absence of a conventional entanglement with a male. This astounding feat suggests that pythons, one of Florida's newest introduced species, could also become our most successful, rapid and expensive invasion.

Monster pets

Burmese pythons were introduced into Florida landscapes by pet owners. An estimated 30,000 pythons are imported into the United States every year, mainly for the pet trade. An unknown number reproduce in homes, museums and pet shops.

Lots of kids go through a "snake phase," and moms unsuspectingly allow the purchase of a 20-inch hatchling, not realizing that a python will become an 8-foot monster after one year's growth. Upon outgrowing their household quarters, many pythons are released in rural roadside settings by these same parents, who think they have averted disaster. But in actual fact, they have created a larger disaster: the invasion of pythons throughout the Southeast, with enormous potential consequences to our economy and environment.

In Florida, invasive pythons were first observed in the Everglades. With Miami as an epicenter for the tropical pet trade, this provided an obvious explanation for the establishment of an unwelcome new reptile in one of the world's most delicate ecosystems. Approximately 201 pythons were captured in or near the Everglades National Park from 2002 to 2005. By 2006, the number doubled to 418. Park biologist Skip Snow estimates that python populations have skyrocketed to over 30,000 from those initial sightings only six years ago.

Right at home

What makes pythons so successful in Florida?

1. They readily adapted their diet to Florida wildlife, eating birds (limpkin and white ibis have been found in python stomach contents), rabbits, squirrels, raccoons, bobcats, deer and American alligators. A recent videotape of a python eating a Florida alligator larger than itself circulated widely on YouTube, attracting millions of horrified viewers. Pythons also have a great appetite for pets (cat and dog owners take note!). Could small children be next?

2. In addition to finding a readily available food supply, pythons grow rapidly in the warm, moist Florida environment. Under favorable conditions, females can reproduce parthenogenically, producing 60 to 80 eggs per year in their native habitat. One pregnant female recently captured in South Florida, contained 85 developing eggs, suggesting that pythons may reproduce even more successfully in Florida than in their homeland of Southeast Asia.

3. And third, pythons are mobile. They are expert swimmers, and have been tracked traveling more than 35 miles to seek new territories. In less than five years, the range of pythons has expanded within both Sarasota and Manatee counties. It is likely that gravid female snakes are slithering their way northward as you read this column.

If the discovery of Burmese pythons mating in swamps of the Everglades weren't threatening enough for park staff, the notion of individual females procreating throughout the state is downright spine-chilling. Florida already faces expensive eradication of invasive plant species, including Brazilian pepper, Australian pine and melaleuca. But, thankfully, plants are not mobile and their removal can be tracked with some degree of accuracy. But pythons, with their incredible mobility and fecundity, may prove the ultimate challenge.

There are solutions

Introduced iguanas, Nile monitors and spiny-tailed lizards have wrought havoc in some South Florida communities, costing taxpayers in Charlotte, Lee and Sarasota counties. The invasion is on, and humans are likely to lose this insidious war, which they unknowingly created. The notion of confronting a 16-foot, 152-pound python on a hike in a park, churchyard or one's own backyard will probably not attract a vibrant community of retirees (or even tourists) flocking to Florida.

But there are solutions! Pet owners, please register your "reptile of concern" with local authorities and insert the new, mandatory microchip (for tracking your pet if it escapes). Or even better, avoid the purchase of exotic pets in subtropical Florida.

Homeowners and visitors, please exercise extraordinary vigilance and report any python sightings immediately to the county hot line. In Sarasota County, call (941) 861-5000 and leave a message for the exotic lizards hot line at any time of day or night.

Pythons are invasive, expensive to control, and threaten Florida's native wildlife as well as overall ecosystem integrity.

Margaret Lowman is director of Environmental Initiatives at New College of Florida. On the Web: www.canopymeg.com

ORNERY NILE MONITORS

25 Aug 2008

'Anoles on steroids' adapt well

"Somebody put us in the really bad position of having to kill these beautiful animals."

*—**Todd Campbell**, University of Tampa, for National Geographic Magazine (2005)*

MEG LOWMAN

NATURE'S SECRETS

Beginning in 2003, a series of signs posted throughout Cape Coral have depicted this headline: Have you seen one of these? An ugly, warty-skinned, long-tailed, hulking Nile Monitor lizard was draped across the notice that described one of Florida's newest invasive reptiles. Enlisting public vigilance to report invasive species is difficult, if not impossible, unless the critters are closer in size to Godzilla. But Floridians are waking up to the cost, energy, devastation and fear factor with regard to some of our recent invasions.

Monitors were introduced accidentally from Africa by frustrated pet owners, who thought they were purchasing a docile and handsome lizard, only to rear an aggressive, ornery-tempered dragonlike beast. Nile monitors were first described by the famous taxonomist, Carl Linnaeus in 1766 as Lacerta monitor. Today, one species of monitor (scientific name Varanus niloticus) is populating Southwest Florida. This species grows up to 7 feet long and can weigh over 50 pounds.

Unfortunately for Floridians, Nile monitors are extremely adaptable, and enjoy a wide range of habitats including forest, savannah, woodland, bush land, thickets, scrub, swamps, mangroves, lakes and rivers. Their only major requirement is water. Since invading Florida, they have also adapted to rooftops, swimming pools, embankments, streets, walls, yards, and roadways. In their homeland of Africa, monitor populations are kept in check by their predators: lions, mongoose, cobras, crocodiles, and large eagles. (One can only hope that, despite pressures to control monitor populations, their enemies are not introduced as an antidote; our landscape is far safer with monitors in the back yard than with lions and cobras!)

Other characteristics of monitors that give them an amazing edge on survival are their abilities to run, climb, swim and dive. In short, they are the proverbial "anoles on steroids" and exemplify Charles Darwin's survival of the fittest. Monitors were first observed in Florida around 1990, with the first recorded sighting at Four Mile Cove Ecological Park adjacent to the Caloosahatchee River. Residents in nearby Cape Coral have reported monitors feeding on their ducks, rabbits, goldfish, and digging grubs from their lawns. Biologists have observed monitors decimating populations of gopher tortoises, burrowing owls, and larger burrowing mammals as well as bird nests.

Professors Todd Campbell and Gregg Klowden of University of Tampa are ringleaders in stalking these aggressive lizards, but their search is almost akin to finding a needle in a haystack. Since original release in the Cape Coral area, monitors have expanded their range into Miami-Dade County, Pine Island, Gasparilla Island, Naples, and Fort Myers.

Given their aggressive behavior and relatively armor-like exterior, monitors will not be easy to eradicate. Citizens are encouraged to report any sightings to county "lizard alerts" or appropriate authorities for immediate removal from public and private properties.

Like most introduced species, monitor populations underwent four classic stages in their invasion: 1. introduction; 2. establishment; 3. naturalization and dispersal; and 4. pest status. The purpose of controlling invasives immediately upon invasion is to avoid reaching stage 3 (naturalization), at which time they begin to displace native animals, eventually disrupting the equilibrium of ecosystems and costing significant expense to eradicate.

Dogs are one possible solution in the control of invasive animals. Dogs have a keen sense of smell that could be enlisted to detect monitors via odor. The U.S. Department of Agriculture has its own Beagle Brigade, which inspects baggage for agricultural contraband in many international airports. Another "dog squad" successfully sniffed skin cancer sites in human patients, and uses scent to discriminate from benign versus melanoma. Dogs have also been successfully trained to detect explosives, locate pipeline leaks, sniff drugs or firearms in airline security, and locate turtle predators and invasive brown tree snakes in Guam. Amber Roux, New College thesis student who studied the possibility of using dogs for Nile monitor detection in Florida, concluded that "Myakka River State Park could someday have its own invasive and threatened species detection dog!"

CITIZEN ACTION

Have you seen an invasive python, Nile monitor or Iguana? Please call the Sarasota County hot line at (941) 861-5000 and leave a message for the Lizard Alert.

ECOLOGY EVENT: Come search for invasive species at Red Bug Slough nature reserve (on Beneva Road just south of Proctor Intersection). Public walk Sept. 6, 11 a.m.-12:30 p.m. Meg Lowman and her New College ecology students will demonstrate "Field Ecology — Tools and Methods." Free and open to the public.

Margaret Lowman is director of Environmental Initiatives at New College of Florida. On the Web: www.canopymeg.com

HERALD-TRIBUNE ARCHIVE / 2004

This Nile monitor was trapped in a Cape Coral neighborhood in 2004.

CONSUME THE INVADERS

8 Sep 2008

An iguana in every pot

Iguana Stew
Yield: 4 Servings
Ingredients: 1 iguana, 1 large onion, 2 cloves garlic, 3 tomatoes, 2 green peppers, 4 teaspoons achiote oil, 1 pinch pepper, salt to taste

Instructions: Cook iguana in salted water until the meat is tender (take care not to let it get too soft). Cut in portions. Season with all the above ingredients and cook with 1 cup water until almost dry.

MEG LOWMAN
NATURE'S SECRETS

ACTIVITY

Report any invasive reptiles seen on your property or on Sarasota County lands by calling Lizard Alert on (941) 861-5000.

Slithering through neighborhoods at 6 feet in length and tipping the scales at 25 pounds, iguanas pose a significant threat to Florida wildlife, as well as to the homeowner. Their prehistoric physique makes them look like close relatives of ET, or perhaps escaped creatures from the movie set of Godzilla.

Three iguana species have been introduced into Florida in the past 50 years: green iguana (Iguana iguana), native to Central and South America; black spiny-tailed iguana (Ctenosaura similes), also from Central America; and Mexican spiny-tailed iguana (Ctenosaura pectinata). The latter species is native to western Mexico, where they are considered a delicacy (to eat, that is!).

Romance ends

Iguanas were initially tolerated, and even loved, at Fairchild Botanical Gardens in Miami, when they first established a local population several decades ago. But when these enormous herbivores began to graze prized orchids and leveled the entire hibiscus display, director Mike Maunders created a new policy of lizard removal throughout the grounds.

Over the past decade, iguanas have also overrun Boca Grande, achieving a population of 10,000 individuals or more. Lee and Charlotte counties have spent several hundred thousand dollars in attempting to control these invasive pests. Iguanas have since expanded northward to the Tampa Bay area, reportedly released by careless pet owners.

Iguanas eat shrubs, trees, landscape plants, orchids, fruits, bird eggs, tree snails and insects — hence, they inflict serious damage to Florida ecosystems and landscapes. They also dig nesting burrows that can destroy sidewalks, sea walls and gardens. Iguanas can transmit Salmonella by defecating in ponds or rivers (iguanas love to swim!) or into swimming pools when they bask in foliage or on pool cages.

On Gasparilla Island, residents say iguanas are chewing through insulation in attics, consuming prize-winning flower beds, displacing gopher tortoises and scaling rooftops.

Females produce up to 65 eggs in one clutch, so two iguanas can quickly become an outbreak of 200 beasts after three or four nesting seasons. As cold-blooded (also known as exothermic) animals, iguanas do not produce heat. Instead, they bask in the sun and comprise an efficient solar-powered lizard-machine.

Useful protein

So how can these highly fecund and aggressive creatures be controlled in south Florida and beyond?

Iguana vasectomies were suggested (albeit jokingly) by Matt Rosenberg in his News of the Skewed report from Seattle. Another suggestion is to control the pet trade, making it illegal to sell or own invasive reptiles, and/or requiring a tracking chip and a permit for any iguana sales. Because green iguanas are not native to Florida, they are not legally protected. Private property owners may trap (and barbecue) these hulking creatures on their own property; iguana stew may represent the most sustainable and energy efficient means of controlling iguana populations.

For Christopher Columbus and his sailors, iguana was a delicacy; they reported it as "white, soft and tasty." Google lists 243,000 results for the topic "iguana recipes." These large, cumbersome creatures form an important part of the diet in Central and South America.

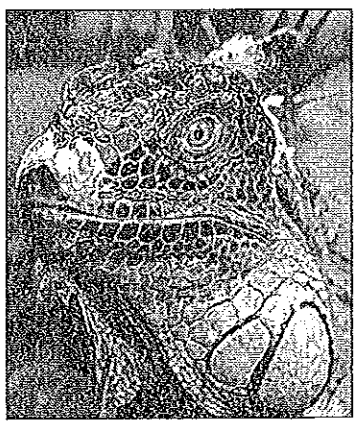
Considering the outrageous cost of controlling invasive iguana, and the extensive ecological damage wrought by their invasions into Florida landscapes, it seems tempting to contemplate them as a new and highly sustainable cuisine.

Conservation cuisine

In Nick Payne's exotic kitchen (www.exotickitchen.com), he writes about the popularity of iguana as a main course: "Throughout Mexico, ancient manuscripts have revealed that iguana has been a source of food for several thousand years. Although tough yet tasty when grilled on the fire, iguana sauteed in tomato, onion and chili is the most traditional."

How about serving iguana hors d'oeuvres at green fundraisers? After all, eating iguana helps to conserve native landscapes and wildlife — so iguana cuisine represents a sustainable diet! Colonel Sanders, take note!

Margaret Lowman is director of Environmental Initiatives at New College of Florida. On the Web: www.canopymeg.com



AP ARCHIVE / 2008 / KENT GILBERT

Iguana throwdown for Bobby Flay?

AN ONSLAUGHT OF ALIEN REPTILES 6 OCT 2008

Invasion of the eco-snatchers

Stop studying them and start killing them!

— **Dan Simberloff**, Institute for Biological Invasions, University of Tennessee

MEG LOWMAN

NATURE'S SECRETS

The invasion is on. During 2003, iguanas were first sighted in Sarasota County. Burmese pythons were spotted in 2006, with Nile monitors confirmed in 2007. Such official observations, however, are only chance events and indicate that the critters likely existed undetected in the region prior to a confirmed sighting.

So, after about five years of reproduction for some, local reptile invasions may be about to explode. What can county officials do about this incredible onslaught of unwelcome snakes and lizards?

The bad news is that regional governments have limited budgets, so identifying the most effective strategies is critical. But the good news is that obtaining sound scientific information about invasives before they become widespread can save enormous amounts of time and money.

For this reason, the science partnership between Sarasota County and New College recently convened a workshop on invasive reptiles, to get the facts and find solutions *before* the critters take over. Sept. 22, reptile experts from around Florida and beyond gathered in one room to determine "best practices" for our region.

The workshop constitutes a real economic development action because these animals can devastate tourism, gardening, native wildlife, and even road safety. The Invasive Reptile Workshop was a great example of county officials taking the offensive (rather than defensive) on a potentially noxious invasion.

Fortunately, as with almost every other environmental challenge that Florida faces, professionals in other places have often configured good solutions. By bringing in experts, we can learn from their experience.

Here are a few factoids highlighted by our visiting experts. (Warning: some of this information could be downright frightening to readers!)

three frogs, one turtle, and one crocodile.

2. Nearly 100,000 pythons were imported for the pet trade in the last decade, many slithering northward through Florida at a rapid rate, thanks in part to the warming climate trends (since pythons are averse to cold). Northeast Florida already has recorded a large variety of invasive reptiles!

3. In 2001, fewer than 10 pythons were captured in the Everglades, but in 2008 more than 600 were trapped and eliminated. Biologists are not sure how many pythons exist in the Everglades, but estimates go up to 30,000.

4. A local trapper eliminated over 12,000 black spiny-tailed iguanas from Gasparilla Island, with an average length of slightly over 3 feet. The island ecosystem was devoid of anoles, gopher tortoises and most birds, due to the voracious appetites of the iguanas.

5. In 1998 alone, 1,800-plus shipments of exotic reptiles containing over 500,000 reptiles came into the ports of Miami and Tampa alone. Their total street value was estimated at nearly $3 million. Miami is considered the Grand Central Station for imported reptiles.

6. Reptile imports have very little enforcement, despite the fact that Florida's climate is exceptionally conducive to escapees' survival. It is common knowledge around Miami that school children needing a last-minute science project can easily find escaped exotic reptiles in the parking lots and yards of a well-known exotic reptile distribution center.

7. Nile monitors are spreading north from Cape Coral, where they have tormented residents for the past several years. These reptiles are smart, aggressive and long-lived.

Armed with these sobering facts, Florida needs to deploy effective strategies to eliminate invasive reptiles. At the workshop, several sound solutions were proposed. I highlight a few of the least expensive, and perhaps most effective, strategies:

- EDRR — early detection and rapid response.
- Educate the public.
- Encourage citizens to report invasive reptiles. The Sarasota County Lizard Alert is (941) 861-5000.
- Create an online key to identification of all 44 invasive reptiles, including their footprints (in sand).
- Write letters to state government advocating control of the pet trade.
- Euthanize all invasive reptiles as the most ethical control measure.
- Prioritize new invasions, to "nip them in the bud," which saves time, energy and money.

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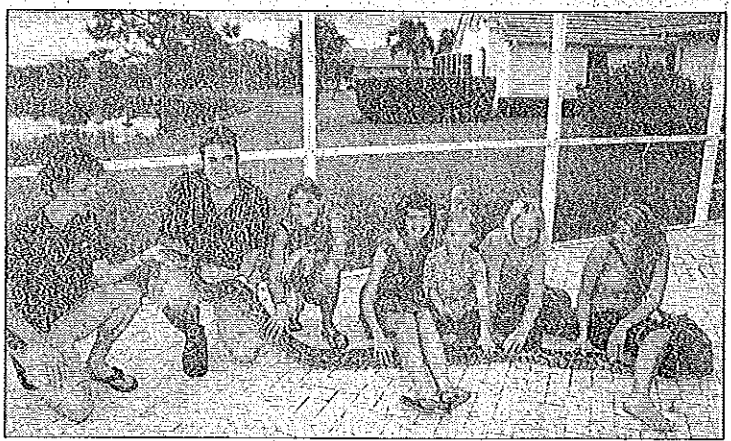

PROVIDED BY MEG LOWMAN

COURTESY PHOTO / NUISANCE WILDLIFE REMOVAL INC.

From left, Matthew Hunt, Bronson Blades, Chad Picard and Buddy Howell Jr. hold a 10-foot Burmese python that was captured at a home in Myakka City on Friday. Nuisance Wildlife Removal in Ellenton was dispatched to the home off Crosby and Verna Bethany roads.

Finding 10 feet of trouble

By PATRINA A. BOSTIC
patrina.bostic@heraldtribune.com

MYAKKA CITY — As a wildlife trapper, Matthew Hunt has captured his share of snakes.

Usually, they are in the 3- to 6-foot length and no big deal.

But on Thursday, Hunt got a call that a Myakka City homeowner had discovered a snake in her driveway.

What Hunt found was shocking: a 10-foot albino Burmese python.

"It's something that would scare you if you stumbled upon it at night," said Hunt, a field supervisor at Nuisance Wildlife Removal in Ellenton.

The company received a call about 9:30 p.m. Thursday from the Manatee County Sheriff's Office to respond to the residence in Myakka City.

The home where the snake was found is off Crosby and Verna Bethany roads in Myakka City in an area of ranchettes and homes on large lots.

INTERESTED?

People interested in adopting wildlife can go to http://myfwc.com/nonnatives/amnestyDay2008.html to download an application. For more information, contact Jenny Tinnell at (850) 926-0128 or via e-mail at jenny.tinnell@myfwc.com.

The people who found the snake had corralled it into a box.

Hunt had planned to put the snake in a tank he carries, but the tank was too small, so he taped up the box and took it back to his workplace.

Jeff Norris, president of Nuisance Wildlife Removal, said he and Hunt chuckled when they first got the call that someone had found a 10-foot python.

Not until they saw the creature were they convinced. Later, they took a photo of four men holding the snake.

"This is really an usual thing," said Norris, whose Web site is floridawildlifetrapper.com. "I would imagine it was someone's pet; either it escaped or someone got tired of it and turned it loose."

The Burmese python is on the Florida Fish and Wildlife Conservation Commission "reptiles of concern" list and is required to have a microchip placed in it that identifies the owner. Python owners must get a state permit before they can buy the snake.

Nuisance Wildlife Removal is planning to scan the python to determine if it has a microchip and learn who might own it.

Gary Morse, a spokesman for the fish and wildlife commission, said pet owners are required to report when they lose a pet that is listed on the "reptiles of concern" list.

He said if a pet owner is located from microchip information, he or she could be fined.

If no owner is found, the striking yellow and white python could be euthanized, he said.

"You don't just find an albino Burmese python running around," Morse said. "In this case, the snake running around would be a violation."

Morse said pet snakes sometimes become a burden on owners.

"They get expensive," he said. "The owners become afraid of them or they can't handle them."

The agency, he said, is working to form an adoption network that would allow Floridians to adopt non-native pets that owners no longer want.

Lowman, Margaret

From: SpanishLakes@aol.com
Sent: Saturday, October 22, 2005 11:07 AM
To: meg@canopymeg.com
Cc: SpanishLakes@aol.com
Subject: Siting of invasive lizard Iguana Iguana.

Meg,

Hope you remember me from our contact through Booker Middle School. I have since moved on to try teaching high school students, a new challenge for me. I am writing today to let you know of a recent siting I had of an invasive species to Florida. While golfing at a local golf course, Capri Isles, in Venice I had the opportunity to observe an Iguana Iguana, the common iguana. I know this is a species that was somehow released into the Florida environment in the Sanibel Island area a few years ago. I watched a show a few months ago on the concerns that invasive lizards (also the Nile Monitor lizard up from the Keys) were having on the local indigenous bird populations. I was anticipating hearing that these lizards were moving into our Sarasota area but was surprised that I would be one of the observers in such a populated area. This lizard was approximately a meter in length including the tail and very well nourished, it was not lacking in aggresiveness as it promptly displayed its throat pouch as a warning for me to keep my distance. I have included an attachment of a picture of the common iguana showing the coloration and morphotype which is a match for the lizard I observed.

My wish in contacting you is informational for our general public so that they will be aware of this type of lizard as an occaisonal viistor to our backyards. They may also want to keep a better eye on "Fluffy" when letting them out for the night. I hope to alay any overreaction that might occur when people start talking about the "GIANT meat eating lizards" that are attacking our area. This lizard was magnificant to observe in a natural setting and I feel blessed for the chance to watch it go about its business. You could tell that I was a minor inconvenience to it and it tolerated my existance which in a way was humbling to me.

I hope all is well with you and that you will continue your fine work in reaching many people who need to be aware of the natural world around them. Cindy and I love your articles in the Sunday paper.

Respectfully yours,
Peter Hinman-Cosola
North Port High School Science Teacher
1347 Pinebrook Way
Venice, Florida 34285

MiamiHerald.com

Posted on Thu, Feb. 21, 2008

Pythons could thrive -- beyond South Florida

BY CURTIS MORGAN

The Everglades apparently isn't big enough for the giant invaders, who have grown fat, happy and increasingly numerous on a diet of unsuspecting natives. Over the last year, pythons have been found in the wild from Key Largo to Glades County -- and a new study suggests the exotic predators could spread beyond South Florida.

Far beyond.

The Burmese, or Indian, python -- at least theoretically -- would feel right at home from California to Delaware in a array of habitats from scrub deserts to mountain forests, according to a study by federal scientists. In 100 years, global warming might even extend the range for the big snakes as far north as the Big Apple.

The results, said lead author Gordon Rodda, a zoologist with the United States Geological Survey, will probably even surprise many biologists.

'Many people get their image of where pythons live from *The Jungle Book*,' " said Rodda, one of a number of scientists working with Everglades National Park on eradication efforts. ``Pythons don't just occur in tropical areas."

The study, soon to be published in the journal Biological Invasions -- the exotic-species threat is serious enough to merit its own academic publication -- doesn't point to places pythons definitely will spread, but presents maps showing where the climate could allow migrating or illegally released pythons to survive.

The suitable habitat, which stretches from coast to coast, underlines an all-terrain capability that scientists say has allowed one of the world's largest snakes to thrive in the Everglades.

"It's a pretty hardy animal," said Skip Snow, a biologist with Everglades National Park who leads a multiagency effort to eradicate fast-spreading and formidable invaders that threaten native wildlife.

