Florida's Wildlife:

On the front line of climate change

Climate Change

Summit Report

Florida Fish and Wildlife
Conservation Commission

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The Caribbean Conservation Corporation is a Florida-based, not-for-profit corporation founded in 1959 to ensure the survival of sea turtles within the wider Caribbean basin and Atlantic. It accomplishes that mission through research, education, training, advocacy and the protection of the natural habitats that sea turtles depend upon. (www.cccturtle.org)

Defenders of Wildlife

Founded in 1947, the Defenders of Wildlife is a national, nonprofit organization dedicated to the protection of all native animals and plants in their natural communities. It works to protect and restore America's native wildlife, safeguard habitat, resolve conflicts, work across international borders, and educate and mobilize the public. (www.defenders.org)

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The Environmental Defense Fund was established in 1967 as a nonprofit organization dedicated to protecting the environmental rights of all people, including future generations. It achieves that goal by linking science, economics and law to create innovative, equitable and cost-effective solutions to urgent environmental problems. (www.edf.org)

Florida Oceans and Coastal Council

Created by the 2005 Oceans and Coastal Resources Act, the Florida Oceans and Coastal Council is charged with developing annual priorities for ocean and coastal research and establishing a statewide ocean research plan. It also coordinates public and private ocean research for more effective coastal management. (www.floridaoceanscouncil.org)

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National Wildlife Federation

Founded in 1938, the National Wildlife Federation is a nonprofit organization that works to inspire Americans to protect wildlife for our children's future. Its work focuses on three major areas that are important to the future of America's wildlife: confronting global warming, protecting and restoring wildlife habitat, and connecting with nature. (www.nwf.org)

Florida's Wildlife Legacy Initiative

FWC's Florida Wildlife Legacy Initiative is a program supported by the federal State Wildlife Grants Program, which provides annual funding to every state and territory. This is a matching grants program, providing financial support for projects that address conservation needs identified in the Comprehensive Wildlife Conservation Strategy. (MyFWC.com/WILDLIFEHABITATS/Legacy)

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Oct. 1-3, 2008
Orlando, Fl.

Summit Report

Acknowledgements

The Florida Fish and Wildlife Conservation Commission (FWC) was joined by the Caribbean Conservation Corporation, the Defenders of Wildlife, the Environmental Defense Fund, the Florida Oceans and Coastal Council, Florida Power & Light, and the National Wildlife Federation in sponsoring Florida's Wildlife: On the front line of climate change. Special thanks to Florida Atlantic University's Center for Environmental Studies for organizing the event.

About the Author

Jean Scott prepared this report for the FWC. Scott is a senior fellow with the Center for Urban and Environmental Solutions at Florida Atlantic University and the owner of Strategies for Livable Communities, a Boca Raton-based firm specializing in sustainable planning practices and the outreach and communication strategies that enable those with diverse interests to find common ground.

Summit Report Committee (FWC)

Chuck Collins

Doug Parsons

Thomas Eason

Ann Forstchen

Nancy Linehan

Carla Monroe

Editor: Patricia Behnke, FWC

Graphic Design: Ann Marie Tavares, FWC

Marrell Cooper, FWC

Photos: FWC, unless otherwise noted.

The Summit's complete agenda, PowerPoint presentations for each of the presenters and workshops are available at *www.ces.fau.edu/floc/agenda.php*.

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Executive Summary

"I was truly impressed with how well our key stakeholders came together at the FWC's climate change summit to tackle the very important issue of climate change. With so many great partners joining this effort, we are bound to make great progress and show Florida is fully ready to identify workable solutions to this looming challenge."

–Kenneth Wright
FWC Commissioner

Florida's geography and diverse ecosystems, stretching from the Atlantic and Gulf coasts to the Everglades, places the state in a frontline position for experiencing the effects of climate change. That position makes Florida a key state to learn about the impacts of climate change on fish and wildlife. The realities of climate change and what they mean for Florida's fish and wildlife managers was the focus of the Florida Fish and Wildlife Conservation Commission's (FWC) 2008 Summit, Florida's Wildlife: On the front line of climate change (www.ces.fau.edu/floc/).