Pythons, which can top 20 feet in length, potentially could upset the natural balance of the Everglades or other wild places -- a concern memorably illustrated in 2005 by now-famous photos of a 13-foot python that exploded after attempting to swallow a six-foot alligator.

In 2002, when python numbers first started climbing in the park, the conventional wisdom was that nature would control them, Snow said -- fire ants would eat their eggs, gators would eat them or maybe a deep freeze would kill them all.

Now, they're breeding and the population appears to be booming. The number of captures in the park hit nearly 250 in 2007, Snow said, more than a 50 percent jump. While that may not sound like much in so vast a park, the captures represent only a fraction of the actual population.

Last year, pythons also showed evidence of pushing beyond the Everglades, with more than a half-dozen captures in Key Largo, including one snake found because it swallowed an endangered wood rat equipped with a radio tracking device. Another snake was found as far north as the Brighton Seminole Reservation in Glades County, where it revealed itself, freshly chopped, under a roadside mower.

To assess the potential threat of the python nationally, Rodda and two colleagues in the USGS Invasive Species Science Branch -- ecologist Catherine Jarnevich and wildlife biologist Robert Reed -- looked at weather patterns in its native Southeast Asia.

There the snake is found in 11 countries, from Bangladesh to Vietnam, and survives not just in swamps but forests, scrub deserts and the foothills of the Himalayas. Hibernation, which can last for four months, allows the snakes to survive extended chills in some areas.

Rodda stressed that the study was intended only as a broad survey of suitable areas and did not take into account critical factors like the availability of prey or burrowing areas. But similar climate-based assessments are frequently used to evaluate the threats of exotic plants, weeds and pests, the study said.

The scientists found that the snakes could adapt to climates in 11 states across the southern border as well as Mexico. Under a global warming model, it could make a go of it as far north as New York and New Jersey.

For scientists and state wildlife managers, the continuing spread of the snake on its own is a real concern.

"The evidence from Florida is that they are spreading northward at a rapid rate," Rodda said.

Last year, the Florida Fish and Wildlife Conservation Commission adopted tougher restrictions, including snake registration, in an effort to confine the python to south of Lake Okeechobee and deter illegal releases, considered the source of the problem. The agency is also sponsoring exotic-pet amnesty days for owners to turn in unwanted creatures, with the third set for Saturday at Metrozoo.

But Rodda said the study underlines a bigger threat that released pets could take hold elsewhere, as they have in the Everglades. He and Snow hope wildlife managers in other states deemed "suitable" for the big snakes pay attention and begin to adopt restrictions, like Florida.

"The most direct use of this map is for managers who are concerned about where something could get released and survive," Rodda said. 'If somebody in Corpus Christi, Texas, says, `I have a bunch of pythons and I want to release them,' then worry about that dude. It could be a big problem."

Appendix 4 – Data sheets on invasive reptile hotline activity, ground-truthing, and gut content analyses of iguanas

Date	Location	Date Seen	Time	Contact	Contact Numbe	Species
28-Mar	Colonial Gables woodr	21-Mar	4:30 PM	Liz Ross	237-8020	Unknown
28-Mar	Ackerman Lake	24-Mar	3:00 PM	Jim Lanier	925-7499	Green Igua
28-Mar	831 Carnousti Dr	27-Mar	2:00 PM	Dale Shafer	493-5150	Black Spiny
28-Mar	1976 Pennsylvania Ave	28-Mar		Carl Kaufmann	697-2406	Black Spiny
28-Mar	718 S. Casey Key	17-Mar	9:30 AM			Black Spiny
28-Mar	Dearborn/McCall gas st	27-Mar	3:30 PM	Pat Miller	475-8181	Monitors
28-Mar	Casey Key Public beach	27-Mar		Nancy Polk	484-1535	Black Spiny
28-Mar	6820 Manasota Key Rd	27-Mar	5:30 PM	Rita Miller	474-6820	Black Spiny
28-Mar	1974 Mississippi Ave	28-Mar	9:15 AM	Sherry Canterbi	810-919-5717	Black Spiny
28-Mar	Cape Haze Drive	14-Mar		Donald Gavel	697-1334	Black Spiny
28-Mar	Sawgrass Road- Celery Field Ackerman Park			Marge Bernett	366-2787	Monitor
28-Mar	2451 Belle Rd	28-Mar	10:00 AM	Sharon Spencer	468-2081	Black Spiny
28-Mar	Boca Grande Lighthous	18-Mar		Karen McNair	255-6923	Black Spiny
28-Mar	701 S. Green Cir	27-Mar		Joan Osterberg	485-9162	Black Spiny
28-Mar	Shamrock and Meridiar	21-Mar		Elizabeth Hamil	493-1876	Black Spiny
28-Mar	3761 Torrey Pines Boul	20-Mar		Janon Zordan		Green Igua
28-Mar	119 Grand Oak Circle H	24-Mar		Evelyn Viava	486-4206	Green Igua
28-Mar	Bayshore Dr, gladstone	25-Mar	11:30 AM			Unknown
28-Mar	Lemon Bay	28-Mar	1:00 PM	Chris Landry	225-717-5779	Black Spiny
28-Mar	8233 Cypress Lake Dr	27-Mar	6:00 PM	Celeste Garcia	355-4079	Unknown
28-Mar	3905 Casey Key Rd. Gul	26-Mar		Dawn Durnell	966-5987	Black Spiny
28-Mar	Lemon Bay Park	28-Mar		Patricia Winne	493-3053	Black Spiny
28-Mar	715 Sesame Street	21-Mar	1:00 PM	Donna Pearson	474-7732	Unknown
28-Mar	2091 Wood Hollow Lan	28-Mar	11:30 AM	Dagmar Sauers	377-7842	Monitor
31-Mar	Palm and Pine Mobile H	14-Mar		Shirley Dejean	419-561-1432	Unknown
31-Mar	620 Casey Key Rd	31-Mar		Don Heath	484-3628	Black Spiny
31-Mar	Myrtle Trace Plantatior	31-Mar	9:50	Milley	496-8818	Unknown
31-Mar	Lemon Bay	27-Mar	3:30	Judy Lindauer	966-1227	Black Spiny
31-Mar	Lemon Bay Park	30-Mar	11:30 AM	Jerry and Maryanne Palmer		Black Spiny
31-Mar	8710 Midnight Pass Roi	31-Mar	11:00 AM	Pat	349-6776	Black Spiny
31-Mar	6361 Roberta Dr	14-Mar		Janice	473-3638	Unknown
31-Mar	1924 S. Osprey	29-Mar				Unknown
1-Apr	613 Hibiscus Drive	1-Apr		Jack Stevenson	488-0613	Unknown
1-Apr	Village Walk	1-Apr		Boyd Phillips	925-8775	Black Spiny
1-Apr	832 Diane Cir	1-Apr	2:45 PM	John Fellin		Black Spiny
2-Apr	900 Lord Street	26-Mar	1:00 PM	Avis Klein	473-0477	Black Spiny
3-Apr	Phillipi Park Playground	3-Apr		Ken Marton	650-5567	Unknown
7-Apr	South Lido Ben Franklin	7-Apr				Black Spiny
8-Apr	6885 Manasota Key Ro.	5-Apr		Neil Goeppinger		Black Spiny
12-Apr	Lemon Bay Park	12-Apr		Jessica		Black Spiny
12-Apr	Shamrock and Meridian Alligator Run Bridge					Black Spiny
14-Apr	Stump Pass Beach	11-Apr		Julie	400-5326	Green Igua
14-Apr	2550 Placida Rd	14-Apr		J. Hummon	375-2214	Black Spiny
14-Apr	Lemon Bay Park	13-Apr		Chris Angel	474-2531	Unknown
15-Apr	41 and Shamrock	1-Apr		Louise Brown	412-9692	Unknown

29-May	Shamrock Park	29-May		Kit McKeon	485-3193	Black Spiny
9-Jun	1040 Owl. Rd Dale Lake	9-Jun		Mr. Sisum	473-1215	Black Spiny
1-Jul	6420 Manasota Key Ro	1-Jul		Mrs. Huneke	474-1521	Unknown
Date	**Location**	**Date Seen**	**Time**	**Contact**	**Contact Numbe**	**Species**
1-Jul	Nokomis	1-Jul		Henry Barker	-	Unknown
14-Jul	Unknown	14-Jul		Hera	-	Monitor
23-Jul	Deer Prairie Creek	23-Jul		Brian Pavlina	-	Burmese P
29-Jul	7600 Midnight Pass Ro	28-Jul	4:30 PM	Roger Skidmore	346-2725	Black Spiny
4-Aug	6422 Otis Road	4-Aug		Imogene Bristo	426-8145	Black Spiny
11-Aug	Legacy Trail Sarasota P	11-Jul			-	Burmese P
11-Aug	618 Seminole	5-Aug		Joe	497-0829	Burmese P
12-Aug	4549 Lola Drive	12-Aug		Angela Hockett	951-0311	Unknown
13-Aug	Wharf Road Vamo Roa	13-Aug		Chance Steed	-	Monitor
26-Aug	*1623 Kenilworth*	26-Aug		Efton Jiles	927-6446	Monitor
26-Aug	*6149 Rockefeller Ave*	26-Aug		Judy and Bill Ge	350-1745	Iguana

Public Sites with Populations		Contact	Latitude	Longitude
Boca Grande	Black Spiny Tail Iguana, M	George Cera	26.749850	-82.261970
Gasparilla	Black Spiny Tail Iguana, M	George Cera	26.789090	-82.269940
Myakka State Forest	Black Spiny	Officer	27.075800	-82.323690
Lemon Bay	Black Spiny Tail Iguanas		26.973580	-82.374400
Shamrock Shores	Black Spiny Tail Iguanas		27.052759	-82.435956
Oscar Sherer	Green Iguanas, Burmese Pythons		27.173410	-82.468190
Ackerman Park	Green Iguanas		27.331820	-82.441299
Celery Fields	Possible Monitor breeding unknown		27.331970	-82.435700
Manasota Scrub Prese	Black Spiny Tail Iguanas		27.017520	-82.391250
Boca Grande State Par	Black Spiny Tail Iguanas		26.741910	-82.263330
Englewood Bay Park	Black Spiny Tail Iguanas,		26.972150	-82.373740
Deer Prairie Creek Pre	Black Spiny Tail Iguanas, F	John J.. Roche	27.106370	-82.309220
Carlton Reserve	Black Spiny Tail Iguanas, F	John J.. Roche	27.127450	-82.333660
Nokomis Beach	Black Spiny Tail Iguanas	718 S Casey K	27.122800	-82.462820
Blind Pass Park	Black Spiny Tail Iguanas		27.218000	-82.516510
South Lido Park	Black Spiny Tail Iguanas		27.304030	-82.566355
Phillipi Estate Park	Green Iguanas	Ken Marton c	27.269791	-82.530731
Myakka State Park	Python breeding unknown		27.246750	-82.291800

Unknown
Myakka State Park
Red Bug Slough Preserve
Don Pedro State Park
Jacaranda Park
Charlotte Harbour Preserve State Park
Amberjack Environmental Park
Oyster Creek Regional Park
Kiwanis Foundation Park
Cedar Point Park

Sheet1

	A	B	C	D	E	F	G	H	I	J	K	L
1	Locality	SRQ			Lat/Long					# regen, * broken		
2												
3	capture	ID	dd/mm/yy	species	sex	maturity	breeding	wt (g)	SVL (cm)	Total length (cm)	head length/width (cm)	Stomach samples (plant, animal)
4	Lem Bay	A	8-Jun	Black Spiny Tail Iguana	F	I	N	240	20.5	60.5	4.52/2.88	(+), (+)
5		B			M	I	N	255	21.5	61.5	5.24/3.72	(+), (-)
6		C			F	I	N	250	20	56.5	4.33/3.06	(+), (+)
7		D			F	I	N	260	21.5	62	4.74/3.43	(+), (-)
8		E			F	I	N	225	19	51	4.29/3.08	(+), (-)
9		F			M	I	N	40	11.5	35.5	2.86/1.98	(+), (-)
10		G			F	I	N	175	18	56	3.92/2.735	(+), (-)
11												
12												
13												
14	Shamrock	H	8-Jun	Black Spiny Tail Iguana	U	I	N	5.9	5	18.5	1.48/1.17	(+), (-)
15		I			U	I	N	6.5	5.75	12*	1.74/1.19	(+), (-)
16		J			U	I	N	6.5	5.5	7.5*	1.8/1.205	(+), (-)
17		K			U	I	N	6.3	5.5	19	1.7/1.3	(+), (-)
18		L			U	I	N	5.9	6	19.25	1.76/1.1	(+), (-)
19		M			M	M	Y	300	20.5	61#	4.525/3.28	(+), (-)
20		N			F	M	Y (w/ eggs)	620	26.5	70.5#	5.59/4.21	(+), (-)
21		O			F	M	Y (w/ eggs)	650	26	63	5.34/3.95	(+), (-)
22												
23												
24	Blind Pass	P	8-Jun	Black Spiny Tail Iguana	M	I	N	280	19.5	60	4.48/3.55	(+), (-)
25		Q			F	I	N	500	23	61.5	4.73/3.59	(+), (-)
26		R			M	I	N	175	16	50.5	3.4/2.7	(+), (-)
27		S			F	I	N	380	22	52.5	4.51/3.48	(+), (-)
28		T			M	I	N	125	14.5	44.5	3.24/2.34	(+), (-)
29		U			F	I	N	275	19	59.5	4.11/3.2	(+), (-)

30		V			M	M	Y	450	22.5	38#	4.94/4.18	(+), (-)
31		W			F	I	N	275	20	46#	4.26/3.13	(+), (-)
32		X			M	I	N	80	12	38.5	2.88/2.18	(+), (+)
33		Y			F	I	N	360	22.5	67	4.59/3.16	(+), (+)
34		Z			M	M	Y	1125	30.5	91	6.8/5.94	(+), (+)
35		AA			M	M	Y	1700	35.5	92.5	8.1/6.5	(+), (+)
36		AB			F	M	Y	825	28.5	73.5	5.89/4.04	(+), (+)
37												
38												
39	KEY:			n= 28								
40	* = TAIL LOSS											
41	# = TAIL REGENERATION											
42												

Sheet1

	A	B	C	D	E	F	G	H	I	J	K	L
1	Locality				Lat/Long							
2												
3	capture	ID	dd/mm/yy	species	sex	maturity	breeding	wt	SVL	Total length	head length	Stomach samples
4												

Locality SRQ Lat/Long # regen, * broken

capture	ID	dd/mm/yy	species	sex	maturity	breeding	wt (g)	SVL (cm)	Total length (cm)	head length/width (cm)	Stomach samples (piant, animal)
Lem Bay	A	8-Jun	Black Spiny Tail Iguana	F	I	N	240	20.5	60.5	4.52/2.88	(+), (+)
	B			M	I	N	255	21.5	61.5	5.24/3.72	(+), (-)
	C			F	I	N	250	20	56.5	4.33/3.06	(+), (+)
	D			F	I	N	260	21.5	62	4.74/3.43	(+), (-)
	E			F	I	N	225	19	51	4.29/3.08	(+), (-)
	F			M	I	N	40	11.5	35.5	2.86/1.98	(+), (-)
	G			F	I	N	175	18	56	3.92/2.735	(+), (-)
Shamrock	H	8-Jun	Black Spiny Tail Iguana	U	I	N	5.9	5	18.5	1.48/1.17	(+), (-)
	I			U	I	N	6.5	5.75	12*	1.74/1.19	(+), (-)
	J			U	I	N	6.5	5.5	7.5*	1.8/1.205	(+), (-)
	K			U	I	N	6.3	5.5	19	1.7/1.3	(+), (-)
	L			U	I	N	5.9	6	19.25	1.76/1.1	(+), (-)
	M			M	M	Y	300	20.5	61#	4.525/3.28	(+), (-)
	N			F	M	Y (w/ eggs	620	26.5	70.5#	5.59/4.21	(+), (-)
	O			F	M	Y (w/ eggs	650	26	63	5.34/3.95	(+), (-)
Blind Pass	P	8-Jun	Black Spiny Tail Iguana	M	I	N	280	19.5	60	4.48/3.55	(+), (-)
	Q			F	I	N	500	23	61.5	4.73/3.59	(+), (-)
	R			M	I	N	175	16	50.5	3.4/2.7	(+), (-)
	S			F	I	N	380	22	52.5	4.51/3.48	(+), (-)
	T			M	I	N	125	14.5	44.5	3.24/2.34	(+), (-)
	U			F	I	N	275	19	59.5	4.11/3.2	(+), (-)
	V			M	M	Y	450	22.5	38#	4.94/4.18	(+), (-)
	W			F	I	N	275	20	46#	4.26/3.13	(+), (-)
	X			M	I	N	80	12	38.5	2.88/2.18	(+), (+)
	Y			F	I	N	360	22.5	67	4.59/3.16	(+), (+)
	Z			M	M	Y	1125	30.5	91	6.8/5.94	(+), (+)
	AA			M	M	Y	1700	35.5	92.5	8.1/6.5	(+), (+)
	AB			F	M	Y	825	28.5	73.5	5.89/4.04	(+), (+)
KEY:			n= 28								
* = TAIL LOSS											
# = TAIL REGENERATION											

Locality ____________________ Lat/Long ____________________

capture	ID	dd/mm/yy	species	sex	maturity	breeding	wt	SVL	Total length	head length	Stomach samples		

Appendix 5 – Three tiers of potential carbon modeling proposed for Sarasota County

1. **Low tier at $6000 – Parameterization and point validation of the DayCent model for 15-20 factors to include: understory, overstory, soils, hydric conditions, management combinations all of which are representative of Sarasota County to be determined by county staff.**
   Results of low tier – Current Carbon stocks of selected landcover types, one-two simple case studies for management and future environmental changes as predicted for Florida. (NOTE: this level funded by New College budget)

2. **Mid tier at $9000 – All of the above plus more in-depth case studies of environmental changes and predictions for future impacts and scenarios; and training of 1-3 staff and students to utilize the model and perform their own scenarios/case studies. (training at Colorado State University where the models are developed).**
   Results of mid tier – Current carbon stocks, plus extensive case studies for management and future environmental changes, plus training of staff to utilize the model and perform additional cases studies into the future. (NOTE: this level pending input of $3000 from County or other sources)

3. **High tier at $12,000 – All of the above, plus a gridded approach to simulate the entire county with 1 K climate data, with actual soils, and all of the representative vegetation types. This would also include 1-2 scenarios performed across all of the appropriate systems on the grid.**
   Results of high tier – Current carbon stocks, plus extensive case studies (as above), plus training of staffers to utilize the model, plus a detailed model that includes all of the vegetation types utilizing different environmental scenarios….. "the full Monty" .
   (NOTE: this level pending input of $6000 from County or other sources)

Appendix 6 – County vegetation maps that would utilized in the carbon sequestration models by the team of Heinz Center and Colorado State University climate change modelers

Lilard

Carbon and Fire Data for Quercus virginiana

Carbon Data required for models, collected by New College students

- Initial percent mass of leaves that is N is 0.83% before decomposition. Grams of N immobilized per gram of weight loss is 0.0033. Critical % N (Concentration after which N crystallizes and transfers into humus) is 1.3%. Initial % lignin present before decomposition is 18.7%. (John et al 1986)

- The soil beneath Quercus virginiana clusters contained 5802 ± 519 g/m^2 C and 446 ± 26 g/m^2 N. $P<0.05$ (Jessup et al 2003)

-Mean canopy diameter for measurements made in 12 canopy locations come to 31.3 m^2. The average leaf area per tree was measured as 58 m^2. The LAI of the canopy layer is 0.78, with about 42% of the leaves in the middle. The southeast region of the trees sampled had an LAI of 1.27 versus the northwestern region of the tree with an LAI of 0.28. Leaf photosynthetic rates were measured as 4.1-6.7 μmol CO_2/m^{2}s. Transpiration rates were measured as 1.1-2.1 mmol H_2O/m^{2}s. The average water lost per tree per day was measured at 73 L.

Canopy	C gain (g/d)	Water loss (L/d)	WUE (%)
Lower	111.6	14.6	7.6
Mid	280.2	31.7	8.9
Upper	612.8	26.3	8.9

WUE=Water use efficiency

(Owens 1996)

- Ignition of soil gathered from around Quercus virginiana via the Walkley-Black method for indication of humus content showed a percent weight loss of 1.46 ± 0.19 % from soil in the top 10 cm, 0.53 ± 0.03 % from soil 10-20 cm deep. This is the percent of soil that was humus from 10 samples spaced 1m apart in 8 sites. (Rexford 1990)

-

Quercus Virginiana	Stem height (cm)	Shoot biomass (g)	Root biomass (g)	Total biomass (g)	Root:shoot Ratio
Initial state	20.0	25.6	26.0	51.6	1.01
After Low fertilizer	76.4	54.0	80.9	134.8	1.5
After Medium fertilizer	82.5	43.2	56.4	99.6	1.3
After High fertilizer	77.9	48.6	72.2	120.8	1.4
Average	78.9	48.6	69.8	118.4	1.4

N=20

Observations were made on 20 trees from January 1977 to September 1977.

(James et al 1981)

- Interrill erosion prior to burning an area dominated by Live Oak was measured as 2 kg/ha, and after burning was measured as 4500 kg/ha.

	Burned	Unburned
Infiltration rate (mm/hr)	129 de	202 a
Sediment yield (kg/ha)	4500 a	2 b
Total organic cover (%)	0.0 d	100.0 a
Soil organic matter (%)	12.3 a	11.9 ab
Aggregate stability (%)	8.12 a	84.5 a
Bulk density 0-30 mm (Mg/mm^3)	0.64 b	0.51 c
Bulk density 50-80 mm (Mg/mm^3)	0.88 ab	0.66 c

Infiltration rates and sediment yield after 50 minutes of simulated rainfall.

(Justin et al 1997)

Wasn't sure if you'd want this next piece or not, a brief overview of fire management in the state of Florida. I'll include it anyways.

- Prescribed burnings began early in 1927 on lands that would later become the St. Marks National Wildlife Refuge. Due to public sentiment on fire, many burning programs were halted during the 30s. Prior to 1978, FWS refuge staff didn't have enough fire suppression training and experience to do much more than stop initial wildfire attacks. In 1978, the FWS Fire Management Program was formally instituted. By 1987, the program's budget was 4.5 million with 64 employees. In 1988, the budget was increased to 16.4 million with 214 full-time staff after damaging wildfire outbreaks. As of 2005 the budget is 68.4 million with more than 500 full-time staff and 100 seasonal or part-time employees.

(Fish & Wildlife Service)

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Press Release

Appendix 7– press release illustrating applications of Heinz predictions for urban regions

5.08.2008 - 11:03am ET

Press release from: Ceres

Ceres and Heinz Center Launch Resilient Coasts Initiative

Broad coalition looking to reduce risk of climate change in coastal communities

(CSRwire) BOSTON - May 8, 2008 - Ceres and the Heinz Center today announced the launch of the Resilient Coasts Initiative, a first-of-its-kind collaboration of private and public sector groups to find public policy and private market solutions to better protect coastal communities from rising sea levels and other potentially damaging consequences of climate change.

The national project brings together a broad coalition of insurers, regulators, politicians, environmental organizations, real estate developers and investors to address the need for climate adaptation to reduce ever-increasing coastal risks associated with climate change in the United States. Key participants include American International Group, Inc. (AIG), Travelers, Risk Management Solutions and the chief financial officer of the State of Florida.

"Coastal protection needs to be part of our national conversation on climate change," said Ceres president Mindy S. Lubber, in announcing the joint venture with the Heinz Center at the Ceres conference in Boston last week. "This is an historic moment in which public and private sector leaders recognize the rising threat of climate change in coastal communities and the need for strong policies and market-based solutions to reduce that exposure," Lubber said.

"This is a project about action -- the steps we can take, the things we can do," added Thomas E. Lovejoy, president of the H. John Heinz III Center for Science, Economics and the Environment. The Center's extensive experience in coastal hazards prompted this initiative. "When we're all getting tired of rhetoric, we are seizing the opportunity to establish a blueprint for protecting our most vulnerable places and people," Lovejoy said.

With more than the half of the population living along the coast, the United States is acutely vulnerable to rising sea levels and other impacts from climate change. Cities like Miami are just starting to recognize the threat of rising sea levels where even modest sea level rise could threaten billions of dollars of real estate and economic activity. Stronger hurricanes in recent years have already caused tens of billions of dollars of losses along the Gulf Coast.

Over the next 12 months key priorities for the Resilient Coasts Initiative are to identify policy and market-based solutions that may include initiatives to:

- Limit new development in the most vulnerable areas
- Strengthen and upgrade existing buildings to prevent further losses
- Promote infrastructure investments that will help communities adapt to sea level rise.

Presenters at the kickoff meeting included Howard Kunreuther, Co-Director of the Risk Management and Decision Processes Center at Wharton School, University of Pennsylvania and Celine Herweijer, Director and Principal Scientist of the Climate Change Practice at Risk Management Solutions (RMS) who addressed the far-reaching economic implications of rising losses along the coast and the adaptation tools that will help reduce those losses, even as risks increase.

Participants discussed policy and business solutions to manage coastal climate risks. Some suggested using carbon trading revenues to fund programs that protect coastal areas. Others noted the importance of valuing coastal wetlands, barrier islands and reefs that provide natural protection from storms. Also considered was the need for insurance premiums to reflect real risks in coastal areas.

The Heinz Endowments in Pittsburgh provided seed funding for the Resilient Coasts Initiative. Other key sponsors are AIG, The Travelers Companies, Inc. and the Alcoa Foundation. Risk Management Solutions is contributing substantial technical expertise on climate-driven catastrophe and adaptation modeling.

Attending the meeting were representatives from AIG, Travelers, Swiss Re, Lloyd's of London, A.M. Best, Deutsche Asset Management, Citi Smith Barney, Calvert Group, Bonita Bay Group, Jonathan Rose Companies, The Nature Conservancy, RiskMetrics Group, MIT Sloan School of Management, US Business Council on Sustainable Development, National Oceanic and Atmospheric Administration, Maryland Insurance Administration, Coastal States Organization, Center for Clean Air Policy, the Institute for Business and Home and Safety, and the office of the chief financial officer in Florida.

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Appendix 8

Adaptation Strategies

Among the topics considered by the Governor's Action Team on Energy and Climate Change, adaptation is quite distinct from mitigation. Not only is adaptation about coping with the consequences of climate change rather than trying to prevent or limit them, but adaptation itself is a very broad topic, covering any sector affected by climate and climate change. This includes coastal resources, water resources, extreme climate events (and emergency response), marine, freshwater, and terrestrial ecosystems, and human health. Adaptation to climate change will be addressed by many state agencies, regional and local entities, non-profit organizations, the private sector, and individuals. So, adaptation is diffuse and diverse. This makes it extremely difficult to develop a single approach to adaptation (e.g., adaptation has no overarching solution such as a cap and trade system or a carbon tax). Instead, adaptation is a matter of reviewing the myriad of policies and actions that are affected or could be affected by climate change to ensure their robustness and resilience in the face of climate change.

The Adaptation Technical Work Group (ADP TWG) addressed a wide variety of topics in its deliberations. The work of the ADP TWG is also different from the other TWGs because there is no common metric for measuring success of adaptation measures. Greenhouse gas emission reductions can be compared based on such common metrics as dollars per ton of carbon dioxide equivalent. There is no common outcome on adaptation. Some adaptations concern human life, others property, and others are about reducing impacts of climate change on ecosystems and endangered species. It is quite challenging to measure such impacts using a common metric. So, the adaptation options considered by the ADP TWG were not quantitatively assessed.

Science and Impacts of Climate Change[1]

Florida, because of its low-lying topography and geographical location in the sub-tropics, is especially vulnerable to sea level rise and extreme weather.

The Intergovernmental Panel on Climate Change (IPCC) projected a warming in the southeastern United States of approximately 4 to 6°F (2 to 3°C) for a medium scenario of greenhouse gas emissions (Christensen et al., 2007). Higher emissions scenarios, which are quite possible, would result in larger temperature increases. Temperatures are projected to rise more in the summer than in the winter.

The IPCC also projected that precipitation patterns will change. It is difficult to confidently predict precipitation changes on a scale as small as Florida, but the climate models tend to project decreased precipitation over Florida. The models tend to show a tendency toward reductions in summer precipitation (Christensen et al., 2007).

[1] This section is a summary of Florida Atlantic University, "Florida's Resilient Coasts" (Murley et al., 2008)

The IPCC also projected a sea level rise (SLR) of at least 9" to 23" by the end of the 21st Century (Solomon et al. 2007). This projection was based on published reports through 2005 and did not account for dramatically increased rates of land-based glacial melting observed in Greenland and Antarctica since then (see Pfeffer et al., 2008). Many scientists have stated that increases in melt rates in Greenland and Antarctica will make significant contributions to sea level beyond that projected in the IPCC Assessment (Oppenheimer et al., 2007). For example, the Science and Technology Committee of the Miami-Dade County Climate Change Advisory Task Force projected a SLR of at least 1.5 feet in the coming 50 years and at least 3-5 feet by the end of the century (Murley et al., 2008).

In general, elevations of barrier islands are only minimally above sea level and much of Florida's barrier islands have been subject to extensive development of high value oceanfront real estate. These areas are at significant risk from SLR and increased intensity of hurricanes. Beach erosion, which already costs Florida over $600 million per year (Murley et al., 2008) is likely to increase. Coastal wetlands could be inundated by sea level rise. The Everglades represent the largest and most important of Florida's coastal wetlands. As sea levels rise, brackish waters will extend further inland and dramatically change these and other freshwater ecosystems. Unconfined coastal aquifers, such as the Biscayne Aquifer in South Florida, will become more saline because of sea level rise.

Florida was hit by eight hurricanes in 2004 and 2005 and to date, has been hit by several large hurricanes and tropical storms in 2008. The intensity of hurricanes is projected to increase (Solomon et al., 2007), although there is disagreement in the scientific community about whether the hurricane intensity has changed as a result of climate change. Elsner et al. (2008) document that wind speeds in the most powerful hurricanes have increased since the mid-1980s.

Even if hurricanes do not change, higher sea levels alone will result in higher storm surges. More intense hurricanes will likely lead to even higher storm surges and more damaging wind speeds.

Murley et al. 2008 state: in addition to sea level rise and hurricanes, there are numerous other potential effects of global warming that could affect Florida's communities and environment physically, economically and socially, including

- Prolonged drought affecting water supplies, agriculture, and habitat;
- More wildfires due to excessive drought and heat;
- More flooding due to more torrential rains;
- More frequent and lengthy heat waves creating increased energy demands and health hazards to young children, elderly, and infirm;

- Potential insect infestation and insect-borne disease resulting from increased temperatures combined with increased flooding due to storms;
- Bleaching of coral reefs and adverse effects on marine life and fisheries;
- Ecological changes in the Everglades and other natural systems affecting plant ecology, wildlife, the marine estuaries and coast, and tourism; and
- Economic, environmental, and social impacts.

Framework for Action and Goals

Based on the knowledge about the risks from climate change, the TWG developed a framework of adaptation topics and identified goals and strategies to address each topic. The framework and major objectives are as follows:

ADP-1 Advancing Science Data and Analysis for Climate Change

Scientific data, analyses, and predictive modeling are needed to understand how Florida's climate is likely to change, the consequences of change, and possible solutions.

ADP-2 Comprehensive Planning

Florida's local, state, and regional comprehensive plans should be amended, based on best available data, to include goals, objectives, and policies that will prepare the state for adapting to the future impacts of climate change, such as SLR. Future policies should use incentives to encourage desired actions, including encouragement not to repeat past decisions that will leave new development exposed to SLR and other climate change consequences.

ADP-3 Protection of Ecosystems and Biodiversity

Climate change will change the structure and composition of ecosystems and communities; coastal and estuarine habitats; ocean chemistry; geographic range and timing lifecycles of species; plant growth, nutrient composition, plant-animal interactions, and ecosystem nutrient cycles; and the intensity and magnitude of existing stresses, such as invasive species and wildfire regimes, on biodiversity and ecosystem structures, functions, and processes. Florida's ecosystems should be managed for resiliency by enhancing their ability to naturally adapt to climate change and other stresses. In addition, climate change should be incorporated into all aspects of the beach management and coastal construction regulatory programs.

ADP-4 Water Resources Management

The majority of Florida's population – and the water infrastructure to serve it – resides within 50 miles of the coast and is projected to increase by 50% by 2030. At the same time as additional water infrastructure is necessary to meet this need, coastal and groundwater resources may be at risk due to saltwater intrusion and sea level rise. In order for Floridians to have adequate freshwater supplies available to meet basic reasonable and beneficial needs and the

requirements of natural systems, intense conservation of all water uses and alternative water sources, stakeholder involvement in statewide and regional water supply planning processes, and methods to quantify and plan for uncertainties and risks related to population growth, climate change, and environmental regulations will be needed.

ADP-5 Built Environment, Infrastructure and Community Protection

The reduction of potential damage to the built environment from the impact of natural hazards, especially from those hazards caused or exacerbated by climate change, should be a high priority for all levels of government and the private sector in Florida.

(ADP-6 was on transportation, but after deliberations, this was included under ADP-5.)

ADP-7 Economic Development

Policies, programs, and implementation mechanisms should be developed to support the ability of Florida's economy to adapt to climate change.

ADP-8 Insurance

Insurance rates should reflect risks from climate and climate change and be equitable and affordable. In addition, policies should discourage high risk development, particularly along the coast.

ADP-9 Emergency Preparedness and Response

Florida's future emergency preparedness and response functions should build on the excellence gained through past experience to ensure sufficient capacity and efficacy in protecting public heath and welfare against the risks from climate change such as more intense hurricanes and floods and potential spread of disease and heat stress.

ADP-10 Human Health Concerns

Florida's health plan should incorporate considerations of climate change to protect the health of its citizens.

ADP-11 Social Effects

Issues of social justice should be addressed, food, water, and housing security should be protected, and behavioral responses to extreme events and climate change need to be better understood.

ADP-12 Organizing State Government for the Long Haul

A single point of focus within state government should be created that can continue assessing the risks posed by climate change, develop increasingly informed adaptation planning, and adjust adaptation planning in Florida as events on the ground change. The legislature created the Florida Energy and Climate Commission, which appears at present to have the sufficient scope, powers, and resources to accomplish the intent of this element of adaptation planning. However, it will be important to assess the effectiveness of the commission in addressing adaptation.

ADP-13 State Funding and Financing

Florida should be prepared to fund the protection of human health and critical infrastructure, as well as address other impacts of climate change, where feasible, within a framework of protection, accommodation and, in some cases, retreat.

ADP-14 Coordination With Other Regulatory and Standards Entities

Functional collaborative relationships between the State of Florida and selected federal government agencies, departments, and entities, other states and countries, and key professional societies should be developed on climate change issues of mutual interest. Research agendas and funding sources should be aligned to address common interests and priorities.

ADP-15 Education

Florida should become a national and international leader in the dissemination of climate change information in the process of educating a broad diversity of constituents with a cutting-edge and successful public education programs.

Early Action Items

The following goals were recommended as Early Action Items:

- Research
  - Foster and support a climate science research agenda for Florida with broad priorities. Institute a new scientific advisory council on climate change to advise state government on this research agenda. Identify and establish long-term funding to support research. Funding should be protected from short-term economic or political cycles.
  - Conduct research needed to support incorporation of climate change into the protection of Florida's ecosystems and biodiversity.
  - Enhance support for mapping, monitoring, and modeling, all of which will be necessary to provide information to support policy making. In addition, effective monitoring programs are needed to detect impacts of climate change; modeling is also needed to better project impacts.
- Comprehensive Planning
  - State and regional agencies should provide financial and technical assistance to local governments to ensure timely updates of local plans.
  - Local governments should review their coastal management elements to determine necessary amendments to make their coastal areas (especially the coastal high-hazard area) resilient to the future impacts of climate change, including SLR.
  - Florida statutes, regulations, policies, and the Florida Administrative Code should be reviewed by the Florida Attorney General to determine potential conflicts between private property rights and the state and local governments' responsibility to protect communities.
- Protection of Ecosystems and Biodiversity
  - Ensure that a representative portfolio of Florida's terrestrial, freshwater, and marine natural communities with redundant representation of habitats and species and connecting corridors is protected and managed in a manner that maximizes the health and resilience of these communities when facing climate change impacts.
  - Reduce and discourage future reliance on bulkheading/hardening to stabilize estuarine and beach shorelines. Shoreline hardening should be considered only after a full and cumulative assessment of short- and long-term impacts to coastal resources and coastal ecosystems. Establish policies and regulations that clearly define when, how, where, and under what circumstances emergency beach stabilization is allowed.
  - Assess the vulnerability of Florida's fish and wildlife to climate change impacts, identify the most vulnerable species, and prepare plans to enhance their chances of persistence where there is a reasonable likelihood that the species will persist over the next 50 years.

- Water Resources Management
  - Identify and quantify the vulnerabilities and reliability of existing water supplies to potential effects of differing climate change scenarios with emphasis on source water availability and quality.
- Built Environment
  - Require that the Florida Building Code incorporate building design criteria for resisting future loads that may result from the impact of climate change–exacerbated hazards during a minimum service life of 50 years.
  - Develop a required training program to educate professionals in relevant fields (e.g., architecture, engineering, and construction management) on the need to incorporate adaptation to climate change as a basis for establishing design criteria for new infrastructure. Completion of such required training would be a condition for relicensing.
- Public Education and Outreach
  - Provide immediate training on climate change adaptation.
  - Initiate a major public education campaign to educate the public.

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Acronyms and Abbreviations

ADP Adaptation
IPPC Intergovernmental Panel on Climate Change
SLR sea level rise
TWG Technical Work Group

Framework Identifier	Planning Framework Element	Status
ADP-11.2	Food and Water Security	Approved
ADP-11.3	Housing	Approved
ADP-11.4	Intersection of Climate Change and Human Behavior	Approved
ADP-12	Organizing State Government for the Long Haul	Approved
ADP-13	State Funding and Financing	Approved
ADP-14	Coordinating with Other Regulatory and Standards Entities	Approved
ADP-14.1	Federal Government	Approved
ADP-14.2	Professional Societies	Approved
ADP-15	Public Education and Outreach	Approved

Note: The numbering used to denote the framework elements is for reference purposes only; it does not reflect prioritization among these important draft policy options.

Introduction

The Governor's Action Team on Energy and Climate Change charged the Adaptation Technical Working Group with providing two deliverables. The first deliverable was an adaptation planning framework enumerating the multiple elements for which planning should occur in order to better ready Florida for the changes likely to occur over the next century as global mean temperatures increase consistent with the best available science from the United Nations' Intergovernmental Panel on Climate Change, the National Academy of Sciences, and other sources. Secondly, the Action Team charged the working group with providing early policy actions related to climate change adaptation in advance of more substantive policy development by the Florida Energy and Climate Commission using the planning framework outlined here.

This technical appendix provides the planning template in the full detail as developed by the Adaptation Technical Working Group. It also identifies early policy actions proposed by the Technical Working Group and approved by the Action Team. These early policy actions are denoted as "strategies."

Appendix F
Adaptation (ADP) Planning Framework for Florida

Summary List of Florida's Adaptation Planning Framework

Framework Identifier	Planning Framework Element	Status
ADP-1	Advancing Science Data and Analysis for Climate Change	Approved
ADP-2	Comprehensive Planning	Approved
ADP-2.1	Local Government Level	Approved
ADP-2.2	Regional Government Level	Approved
ADP-2.3	State Government Level	Approved
ADP-3	Protection of Ecosystems and Biodiversity	Approved
ADP-3.1	Uplands, Freshwater and Marine Systems	Approved
ADP-3.2	Beaches and Beach Management	Approved
ADP-3.3	Species Protection	Approved
ADP-4	Water Resource Management	Approved
ADP-5	Built Environment, Infrastructure and Community Protection	Approved
ADP-5.1	Building Codes and Regulation	Approved
ADP-5.2	Flood Protection	Approved
ADP-5.3	Beaches as Infrastructure	Approved
ADP-5.4	Transportation and Other Infrastructure	Approved
ADP-6	Transportation and Other Infrastructure (moved into ADP-5)	Approved
ADP-7	Economic Development	Approved
ADP-7.1	Tourism	Approved
ADP-7.2	Other Resource-based Industries	Approved
ADP-7.2.1	Agriculture	Approved
ADP-7.2.2	Forests	Approved
ADP-7.2.3	Marine	Approved
ADP-7.2.4	Aquaculture	Approved
ADP-7.2.5	Mining	Approved
ADP-7.3	Construction	Approved
ADP-8	Insurance (Property and Casualty)	Approved
ADP-9	Emergency Preparedness and Response (Extreme Events)	Approved
ADP-10	Human Health Concerns	Approved
ADP-10.1	Health Care	Approved
ADP-10.2	Air Quality	Approved
ADP-10.3	Wastewater Treatment	Approved
ADP-10.4	Disaster Response	Approved
ADP-10.5	Medical Treatment and Biomedicine Development	Approved
ADP-11	Social Effects	Approved
ADP-11.1	Social Justice Issues	Approved

ADP-1. Advancing Science Data and Analysis Climate Change

Description of Issues

Florida is one of the most vulnerable areas in the world to the consequences of climate change, especially sea level rise (SLR), and the possibility of increased hurricane activity.[1] Regardless of the underlying causes of climate change, glacial melting and expansion of warming oceans are causing SLR, although the extent or rate for Florida cannot be predicted with certainty. In addition, hurricane activity in the North Atlantic Basin has increased significantly in recent years, but there is controversy over whether the primary cause is global warming or natural weather cycles, making the long-term trend indeterminate at this time. Not knowing which of Florida's barrier islands, floodplains, and what portions of major cities will be inundated, or when are among the factors that make planning for adaptation to climate change difficult. However, there is sufficient information to justify implementing many adaptations. Climate change and the length of time needed to implement some adaptations further justify the need for action in spite of these uncertainties. However, in all cases, adaptation should be guided by good science.

Objectives

Scientific data, analyses, and predictive modeling are needed to understand how Florida's climate is likely to change, the consequences of change, and possible solutions. Focusing on four key issues will help advance the science.

- Reducing uncertainty in climate projections and enhancing predictive power of climate models for Florida is critical, especially their temporal and spatial resolution. Improving models requires addressing considerations specific to Florida: strong marine influence and peninsula effect; the wide climate gradient from the temperate northern region to subtropical southern region of the state; lack of long-term physical climate measurements for historical trends (although some proxies are available); huge climate variability; complicating effects of the interaction of land-use change (e.g., wetland loss); and climate change.
- Given climate modeling limitations for Florida, the current planning template focuses on SLR and the potential for increasing hurricane strength. Scientific data and analyses to predict other potential effects of global warming that could affect Florida are still extremely underdeveloped. There are no data available at this time that adequately assess potential effects, such as increased drought, wildfires, flooding, and invasive species. Until models improve, appropriate risk management and adaptive management will be challenging.

[1] For recent review, see Florida Atlantic University. 2008. "Florida's Resilient Coasts: A Store Policy Framework for Adaptation to Climate Change." Fort Lauderdale, FL: Florida Atlantic University.

- Recognize that adaptability refers to the ability of humans to manage the resilience and capacity of the system (e.g., ecological, economic, social) to absorb the disturbance of climate change. Our science needs to address three crucial aspects of resilience: the amount of change Florida can withstand before switching over to another state or condition from which it cannot recover its former function, the ease or difficulty of making changes, and how close the current system is to a switching threshold.
- Improving our understanding of socioeconomic responses to alternative climate predictions will better guide public policy and incentive programs. New approaches and tools, such as agent-based models (ABMs) will provide a better framework to examine interactions of socioeconomic and climate change.

Assets at Risk

Not applicable.

Existing Actions

House Bill (HB) 7135, passed in the 2008 Legislative Session, directly addressed collecting and acquiring better emissions data, as well as ensuring improved analysis of all emissions data. Among other actions, the bill created the Florida Energy Systems Consortium (FESC) as a "supercenter of excellence" within the State University System (SUS) to better coordinate energy-related research in support of Florida's energy and climate change policy objectives. The bill did not address research that can support adaptation.

Goals and Strategies

Goal 1: Provide a measurable outcome and scientific evaluation for each of the goals and strategies outlined in the Adaptation Policy Options to assess whether they have been met. Evaluation should be science-based, using the complementary skills of climate scientists, ecologists, hydrologists, social scientists, and economists. Test programs and pilots to measure and assess alternative outcomes are encouraged.

Strategy A: HB 7135 in the 2008 Florida Legislative Session created the FESC as a "supercenter of excellence" within the SUS. The center should consider, as a priority order of business, the appointment of a scientific advisory council composed of members from identified disciplines which are relevant to adaptation to climate change and representatives of each participating institution to better coordinate research in support of Florida's adaptation and climate change policy objectives.

Strategy B: The Florida Energy and Climate Research Trust Fund should be created by the Legislature and a dedicated revenue stream should be provided.

Goal 2: Foster and support a climate science research agenda for Florida with broad priorities as outlined below. Consider instituting a new scientific advisory council on climate change to advise state government on this research agenda. Identify and establish long-term funding to support research. Funding should be protected from short-term economic or political cycles.

Strategy A: HB 7135 in the 2008 Florida Legislative Session created the Florida Energy Systems Consortium as a "super center of excellence" within the State University System. The center should consider, as a priority order of business, the appointment of a scientific advisory council composed of members from identified disciplines adaptive to climate change and representative of each participating institution to better coordinate research in support of Florida's adaptation and climate change policy objectives.

Strategy B: The Florida Energy and Climate Research Trust Fund should be created by the Legislature, and a dedicated revenue stream should be provided.

Goal 3: Conduct research needed to support incorporation of climate change into the protection of Florida's ecosystems and biodiversity.

Strategy A: Calculate the economic value and services provided by Florida's natural communities and associated species to inform decisions regarding state budget and policy requirements. Disseminate information broadly.

Strategy B: Define the likely new "states" of Florida ecological systems to determine state budget and policy requirements. Identify species and habitats that are not likely to migrate naturally and craft strategies to assist migration or re-create habitat elsewhere to facilitate this shift.

Strategy C: Expand the newly developed Critical Lands & Waters Identification Project (CLIP) v1.0 database to incorporate impacts and adaptation to climate change. CLIP updates, unifies, and prioritizes existing geographic information systems (GIS) databases. Completed July 1, 2008, CLIP identifies and prioritizes statewide natural resource landscapes, biodiversity, and water and serves as a starting point for the Cooperative Conservation Blueprint project.

Goal 4: Enhance support for mapping, monitoring, and modeling will be necessary to provide information to support policy making. For example, the state is supporting use of light detection and ranging (LIDAR) to improve mapping of Florida's coastlines. Such mapping should be done for the entire coastline of the state. In addition, effective monitoring programs are needed to detect impacts of climate change, as well as modeling to better project impacts.

Strategy: Create a new center to coordinate and align data from proxy data sets to build a more precise picture of climate change in Florida over the last few thousand years and predict the effects of climate change in the future. This data center could also track associated responses in vegetation, sea level, and disturbances such as fire.

Goal 5: Support projection of climate change at smaller scales to forecast state and local impacts and to pinpoint risks.

Goal 6: Collaborate to the greatest extent possible with other similar research efforts by the federal government, the private sector, and non-state research institutions and universities.

Priorities for Further Research and Analysis

A number of plans and proposals for research that will support adaptation to climate change, among other things, have been published, including the "Annual Science and Research Plan" prepared by the Florida Oceans and Coastal Research Council and "A Strategic Implementation Plan for Florida COOS: 2008–2010" written by the Florida Coastal Ocean Observing System (FLCOOS). Such plans can be consulted for specific ideas on research that will enhance Florida's ability to manage marine and coastal resources vulnerable to climate variability and change. It is not known whether there is an integrated research priority list counterpart to this for Florida's terrestrial and freshwater systems; one research priority might be to initiate such a process and to cross-reference these lists for areas of synergy.