The FWC invited experts and professionals on wildlife and climate change to come and share their knowledge. The Summit covered global, national and statewide perspectives, species biodiversity and policies for habitat management. The Summit attendees represented a diverse set of stakeholders. After group presentations, participants broke out into six different workshops where facilitated information exchange and brainstorming occurred. The information gathered at the Summit is guiding the FWC in the development of climate change strategies to ensure the best possible future for Florida's wildlife.

This report summarizes the information from the presentations and the discussions in the workshops. It also identifies some of the concerns, which emerged after three days of discussions about the potential impacts of climate change for Florida's fish and wildlife resources.

Presentations

The FWC invited several keynote speakers to make presentations at the Summit. The speakers included two Nobel Peace Prize laureates, Drs. Virginia Burkett and Jean Brennan; Dr. Thomas Crisman, a professor with the Patel Center for Global Solutions at the University of South Florida; and Dr. Thomas Eason, the FWC's deputy director of the Division of Habitat and Species Conservation. Their presentations helped frame the discussions in the breakout sessions.

Workshops

FWC scientists and managers led six concurrent workshops designed to look critically at the issues, stimulate discussion and generate ideas for all stakeholder groups, including the FWC, to take action to address the impacts of climate change.

Workshop topics included:

- Hunting and Fishing
- Inland Aquatic and Semi-Aquatic Ecosystems
- Invasive Organisms on Biodiversity in Future Climates
- Marine, Estuarine and Coastal Ecosystems
- Native Terrestrial Species, Communities and Ecosystems
- Natural Resource Management and Land-Use Planning

Summit Conclusions

This was the first climate change summit that put a fish and wildlife face on climate change to help understand specifics about what climate change may mean for Florida panthers, manatees, gopher tortoises and other species. Experts learned from each other and asked questions about how climate change impacts fish and wildlife and their habitats. The Summit ended with a set of suggested actions and a renewed determination to keep Florida at the forefront of conserving fish and wildlife during climate change.

The following are the key actions suggested by the participants at the Summit:

- Change from a static to a dynamic view of climate when making fish and wildlife management decisions.

- Step predictive models down to a Florida or regional scale.
- Develop the integrated data and appropriate monitoring needed for the FWC to adaptively manage climate impacts.
- Build broad support and action through continuous education, two-way outreach and the appropriate messages.
- Nurture a coordinated state response and facilitate the climate change dialogue.
- Manage the landscape for wildlife resiliency, which means involving the FWC in land-use planning.
- Protect the connected landscapes that will allow wildlife to move freely as the climate changes their habitat.
- Review conservation methods and priorities in light of a dynamic environment.
- Build on strategic and funding opportunities.
- Provide inspired leadership in the face of uncertainty.

The next steps

The FWC now has a Climate Change Oversight Team charged with integrating climate change issues into all aspects of the FWC's work.

The FWC has committed to work with staff, climate change experts and stakeholders to develop a comprehensive plan of action for Florida to address the impacts of climate change on its fish and wildlife resources.

Introduction

FWC's mandate and mission

"It shall be the policy of the state to conserve and protect its natural resources and scenic beauty."

–Article II, Florida State Constitution, 1998

One concise sentence, one clear mandate and one clear need translate into a tremendous balancing act in one of the fastest growing states in the country. Florida bestowed the responsibility of conserving fish and wildlife upon the FWC.

The magnitude of the FWC's responsibility is reflected in a few facts about Florida:

- 575 species of wildlife
- 200 species of freshwater fish
- 500 species of saltwater fish
- 18 million residents
- 80 million visitors each year
- $11.6-billion component of Florida's tourism industry through hunting, fishing and other wildlife-related activities, plus 120,000 jobs
- $18.5 billion boating industry, creating 220,000 jobs

The FWC's mission expresses the delicate balancing act of its state-mandated charge: Managing fish and wildlife resources for their long-term well-being and the benefit of people.

Florida's forests, rivers and creeks and coastal waters are vital to fish and wildlife, and to our own quality of life. With predictions that Florida's population may double to 36 million in the next 50 years, and further indications that the changing climate will put additional stresses on habitat and wildlife, the FWC began exploring how best to manage in this changing environment.