There are already a number of cross-cutting priorities for research and analysis that Florida should consider, including the following:

- Emphasize collaborations with international climate scientists, to refine climate predictions for Florida. The state, in partnership with federal agencies, international efforts, and Florida universities, should (a) undertake review of current studies and models, (b) consider updating model development to more precisely forecast changes in Florida's weather patterns, and (c) undertake specific analysis of uncertainties and contingencies in climate scenarios for Florida.
- Place special emphasis on establishing or enhancing programs to follow developments regarding the climate-related impacts of SLR and hurricane activity, considering that Florida is particularly vulnerable to potential impacts.
- Establish or enhance existing programs to monitor and determine trends in other climate-related impacts that could have consequences in Florida including increased drought, wildfires, flooding, storm water runoff, heat waves, problems with invasive species and insect-borne disease resulting from changes in temperature and rainfall regimes, adverse effects on native terrestrial species, natural communities and marine life, saltwater intrusion into aquifers, more frequent and intense storms, storm surges, tidal regimes, and coastal erosion. Build a decision support structure to guide and prioritize an ongoing Florida-specific research agenda.
- Deploy a "Florida Land and Sea Mesonet" to serve as a world-class network of integrated environmental monitoring stations, drawing from and contributing to existing terrestrial and marine networks, capitalizing and building on deployed meteorological stations, evapotranspiration (ET) stations, micro-meteorology towers, flow gauges and well/aquifer monitoring, and other critical monitoring networks to meticulously track changes in Florida's climate and hydrology and fill gaps in statewide network coverage. The existing FLCOOS should include climate impacts.
- Support scientists working on availability of remote sensing data and methods for gathering it to provide actual continuous statewide coverage (and for coverage of the associated

surrounding oceanographic area of influence), with consistent spatial grids and measurements, for common inputs for climate and hydrologic models.

- Link climate scientists with ecologists, economists, and social scientists. Issue a request for proposal (RFP) from interdisciplinary teams of social scientists, economists, and climate scientists to build interactive models that include non-linearities and feedbacks to better predict Florida's responses to anticipated changes. ABMs are appropriate here because of the complexity of climate change models and responses.
- Build socioeconomic models to evaluate the effectiveness of alternative incentives and policies. Select pilot areas and locations in the state to test policy programs. Evaluate effectiveness of adaptation strategies at regular intervals
- Build better decision tools to incorporate total cost accounting for local and regional planning decisions, so that proposed land-use changes, agricultural policy shifts, water-use policies, transportation decisions, siting of major new industries, and other changes will have a full assessment of all public costs, including the likely carbon or greenhouse gas (GHG) footprint and water use. Decision tools should also include assessments of proposals for land-use changes in light of the predicted climate changes.

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http://www.floridaoceanscouncil.org/meetings/files/Prioritized_Research_List.pdf

Florida Oceans Council. Science Research Overview available at:
http://www.floridaoceanscouncil.org/meetings/files/Science_Research_Overview.pdf

ADP-2, Comprehensive Planning

Description of Issues

Florida has an integrated planning process that local, state, and regional governments can use to prepare plans that direct future growth and development, conservation of natural resources, and provision of public facilities. Under state law, planning in Florida is guided by standards that require a consistent policy direction and coordination among plans.

The framework for the integrated planning process starts with Florida's State Comprehensive Plan (SCP), which contains goals and policies that set broad directions on energy, land use, and other issues relevant to future adaptation to climate change. At the state level, there is a transportation plan and a water plan. At the regional level, there are 11 planning councils, each of which has adopted a strategic policy plan. In addition, at the regional level, there are five water management districts and seven transportation districts, each with planning documents that guide programs and decision making. At the local level, each county and municipality in Florida has adopted a comprehensive plan that includes goals, objectives, and policies that address future land use, conservation, coastal management (where applicable), transportation, public facilities, parks and recreation, housing, intergovernmental coordination, and capital improvements. Local land development regulations and permits must be consistent with the comprehensive plan.

The 2008 Florida Legislature amended the SCP to address GHG reduction strategies with attention to facilities that generate electrical power. The 2008 requirements for local comprehensive plans represent an important initial step but are oriented more toward energy use and GHG emission reductions than on adaptation to changing climatic conditions.

Objectives

Chapter 187 of the Florida Statutes requires that, "The State Comprehensive Plan shall provide long-range policy guidance for the orderly social, economic, and physical growth of the state." It also states that the plan is a "direction setting document" that should be "reasonably applied where they are economically and environmentally feasible, not contrary to the public interest, and consistent with the protection of private property rights."

Florida's local, state, and regional comprehensive plans should be amended, based on best available data, to include goals, objectives, and policies that will prepare the state for adapting to the future impacts of climate change, such as SLR. Future policies should use incentives to encourage desired actions, including encouragement not to repeat past decisions that will leave new development exposed to SLR and other climate change consequences.

Assets at Risk

Florida may be one of the states most at risk to climate change. It is surrounded by water on three sides, and its relatively flat terrain means that large areas of the coast are at risk of inundation from SLR or coastal storm exposure, particularly tropical storms and hurricanes.

SLR will affect Florida's valuable shoreline resources, including the beach, coastal vegetation and habitat, and significant public and private built investment. Decisions will need to be made about relocation, redevelopment and, where appropriate, retreat from the shoreline.

The projected consequences from climate change, such as SLR, may lead to future questions about reducing risks in hazard-prone areas and areas that could face increased risks under climate change as well as the rights of private property owners and the police power and trusteeship responsibilities of state and local governments to protect the community at large. These issues will likely be focused on private property adjacent to the beach and in low-lying areas subject to increased flooding. All these issues must be considered while planning for future growth, because between now and 2030, the state will need to develop residential, commercial, and retail areas to serve twice our current population.

Existing Actions

Governor Crist created the Florida Energy and Climate Change Action Team through executive order. That Action Team has appointed Technical Work Groups (TWGs) to address these issues. One TWG is reviewing the state's Transportation and Land Use (TLU) planning in particular, and the Government Policy (GP) TWG is addressing these issues as well.

The 2008 Florida Legislature passed HB 7135, which created the Florida Energy and Climate Commission (FECC). The FECC will continue the work of the Action Team and consider and coordinate certain recommended Action Team adaptations to the land-use planning process. The bill also amended Section 339.175, Florida Statutes, to encourage metropolitan planning organizations (MPOs) to consider GHG emissions in their planning processes.

ADP-2.1 Local Government Level

Goals and Strategies

Goal 1: Ensure that all relevant elements of local government comprehensive plans (e.g., future land use, coastal zone management, and capital facilities) are updated to reflect the best available data and strategies for adapting to future climate change impacts.

Strategy A: The Florida Department of Community Affairs (DCA) should work with the FECC to create a phase-in formula requiring future updating of local plans through the Evaluation and Appraisal Process (EAR).

Strategy B: The FECC and DCA will recommend to the Florida legislature new authority to provide necessary direction for local government comprehensive plans to address the range

of adaptation actions, including built environment, anticipated from climate change impacts.

Goal 2: State and regional agencies should provide financial and technical assistance to local governments to ensure timely updates of local plans.

Strategy A: Update the climate change section of the FL DCA Planning Tools Web site with adaptation information from the Action Team and other sources.

Strategy B: Tie state and regional agencies into a broadly available state digital database focused on climate change and ensure that all pertinent state records are digitized to provide local government planners with instant access to the information they need to better consider the impacts of updates to local plans.

Goal 3: Counties and municipalities located within each county should collaborate to create working groups (e.g., Miami-Dade County Climate Change Advisory Task Force) to study their comprehensive plans and recommend changes that better address adaptation to local climate change.

Goal 4: Local governments should review elements of their coastal management plans to determine whether there are any amendments that could make their coastal areas (especially the coastal high-hazard areas) more resilient to the impacts of climate change, including SLR.

Strategy A: Amend Chapter 163.3178 (8), to provide for coastal counties to include SLR as a criterion when prioritizing lands for acquisition through state programs.

Strategy B: Create a best practices manual for local governments to use that incorporates risk from SLR when identifying coastal lands for state acquisition using new adaptation language incorporated into local, state, and regional government land acquisition processes.

Strategy C: Identify and revise statutory direction for local, state, and regional planning processes to identify potential within planning areas, particularly coastal areas, for SLR. Provide for an assessment of

- The potential movement of the coastal construction control line and related changes,
- The extent and potential for expansion of floodplains, and
- Habitat and wildlife migration potentials.

Strategy D: DEP, DCA, and the state's Regional Planning Councils (RPCs) should jointly develop, assess, and recommend a suite of planning tools and climate change adaptation strategies for local governments so they can maximize opportunities to protect the beach/dune system, coastal wetlands, and other coastal resources in an era of rising seas. The tools should include strategies to encourage the landward siting and relocation of

structures and public facilities in areas adjacent to receding shorelines through acquisition, rolling easements, transfer of development rights, stronger setbacks, and tax incentives.

ADP-2.2 Regional Government Level

Goals and Strategies

Goal 1: RPCs should update their Strategic Regional Policy Plans (SRPPs) to reflect important regional issues concerning adaptation to the impacts of climate change.

Strategy: DCA, RPCs, and the FECC should agree on guidance in the DCA-RPC annual contracts that directs how adaptation language is to be made part of the SRPPs.

Goal 2: Water management districts should modify regional water supply plans and other regional water management activities to include adaptation measures that address impacts from climate change.

Strategy: DEP, the five water management districts, and the FECC should agree on future guidance for updating regional water supply plans and other water management activities to ensure that they address adaptation to climate change impacts such as SLR.

ADP-2.3 State Government Level

Goals and Strategies

Goal 1: The SCP and comprehensive plans of other relevant state agencies should be updated to reflect future actions that promote adaptation measures that address the impacts from climate change.

Strategy A: The Governor, acting as Chief Planning Officer of the state, should direct the Office of Planning and Budget to work with the FECC, state and regional agencies, local governments, special districts, and interested parties to propose changes to the SCP that address climate change adaptation for review by the Legislature.

Strategy B: The SCP, Chapter 187.201(8), Coastal and Marine Resources, goals and policies should be amended to address adaptation to the consequences of climate change.

Strategy C: The Florida DCA should explore using the Areas of Critical State Concern Program as a way to provide special assistance in planning and redevelopment for areas of the state at high risk of change due to SLR.

Strategy D: The Florida Division of Emergency Management (DEM) should incorporate SLR and increasing storm surge impacts into its efforts to remap potential hazard areas in coastal zones. Revised hazard area designations should better reflect the risks to communities

associated with climate change and allow reevaluation of suitability for development in these areas.

Goal 2: The FECC should encourage cooperation at all levels of government and recommend additional goals and strategies to ensure that adequate measures are taken to adapt to future impacts from climate change.

Goal 3: A balance should be achieved between protecting property rights and protecting communities and natural resources.

Strategy A: The Office of the Florida Attorney General should monitor state, regional and local actions to address the impacts of climate change for potential conflicts between private property rights and the government's responsibilities to protect its communities, natural resources and public usage and access to government lands. Specific attention should be given to possible conflicts with the individual rights of private landowners who are affected by sea level rise, beach erosion and other impacts of climate change. The Attorney General should issue a report with recommendations every five years.

ADP-3. Protection of Ecosystems and Biodiversity

Description of Issues

Florida's terrestrial, freshwater, and marine systems extend from temperate north Florida to subtropical south Florida. Many tropical species are at their northern range limits in Florida; many temperate species are at their southern limits. The result is a highly diverse, unique assemblage of species and, in terrestrial and freshwater systems, many species which occur only in Florida. Florida has 1,350 miles of coast that is home to a diverse array of marine and coastal natural communities and associated species, including the world's third largest fringing barrier reef and a barrier island system that provides a great amount of habitat diversity.

The State of Florida has the third highest number of species in the United States (over 5,000), of which approximately 670 occur only in Florida. Its approximately 4,000 native and exotic plant species are distributed over 81 plant communities. According to the U.S. Fish and Wildlife Service (US FWS), 114 species are listed as endangered or threatened (2008), including the West Indian manatee, green sea turtle, and brown pelican.

Florida's upland ecosystems are characterized by temperate climate, dry soils, and gently sloping, forested hills. The dominant plant species in dry uplands include pines and oaks. Plant species in the wetter uplands include southern magnolia, beech, spruce pine, Shumard oak, Florida maple, and other hardwoods. Coastal uplands feature sandy soils, and their plant communities consist of sea oats and mixed salt-spray-tolerant grasses, shrubs, and herbs.

Florida's freshwater ecosystems include wetlands, streams, lakes, and ponds. Coastal wetlands and swamps are generally inundated with freshwater but are subject to tidal cycles and are saltwater-tolerant.

Wetlands cover approximately 30% of the State of Florida and play an important role in flood protection. Streams can vary from seasonal to permanent waterways, and plant species generally grow along stream edges.

Beaches, as Florida's primary tourism attraction, are one of the state's most important economic engines, generating tens of billions of dollars in annual revenues through jobs, tourism, recreation, and taxes. Beach-related tourism has a $41.6 billion annual impact on Florida's economy. In addition, over 25% of the value of Florida's coastal real estate can be attributed to beaches.[2]

A healthy beach/dune system provides protection for upland property and infrastructure and increases a beach's resiliency (i.e., its ability to recover from storm events). Florida's beach/dune

[2] Stronge, W.B. 2002. "The Economic Benefits of Florida's Beaches: Local, State, and National Impacts." Boca Raton: Florida Atlantic University.

system also provides important habitat for marine turtles, shorebirds, beach mice, invertebrates, and other species. Currently, more than half of Florida's 825 miles of sandy beaches are experiencing chronic erosion, and about 42% are designated as critically eroding (meaning they need long-term maintenance in order to ensure protection of vulnerable upland properties, recreational interests, wildlife habitat, or important cultural resources).

Reefs are affected by disease and bleaching. In addition, overfishing, polluted runoff, and reduced freshwater inflows also threaten the health of marine ecosystems. The state is making an effort to establish marine sanctuaries to protect its marine ecosystem from further damage. Species found here include seabirds, dolphins, whales, and manatees, as well as many types of invertebrates, crustaceans, and fishes (e.g., bony fishes, sharks, skates, rays, and eels). Alligators, crocodiles, and turtles can also be found in this area. Habitats include sea grass beds, sandy bottoms, reefs, and open ocean.

These natural resources provide many economic benefits to Florida. For example, 4.2 million people participated in some form of residential or nonresidential wildlife viewing in Florida in 2006, with related total retail sales estimated at $3.1 billion ($2.4 billion by residents and $653.3 million by nonresidents) for that period.

Objectives

The Florida Constitution calls for the "management, protection, and conservation of wild animal life and freshwater aquatic life." Florida law notes that the "State of Florida harbors a wide diversity of fish and wildlife and that it is the policy of this state to conserve and wisely manage these resources" and calls the state to "protect and acquire unique natural habitats and ecological systems...and restore degraded natural systems to a functional condition." With regard to coastal and marine resources, the "development and marine resource use and beach access improvements in coastal areas do not endanger public safety or important natural resources."

Managing ecosystems for resilience enhances their ability to naturally adapt to the stresses of climate change and other pervasive threats. Specifically, good management should

- Maximize the resilience of species and habitats to climate change impacts by minimizing other human induced threats;
- Facilitate and maintain the persistence of coastal ecosystems and the ecological and human services they provide;
- Increase understanding of how Florida's marine and coastal ecosystems may migrate and change because of climate change;
- Identify areas, natural communities, and species of particular ecological vulnerability;
- Protect natural communities vulnerable to SLR from loss resulting from shoreline hardening and other actions that prevent or inhibit natural upslope migration;

- Identify and secure paths for other inland habitats to migrate with changes in temperature, rainfall patterns, and groundwater levels; and
- Protect inland natural communities from competing climate change adaptation pressures, such as the landward relocation of coastal development, human demands for ground and surface water, and engineered solutions for flood mitigation.

Specific objectives for beaches include ensuring the long-term protection of the beach/dune system and preserving its ecological functions as well as

- Considering how climate change could be incorporated into all aspects of the beach management and coastal construction regulatory programs.
- Developing policies to discourage development adjacent to eroding shorelines and encouraging the placement of structures and infrastructure away from retreating shorelines; these measures may reduce future reliance on coastal bulkheading, which can accelerate beach loss.
- Purchasing private coastal lands that have been strategically targeted to provide buffers for retreating shorelines, to preserve and protect habitats and ecosystem function, and to increase the resiliency of the shoreline to recover from storm events.
- Enhancing communication on coastal resource protection between and within state regulatory agencies, such as the DCA and the DEP, can ensure more efficient use of resources and expertise in developing adaptation responses and strategies.

Assets at Risk

Temperature, rainfall, sea level, and ocean chemistry play critical roles in determining where individual species of plants and animals can live, grow, and reproduce. The effects of climate change on species and ecosystems can be direct and indirect. Climate change will change the structure and composition of ecosystems and communities; coastal and estuarine habitats; ocean chemistry (lower pH levels adversely affect growth of corals, shellfish, and some algae); geographic range of species; timing of species' life cycles, which may become out of sync with other species they depend on; plant growth, nutrient composition, plant-animal interactions, and ecosystem nutrient cycles; and the intensity and magnitude of existing stresses, such as invasive species and wildfire regimes, on biodiversity and ecosystem structures, functions, and processes. In addition, climate change is also projected to result in increased risk of extinction for some species (e.g., those with limited dispersal capabilities or those that live in specialized habitats) and opportunity for range expansion of invasive species.

SLR and other predicted impacts of climate change (e.g., increases in frequency and intensity of coastal storms and higher storm surges) increase beach erosion, shoreline recession, and barrier migration and have a profound impact on Florida's beaches, the beach-using public, and the tourism industry.

As beaches erode and recede, many of the values and benefits they provide are threatened. In addition, public access to lands held in trust for the public, including the wet sand beach and near shore-submerged lands, is greatly diminished. Conflicts over public usage and private property rights will likely increase as beaches recede and the area of dry sand beach decreases.

Existing Actions

The DEP includes in its annual "Florida Forever Work Plan" a list of lands that sequester carbon, provide habitat, protect coastal lands or barrier islands, and otherwise mitigate and help adapt to the effects of SLR. DEP's Office of Coastal and Aquatic Managed Areas (CAMA) has 42 aquatic preserves around the state that are managed to protect natural values. CAMA also co-manages with the National Oceanic and Atmospheric Administration (NOAA) the Florida Keys National Marine Sanctuary, and three National Estuary Research Reserves. The Florida Fish and Wildlife Conservation Commission (FWC) overseas the Florida Wildlife Legacy Initiative; which includes major terrestrial, freshwater, and marine systems and strives to keep common species common. In addition, DEP (state parks and Florida's Division of Forestry [DOF]), the Florida Fish and Wildlife Conservation Commission (FWC), and other state agencies have ongoing programs to maintain natural systems in a healthy state. On a parallel track, federal and local governments and private organizations, such as The Nature Conservancy and the Audubon Society, maintain parks and natural areas.

ADP-3.1 Uplands, Freshwater and Marine Systems

Goals and Strategies

Goal 1: A representative portfolio of Florida's terrestrial, freshwater, and marine natural communities with redundant representation of habitats and species and connecting corridors (e.g., Florida's Biodiversity Blueprint) is protected and well managed in a manner that maximizes the health and resilience of these systems to climate change impacts.

Strategy A: Tie into existing and expanded databases such as CLIP to examine existing local, state, regional, and federal land holdings and categorize these holdings with regard to the representative portfolio.

Strategy B: Provide an accessible, expanded, and updated database to track changes to the natural communities and corridors.

Strategy C: The FECC should consider the recommendations for biodiversity and ecosystem adaptation to climate change developed through the Florida's Wildlife: On the Frontlines of Climate Change summit.

Goal 2: Acquire and appropriately manage lands needed to complete critical south-to-north migration corridors to accommodate range changes in species and natural communities driven by climate change.

Goal 3: Important natural communities vulnerable to SLR (e.g., intertidal and coastal habitats) are buffered or protected (from shoreline stabilization and hardening) to maximize the probability of their persistence into the future.

Strategy A: DEP and other relevant agencies should develop state wetlands conservation and restoration plans that clearly designate wetland migration corridors as the sea level rises.

Strategy B: The Legislature should place a priority on coastal land acquisition through the Florida Forever program, a separate dedicated funding source, or through other means. Greater incentives should be provided to local governments and private organizations to acquire and manage ecologically important coastal lands, including upland buffers. Acquisition efforts should be strategically targeted to protect coastal resources, reduce insured risk, and reduce the impacts of climate change on both ecosystems and communities.

Goal 4: Areas that may serve as refuges for at-risk species are identified, prioritized, protected, and managed in a manner that maximizes the persistence of at-risk species.

Goal 5: Enact legislation to define newly submerged lands contiguous to existing state aquatic preserves, parks, and others as part of the contiguous state-managed areas.

Goal 6: Establish an integrated network of early warning sites on protected lands to track long-term changes in biological communities and processes; establish a Center for Climate Archives for baseline and associated data.

ADP-3.2 Beaches and Beach Management

Goals and Strategies

Goal 1: Reduce and discourage future reliance on bulkheading/hardening to stabilize estuarine and beach shorelines. Shoreline hardening should be considered only after a full and cumulative assessment of short- and long-term impacts to coastal resources and coastal ecosystems.

Strategy A: Address local, state, and regional permitting programs and planning elements to fully assess and consider potential impacts and changes to coastal resources and ecosystems from proposed coastal protection measures in light of potential impacts of climate change.

Strategy B: Add an overview element to state and regional planning documents describing statewide strategies and circumstances for coastal and shoreline retreat and erosion.

Strategy C: The state should undertake a comprehensive reevaluation of the Coastal Construction Control Line Program to ensure that it is accomplishing its intended goal of

protection of the beach and dune system. The reevaluation should consider, among other things, the adequacy of existing coastal setbacks, building siting and design requirements, and post-storm redevelopment policies in light of SLR scenarios.

Goal 2: Estimate the ecological value of beach resources around the state in order to give the highest priority to protecting beach resources with the highest ecological values.

Goal 3: Minimize conditions inhibiting natural long-shore sand movement to reduce coastal erosion, protect existing investment in and reduce the future need for beach re-nourishment, and increase beach system resiliency.

Strategy: DEP should be funded to support the design and implementation of inlet management plans for all of the state's modified inlets and should undertake all reasonable efforts to maximize inlet sand bypassing.

Goal 4: Require the state Acquisition and Restoration Council conduct a review of management plans for those lands under its authority every 10 years and include property-specific analyses of vulnerability to climate change in each management plan.

Strategy: Consider a Full Disclosure Law that alerts buyers of coastal property about erosion rates, storm history, SLR concerns, and other relevant information.

Goal 5: State and local governments establish policies and regulations that clearly define when, how, where, and under what circumstances emergency beach stabilization is allowed.

Goal 6: State and local governments establish policies and regulations that address coastal retreat and at what point vulnerable structures will have to be abandoned.

Goal 7: State and local governments establish policies and regulations to protect coastal resources from contamination resulting from inundation, structural failure, or abandonment of residential, industrial, and municipal assets resulting from SLR or storm events.

Goal 8: Ensure that the state's beach management program can accomplish its intended goals, including the long-term protection and resiliency of the beach/dune system, in an era of climate change and rising seas.

Strategy: DEP's Strategic Beach Management Plan should incorporate a range of sea level rise scenarios over at least a 50 year time horizon.

Goal 9: Provide incentives to encourage public and local governments to site structures and infrastructure away from areas at high risk from the impacts of climate change and SLR.

Strategy: See ADP 2.1, Goal 4, Strategy D

ADP-3.3 Species Protection

Goals and Strategies

Goal 1: The vulnerability of Florida's fish and wildlife to climate change impacts is assessed, the most vulnerable species are identified, and plans are prepared to enhance their chances of persistence where there is a reasonable likelihood that the species will persist over the next 50 years.

> **Strategy A:** Utilize the CLIP and similar expanded and centralized digital databases to determine potential species and habitat vulnerability.
>
> **Strategy B:** Incorporate species and habitat vulnerability from climate change into state and regional planning/zoning, government land acquisition, or determinations for conservation easements.