A study published by 1000 Friends of Florida suggests about 7 million acres of land could be converted from rural and natural to urban uses (www.1000friendsofflorida.org/Publications/main.asp) by 2060. As a result, the FWC prepared a report in 2008, Wildlife 2060: What's at stake for Florida? (MyFWC.com/Conservation) to address the changes that may occur in Florida's fish and wildlife and human lifestyles if the state's population doubles. Climate change was one component of the report. FWC's leaders began planning how to incorporate climate change and the 2060 report into all aspects of "managing fish and wildlife resources for their long-term well-being and the benefit of people."

The FWC's climate change initiative began in 2007 when the Commission adopted a resolution (Appendix A) committing the agency to conserving Florida's fish and wildlife in the face of climate change. The FWC's actions are designed to support the goals of a broader state climate change initiative – Serve to Preserve – a program that began in 2007 when Florida's Gov. Charlie Crist hosted the state's first climate change summit (www.flgov.com/climate_summit).

In 2008, the Florida Legislature unanimously passed comprehensive energy and economic development legislation and created the Florida Energy and Climate Commission to serve as the primary organization for state energy and climate change programs and policies.

The significance of climate change on Florida

"As managers of the state's fish and wildlife, we must recognize that climate change poses an unprecedented threat to functioning ecosystems in Florida. Losing one cog in the wheel of ecological diversity could cause the loss of crucial habitat and the unraveling of an entire ecosystem. To mitigate for those impacts and enable our ecosystems to be more resilient, we need to have the right information in the right hands at the right time – and we need to be ready to act."

–Nick Wiley
FWC's Assistant Executive Director

Florida's unique ecosystems make it one of the country's most desirable places to live and visit, but they also make the state vulnerable to the impacts of climate change.

Florida's shape and location contribute to that vulnerability. Florida is a 500-mile long, relatively narrow, flat, low-lying peninsula that is edged by the longest tidal coastline – 8,400 miles – in the 48 contiguous states. It is surrounded by water

on all three sides: the Atlantic Ocean, the Gulf of Mexico and the Florida Straits. Those many miles of low-lying coastal areas make Florida extremely vulnerable to rising sea levels and more intense storm surges, which are some of the predicted outcomes of climate change.

In addition, the natural features and communities that are the most at risk from climate change are those that drive much of the state's economy. They include the following:

- More than 575 species of wildlife, which annually attract 3.3-plus million wildlife watchers who contribute an estimated $3.1 billion to the economy, and 240,000 hunters, who add an additional $719 million each year. Of those species, 118 are already endangered, threatened or of special concern. They include the Florida panther, the American crocodile, the West Indian manatee and the wood stork.
- The Everglades, which is the largest subtropical wilderness in the continental United States, contains a broad spectrum of ecosystems and wildlife (56 of which are endangered or threatened), and is the focus of one of the world's largest and most expensive restoration projects.
- The 8,400 miles of low-lying tidal coastline and 825 miles of beaches serve as home to fragile ecosystems and 80 percent of Florida residents and attract many of the approximately 82 million visitors who come to Florida each year to fish, boat, kayak, swim, surf, dive, snorkel, spend a day at the beach, and watch birds and other coastal wildlife.
- The largest coral reef barrier system in America, and the third largest in the world, protects coasts and beaches, serves as important nursery grounds for many commercially valuable fish species, and contributes significantly to the economy. In Monroe, Miami-Dade and Broward counties, an estimated $1 billion in income, $2.3 billion in sales tax, and 40,000 jobs are generated as a result of this system.
- The 700 native species of fish (200 freshwater and 500 saltwater) attract 1.4 million freshwater and 2 million saltwater anglers, who annually inject $7.5 billion into the economy, making Florida No. 1 in the nation in total fishing income. Commercial fishing provides an estimated $576 million each year and boating another $18.5 billion.

The Summit

"Planning for the impacts of climate change and assisting species survival and adaptation is such a new and evolving field, that we are literally 'learning by doing' and refining our management as necessary. Florida offers a lot in helping advance our knowledge and understanding. It is at the tip of the climate change spear, stands to lose ecosystems and species that are not found any place else, and, as evidenced by the Summit, has an FWC that is at the forefront of figuring out how to most effectively address climate change impacts."

–Dr. Jean Brennan, Defenders of Wildlife
2007 Nobel Peace Prize laureate

With the potential risk of losing ecosystems to predicted climate change impacts, the FWC began making plans in 2008 to hold a climate change summit. Experts from around the country were invited to attend and share their knowledge. This information is a valuable component to assist the FWC and its partners as they begin to prepare for an uncertain future.

The Summit was planned for August 2008 in Orlando. However, days before the scheduled event, Tropical Storm Fay hit Florida and the Orlando area, postponing the Summit and reminding everyone of Florida's vulnerability to increased storms, a predicted result of climate change. The summit was rescheduled for Oct. 1-3, 2008.

The Summit attracted an array of leading national and state fish and wildlife and climate change experts, including two Nobel Peace Prize laureates. Their presence underscored the Summit's national and international importance. The experts were drawn by the opportunity to examine the impacts of climate change on a state where fish and wildlife are particularly vulnerable to those impacts. They also were drawn by the opportunity to use the FWC's approach to climate change as a model for its counterparts across the country.

Other Summit participants included:

- Fish and wildlife leaders, managers, biologists, researchers and academics who have an interest in planning for sustainable wildlife populations in Florida;

- Members of nongovernmental organizations, land managers, representatives of state, regional, county and municipal governments and agencies, and tribal leaders;
- Game and nongame wildlife organizations and enthusiasts and media and educational representatives;
- Representatives from federal entities, including the Fish and Wildlife Service, Forest Service, National Park Service, Department of Defense, National Oceanic and Atmospheric Administration, and the Army Corps of Engineers.

FWC staff, scientists and commissioners took part in panels designed to inform participants about the short- and long-term impacts of climate change on Florida's fish and wildlife. The FWC's division directors led six workshops that enabled the participants to examine the issues in more depth and provide their concerns about the potential impacts of climate change on Florida's fish and wildlife. Participants also provided suggested actions that the FWC and its partners can consider as they develop comprehensive plans to minimize negative impacts.

The 225 participants stressed that intervention should begin now, before climate change potentially pushes many species to the point of extinction. Management strategies must ensure that fish and wildlife remain healthy, resilient and adaptive to the impacts of climate change.

Presentations

Speaker summaries

Virginia Burkett
Senior Climate Change Scientist, Global Change Research, U.S. Geological Survey and a recognized member of the Intergovernmental Panel on Climate Change that shared the 2007 Nobel Peace Prize.

Dr. Burkett summarized the findings of elimate science and related reports from the Intergovernmental Panel on Climate Change. She noted that over the next 50 years South Florida will see an increase in temperatures and an increase in drought conditions.

"With that drought will come increased wildfire conditions and water shortages during certain times of the year," Burkett said.

Thomas Crisman
Patel Professor of Environment, Patel Center for Global Solutions at the University of South Florida.

Dr. Crisman outlined the uncertainties of climate change for Florida. He recognized the resilience of species but warned that wildlife managers should examine Florida's different climate regions and ensure that conservation corridors go north to south.

Thomas Eason
Deputy director, Division of Habitat and Species Conservation, FWC.

Dr. Eason highlighted the implications of climate change, including the challenges and opportunities, on an already changing human and wildlife landscape as reported in FWC's Wildlife 2060: What's at stake for Florida?

"Natural habitats could become islands in a sea of development, cutting off corridors for wildlife to move in response to changing conditions," Eason said. "As wildlife managers, we must be prepared for the potential impacts of climate change."

Jean Brennan
Senior climate change scientist, Defenders of Wildlife, and a recognized member of the Intergovernmental Panel on Climate Change that shared the 2007 Nobel Peace Prize.

Dr. Brennan focused on the response of wildlife to climate change and the related management challenges to helping species adapt. Brennan advised that as climate changes, species will do one of three things. They will shift their range; some will adapt to the changes; and yet others will become extinct. She stressed Florida's vulnerability to climate change.

Panel discussions

Biodiversity: Species on the Front line

Reed Noss – *Davis-Shine Professor of Conservation Biology at the University of Central Florida* – described the characteristics of terrestrial climate-sensitive species and the necessity of land corridors to facilitate species migration in response to climate change.

Scott Hardin – *Exotic Species coordinator, Division of Habitat and Species Conservation, FWC* – reviewed the challenges of managing nonnative wildlife in a changing climate.

Greg Jubinsky – *Invasive Plant Management program manager, Division of Habitat and Species Conservation, FWC* – outlined the challenges of managing invasive plant species in a changing climate.