Goal 2: Put in place a system for monitoring how Florida's natural communities and associated species are responding to climate change impacts and widely distribute the results of this monitoring to all interested stakeholders.

Goal 3: Consider how climate change affects the nexus between species and habitat and act to protect habitat for vulnerable species in light of additional risks posed by climate change.

Goal 4: Evaluate likely persistence of Florida's rare species, natural communities, coastal ecosystem, and parks and protected areas under climate change.

> **Strategy:** Conduct a review of required management plans for public parks, forests, and wildlife areas every 10 years and include analyses of vulnerability to climate change for each area.

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ADP-4. Water Resource Management

Description of Issues

The State of Florida is currently facing many water resource management challenges, including shortages due to drought, saltwater intrusion, and deterioration in quality and limits on the availability of its groundwater sources. The system is stressed even further by continued pressures from population growth, development styles, and potential new challenges resulting from climate change. Although there are uncertainties about climate change, water managers must nonetheless plan for potential increased variability in precipitation regimes, storm events, and rising sea levels. Significant changes in these phenomena are likely to result in changes to the amount of freshwater resources and land available to sustain life and maintain healthy water-dependent natural systems.

While Florida's extensive coastline provides a unique ability to tap saltwater as a future water source, primary water resource concerns revolve around changes to water-dependent ecosystems, impacts to and from human activity, and the quality of groundwater and surface water. There may be shifts in water demands for agricultural and municipal supply; increased energy consumption for advanced water treatment, transmission, and disposal; and changing environmental needs.

The rate of climate change and potential consequences over the next 100 years is uncertain, but the more rapid the rate of change, the more quickly Floridians will have to respond to manage Florida's water resources effectively. Planning and action now may significantly reduce the cost of deferring action.

Objectives

Local, state, and regional policies to protect groundwater and other water resources are designed to ensure adequate supplies to meet the needs of humans and the environment. Policies and measures to encourage conservation, protect existing supplies, identify and develop new supplies, and further invest in innovative technologies to treat water will be needed. Florida recognizes four areas of responsibility (AOR) critical to water resource management, as expressed in Chapter 373, Florida Statutes.

1. Water Supply—Managing water resources to ensure that there are adequate supplies for current and future Floridians.

2. Water Quality—Implementing measures to ensure that changes to existing landscapes will not cause degradation of existing groundwater and surface water quality.

3. Flood Protection—Identifying and protecting flood-prone areas to minimize the risk of floods to human activities through structural and non-structural means.

4. Natural Systems Protection—Managing water and related land resources to ensure that there are supplies of adequate quantity and quality to protect and maintain healthy natural systems.

In order for Floridians to have adequate freshwater supplies available to meet basic reasonable and beneficial needs and the requirements of natural systems, these principles should be followed:

- Intense conservation of all water uses and alternative water sources will need to play a larger role in meeting Florida's future water needs.
- Provide for stakeholder involvement in statewide and regional water supply planning processes.
- Incorporate methods to quantify and plan for uncertainties and risks related to population growth, climate change, and environmental regulations.

It is important that the five water management districts have consistent and coordinated water policies to address climate change.

Assets at Risk

The majority of Florida's population and the water infrastructure to serve them reside within 50 miles of the coast. The Florida population is projected to increase by an additional 50% by 2030. In addition to new infrastructure required to develop and distribute water supplies to meet the needs of that growing population, existing coastal and groundwater resources may be at risk due to saltwater intrusion and SLR. Additional consumptive use of freshwater will further diminish the head of pressure needed to stave off saltwater intrusion.

Florida could face rising seas, decreased precipitation, and more intense storms. These three currently predicted impacts alone could have serious implications for Florida's major areas of water resource responsibility.

Goals and Strategies

Goal 1: Identify and quantify the vulnerabilities and reliability of existing water supplies to potential effects of differing climate change scenarios with emphasis on source water availability and quality.

Strategy A: Develop an inventory of water supply facilities (source, storage, treatment, and distribution) and conduct a study to develop different climate change scenarios and potential impacts and adaptation strategies for high-risk utilities.

Strategy B: DEP, water management districts, and local and regional staff should evaluate and prepare for relocation and/or protection of drinking water well fields and groundwater recharge areas from saltwater intrusion.

Goal 2: Develop regional and statewide water demand projection scenarios that account for potential changes in (1) agricultural demand due to changes in the growing season or impacts on crop production; (2) municipal and industrial demand as temperatures increase and drought (seasonal or intra-annual) persists; and (3) water demand for energy generation due to possible changes in fuel sources over a 100-year planning horizon, with consideration for Florida's statutory obligation to provide water for the environment.

> **Strategy A:** DEP, water management districts, and local and regional planners must evaluate and implement maximum wastewater treatment and reuse options to optimize drinking water and water for the environment and other beneficial uses.

Goal 3: Develop conservation programs that address and incentivize water and energy usage efficiencies.

Goal 4: Encourage water reuse.

Goal 5: Implement local, state, and regional water supply planning processes that quantify potential changes in existing water supplies and identify potential new water sources, including synergies between flood management structures and water supply. Promote coordination across jurisdictions within and across watersheds as appropriate. Incorporate methodologies that use not only historic hydrologic data, but also consider changes that may result from climate change and prioritize water for natural systems.

Goal 6: Integrate land-use considerations, flood management, and storm-water best management practices (BMPs) designed to protect water quality, water demand/supply management, and water reservations for the environment in watershed planning and design standards.

Goal 7: Incorporate methods that consider energy, environmental, and economic sustainability when evaluating potential water management strategies (e.g., in developing new surface water supplies or desalination projects).

Goal 8: Change monitoring compliance with minimum flows and levels and water/consumptive use permits, how structures are operated, and when alternative supplies sources are needed.

Goal 9: Change the basis for current Environmental Resource Permits (ERPs), watershed and water quality modeling, structural operations, and other flood management methodologies.

Goal 10: Address water quality changes and flooding of coastal and tidally influenced bodies of water that may occur due to more intense storms, higher surface water temperatures, and rising sea levels on coastal aquifers.

Goal 11: Increase freshwater pressure to offset SLR, retain as much freshwater in natural systems as is reasonable, and restore previously drained systems.

Goal 12: Redesign as necessary coastal recovery strategies, coastal restoration projects, coastal land acquisition, and other measures to allow for natural adaptations and movement inland.

Goal 13: Protect and maintain the natural mosaic of ecosystems, such as upland and lowland interfaces, to ensure the health of water and related natural resources.

Goal 14: Allow coastal estuaries, riverine, and other water dependent ecosystems to migrate or adapt to maintain healthy wildlife and fish populations consistent with new climate regimes.

Goal 15: Well fields, surface or subsurface storage facilities, and water treatment plants may be vulnerable. Siting and plans for new facilities should be closely examined to mitigate impacts or locate the facilities to reduce risks from increased winds and flooding.

ADP-5. Built Environment, Infrastructure, and Community Protection

Definition of Issues

The built environment can be defined as the aggregate of all buildings, facilities, and structures designed and built to provide shelter or to house the full breadth of human activity, as well as the infrastructure designed and built to supports or protect such human activity.

The conjugation of these factors has resulted in more than 70% of the population living in coastal counties, and perhaps close to 85% of the built environment (on the basis of total area of construction) is located in coastal counties with a high concentration in large urban areas such as the tri-county (Palm Beach, Broward, and Miami-Dade) corridor in Southeast Florida, the west-central region around Hillsborough and Pinellas counties, and the Jacksonville-St. Augustine region.

U.S. Census Bureau projections and other studies estimate that Florida's population will reach close to 29 million by 2030, which means an increase of some 10 million people over the estimated 2007 state population and 7 to 8 million more residents in coastal counties. If these projected trends continue, the concentration of built environment will likely continue to increase along the same parameters as those currently in place.

Florida is vulnerable to a wide range of natural hazards, including hurricanes, coastal storms, floods, tornadoes, wildfire, drought, extreme heat, winter storms and freezes, erosion, sinkholes, and storm surge. The risk of some of these hazards will be exacerbated by climate change, while the risk of others will be lessened.

Design criteria are part of building codes used to design buildings that are expected to have a minimum service life of 75–100 years and that can withstand extreme events. The Florida Building Code became the single-state building code as of March 1, 2002. The expressed intent of the Florida Building Code is "...to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, sanitation, adequate light and ventilation, energy conservation, and safety to life and property from fire and other hazards attributed to the built environment..."

One of the most important issues with regard to adapting the built environment to climate change is that buildings and structures are designed on the basis of the minimum requirements established by the building code, which are primarily based on historical data on forces such as wind loads and hydrodynamic pressure from storm surge. As the risks from such natural hazards are exacerbated by climate change, existing buildings and those being designed today may be subjected to impacts that exceed the designed capabilities. This could lead to catastrophic damage. Adapting the built environment to the impact of climate change will require design criteria and building codes that consider potential future impacts in establishing minimum design requirements.

Objectives

1. Reduce the potential for damage to the built environment from the impact of natural hazards, especially from those hazards caused or exacerbated by climate change, make this a high priority for all levels of government and the private sector in Florida.

2. Make the practice of adapting the built environment to the impact of climate change an integral component of comprehensive planning, building codes, life-safety codes, emergency management, land development and zoning regulations, water management, flood control, coastal management, and community development.

3. Make the practice of adapting the built environment to the impact of climate change a preferred objective of building design, siting, and construction research funded by public monies in Florida.

4. Foster an environment of communicating and sharing knowledge about adaptation to climate change and the adaptation/protection of the built environment among the scientific community, lawmakers, various professional sectors (practitioners), and the general public.

5. Promote an environment to connect science with decision making regarding climate change and the need to adapt the built environment to its impacts.

6. Promote an environment for connecting scientific research with practical applications that will contribute to the adaptation of the built environment to the impact of climate change.

7. Encourage the search for practical and effective solutions to ensure that existing and future built environment in Florida will remain habitable, providing viable shelter for the full range of human activity and ensuring continuity of critical and essential functions in the aftermath of impact by climate change–exacerbated hazards.

8. Establish educational and professional licensing requirements to ensure that key professional sectors become practitioners of adaptation in support of planning, building design, and construction activities.

9. Require the state, county, and municipal governments throughout Florida to develop and maintain a local climate change adaptation plan, to provide a framework for assessing vulnerability, identifying risks, defining and quantifying the value of the built environment that is at risk (see attachment on Quantifying Value at Risk), and identifying and implementing effective adaptation measures at each jurisdictional level (i.e., state, county, municipality, and individual facility).

Exercise fiscal responsibility in recognizing not only the magnitude of the problem to be confronted by future generations but also the need to start implementing and paying for solutions now while also creating reserves to pay for future measures, especially those that may be community-wide or regional in scope.

Objectives for beaches in ADP-3 are relevant to this ADP Policy Option.

Assets at Risk

Climate change will modify or exacerbate most of the factors mentioned above, which were used to establish design criteria, during the remaining service life of existing buildings and new buildings just now being built. For example, certain aspects of climate change (specifically, increased global mean temperature and SLR) have the capacity to amplify hurricane strength and potential damage. SLR will have a direct impact on storm surge, perhaps the most destructive characteristic of hurricanes, as they impact the built environment in the coastal region. There will also likely be higher incidence of extreme rain events.

This means that a building created on the basis of current design criteria and the minimum requirements of the Florida Building Code may be subjected to higher loads from storm surge, wave impact, and precipitation during hurricanes than what it was originally designed for during its remaining service life. It is likely and perhaps highly probable that a building under such conditions will suffer severe damage and even structural failure. Those buildings constructed before the Florida Building Code came into effect are at much higher risk of suffering catastrophic damage under the impact of climate change–exacerbated hazards.

Existing Actions

HB 7135, passed by the 2008 Florida Legislature, provides certain "lead by example" improvements to local, state, and regional government building and renovation standards, including the use of specified green building standards and energy-efficient design. The Bill also creates the FECC to centralize policy development and program implementation for energy and climate change and to review and consider recommendations by the Action Team concerning building standards and adaptation. In addition, the Bill created the FESC as a "supercenter of excellence" within the SUS to better coordinate energy-related research that supports Florida's policy objectives for energy and climate change.

This ADP Policy Option covers the entire infrastructure and is divided into the following categories: building codes and regulations, flood protection, beaches as infrastructure, and transportation. Many of the issues regarding climate change, goals, and strategies can be applied to other infrastructure, such as communications; electric power production, transmission, and distribution; education; and government.

ADP-5.1 Building Codes and Regulations

Goals and Strategies

Goal 1: Require that the Florida Building Code incorporate design criteria for buildings to resist future loads that may result from the impact of climate change–exacerbated hazards during a minimum service life of 50 years.

Strategy A: Strengthen Florida Building Code requirements for new structures and appropriate renovations to encourage resistance to the impacts of climate change.

Strategy B: Conduct research on how building codes can be routinely updated to account for changes in climate and to develop options on how such codes could account for potential future changes in risks from climate change.

Strategy C: Determine whether existing construction siting and design requirements under the Coastal Construction Control Line (CCCL) Program intended to ensure avoidance of "significant adverse impacts" to the coastal system are adequate under a range of SLR scenarios.

Goal 2: Require the Florida Building Commission (FBC) to establish a technical committee that focuses on vulnerability to climate change and that will recommend updates to the building code as evidence of new trends of risk factors from climate change arise.

Goal 3: Encourage builders to construct new buildings that meet Leadership in Energy and Environmental Design™ (LEED) standards. Reducing energy demand is also an adaptation strategy, because less energy will be demanded during heat waves and the need for water to support energy production will be reduced.

Goal 4: Develop a required training program to educate professionals in relevant fields (e.g., architecture, engineering, and construction management) on the need to incorporate adaptation to climate change as a basis for establishing design criteria for new infrastructure. Completion of such required training should be a condition for relicensing.

Strategy A: Examine licensing and recertification requirements for building professionals and revise them to include design criteria that account for the impacts of climate change.

Strategy B: Add adaptation criteria to professional education curricula at state universities and trade schools for building and design degrees.

Goal 5: Empower the Department of Business and Professional Regulation (DBPR) and the various professional licensing boards to incorporate sections on climate change vulnerability and built environment adaptation methodologies in all licensing examinations.

Goal 6: Create and fund a built environment Climate Change Adaptation Program as a state research initiative. The program would be charged with engaging the scientific and research community, by way of competitive research projects and annual announcements of funds availability, in the assessment of vulnerability and risk of the built environment to the impact of climate change. It should focus on the development of adaptation methodologies based on new design criteria, methods and materials of construction, and similar initiatives.

Goal 7: Encourage public universities in Florida to develop educational programs for building design and construction professionals, planners, and those in other pertinent fields, focusing on vulnerability to climate change and adaptation methodologies.

ADP-5.2 Flood Protection

Goal 1: Reduce or eliminate the potential for damage from flooding by requiring all new or substantially renovated buildings to be elevated above potential threshold flood depth (considering climate change), which is to be determined on a site-specific basis for the projected service life of the building.

> **Strategy:** Implement zoning criteria and/or building code design criteria that will require all new buildings or buildings that are substantially renovated to have a zero-flood-depth elevation that is a minimum of one foot above a projected site-specific flood depth with an annual probability of flooding of 0.5% during the remaining service life of the building. For purposes of these requirements, a substantially renovated building is one where work to be done is equal to or above 25% of the current replacement value of the structure.

Goal 2: Substantially reduce or eliminate storm water runoff as a contributor to flooding.

> **Strategy:** Implement land use and zoning regulations and/or building code design criteria requiring all new or substantially renovated buildings to incorporate porous materials and other low-impact development techniques for site work, sidewalks, curbs, driveways, and other locations in order to promote water percolation into the ground to reduce runoff volume during rain events.

Goal 3: Set new parameters for water management with the objective of reducing the potential for flooding from extreme rain events.

> **Strategy:** Encourage the five water management districts in Florida to work with pertinent federal and state agencies and the research community to develop extreme-precipitation threshold models, which will be used to activate water management actions to reduce the potential for flash floods. These models and related water management actions are to be linked to monitoring systems using virtual rain gauges, satellite observations, and other technology to forecast the risk of a given amount of precipitation occurring within a given time frame.

Goal 4: Substantially reduce or eliminate currently developed building sites subject to repetitive flood loss events.

> **Strategy:** Charge counties and municipalities with cataloging currently developed building sites that have been flooded three or more times within the last 10 years. Target those sites for future use conversion to reduce the human risk or the potential for property damage.

Goal 5: Incorporate regional or community-wide flood protection, on the basis of projected SLR and other flood threats, into regional and/or comprehensive plans that focus on development and redevelopment over the next 50 to 100 years.

> **Strategy:** Fund studies to identify community-wide or region-wide adaptation alternatives to reduce the potential for damage from coastal flooding exacerbated by projected SLR. Such studies will incorporate a comparative analysis, estimated costs, timelines, and associated economic, social, and environmental impacts of a range of adaptation measures, including engineering and structural works as well as land-use and zoning measures.

Goal 6: Develop scenarios for land-use conversion that accommodate future population growth and development and that incorporate flood prevention criteria on the basis of projected flood threats 50 to 100 years from now.

ADP-5.3 Beaches as Infrastructure

Goals and Strategies

Goal 1: Examine where, how, and to what extent coastal ecosystems confer protection to vulnerable human communities. Set priorities for protection and for the appropriate management of these systems.

> **Strategy A:** Undertake comprehensive research and analysis to determine alternative solutions and establish the engineering and economic feasibility of whether or not selected sections of the coasts can or should be protected.

- Determine the engineering feasibility of protecting selected coastal areas, taking into consideration the porous nature of much of Florida's coastal geology.
- Compare the economic cost of armoring and other protection alternatives versus the cost of abandoning major coastal urbanized areas.
- Assess economic, political, social, and environmental impacts of alternative solutions or no action on Florida's beaches, coastal wetlands, other ecologically important areas, and near-shore coastal marine habitats.
- Begin the evaluation in the relatively near future since public works projects of this magnitude take many decades from concept to completion.

ADP-5.4. Transportation and Other Infrastructure

There are 121,525 miles public roads in the state: 12,062 on the state highway system (owned by FDOT), 107,421 city and county roads, and 2,042 owned by other federal entities.[3] There are 19

[3] FDOT Website, Highway Mileage Reports at http://www.dot.state.fl.us/planning/statistics/mileage-rpts/shs2007.pdf

commercial airports, 14 of which are international. In addition, the state has 14 deepwater ports.[4]

Roads, airports, rail, pipelines, ports, beaches, and other infrastructure along and close to Florida's coastline are potentially vulnerable to climate change impacts. Unfortunately, a comprehensive listing of transportation infrastructure at risk in the United States has not been prepared. Improved information about projected climate change impacts and timing of such events will be needed to identify specific transportation and other infrastructure at risk.

In Florida, potential impacts of climate change include rising temperatures, increases in the intensity of heavy rainfalls and hurricanes, and rising sea levels. Because of this, transportation and other infrastructure along the coast and in low-lying areas are susceptible to damage from SLR, storm surge, erosion, flooding, and higher temperatures. However, adaptation, particularly related to transportation, has not yet received as much attention or research as climate change mitigation.

Goals and Strategies

Goal 1: Inventory the critical transportation infrastructure at risk; determine whether, when, and where projected impacts from climate change might be significant; and evaluate the costs and benefits of alternatives.

Goal 2: Ensure the coordination of adaptation efforts on transportation across jurisdictional boundaries and the exchange of information, resources, and best practices among government, the private sector, and other stakeholders.

Goal 3: Ensure that the long-range planning process on transportation addresses adaptation and the protection of critical infrastructure.

The following strategies support all three goals:

Strategy A: The Florida Department of Transportation (FDOT) should update the Florida Transportation Plan in cooperation with federal, state, regional and local governments and modal partners to develop long range goals, objectives, and strategies for addressing climate change and adapting to potential impacts from climate change.

Strategy B: State, regional and local governments and modal partners in Florida should work cooperatively to identify and evaluate transportation infrastructure at risk and to coordinate adaptation efforts for infrastructure immediately landward of coastal high hazard areas or to provide emergency evacuation routes for coastal populations.

2007 SHS Annual Report at http://www2.dot.state.fl.us/planning/mileage/word/pdf/pdf_report_final_inet.asp

[4] State of Florida.com "Florida Quick Facts," available at: http://www.stateofflorida.com/Portal/DesktopDefault.aspx?tabid=95, accessed. July 23, 2008.

Strategy C: FDOT should continue its analysis of rainfall statistics and hurricane surge (including updating such statistics and analyzing the accompanying affects of wave forces and erosion on highways and bridges) and in other areas to identify infrastructure at risk.

ADP-6. Transportation and Other Infrastructure

This section was incorporated into ADP-5.4.

ADP-7. Economic Development

Description of Issues

Florida's gross state product in 2007 was more than $734.0 billion. Of that, agriculture was $7.0 billion, mining was $1.0 billion, and construction was $45.0 billion. In 2007, Florida had more than 85 million visitors, generating more than $65.0 billion in revenues.

Objectives

- To adapt Florida to new economic trends and realities brought on by the powerful drivers of energy and climate change;
- To generate useful economic trend analysis and data to guide economic development decision making; and
- To create policies, programs, and implementation mechanisms that support the ability of Florida's economy to adapt to climate change.

Assets at Risk

Climate change is likely to have a significant effect on all sectors of Florida's economy. Some sectors will likely face acute challenges, while others will likely enjoy growth opportunities. There could be significant damage to some economic sectors, such as real estate, tourism, agriculture (e.g., productivity and export markets), and other resource-based industries.

The state would benefit by early identification of business opportunities (and risks) associated with climate change to increase its global competitive advantage and to increase the creation of new jobs within the state. An impact assessment is needed to forecast potential disruption to Florida's major economic sectors due to climate change impacts, such as more frequent tropical storms, SLR, drought, acute flooding events, saltwater intrusion, and possible habitat and species disruption.

Successful economic adaptation will require anticipating and responding to the challenges and opportunities, given such economic trends.

Goals and Strategies

Goal 1: The Office of Tourism, Trade, and Economic Development (OTTED) and Enterprise Florida—in conjunction with the FECC—should undertake an analysis to look at new opportunities and at economic sectors that may be negatively impacted.

Goal 2: Establish the economic value and importance of natural resources to the state economy overall and to tourism and other resource-based sectors.

Goal 3: Identify policy issues related to habitat and species management, human needs, hunting, fishing, boating, and outdoor recreation.

ADP-7.1 Tourism

Tourism in Florida constitutes more than 10% of the state's economy. The state's thriving tourism sector depends on the richness and diversity of Florida's natural resources. Its climate, forests, parks, waterways, beaches, marine systems, habitat, species, flora and fauna, and other attractions bring more than 70 million tourists to the state each year.

SLR, increased hurricane intensity, increased storm intensity, drought, wildfires, human health risks, and other outcomes of climate change could be threats to Florida's tourism industry. In addition, rising temperatures could make locations further north relatively more attractive to tourists.

Goals and Strategies

Goal 1: Assess the economic impact of climate change on the tourism sector.

Goal 2: Given the state's interest in ensuring a healthy tourism sector, assess the level of appropriate investment in the state's natural resources.

ADP-7.2 Other Resource-Based Industries

Other resource-based industries, besides tourism, include agriculture, forestry, marine resources (e.g., commercial fishing), aquaculture, and mining. While these constitute only about 1.0% of the state's economy, such industries are important to Florida's way of life and character. The state should contemplate its interest and role in mitigating the impact of a changing climate on these sectors.

ADP-7.2.1 Agriculture

The productivity of many crops may be impacted by warmer temperatures, altered precipitation patterns, more intense storms, changes in runoff patterns, invasive species, and new pests. Biofuels may present new growth opportunities; however, adequate care should be taken not to displace food crops. Planning for adequate water supplies may be important to sustaining this sector.

Goals and Strategies

Goal 1: Assess potential changes in the geographic range, climate tolerances, and economic viability of current and potential new annual and perennial crops and livestock.

Goal 2: Review land-use, tax, and subsidy policies to encourage appropriate adaptation in the agriculture sector.