Keith Ingram – *coordinator of the Southeast Climate Consortium and an associate research scientist with the University of Florida's Institute of Food and Agricultural Sciences and Department of Agricultural and Biological Engineering* – summarized the future of agriculture and the conflicts and opportunities created by climate change.

Hal Wanless – *professor and chair of the University of Miami's Department of Geological Sciences* – highlighted the ocean effects of climate change including the impacts of sea level rise on coastal communities and environments.

Robert van Woesik – *professor, Department of Biological Sciences, Florida Institute of Technology* – reviewed the characteristics of Florida's unique coral reefs and the potential impacts of climate change on this already stressed ecosystem.

Policies and Communication

Tim Breault – *director, Division of Habitat and Species Conservation, FWC* – highlighted the policy, management, communication, and public education and outreach issues related to habitat and species management in a changing climate.

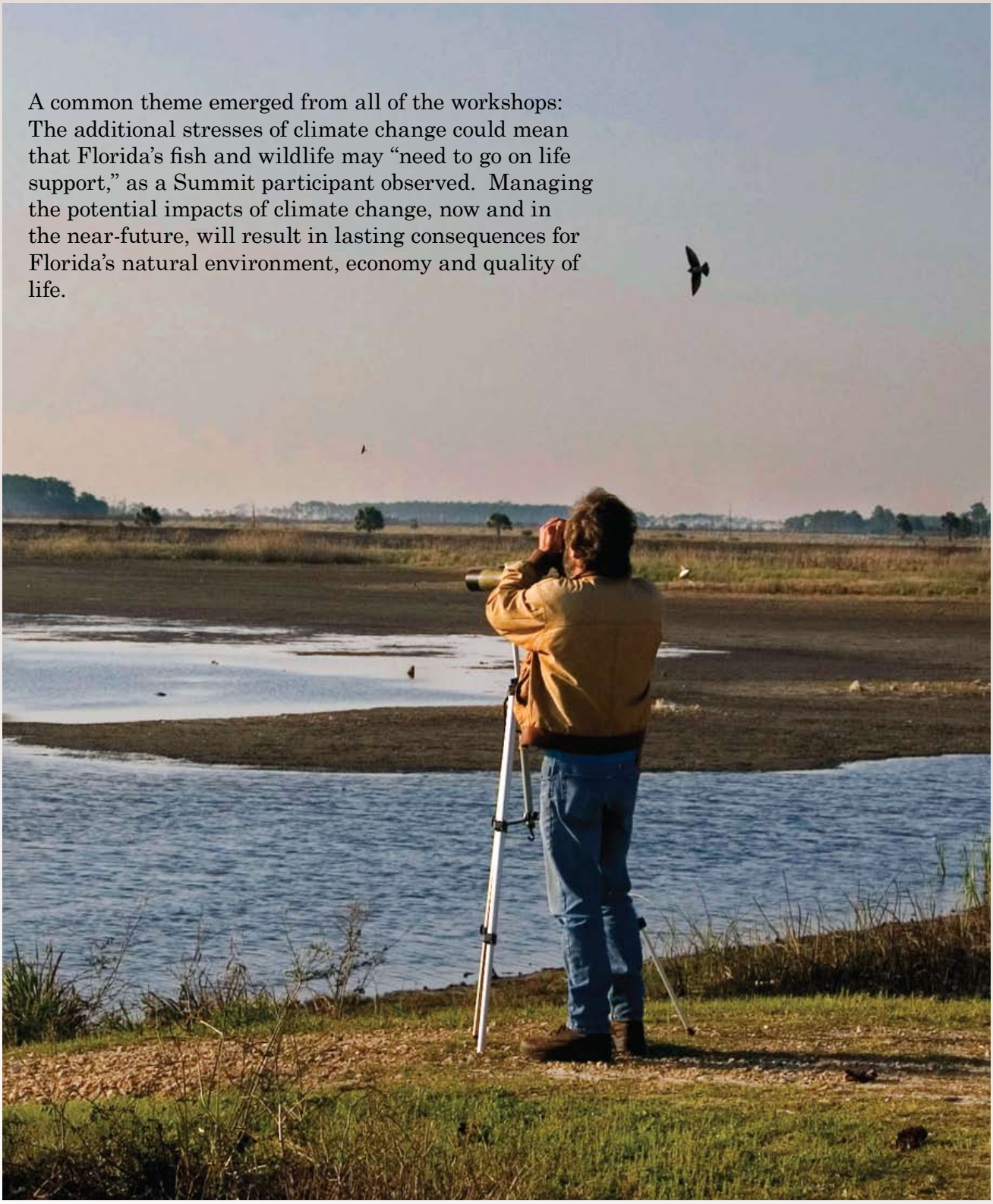
John Cooper – *senior advisor to the Bipartisan Policy Center* – reviewed the current and future challenge of climate change with a specific focus on threats to fishing and hunting as outlined in the book "Seasons' End – Global Warming's Threat to Hunting and Fishing."