Goal 3: Assess potential changes in the extent and distribution of irrigation demand and supply for agriculture that are due to climate change and incorporate long-term planning for agriculture.

ADP-7.2.2 Forests

Aside from the inherent value of Florida's forests as habitat for many native species, they have economic value as recreational areas for ecotourism activities and in traditional commercial applications as a resource for building products. In addition, Florida's many acres of longleaf pines and bottom hardwoods on public and private lands are excellent carbon sinks and could be a source of revenue for public and private landowners through a carbon-credit trading system.

Forest resources must be conserved and expanded. Work needs to be done to determine the level and areas of risk from climate change impacts (e.g., drought, pests, storms, saltwater intrusion, and invasive species) for this valuable resource.

Goals and Strategies

Goal 1: Continue existing land acquisition/management programs for forested lands.

Goal 2: Adopt land acquisition/management programs with a climate change component.

Goal 3: Explore adaptation of forest stocks through genetics to strengthen stocks against risks associated with climate change.

ADP-7.2.3 Marine

Florida's industries based on living marine resources include commercial and recreational fishing, marine ecotourism (including coastal parks and conservation areas), marine pharmaceuticals, and marine research and education. The direct 2006–2007 value of these industries to Florida's economy was $4.4 billion (National Ocean Economics Program [NOEP], 2008), and the indirect value of related infrastructure and support was many times larger. Adaptive responses to protect the core living resources these industries rely on are addressed in ADP-3, Protection of Ecosystems and Biodiversity. This section addresses threats to the availability and human uses of the resources, beyond considerations made in other adaptation response actions.

The adaptive management of Florida's marine resources and their sustainable use in a changing climate will be designed to protect the living resources and the social, economic, and cultural systems that form Florida's industries.

The geographic ranges and abundances of living marine resources are likely to change as climate, ocean temperatures and currents, water quality, and related controlling factors change. Likewise, the ranges, abundances, and impacts of marine diseases, invasive species, parasites, and harmful algal blooms could change.

Fisheries, principal fishing grounds, ecotourism destinations, and the land-based operations and facilities that support these industries may migrate to different areas in the state as a consequence of these changes. Such changes have the potential to impact the economic viability of industries dependent on living marine resources. The same changes can also have negative effects on the health and safety of industry workers and consumers of industry products and services. Public and private investments in land acquisition for future parks and conservation areas, future working waterfronts for fishing and ecotourism, and future marine research and education facilities will be influenced by climate change, and the effects could be significant. The same processes that may diminish Florida's existing marine industries may lead to new opportunities for fisheries, ecotourism, and allied economies. Adaptive management will require an ability to detect and exploit such possibilities.

Goals and Strategies

Goal 1: Provide an integrated tracking and reporting system for the ranges, abundances, and condition of species valued for their roles in fisheries, ecotourism, aquaculture, pharmaceuticals, and research.

Goal 2: Develop and implement an integrated screening and tracking program for species die-offs, marine diseases, invasive species, and parasites that is modeled after programs that monitor the state's harmful algal blooms.

> **Strategy:** Goals 1 and 2 will be met through the use and expansion of existing state and federal programs and platforms for monitoring, event responses, data management, and public reporting.

Goal 3: Implement educational programs to reduce vessel-based conveyances of unwanted species into Florida waters and to protect industry workers and consumers from novel health and safety challenges.

> **Strategy:** Collaborate with the Florida Sea Grant College Program (FSG) to implement the programs.

Goal 4: Develop conceptual plans for the co-location of new working waterfronts for activities such as fishing, ecotourism, and marine research that employ green infrastructure adapted to emerging challenges of climate change.

> **Strategy:** Engage university planning, engineering, and architectural schools in developing the conceptual plans.

ADP-7.2.4 Aquaculture

Aquaculture is a rapidly developing industry in Florida. As the state's fisheries become depleted, either through over-harvest or climate change impacts, cultured seafood products will increase in importance. Florida producers sold $74.9 million of aquaculture products in 2005, ranking Florida seventh in the nation in terms of aquaculture sales. More than 900 Florida

aquaculturists produce the largest variety of aquatic species of any state in the nation. Tropical fish dominate the Florida aquaculture industry as the number one commodity with $33.0 million in sales in 2005, also making the state the number one producer nationwide. The state is also a leading U.S. producer of farm-raised aquatic plants and an important producer of hard clams.

The industry could be threatened by warmer water temperatures, which may make current breeding grounds unsuitable in the future by exceeding thermal tolerances of the species in question, reducing dissolved oxygen levels, and allowing for the introduction of pests and disease. SLR can threaten facilities with inundation, turn freshwaters brackish, and inundate coastal wetlands. Increased intensity of hurricanes and other storms can damage or destroy fisheries and facilities. Drought can reduce freshwater flows and degrade water quality.

Goals and Strategies

Goal 1: Develop plans for increasing seafood product aquaculture to supplement declining ocean stocks.

Goal 2: Encourage expanded and increased leases for aquaculture on submerged state lands.

Goal 3: Review existing out-of-state marketing programs with an eye to increasing those sales of Florida aquaculture products.

Goal 4: Identify and institute management practices to ensure healthy growth of this industry.

Goal 5: Identify innovative and federal funding sources for mitigation and adaptive strategies.

ADP-7.2.5 Mining

Nationally, Florida ranks fifth in the production of limestone, sand and gravel, clay, peat, heavy minerals, and phosphate. The state's mines supply one-quarter of the world's and three-quarters of the U.S. domestic needs. Nearly all of the phosphate mined is used for the national and international production of agricultural fertilizer. In 2000, approximately $1.13 billion worth of fertilizer was exported. Phosphate mines in northern and central Florida have been a valuable resource for the national and international production of agricultural fertilizers, although many of these lands are now considered degraded and disturbed.

After mining operations have ceased, these lands could be used for rotation bioenergy crops, as well as for carbon sequestration. Mining also has implications for aquifers and water supplies and storage that should be noted here.

Goals and Strategies

- Study soil carbon dynamics to estimate the long-term potential for carbon sequestration in new growth forest and through underground sequestration.

- Determine environmental and cost benefits of developing short-rotation woody crops on formerly mined lands.
- Review and select tree species appropriate for such sites.
- Identify management practices to ensure plant survival and maximize growth.

ADP-7.3 Construction

Construction is more than 6.0% of Florida's economic output. Construction employment represented approximately 8.5% of total non-agricultural jobs, and more than 210,000 annual building permits were issued as recently as the end of 2006. The industry has been affected by a change in supply and demand for key building materials (e.g., lumber, cement, reinforcing steel, and plywood), resulting in huge increases in prices that in some cases reached 200%, 300%, or higher in just one year. Climate change has the potential for exerting significant impact on the construction sector through such changes as extreme precipitation, drought, SLR, or the exacerbation of natural hazards such as storm surge and flooding.

Climate change–driven modifications in the construction industry have the potential to significantly impact the economy of the communities and regions affected. The consequences of climate change may include the following, all of which would likely result in increased costs:

- The need to adapt existing and future buildings so that they can withstand the impacts of climate change will require that design professionals carry out additional studies and calculations or engage other experts as consultants.
- Buildings may need to have deeper and stronger foundations, be elevated above a higher "zero flood elevation," have much higher insulation values than currently required, have much higher roof drainage capacity, or incorporate green building features.
- Higher temperatures during the work day or higher and more frequent extreme precipitation events have the potential for affecting working conditions, which will increase not only the cost of construction but also the income of construction workers.
- Should the need for adaptation become a requirement for new construction, the demand for adaptation-related practices would increase.
- Retrofitting, demolition, or conversion projects of existing buildings may be needed to adapt them to climate change, or to retreat from hazardous zones.

Retreat may have an adverse effect on the volume of construction in relatively vulnerable areas, leading to economic losses and labor reductions in the construction industry.

Goals and Strategies

Goal 1: Identify the sensitivity of the construction industry in Florida to a range of external, non-climate change–driven factors that have the potential for affecting the economic aspects of the construction industry.

Goal 2: Measure the economic impact resulting from climate change–driven consequences on the construction industry and related sectors and from non-climate change factors, with projected scenarios at 5-year intervals.

Goal 3: Identify those communities, regions, or sectors along with related or interlinked sectors that may suffer adverse economic consequences as a result of the impact of climate change on the construction industry, and commission a study to identify effective measures to reduce the potential for such adverse consequences.

Goal 4: Measure how adaptation procedures applied through construction methods, materials, or design criteria may reduce the risk of damage to the built environment and link such risk-reduction to a reduction in insurance premiums.

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ADP-8. Insurance (Property and Casualty)

Description of Issues

With more than 1,350 miles of coastline, Florida is physically and financially vulnerable to the effects of climate change. Ninety percent of Floridians live within 50 miles of the coast, and the value of property in this area is approaching $2.0 trillion. Additionally, the state's largest insurance company—Citizens Property Insurance Corporation—has 1.3 million policyholders and is financially supported by Florida's insurance consumers.

Insurance from flooding falls under the National Flood Insurance Program (NFIP), which is administered by the federal government, and Floridians account for 40% of NFIP's policyholders. Insurance for wind damage is typically covered by private insurance policies, which are regulated by state governments. The Citizens Insurance Company is the insuring entity of last resort for hurricane wind coverage.

Assets at Risk

Insurance companies in Florida insure assets worth billions of dollars—homes, businesses, agriculture, infrastructure, parks, and beaches. All of these assets and more are at risk to the myriad effects of climate change. Florida's current pricing structure does not truly reflect the risk of loss, particularly for Florida's coastal regions.

Scientific studies have established that climate change increases the intensity of hurricanes. In addition, SLR will erode shorelines, threatening many properties, and will result in higher storm surge from hurricanes. Other climate outcomes, such as wildfire, intense rain events, and drought can also pose risks to lives and property. Given Florida's geography, coastal density, and a $65.0 billion dollar tourism economy, plus eight major storms in 2004 and 2005, property insurance and affordability issues are one of Florida's greatest challenges.

Existing Actions

In 2005, the Florida Legislature passed a law requiring all residential property insurance companies to file with the Office of Insurance Regulation (OIR) a range of premium discounts offered to customers who live in homes of certain construction types or who apply loss mitigation devices (like shutters) to their homes. Beginning on September 5, 2007, all property insurers were required to offer higher discounts in their insurance rates for policyholders who had recognized loss mitigation devices on their homes. Insurers are required to send a list of those discounts with exact dollar savings to all new and renewed policyholders.

The NFIP, managed by the federal government, provides insurance for damage from flooding (e.g., storm surge). Damage from wind and other causes is typically covered by private insurance. In 2007, Florida created the Florida Citizens Property Insurance Corporation (CPIC)

to provide multi-cause and wind-only insurance coverage to homeowners and businesses in Florida.

Goals and Strategies

Goal 1: Encourage insurance companies to provide policyholders with greater disclosure about climate risk. Insurance companies need to adequately inform their customers and shareholders about the risks climate change poses to the insurance business and the ability of the industry to pay policyholders' claims. Insurance companies also need to take necessary steps to mitigate against these risks.

Goal 2: Understand the relationship between the threats of climate change, SLR, and providing affordable insurance premiums to Florida home and business owners. Address equitable and fair differences in insurance for coastal and inland properties.

Goal 3: Florida should develop policies that make coastal communities and infrastructure more resilient to natural disasters through programs such as the My Safe Florida Home program.

Goal 4: Fully define the issues surrounding risk-based pricing in the property and casualty insurance industry for Florida.

Goal 5: Insurance pricing and availability can encourage or discourage particular forms of coastal development. Subsidized coastal insurance polices such as the Florida CPIC, should be consistent with federal and state programs designed to reduce high-risk shoreline development, increase coastal system resiliency, and protect important coastal resources vulnerable to risks associated with climate change.

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ADP-9. Emergency Preparedness and Response (Extreme Events)

Definition of Issues

Throughout the history of settlement in Florida, extreme weather events—particularly in the form of hurricanes—have played a major role in shaping culture, commerce, and community development. As a result, Florida's state government has developed one of the more robust emergency preparedness and response infrastructures in the nation. This was particularly evident in the depth of aid provided by Florida to Mississippi during the 2006 hurricane season in the aftermath of Hurricane Katrina.

Global climate change is likely to increase Florida's risk of extreme weather events. Whether hurricane frequency will increase, given rising sea-surface temperatures, is uncertain at present. Current science supports increased intensity and duration for storms that form in the Atlantic and the Gulf of Mexico. When coupled with rising sea levels, future hurricane events may yield greater storm surge effects to put coastal communities at greater risk for damage than is the case today. In addition, there could be more intense rain events, droughts, wildfires, and heat emergencies.

Extreme weather across the state can:

- Overtax the emergency response systems and funding for flood response,
- Result in major storms and power outages,
- Affect buildings or transportation routes, and
- Cause drought-related fires.

Hurricanes, as Florida's typical extreme weather event, may no longer be the only major threat to Floridians. An analysis of predictable climate change impacts would include projections for other intense rain events, not to mention increased droughts, wildfires, heat, and public health emergencies.

Additionally, given the many fronts that climate change is expected to present to Florida's emergency infrastructure, there is the possibility that several of these impacts might occur simultaneously.

Delayed emergency response could become more common.

Objectives

Florida's current emergency preparedness and response functions are a coordinated effort between federal, state, and local governmental agencies, as well as nongovernmental organizations (NGOs). The objective of Florida's future emergency preparedness and response

functions must be to build on the excellence gained through past experience to ensure sufficient capacity and efficacy in protecting public heath and welfare in more severe storm events with increased incidence of storm surge and the associated coastal damage. As the impact of SLR and higher storm surges becomes more evident, development patterns must be constrained to increase the resiliency of coastal communities and to protect those communities.

Floridians must be prepared for an increased incidence of heat-related illness in large sectors of the public, particularly given Florida's large population of senior citizens. As temperatures rise and the climate becomes more tropical, water- and vector-borne diseases now associated with more equatorial climes might become commonplace in Florida. This situation will be aggravated by increased flooding events and their associated impacts on certain portions of the public infrastructure such as sewage systems, hospitals, and nursing homes.

Moreover, Florida must be prepared to address the synergistic effects of multiple climate stressors on its emergency response infrastructure and, prior to such occurrences, must devise an approach to deal with this by building on our existing skills in emergency preparedness and environmental response. Policy makers in particular need information and data on changes in risks from climate change and need to know where to get such information.

Assets at Risk

While all of Florida's counties are subject to extreme weather events, our coastal communities and ecosystems are at particular risk from increased storm surge and increased hurricane intensity. The vast majority (70%) of Florida's population lives in the coastal zone. Likewise, the vast majority of the state's existing building stock is situated near the coast. While many coastal ecosystems have adapted to periodic extreme weather, system resiliency in some cases may be undermined because of the loss of habitat, pressures from invasive exotic species, or other incidences that prevent post-hurricane recovery.

Aside from risk to the human population from hurricane events, increases in temperatures may cause certain water- and vector-borne diseases normally associated with more southern climates to migrate to Florida. Increased flooding and infrastructure damages resulting from increased heat and flooding could aggravate these risks.

Existing Actions

Many of the impacts that climate change is projected to bring are already familiar to Floridians. Consequently, programs to address impacts such as increased intensity of hurricanes and major storm events, storm surge and erosion, saltwater intrusion, and the availability of potable drinking water supplies have been implemented. Additionally, Florida's excellent emergency response infrastructure has proven itself under many scenarios, and the planning mechanisms that are part of that infrastructure are in place to deal with a large variety of catastrophic events. However, it is uncertain to what extent these programs and infrastructure will be affected by future impacts associate with climate change, or to what extent additional financial resources will be needed to meet these future conditions.

Goals and Strategies

Goal 1: Ensure sufficient response capability among regional, state, and local first responders to potential increases in extreme weather events.

Goal 2: Increase the resiliency of coastal communities to storm surge.

Strategy: See ADP 2.1, Goal 4, Strategy D

Goal 3: Assess the role of ecosystems such as coastal wetlands and beaches and dunes in reducing risks from extreme events.

Goal 4: Plan for other extreme events (e.g., flooding, wildfire, and heat waves).

Goal 5: Develop a process for early detection, evaluation, and handling of extreme events resulting from climate change. Effectively distribute such information to key emergency preparedness and response personnel.

Goal 6: Invest in emergency response and mitigation strategies for extreme environmental events likely to be exacerbated by climate change.

ADP-10. Human Health Concerns

Description of Issues

Florida's current population is over 18 million, and 17% are over 65 years of age (higher than the national average of 12%). By 2030, Florida is projected to be the nation's third most populous state with almost 29 million residents, with 27% of the population projected to be over age 65. That keeps Florida as the state with the highest population of senior citizens as a percentage of total population. Senior citizens have greater vulnerability to impacts of climate change than the population at large, although children under 5, those living in poverty, and those living in coastal areas can also be vulnerable.

Objectives

The health and wellbeing of the citizens is of prime importance to the State of Florida. Incorporating considerations of climate change into the state's health plan to protect the citizens is as important as designing water treatment infrastructure to reduce harm to human health.

Successful research in this area would identify the increasing risks to human health, which segments of the population are most vulnerable, and how risks to their health can be reduced.

Assets at Risk

Climate change is expected to have a wide range of impacts on Florida's health systems. The historical range of mosquito- and vector-borne diseases may shift with a changing climate. More intense extreme weather events, such as hurricanes, heat waves, flooding, and wildfires, will directly impact human health in Florida. Equally important are alterations in the moisture content of the atmosphere and wind patterns that will likely affect the concentration of air pollution in a given location.

Climate change may increase the risk of some infectious diseases; particularly those diseases that appear in warm areas and are spread by mosquitoes and other insects. These vector-borne diseases include malaria, dengue fever, yellow fever, and encephalitis. Also, algal blooms could occur more frequently as temperatures warm—particularly in areas with polluted waters—in which case diseases (such as cholera) that tend to accompany algal blooms could become more frequent. These diseases can be transmitted to people and can also affect livestock and wildlife, which can indirectly affect people.

Goals and Strategies

ADP-10.1 Health Care

Goal 1: Ensure that health codes and policies are adequate to protect against known risks from observed (current) climate and appropriately incorporate potential changes in risk that are due to climate change.

Goal 2: Regularly revisit health codes and regulations as evidence of new or altered risks from climate change arises.

Goal 3: Strengthen vaccine campaigns.

ADP-10.2 Air Quality

Goal 1: Ensure that air quality policies provide an adequate level of safety to protect against known risks from the current climate.

Goal 2: Ensure that new air quality policies incorporate potential changes in risks from climate change to ensure appropriate design and adequate mitigation factors.

ADP-10.3 Water Supply and Wastewater Treatment

Goal 1: Ensure that wastewater infrastructure provides an adequate level of safety to protect against known risks from the current climate.

Goal 2: Ensure that new wastewater infrastructure incorporates potential changes in risks from climate change to ensure appropriate design and capacity over the lifetime of projects.

Goal 3: Ensure that water treatment facilities are able to safely capture, store, treat, and distribute potable water as the climate changes, creating possible subsequent changes in rainfall patterns, SLR, and flooding. Water treatment systems should anticipate changes in source water quality and availability and plan for corresponding changes needed to ensure effective water treatment.

Goal 4: For aboveground storage, such as reservoirs, management and operations protocol should account for changes in rainfall patterns and the impacts such changes may have on the adequacy of the storage volume as well as the structural safety of the impoundment.

ADP-10.4 Disaster Response

Goal 1: Establish communication mechanisms to coordinate efforts between disaster relief agencies and public health agencies.

Goal 2: Create communication systems and plans that address health issues associated with low-income and underserved populations and other vulnerable groups.

Goal 3: Provide adequate training for first responder and emergency responder personnel.

Goal 4: Limit growth in areas whose evacuation will be challenged by SLR and increased storm frequency or severity.

ADP-10.5 Medical Treatment and Biomedicine Development

Goal 1: Increase the focus of medical schools at state universities to include diseases that can be attributed to climate change.

Goal 2: Promote the research and development (R&D) of biopharmaceuticals for treating diseases that can be attributed to climate change.

ADP-11. Social Effects

Description of Issues

Currently Florida's population is over 18 million, and its projected growth is to 29 million by 2030. Additionally, Florida's coasts are home to at least 70% of the population. The coastal environment provides diverse habitats for countless marine and terrestrial species. For centuries, humans have lived, worked, and played along the coasts, and the ocean has long been an important component of the economy, from fishing to tourism.

Sea levels are expected to rise in the foreseeable future at an accelerated rate as the earth's climate warms, which makes Florida's coastlines particularly vulnerable. Climate change will likely affect not only the physical coastline, but also the millions of people who live and work in Florida. Understanding the impacts of climate change on Florida's coasts and inland areas therefore requires the perspectives of sociologists, economists, and scientists alike.

Society can deal with slow trends in climate, occurring over the many thousands of years that are characteristic of ice age cycles, but decade-to-century changes (i.e., those that occur on the timescale of a human lifetime) and the ability of societies to evolve quickly enough are potentially catastrophic.

Objectives

Climate change has the potential to play a critical role on human behavior over the next century. Even if all human activities that contribute to global change were stopped today, change would continue, as the present surplus of GHG in the atmosphere will remain for centuries. Therefore, Floridians need to decide today what changes they must make in their present behaviors in order to live in the changing climate.

Disaster management can provide some valuable lessons on encouraging changes in behavior. With Florida's experience in preparing for and responding to hurricanes, the tactics and strategies that people have learned to use to mitigate the effects of climate variability are now very basic. People will make decisions based on what they know and how they have operated in the past. It will be more difficult to adapt to climate change if it is dramatic and sudden and causes large disturbances. Thus, education and outreach (see ADP-15) will be an important component of adaptation, as will understanding how people respond to changes in risks and information on changes in risks.

Assets at Risk

Increased development to accommodate Florida's projected population growth will most likely increase climate exposure and risks to Florida's citizens and their current way of life. Florida must recognize that all regions of the state will encounter socioeconomic changes, including

- Increased housing and insurance costs, especially those related to storm events and SLR;
- Increased charges for energy consumption and transportation changes; and
- Increased cost of infrastructure improvements, including roads, sewer systems, wastewater treatment facilities, water control structures, and property protection.

An additional concern is the migration of people. Florida could attract people migrating from the Caribbean and elsewhere as a result of climate change impacts. In addition, it is possible that some Floridians will migrate inland from the coast.

ADP-11.1 Social Justice Issues

Goal 1: Promote social and economic equity, improve environmental management, reduce poverty, decrease the discharges of wastes, increase consumption efficiencies, and increase the quality of life for the vulnerable.

Goal 2: Assess potential social impacts of climate change on incomes, and other measures of well-being in vulnerable communities.

ADP-11.2 Food and Water Security

Goal 1: Ensure that access to safe food supply and water considers variations in risks from climate change such as SLR, increased hurricane intensity, inland flooding, wildfire, drought, changes in water quality, and other potential impacts

ADP-11.3 Housing Security

Goal 1: Consider potential impacts of climate change on housing. In particular, plan for SLR to threaten homes and apartment buildings located on the coast. Also consider other impacts of climate change and their risks to housing, such as more severe hurricanes, flooding, and wildfire.

ADP-11.4 Intersection of Climate Change and Human Behavior

Goal 1: Create incentives for the general public and businesses to use the latest technologies to adapt to climate change

Goal 2: Improve tracking of national and global trends on modifying human behavior and adopt the best management practices applicable to the State of Florida.

Goal 3: Convey information on the risks from changes in extreme events, including worst-case scenarios, to the public through education and outreach programs.

ADP-12. Organizing State Government for the Long Haul

Description of Issues

The range of adaptation planning issues outlined in this document is a testament to the number of issue areas and concerns that need to be adequately addressed to ensure that Florida successfully adapts to impacts caused by global climate change over the next century. In developing and implementing such a wide-ranging adaptation plan for the state, Florida will require a single point of focus within state government.

During the 2008 regular session of the Florida Legislature, HB 7135 (Ch. 2008-227, Laws of Florida) created the FECC and imbued the commission with a broad range of duties and powers, including responsibility for coordinating adaptation planning development and implementation within state government. The FECC is appropriately housed within the Executive Office of the Governor, thus elevating the climate change issue and enabling cross-agency coordination of efforts.

Objectives

The principal objective is to ensure the creation of a single point of focus within state government that can continue assessing the risks posed to Florida by global climate change, develop increasingly informed adaptation planning over many decades, and learn from prior implementation to adjust adaptation planning in Florida as events on the ground change.

Assets at Risk

Florida is a state with more than 1,300 miles of coastline and mostly low elevations. It is within the historic pathway of destructive weather events and particularly vulnerable to SLR, tidal surge, saltwater intrusion, and flooding. Coastal infrastructure (e.g., roads, bridges, and utilities) and towns and cities are also at risk. Florida has already felt the effects of mass human migrations for storm events alone. These conditions are expected to worsen in the future and be less temporary in nature. Freshwater resources are increasingly precious in the state and already pressured by Florida's growing population. Climate change poses risks to terrestrial and aquatic ecosystems, agriculture, forestry, and fisheries. All of these can add to existing stresses, such as population growth, land-use change, and pollution. The state of Florida will be affected by climate change through impacts on its physical assets, changes in revenues and expenditures, and changes in the activities it regulates.

Existing Actions

The Legislature created the FECC, which has the sufficient scope, powers, and resources to accomplish the intent of this element of adaptation planning.

Goals and Strategies

Goal 1: Determine effective planning and implementation mechanisms to integrate land, transportation, habitat, fish and wildlife protection, and water planning and management at all levels of government.

Goal 2: The FECC should create a State Climate Change Adaptation Plan Advisory Team to draft a State Climate Change Adaptation Plan. The plan should include identifying management, engineering, and technical solutions; developing design concepts for preferred solutions; and conducting initial feasibility studies relative to the scope, budgets, regulatory compliance, and timelines for the implementation of specific proposed adaptation solutions on regional scales.

Goal 3: Determine whether Florida should create a Coastal Commission to provide for more centralized authority and management of the state's coastal resources in view of future climate change impacts. The study should review existing Florida institutions, such as the Florida Ocean and Coastal Resources Council and similar institutions in other coastal states.

ADP-13. State Funding and Financing

Description of Issues

Adequate adaptation funding for Florida would include funds made available to address the impacts of climate change. Many programs are already in place and are intended to deal with some of these impacts. Some of these programs are already funded and may even have dedicated financing streams, but most existing programs are subject to political and economic cycles and disruption. Climate change impacts can be expected to intensify in the future and might also occur simultaneously, on all fronts, as opposed to the isolated incidences that are customary to Floridians and program resources. If and when this happens, it can be expected to greatly increase the pressure on funding and financing infrastructure.

Objectives

Florida should be prepared to fund the protection of human health and critical infrastructure, as well as address other impacts of climate change, where feasible, within a framework of protection, accommodation and, in some cases, retreat.

Assets at Risk

Florida is a state with more than 1,300 miles of coastline and mostly low elevations. It is within the historic pathway of destructive weather events and particularly vulnerable to SLR, tidal surge, saltwater intrusion, and flooding. Coastal infrastructure (e.g., roads, bridges, and utilities) and towns and cities are also at risk. Florida has already felt the effects of mass human migrations for storm events alone, and these conditions are expected to worsen in the future and be less temporary. Freshwater resources are increasingly scarce in the state and already pressured by Florida's growing population. Climate change poses risks to terrestrial and aquatic ecosystems, agriculture, forestry, and fisheries. All of these stresses can add to existing stresses, such as population growth, land-use change, and pollution, further straining any existing funding and financial resources intended to address these impacts.

Existing Actions

HB 7135, passed by the 2008 Florida Legislature, provided for the FECC, which is already preparing to explore funding and financing options with regard to adaptation issues in its deliberations.

Many of the expected impacts that climate change might bring are already familiar to Floridians. Consequently, programs to address such things as hurricanes and major storm events, storm surge and erosion, saltwater intrusion, and the availability of potable drinking water supplies have been implemented. Additionally, Florida's excellent emergency response infrastructure has proven itself under many scenarios and the planning mechanisms that are part of that infrastructure are in place to deal with a large variety of catastrophic events. However, it is not known to what extent these programs and infrastructure will be pressured by

future climate change–associated impacts or to what extent the funding will continue to be adequate under those future conditions.

Goals and Strategies

Many of the goals and strategies in other ADPs will require financial and staff resources. Florida will need to consider the financial implications of the adaptation goals and strategies.

Goal 1: Examine existing funding and financing infrastructure to determine adequacy for meeting increased demands of climate change impacts.

Goal 2: Examine alternative financing methods to meet climate change demands and consider protecting them from short-term economic or political cycles by dedicating funding.

Goal 3: Consider strategies for emergency funding or financing mechanisms for unforeseen and unplanned consequences of climate change.

Goal 4: Consider carbon credit revenues as an adaptation financing resource.

Goal 5: Examine opportunities for other sources of funding such as federal funds from emerging federal climate change legislation. In addition, opportunities to coordinate with private financing, including foundation resources, should be examined. Support allocation of cap and trade allocation funds to the states to support climate change adaptation.

ADP-14. Coordinating with Other Regulatory and Standards Entities

Description of Issues

The federal government is participating in a wide range of climate activities nationwide. They also fund state and regional entities that provide climate services. Activities include data collection and interpretation and product dissemination. Primary agencies involved include NOAA, U.S. Geological Survey (USGS), U.S. Environmental Protection Agency (EPA), Natural Resources Conservation Service (NRCS), and U.S. Department of Agriculture (USDA). Several products developed by federal agencies (e.g., drought severity categories and river flood forecasts) trigger a variety of Florida emergency and economic relief activities. Additional federal entities to be considered include the U.S. Energy Information Administration (EIA), U.S. Department of Energy (US DOE) (including the ENERGY STAR Program), National Science Foundation (NSF), and others.

In addition, a number of professional societies and other organizations are actively involved in activities to better understand the potential impacts of climate change on the members they serve. These societies often represent fundamental public service providers (e.g., water utilities [American Water Works Association] and coastal states [Coastal States Organization]) or are organizations such as the Intergovernmental Panel on Climate Change, the Pew Center on Global Climate Change and the Heinz Center that have examined climate change risks and adaptation. These organizations need early involvement in decision making and will require sufficient data to make informed decisions regarding risk and reliability, public health and safety, and financial management. Collectively, they represent a broad base of the population, possess unmatched knowledge of the industry they represent, and offer tremendous opportunities for technology transfer, public education, and widespread reach.

Objectives

Develop functional collaborative relationships between the State of Florida and selected federal government agencies, departments, and entities, as well as other states and, as appropriate, other countries and key professional societies to collaborate on climate change issues of mutual interest.

- Develop a research agenda to address shared interests and priorities.
- Identify and align with funding sources and allocation decisions essential to Florida's future as it relates to climate change.

Assets at Risk

The federal government has the lead and is central to most of the significant climate change and related programs, research, funding, and information dissemination. Failing to actively engage with the various agencies will result in missed opportunities to ensure that Florida's needs are

expressed, understood, and addressed. Additionally, working in a vacuum will result in waste and inefficient use of the limited financial, intellectual, and physical resources and will not properly leverage the vast pool of people who have been working on climate change and related issues for years. Lastly, Florida must actively engage with the federal process and work as a cohesive unit (a state with numerous needs, challenges, and sometimes competing objectives) to ensure that the concerned parties are not competing with each other for limited dollars and research priorities.

Additionally, adaptation only "buys time." Rapid and significant GHG mitigation is the only long-term solution. Understanding that the two must go hand-in-hand is crucial.

Existing Actions

HB 7135, requires the DEP and the Florida Department of Education (DOE), in coordination with the business, environmental, and energy communities, to develop an awards program to recognize efforts or achievements in conservation, energy and water use reduction, green cleaning solutions, green pest management, recycling efforts, and curriculum development that enhance the quality of education while preserving the environment. The Legislature encouraged the Florida DOE and DEP to form partnerships with the private sector to help fund the program. The provision would implement an environmental and educational award/recognition program that encourages district school boards, teachers, classes, and students to actively participate in strategies leading to environmental preservation.

14.1 Federal Government

Goals and Strategies

Goal 1: Develop a clear understanding of the functions and information available (needed) from key federal agencies.

Goal 2: Identify data gaps and prioritize research needs to establish an agreed-upon research agenda representing Florida's collective needs.

Goal 3: Prioritize funding needs and develop a strategy to secure federal and federal flow-down funding to meet strategic needs in Florida.

Goal 4: Request and engage the support of federal agencies, such as NOAA, USGS, Federal Emergency Management Agency (FEMA), and the U.S. Army Corps of Engineers (USACE), that can provide technological and logistical support and work with RPCs and other state, county, and local planning bodies to develop regional scenarios of climate change and analyze potential changes in vulnerability.

14.2 Professional Societies

Goals and Strategies

Goal 1: Engage professional societies and other organizations in establishing industry priorities for research and funding and work with state and federal officials to promote priorities.

Goal 2: Develop training and technology transfer tools and engage professional societies in reaching their members.

Goal 3: Establish a cross-functional task force of members of professional societies and other appropriate organizations that will be responsible for coordinating climate change issues within their respective industries.

Annex III of this Appendix includes the names of and summarizes the function of key professional societies involved with or who have a stake in climate change.

ADP-15. Public Education and Outreach

Description of Issues

Public education and outreach about climate change in Florida is needed to support necessary mitigation and adaptation actions. Florida is "ground zero" for climate change impacts in the United States with its low lying and densely populated coastal zones, susceptibility to hurricanes, and vulnerable natural resources. It seems that few people realize Florida's vulnerability, but these few are calling for detailed and accurate information and solutions. A focused and comprehensive stakeholder education and outreach program is a key component in building support for the mitigation and adaptation policy changes that will become critical issues in Florida.

Objectives

Florida can become a national and international leader in the distribution of climate change information in the process of educating a broad diversity of constituents with a cutting-edge and successful public education program. The success of any climate change adaptation demands full participation of the stakeholders (i.e., the citizens of Florida). The objectives of a successful public education outreach program would be fourfold:

1. To educate all of the stakeholders, including state leadership and state and regional government officials who implement adaptation actions, citizens of Florida (including retirees, families, the work force, and K-16 students), the broader business community, and faith-based and community organizations within and outside of Florida who are important stakeholders in Florida's adaptation actions. Create incentives to encourage involvement of the public and key stakeholders. Share not only current knowledge of the impacts already occurring and expected in Florida, but also short- and long-term solutions.

2. To design an overarching program that could be quickly and effectively disseminated to the stakeholders listed above, in clear, concise, and simple terms so all Floridians can embrace the knowledge. Use media such as the Internet that are widely and easily accessible.

3. Train, engage, and coordinate practitioners of climate change adaptation and needed technical support to help Florida plan for climate change. Climate change adaptation science and related policy improvements are developing fields requiring specific conceptual and technical skills, which exist independently in the expert community but require facilitation and training to bring together in a support group of adaptation experts.

4. Link outreach programs in public education to the best climate change science so that issues relating to adaptation and risk management create positive solutions to the environmental challenges of the future.

Assets at Risk

Principal risks include misunderstood and failed policy actions resulting in political stalemate and inaction. The best climate change adaptation programs will be at risk if not embraced by the stakeholders. The best policies might be approved in Tallahassee, but the full understanding and education of citizens will ensure their timely implementation and endorsement.

Existing Actions

HB 7135 addressed public outreach and education by requiring the DEP and the DOE, in coordination with the business, environmental, and energy communities, to develop an awards program to recognize efforts or achievements in conservation, energy and water use reduction, green cleaning solutions, green pest management, recycling efforts, and curriculum development that enhances the quality of education while preserving the environment. The Legislature encouraged DOE and DEP to form partnerships with the private sector to help fund the program. The provision would implement an environmental and educational award/recognition program that encourages district school boards, teachers, classes, and students to actively participate in strategies leading to environmental preservation.

Goals and Strategies

Goal 1: Provide immediate training on climate change adaptation.

Strategy A: Conduct short (2-day) executive seminars for Chief Executive Officers (CEOs) and state legislators that have been designed for policy makers and that are conducted by scientists trained in public education outreach.

Strategy B: Conduct a follow-up series of comprehensive workshops (4–6 days) that mixes business and civic leaders from public and private sectors. Local teachers should be included in all sessions.

Goal 2: Educate the public.

Strategy: Initiate a major public education campaign. Use high profile media and other appropriate outlets to raise general awareness on climate change in Florida. Make connections between mitigation and adaptation solutions and policy changes. Educate the public about the expected costs of inaction and delayed action compared with the costs of acting proactively. Focal topics could include heat waves and associated health risks, SLR and associated infrastructure and property risks, wildfire risks, species disturbances and habitat loss or change and associated ecosystem services losses (impacts to valuable and highly visible resources such as coral bleaching), and risks to water supplies. Focus groups

could include the public; policy makers; media; business leaders; developers; and land owners, buyers, and sellers.

Goal 3: Create adaptation training and collaboration opportunities.

Strategy: Create opportunities for government agencies to work together and with experts in climate change adaptation to develop needed skills in applying adaptation concepts to their daily management and planning efforts. Adaptation focus areas would be natural resources and ecosystem services, infrastructure and development, financial markets, job markets, and human health and welfare. Technical expert focus groups would include Florida's policy makers, research institutions, NGOs, water boards, state agencies, and the media.

Goal 4: Develop education programs on climate change adaptation for primary and secondary schools.

Strategy: Revise the state Sunshine Standards for K-12 education so that vulnerability to climate change and the practice of adaptation become required subject matter in the curricula of public schools in Florida. In conjunction with the state standards, a team of professional educators and scientists should be funded to develop effective units of learning for all grade levels to ensure that all students are educated about climate change adaptation and, most importantly, on mechanisms for families to conserve energy and live more sustainably.

Goal 5: Encourage research and training on adaptation in Florida's public universities and research centers. Encourage public universities and research centers in Florida to develop educational programs in disciplines and professions affected by climate change to focus on developing adaptation methodologies.

Abbreviations and Acronyms

ABM	agent based model
AOR	areas of responsibility
BMP	best management practice
CAMA	[Florida Office of] Coastal and Aquatic Managed Areas
CCCL	Coastal Construction Control Line [Program]
CEO	Chief Executive Officer
CERP	Comprehensive Everglades Restoration Plan
CLIP	Critical Lands & Waters Identification Project [v1.0 database]
CPIC	[Florida] Citizens Property Insurance Corporation
DBPR	[Florida] Department of Business and Professional Regulation
DCA	[Florida] Department of Community Affairs
DEM	[Florida] Division of Emergency Management
DEP	[Florida] Department of Environmental Protection
DOE	[Florida] Department of Education
DOF	[Florida] Division of Forestry
EAR	Evaluation and Appraisal Process
EIA	[U.S.] Energy Information Administration
EPA	[U.S.] Environmental Protection Agency
ERP	Environmental Resource Permits
ET	evapotranspiration; evaporation from water bodies and water released from plants through transpiration
FBC	Florida Building Commission
FDACS	Florida Department of Agriculture and Consumer Services
FECC	Florida Energy and Climate Commission
FEMA	[U.S.] Federal Emergency Management Agency
FESC	Florida Energy Systems Consortium
FLCOOS	Florida Coastal Ocean Observing System
FSG	Florida Sea Grant [College Program]
FWC	[Florida] Fish and Wildlife Conservation Commission
GHG	greenhouse gas
GIS	geographic information system
GP	Government Policy [TWG]
HB	House Bill
LEED	Leadership in Energy and Environmental Design™
LIDAR	Light Detection and Ranging
MPO	metropolitan planning organization
NFIP	National Flood Insurance Program
NGO	nongovernmental organization
NOAA	National Oceanic and Atmospheric Administration

NOEP	National Ocean Economics Program
NRCS	Natural Resources Conservation Service
NSF	National Science Foundation
OIR	[Florida] Office of Insurance Regulation
OTTED	[Florida] Office of Tourism, Trade, and Economic Development
R&D	research and development
RFP	Request for Proposal
RPC	Regional Planning Council
SCP	[Florida] State Comprehensive Plan
SLR	sea level rise
SRPP	Strategic Regional Policy Plans
STA	storage treatment area
SUS	State University System
TLU	Transportation and Land Use [TWG]
TMDL	total maximum daily load
TWG	Technical Work Group
US DOE	U.S. Department of Energy
US FWS	U.S. Fish and Wildlife Service
USACE	U.S. Army Corp of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

Annex 1: Early Action Items Proposed by the ADP TWG

Aside from outlining a structure and plan for moving forward with a comprehensive effort to address adaptation in Florida, the Technical Work Group (TWG) was asked to identify up to approximately two dozen strategies or actions that merited early implementation. The TWG believes that the items listed below represent a selection of appropriate efforts that should be undertaken promptly. Please note that there are many additional strategies listed in the accompanying Adaptation TWG Policy Options Document (POD), and it is anticipated that the successor Florida Energy and Climate Commission will develop additional strategies to address the goals indicated in the POD in the course of its work.

ADP-1. Advancing Science Data and Analysis for Climate Change

Goal 2: Foster and support climate science research agenda for Florida with broad priorities. Institute a new scientific advisory council on climate change to advise state government on this research agenda. Identify and establish long-term funding to support research. Funding should be protected from short-term economic or political cycles.

a. HB created the Florida Energy Systems Consortium as a "super center of excellence" within the State University System. The center should consider, as a priority order of business, the appointment of a scientific advisory council composed of members from disciplines relevant to adaptation to climate change and representative of each participating institution to better coordinate research in support of Florida's adaptation and climate change policy objectives.

b. The Florida Energy and Climate Research Trust Fund should be created by the Legislature, and a dedicated revenue stream should be provided.

Goal 3: Conduct research needed to support incorporation of climate change into the protection of Florida's ecosystems and biodiversity.

a. Define the likely new "states" of Florida ecological systems to determine state budget and policy requirements. Identify species and habitats that will likely be unable to migrate naturally and craft strategies to assist their relocation or recreate habitat elsewhere to facilitate this shift.

b. Expand the newly developed Critical Lands & Waters Identification Project (CLIP) v1.0 database to incorporate impacts and adaptation to climate change.

Goal 4: Enhance support for mapping, monitoring, and modeling, all of which will be necessary to provide information to support policy making. For example, the state is supporting the use of light detection and ranging (LIDAR) to improve mapping of Florida's coastlines. Such mapping should be done for the entire coastline of the state. In addition, effective monitoring programs

are needed to detect impacts of climate change; modeling is also needed to better project impacts.

a. Create a new center to coordinate and align data from proxy data sets to build a more precise picture of climate change in Florida over the last few thousand years and predict the effects of climate change in the future. This data center could also track associated responses in vegetation, sea level, and disturbances such as fire.

ADP-2.1. [Comprehensive Planning] Local Government Level

Goal 2: State and regional agencies should provide financial and technical assistance to local governments to ensure timely updates of local plans.

a. Update the Florida Department of Community Affairs (DCA) planning tools Web site section on climate change with adaptation information from the Action Team and other sources. Tie state and regional agencies into a central state digital database and ensure that all pertinent state records are digitized. This will provide local government planners with instant access to the information they need for considering the impacts of updates to local plans.

Goal 4: Local governments should review their coastal management elements to determine necessary amendments to make their coastal areas (especially the coastal high-hazard area) resilient to the future impacts of climate change, including sea level rise (SLR).

a. Create best practices manual, for local governments, that identifies coastal lands for state acquisition with new adaptation language incorporated into local, state, and regional government land acquisition processes.

b. Identify and revise statutory direction for local, state, and regional planning processes to determine the potential within planning areas for SLR, particularly in coastal areas. Provide for an assessment of:

- The potential movement of the coastal construction control line and related changes,
- The extent and potential for expansion of floodplains, and
- Potential habitat and wildlife migration.

c. The Florida Department of Environmental Protections (DEP), DCA, and the state's Regional Planning Councils should jointly develop, assess, and recommend for local governments a suite of planning tools and climate change adaptation strategies to maximize opportunities to protect the beach/dune system, coastal wetlands, and other coastal resources in an era of rising seas. The tools should include strategies to encourage the landward siting and relocation of structures and public facilities in areas adjacent to receding shorelines through acquisition, rolling easements, transfer of development rights, stronger setbacks, and tax incentives.

ADP-2.3. [Comprehensive Planning] State Government Level

Goal 3: Balancing Property Rights and Protecting Communities and Natural Resources Florida statutes, regulations, policies, and the Florida Administrative Code should be reviewed by the Florida Attorney General to determine potential conflicts between private property rights and the state and local governments' responsibility to protect communities.

a. The Florida Attorney General should examine Florida statutes, state policies, and agency administrative rules to identify, in advance, any potential conflicts between private property rights and the government's response to potential climate change impacts. State or local governments are responsible for protecting their communities, natural resources, and public usage and access to government-owned lands. That responsibility may come into conflict with the individual rights of private landowners who are affected by SLR, beach erosion, and other impacts of climate change. The Attorney General should issue a report of his findings that includes recommendations.

ADP-3.1. [Protection of Ecosystems and Biodiversity] Uplands, Freshwater and Marine Systems

Goal 1: Ensure that a representative portfolio of Florida's terrestrial, freshwater, and marine natural communities with redundant representation of habitats and species and connecting corridors (e.g., Florida's Biodiversity Blueprint) is protected and managed in a manner that maximizes the health and resilience of these communities when facing climate change impacts.

a. Tie into existing and expanded databases such as the CLIP in order to examine existing local, state, regional, and federal land holdings and categorize these holdings with regard to the representative portfolio.

b. Provide an accessible, expanded, and updated database to track changes to the natural communities and corridors.

c. Evaluate the adequacy of upland, freshwater, and marine systems protection status (for example through gap analysis) and, where necessary, increase protection area and/or status in each system to maximize their probability of adapting well to climate change impacts.

ADP-3.2. [Protection of Ecosystems and Biodiversity] Beaches and Beach Management

Goal 1: Reduce and discourage future reliance on bulkheading/hardening to stabilize estuarine and beach shorelines. Shoreline hardening should be considered only after a full and cumulative assessment of short- and long-term impacts to coastal resources and coastal ecosystems. Establish policies and regulations that clearly define when, how, where, and under what circumstances emergency beach stabilization is allowed.

a. Address local, state, and regional permitting programs and planning elements to fully assess potential impacts and changes to coastal resources and ecosystems from proposed coastal protection measures in light of potential impacts of climate change.

b. Add an overview element to state and regional planning documents describing statewide strategies and circumstances for coastal and shoreline retreat and erosion.

c. The state should undertake a comprehensive reevaluation of the Coastal Construction Control Line Program to ensure that it is accomplishing its intended goal of protecting the beach and dune system. The reevaluation should consider, among other things, the adequacy of existing coastal setbacks, building siting and design requirements, and post-storm redevelopment policies in light of SLR scenarios.

ADP-3.3. [Protection of Ecosystems and Biodiversity] Species Protection

Goal 1: The vulnerability of Florida's fish and wildlife to climate change impacts is assessed, the most vulnerable species are identified, and plans are prepared to enhance their chances of persistence where there is a reasonable likelihood that the species will persist over the next 50 years.

a. Utilize the CLIP and similar expanded and centralized digital databases to determine potential species and habitat vulnerability.

b. Incorporate species and habitat vulnerability to climate change into state and regional planning and zoning, government land acquisition, and determinations for conservation easements.

ADP-4. Water Resource Management

Goal 1: Identify and quantify the vulnerabilities and reliability of existing water supplies to potential effects of differing climate change scenarios with emphasis on source water availability and quality.

a. Develop inventory of water supply facilities (source, storage, treatment, and distribution) and conduct a study to develop different climate change scenarios and potential impacts and adaptation strategies for high-risk utilities.

ADP-5.1. [Built Environment, Infrastructure, and Community Protection] Building Codes and Regulation

Goal 1: Require that the Florida Building Code incorporate building design criteria for resisting future loads that may result from the impact of climate change–exacerbated hazards during a minimum service life of 50 years.

a. Strengthen Florida Building Code requirements for new structures and appropriate renovation to encourage climate change impact resistance.

b. Conduct research on how building codes can be routinely updated to account for changes in climate and develop options on how such codes could account for potential future changes in risks from climate change.

Goal 4: Develop a required training program to educate professionals in relevant fields (e.g., architecture, engineering, and construction management) on the need to incorporate adaptation to climate change as a basis for establishing design criteria for new infrastructure. Completion of such required training would be a condition for relicensing.

a. Examine licensing and recertification requirements for building professionals and revise them to include climate change impact design criteria.

b. Add adaptation criteria to professional education curricula at state universities and trade schools for building and design degrees.

ADP-15. Public Education and Outreach

Goal 1: Provide immediate training on climate change adaptation.

a. Conduct short (2-day) executive seminars for Chief Executive Officers (CEOs) and state legislators that have been designed for policy makers and that are conducted by scientists trained in public education outreach.

b. Conduct a follow-up series of comprehensive workshops (4–6 days) that mixes business and civic leaders from public and private sectors. Local teachers should be included in all sessions.

Goal 2: Educate the public.

a. Initiate a major public education campaign.

b. Use high-profile media and other appropriate outlets to raise general awareness on climate change in Florida. Make connections between mitigation and adaptation solutions and policy changes. Educate the public about the expected costs of inaction and delayed action compared with the costs of acting proactively. Focal topics may include heat waves and associated health risks; SLR and associated infrastructure and property risks; wildfire risks; species disturbances and habitat loss or change and associated ecosystem services losses (impacts to valuable and highly visible resources such as coral bleaching); and risks to water supplies. Focus groups may include the public; policy makers; media; business leaders; developers; and land owners, buyers, and sellers.

Annex 2: Priorities for Further Research and Analysis

ADP-1. Advancing Climate Change Science Data and Analysis

Priorities for Further Research and Analysis

Florida needs to *emphasize collaborations with international climate scientists, to refine climate predictions for Florida.* The state in partnership with federal agencies, international efforts, and Florida universities should (1) undertake review of current studies and models and (2) consider undertaking updating model development to more precisely forecast Florida's changes in weather patterns, (3) Undertake specific analysis of uncertainties and contingencies in climate scenarios for Florida.

Considering that Florida is so vulnerable to potential impacts of *sea level rise and hurricane activity, the state should place a special emphasis* on establishing or enhancing existing programs to follow developments in this field.

In addition to work on sea level rise and hurricane activity *the state needs to establish or enhance existing programs to monitor and determine trends in other climate related impacts* that could have consequences in Florida including: increased drought, wildfires, flooding and storm water runoff, heat waves, problems with invasive species and insect-borne disease resulting from changes in temperature and rainfall regimes, adverse effects on native terrestrial species, natural communities and marine life, salt water intrusion into aquifers, more frequent and intense storms, storm surges, tidal regimes, and coastal erosion. Build a decision support structure to guide and prioritize ongoing Florida-specific research agenda.

Deploy a "Florida Land and Sea Mesonet" (see e.g., the Oklahoma Mesonet for terrestrial counterpart) *to serve as a world class network of integrated environmental monitoring stations,* drawing from and contributing to existing terrestrial and marine networks, capitalizing and building upon deployed meteorological stations, ET stations, micro-meteorology towers , flow gauges and well/aquifer monitoring, and other critical monitoring networks, to meticulously track changes in Florida's climate and hydrology, filling missing gaps in statewide network coverage. The existing Florida Coastal Observing System should include climate impacts.

Support scientists working on *methods and availability of remote sensing data for continuous statewide coverage* (and associated surrounding oceanographic area of influence), with consistent spatial grids and measurements, for common inputs for climate and hydrologic models.

Long-term Climate Proxy data. Create a new Center, or virtual center, to coordinate and align data from available proxy datasets to build a more precise picture of climate change in Florida over last few thousand years with associated responses in e.g., vegetation, sea level, changes in fire regimes, etc. need for more proxy work and gaps in knowledge – spatial and temporal.

Evaluate likely persistence of Florida's rare species, natural communities, coastal ecosystem and parks and protected areas under climate change. Suggest during every 10-year review of state park, forest, and Wildlife Management Area Management Plans include a thoughtful analysis of vulnerability to climate change as part of their systematic management planning.

Linking climate scientists with ecologists, economists and social scientists. Issue a RFP from interdisciplinary teams of social scientists, economists and climate scientists, to build interactive models, including non-linearities and feedbacks, to better predict Floridian responses to anticipated changes. Agent based models are appropriate here because of the complexity of climate change models and responses.

Build socioeconomic models to evaluate the effectiveness of alternative incentives and policies. Select pilot areas and locations of the state to test policy programs. Evaluate effectiveness of adaptation strategies at regular intervals

Build better decision tools to incorporate total cost accounting for local and regional planning decisions, so that proposed land use change, agricultural policy shifts, water use policies, transportation decisions, siting of major new industries, etc. have a full assessment of all public costs including likely carbon/greenhouse gas footprint, and water use. Decision tools should also include assessments of proposals land use changes in the light of predicted climate changes.

ADP-3. Protection of Ecosystems and Biodiversity

Priorities for Further Research and Analysis

Florida's coral reef system should be evaluated, to ascertain changes from climate change or other stressors caused by people and actions taken to alleviate those that would provide greater resiliency and chances for coral recovery and expansion.

DEP should amend the Southeast Florida Coral Reef Initiative Local Action Strategy to consider the added stress on coral reefs due to global warming and develop an effective, coordinated management strategy to increase the protection of the region's coral reef ecosystem.

FWCC and other relevant agencies should expand research and monitoring of coral reef ecosystems and assess of water quality and its effects on reefs over time.

Ecologically valuable coral reefs identified under Goal 1 above should be protected from shoreline development, overfishing and overuse, and other impacts to minimize their disappearance and to enhance their capacity to provide critical nursery habitat for fish and other organisms, storm surge protection and other public benefits.

The state should make monitoring of ocean pH and calcification rates a part of the coral monitoring plans in the Tortugas Ecological Reserve, the Florida Keys National Marine

Sanctuary, Biscayne National Park, Florida Middle Grounds, Pulley Ridge and Oculina Bank Habitat Area of Particular Concern, and other locations around the state.

DEP, DACS and FWC should enhance state monitoring of biogenic reefs such as oyster reefs as well as valuable shellfish such as scallops and clams for calcification problems.

Priorities for Further Research and Analysis

Priorities for further research may include:[5]

- Estimate the absolute and relative vulnerability of species and habitats to climate change impacts;
- Determine the anticipated new states of natural communities in the face of climate change impacts
- Assess the potential economic costs and benefits of climate change impacts on biodiversity, ecosystem processes, functions and services.
- Determine future costs (including environmental mitigation costs) of beach nourishment under different sea level rise scenarios. Will these costs be different in areas where adequate buffers have been established and where the shoreline is lined with high density development?
- Assess whether the state needs an Open Beaches Act. The research could address who owns the beach and what are the public's rights of access. On eroded shorelines with bulkheads, what happens to the public's common law right of access and customary use?
- Assess how the Burt Harris Act (takings law) affects the ability to adequately address coastal protection in an era of rising seas? Is it having a dampening effect on adequate regulatory policies? Will it increase the cost of implementing adaptation strategies?
- Asses how can the state legally authorize bulkheading or other armoring that will result in imperiled species take, violating state and federal endangered species law?
- Examine how beach access could be affected by climate change.
- Determine offshore sand availability for renourishment under differing scenarios and for different regions of the coast.
- Model shoreline recession and erosion rates under different sea level rise scenarios.
- Model need for bulkheading under different scenarios.
- Inventory coastal public lands susceptible to impacts and assess those impacts. Determine need for buffers to allow habitat migration.

[5] Some of these priorities for research can be found in Florida's Comprehensive Wildlife Conservation Strategy (FWC, 2005) and Florida Ocean and Coastal Council's 2008-2009 Scientific Research Plan (FOCC, 2008).

ADP-4. Water Resources Management

Priorities for Further Research and Analysis

The following is a partial list of research and analysis priorities.

Water Supply:

- Incorporate robust analytical methods to drive holistic planning and management of the built and natural water cycle. Such planning is essential to appropriately address an unknown future and should address energy requirements for water supply development, treatment and distribution and wastewater management.
- Apply "risk assessment" and "scenario planning" methodologies to assess risk under different climatic futures so that risks to existing assets can be understood, mitigation approaches evaluated and future assets can be developed within an anticipated risk framework.
- Continue innovation in the administration of District rules authorized under Chapter 373, F.S. (Applicable to water quality and flood protection.)
- Develop evolving technologies to improve the quality and reliability of data collection.
- Research to improve water use efficiency in various water use sectors.
- Identify new storage areas and technologies.
- Continue research on development of alternative water sources.
- Partner with other public and private sector entities to leverage resources to extend existing water supplies and develop prospective supplies.
- Research to identify and determine changes to the rainy season/rainfall patterns.
- Research to forecast quantities needed to fill and retain adequate water in reservoirs and other storage facilities.
- Assess and revise water conservation education activities
- Assess and revise appropriate quantities for water use and other permitting activities.
- Research to determine quantity effects of sea level rise on groundwater resources.
- Conduct regional downscaling on a watershed basis to quantify climate change on existing and potential water supplies.
- Research to determine the effects that predicted climate changes will have on the ground and surface water requirements of imperiled species.

Water Quality:

- Continue aggressive establishment of Minimum Flows and Levels and development of innovative and evolving methods to respond to future adaptations.
- Continue coordination with EPA, the Army Corps of Engineers, and other federal, state and local environmental agencies with shared jurisdiction to ensure that project activities will not degrade water resources.
- Work with the university community, Florida Yards & Neighborhoods, Adopt-A-Pond and other educational efforts to develop climate change and water resource materials to educate the public.
- Research innovative stormwater retention designs that maximize water quality benefits.
- Research necessary adjustments to the TMDL program.

Flood Protection:

- Continue assistance to update FEMA maps and maintain data as development occurs and flood prone areas change.
- Assist local governments with techniques to minimize development and infrastructure in potentially hazardous coastal areas.
- Research to determine effects of sea level rise on flood prone and historically non-flood prone areas.
- Develop stormwater retention designs and identify additional retention/storage areas to manage larger storm events.
- Create incentives to reverse the historic effects of drainage on landscapes to increase their capacity for natural water storage.
- Continue coordination with federal, state, and local emergency response agencies to develop adequate preparedness plans for potential flooding events as flood regimes change.
- Investigate and implement coastal and shoreline "rolling easements" to minimize potential structural damage and to maintain access and recreational benefits (tourism).

Natural Systems:

- Continue aggressive establishment of Minimum Flows and Levels and development of innovative and evolving methods to respond to future adaptations.
- Continue innovation in the administration of District rules authorized under Chapter 373, F.S.
- Develop processes to ensure environmental restoration work is done where long-term benefit is ensured under changing scenarios.

- Emphasize partnerships with other resource protection organizations to research and better facilitate acquisition and preservation of additional lands critical to preserving Florida's natural water resources.
- Develop a long-term and dense monitoring network for natural system health to ensure these resources are not endangered.
- Investigate strategies such as "rolling easements" (similar to strategies used in Texas, South Carolina and Maine) to allow long-term coastal migration, ecosystem adaptation and public access.
- Research to determine quality and quantity effects of sea level rise on ecosystems in transition.

ADP-5. Built Environment, Infrastructure and Community Protection

Priorities for Further Research and Analysis

Storm Surge:

Although ASCE-7 and the Florida Building Code prescribe methodology to quantify the main loads resulting from storm surge, there is very little region or site-specific information regarding the behavior of storm surge at specific locations and under the influence of local impact modifiers. Information such as: the angle of attack of storm surge at a given coastal location as a function of the direction of travel of a tropical cyclone, the velocity of flow of storm surge as it approaches a coastal location and the factors that influence such velocity of flow, and other related information are not readily available or not available at all for building design professionals to use in establishing design criteria for a specific building.

Research to identify such storm surge behavioral parameters on a basin-specific basis throughout the state could provide invaluable information to design professionals.

Research to develop protocols for the removal of abandoned residential, industrial and municipal structures will be essential to insure these structures do not release contaminants into coastal waters when inundated by sea level rise.

ADP-7. Economic Development

7.2.1 Forests

Priorities for Further Research and Analysis

- Determine carbon sequestration capacity of Florida's native tree species.
- Determine at-risk areas of forest resources due to climate change impacts.

- Research to determine the effects that predicted climate changes will have on the production and cultivation of agricultural commodities.

7.2.2 Marine

Priorities for Further Research and Analysis

- Couple IPCC outputs, regional climate and oceans data, and ocean circulation models to forecast areas and rates of coastal water temperature changes under several scenarios.
- Expand existing state programs and platforms for monitoring, event responses, data management, and public reporting to include range extensions, shifts in population centers of valued species, dispersion patterns of non-native marine and coastal species, marine diseases, and biological threats to industry workers and consumers.
- Couple future land use plans, sea level projections, hurricane risk models, energy-efficiency standards for marine ops, and land-based transportation systems to co-locate new parks, conservation areas, and working waterfronts for fishing, ecotourism, and marine research.

7.2.5 Mining

Priorities for Further Research and Analysis

Examination of soil characteristics for use of such properties as forested carbon sinks, bioenergy crop production and underground carbon sequestration.

ADP-8. Insurance (Property and Casualty)

Priorities for Further Research and Analysis

Conduct further research on incorporating climate change into hurricane models. Try to develop more of a scientific consensus on how hurricanes will change.

Conduct more research on hurricane mitigation techniques and effectiveness. For example, Ren Re and Florida International University are researching how to build homes to withstand stronger hurricanes at the Wall of Wind, a cutting edge facility in Miami-Dade County. (www.renre.com/wow.html)

Currently, the Florida Office of Insurance Regulation has engaged in a residential wind loss mitigations study. The scope of this project is to evaluate windstorm loss relativities for construction features including but not limited to, those which enhance roof strength, opening protection, and window, door and skylight strength. The study includes single and multi-family homes. This report will be used, in part, to assist in developing accurate discounts for homeowners that employ specific mitigation methods.

ADP-9. Emergency Preparedness and Response (Extreme Events)

Priorities for Further Research and Analysis

Enhancing Florida's emergency preparedness and response functions to perform effectively in extreme events exacerbated by global climate change will require additional science and analysis. Current priorities include

- Additional research to better understand and predict the effects of global climate change on hurricane frequency and intensity in the Atlantic Basin;
- Local and regional analysis of shoreline elevation to better predict storm surge using statewide LIDAR survey data recently completed for the state's coastline;
- Additional research and analysis into the behavior of Floridians when facing extreme weather events and communications strategies that more effectively result in the evacuations of high-risk areas; and
- Analysis of strategies to ensure that special-risk populations can be effectively evacuated from high-risk areas.

ADP-10. Human Health Concerns

Priorities for Further Research and Analysis

- Improved projections of potential public health risk from the interaction of increasingly intense and long heat waves with existing air-quality problems in major urban areas.
- Projects on the potential in Florida for increases in the transmission of vector-borne infectious diseases (e.g., malaria, dengue, yellow fever, and some viral encephalitis) resulting from immigration from other climate change affected areas.
- Analysis of the relationship between heavy rainfall and biological contamination of water supplies, the influence of climate variability and extremes on notified illnesses, and quantification of the burden of water-related illnesses (including conditions such as gastroenteritis and skin infections).

ADP-12. Organizing State Government for the Long Haul

Priorities for Further Research and Analysis

Beyond the creation of the Florida Energy and Climate Commission, other entities and coordinating mechanisms may be required. Development and implementation of Florida's first

generation adaptation plan should bring these additional organizational requirements to light. Further analysis of the following issues is encouraged:

- What coordinating mechanisms are required to assure that multiple state agencies with similar powers and duties are collaborating on adaptation planning and implementation?
- What coordinating mechanisms are required to assure that state government is working in concert with regional and local agencies to reduce risk and increase Florida's adaptability?

ADP-13. State Funding and Financing

Priorities for Further Research and Analysis

- Traditional funding mechanisms such as state, regional and local taxes, utility and land use fees.
- Develop new revenue streams resulting from federal legislation, cap and trade program revenues, potentials for carbon offsets/sequestration, resource use taxes, etc.

ADP-14. Coordinating with Other Regulatory and Standards Entities

14.1 Federal Government

14.2 Professional Societies

Priorities for Further Research and Analysis

Identify targeted Federal agencies based on Florida needs and issues addressed.

ADP-15. Public Education and Outreach

Priorities for Further Research and Analysis

Florida can learn from other successful outreach and education strategies for climate change in other states and countries which are farther along in these areas. Just as we are learning about managing coral reefs in a changing climate from Australia, Florida can learn how to engage stakeholders from similar efforts.

Annex 3: Federal Agency Resources

The following list includes the name and summarizes the function of key Federal agencies (by category) involved with or who have a stake in climate change.

Drought Preparedness

- National Drought Mitigation Center (NDMC)

  This site hosts the Drought Monitor and The Drought Impact Reporter. NDMC helps people and institutions develop and implement measures to reduce societal vulnerability to drought. http://www.drought.unl.edu/dm/index.html, http://droughtreporter.unl.edu/

- National Integrated Drought Information System (NIDIS)

  This National Oceanic and Atmospheric Administration (NOAA) site hosts the federal drought monitoring system. NIDIS provides a complete summary of drought information at national, regional, state and local scales.

- Climate Prediction Center (CPC-NOAA)

  CPC provides a variety of climate analysis and prediction products, including the Drought Outlook, which projects drought category tendencies for a 3-month period. http://www.cpc.ncep.noaa.gov/

Climate Information

- National Climatic Data Center (NCDC)

  NCDC is the national archive for climate data and products. http://www.ncdc.noaa.gov/oa/ncdc.html

- Applied Climate Information System (ACIS)

  ACIS is supported by the National Climatic Data Center (NCDC) under the National Virtual Data System and operated by the six Regional Climate Centers. ACIS provides both real-time and historical climate data from a variety of networks. ACIS also allows execution of user adjustable programs to support drought risk analysis. http://rcc-acis.org/

- Florida State Climatologist

  The Florida Climate Center is part of three-tiered system that serves to provide climate data, information, and services for the United States. http://www.coaps.fsu.edu/climate_center/nav.php

- Southeast Climate Consortium

  The mission of the Southeast Climate Consortium is to use advances in climate sciences, including improved capabilities to forecast seasonal climate, to provide scientifically sound

information and decision support tools for agriculture, forestry, and water resources management in the Southeastern USA. http://secc.coaps.fsu.edu/

Water Information

- National Water Information System (NWIS)

  NWIS is operated by the United States Geologic Survey (USGS) and provides both real-time and historical surface streamflow, reservoir and groundwater information. http://water.usgs.gov/waterwatch/

- U.S. Water Monitor

  This site provides a summary of water information at national, regional, state and basin scales. http://watermonitor.gov/

- National Weather Service--Hydrology

  The River Forecast Centers provide streamflow and flood forecasts for the U.S. http://www.nws.noaa.gov/oh/index.html

- U.S. Army Corps of Engineers

  In support of nation's interests, build broad-based relationships and alliances to collaboratively provide comprehensive, systems-based, sustainable and integrated solutions to water resources national and international challenges. http://www.usace.army.mil/

The majority of Florida is served by the Jacksonville District Office (http://www.saj.usace.army.mil/) and the Panhandle is served by the Mobile, Alabama, office (http://www.sam.usace.army.mil/)

Agriculture

- Joint Agricultural Weather Facility (JAWF)

  This joint USDA/Department of Commerce operation provides production agriculture predictions for the United States and the world. http://www.usda.gov/oce/commodity/index.htm

- Natural Resources Conservation Service (NRCS)

  NRCS's natural resources conservation programs help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. http://www.nrcs.usda.gov/programs/

Ecosystems

- The Mission of the U.S. Fish & Wildlife Service (USFS) is working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

> The challenge of climate change to the USFS is two-fold. The scientific challenge is one of translating projections of climate change into transparent predictions of trust resource response that can guide management decisions. The resource conservation challenge is one of articulating and directing a conservation response that is strategic, adaptive, and collaborative.

The mission of the Environmental Protection Agency (USEPA) is to protect human health and the environment. Since 1970, EPA has been working for a cleaner, healthier environment for the American people. http://www.epa.gov/

The following list includes the name and summarizes the function of key professional societies involved with or who have a stake in climate change.

- American Water Works Association (AWWA) and the Florida Section AWWA (FSAWWA)
- AWWA Research Foundation (AWWARF)
- Water Environment Foundation (WEF) and Florida Water Environment Association (FWEA)
- Water Environmental Research Foundation (WERF)
- American Water Resource Association (AWRA)
- WateReuse Foundation
- Southeast Desalting Association (SDA)
- Florida Stormwater Association (FSA)
- American Society of Highway Engineers (ASHE)
- Florida Engineering Society (FES)
- Association of Public Works Administrators (APWA)

Annex 4: Values at Risk

In order to assess the vulnerability of the built environment to hazards driven or exacerbated by climate change, it is essential to define and quantify the value at risk. In this specific case this refers to the value of the built environment and associated infrastructure.

The value at risk provides a baseline to assess the potential for damage from the impact of climate-driven or exacerbated hazards over a given time period, and to identify and evaluate the cost effectiveness of adaptation alternatives.

Defining the Value at Risk

Before quantifying the value of the built environment that is or may be at risk it is necessary to first define what is meant by value at risk. In defining the value at risk of the built environment the following criteria must be considered:

1. The value of the built environment is dynamic, meaning that it changes over time in response to a range of factors, such as total population, density of population, demographics, land use and zoning, the mix of occupancies in a given community or region, importance or criticality of the functions sheltered by given buildings or structures, total area of constructed space and others.
2. The value of the built environment is not limited to the cost of construction of the physical buildings, facilities and structures, but it is directly affected by the value of the human activity or function sheltered or supported by components of the built environment in a given community or region.
3. The value of the built environment is interlinked with the value of the land on which it is located. To the degree that buildings change the character of land from vacant to developed, they also change the value of the land. In this sense the value of the built environment and the value of property become synonymous.
4. The value of the built environment is a function of the vulnerability of the location on a regional and/or a site-specific basis.

Given the above criteria it is clear that there are several factors to be taken into account to define the value of the built environment that is at risk of being damaged by the impact of hazards caused or exacerbated by climate change. With respect to the built environment it is also clear that defining and quantifying the value at risk can at best be achieved through a series of snapshots that represent either current conditions or projected conditions based on future scenarios.

Given the variability of these factors from region to region, or from one community to the next, it should be noted that the value at risk must be defined by community or regional basis. The

aggregate of all the regionally defined values at risk constitute the value at risk for the whole state of Florida.

In essence this means that the definition and quantification of the value at risk, of the built environment, must be a continuous exercise requiring the establishment of a baseline for a given region, community or site and periodic updates at specific time intervals.

Quantifying the Value at Risk

Once the value at risk has been defined on the basis of region or community-specific criteria and factors the value at risk can be quantified at the community or regional scale.

Quantifying the value at risk provides an essential foundation for the following:

1. The potential for damage to the built environment, from the impact of climate change caused or exacerbated hazards can be estimated as a percentage of the value at risk.
2. The effectiveness and benefits of adaptation measures can be quantified on the basis of their damage reduction capabilities.
3. The cost-effectiveness of adaptation measures can be assessed on the basis of their respective benefit-to-cost ratio.

Quantification of the value at risk [of the built environment] can be based, at a minimum, on the following parameters:

a) Replacement Value of Building[s]
b) Replacement Value of Contents
c) Criticality Factor: a multiplier reflecting the type of function housed in the building

Use of these parameters is represented by the equation below:

$$Vr = (C + N) \times Fc$$

Where: Vr = Value at Risk in current U.S. Dollars
C = Replacement value of building in current $
N = Replacement value of contents in current $
Fc = Criticality factor

Quantification of the value at risk for the built environment can be simplified at the local level, by quantifying the value on the basis of the type of function sheltered by various buildings, facilities and structures. For example, all residential use buildings can be grouped together, the same as all educational facilities, or health-care facilities, or government buildings etc. In the end the aggregate of all the values at risk by type of function will constitute the total value at risk at the municipal level for example.