John Kostyack – *executive director, Wildlife Conservation and Global Warming, National Wildlife Federation* – outlined federal climate change legislation and how cap and trade can protect natural resources threatened by climate change.

Margo Stahl – *manager, Hobe Sound National Wildlife Refuge, U.S. Fish and Wildlife Service* – reviewed her field findings about the impacts of climate change that are already occurring in Florida, which are expected to continue in the future on coastal fish, wildlife and plant species.

Dan Walker – *assistant director for the Environment, White House Office of Science and Technology Policy* – highlighted the need to reduce the vulnerability of coastal communities and ecosystems, protect and restore coastal ecosystems and their services, and promote sustainable uses of coastal areas to meet societal needs.

Workshop summaries



A common theme emerged from all of the workshops: The additional stresses of climate change could mean that Florida's fish and wildlife may "need to go on life support," as a Summit participant observed. Managing the potential impacts of climate change, now and in the near-future, will result in lasting consequences for Florida's natural environment, economy and quality of life.

Hunting and fishing

Leader: Diane Eggeman, director, FWC Division of Hunting and Game Management; and Mark Robson, director, FWC Division of Marine Fisheries Management

"The important message for hunters and fishers is that the timing, success and methods of hunting and fishing will change and will likely be less predictable, which means that annual hunting or fishing trips at the same time every year may need to change."

–Diane Eggeman

Key conclusions

- Recognize uncertainties and remain flexible.
- Use adaptive management practices.
- Monitor climate change impacts and collect data to assess a range of climate change possibilities.
- Use reliable information and the best available science to tailor management to necessary actions.
- Involve partners (stakeholders, other agencies and organizations, the legislature and the federal government). The FWC cannot address climate change alone.
- Ensure that hunting and fishing opportunities and participation remain vibrant in Florida.

Our assumptions: climate change impacts

Hunters, fishermen and fish and wildlife managers need to consider the possible impacts upon fishing and hunting in Florida as the climate changes. Warmer air and water temperatures – even a degree or two – and changes in intensity, frequency and duration of climatic events could have an effect upon the species. More extreme fluctuations in freshwater levels and sea level rise in coastal areas may impact both fishing and hunting opportunities.

Workshop participants identified the following potential impacts for fish and wildlife in Florida:

Habitat and life history changes could lead to changes in the number of and accessibility to harvested species. For example, a species may have a shorter or longer life expectancy or a higher or lower reproductive rate. Those changes could impact how, when and to what extent different populations are harvested. The habitats for wildlife and fish could all be impacted. Upland wildlife habitat and food availability also could be affected, by both rising temperatures and more extreme rainfall events. Warmer water, sea level rise and higher salinity levels could lead to accelerated changes in existing marine fish nursery habitat and adversely affect established fish populations. Warmer water temperatures may alter the growth and life history characteristics of saltwater fish. Even a moderate change can make a big difference in fish size, distribution and numbers. The ecology of estuaries also may be impacted, which could lead to fewer and

smaller fish. Freshwater fish could be stressed by changes in water levels and quality because of extreme weather periods, including extended droughts and heavy, flood-producing rains, and saltwater intrusion into low-lying freshwater lakes and rivers.

Climate change already is altering migration patterns and could continue to do so. Warmer temperatures could lead to some species migrating north, some not going as far south, or some shifting migration times. As species' ranges expand or shift, hunters and anglers may observe new species not previously seen before in a given region. For hunters, those changes might take the certainty out of when to plan their annual hunting trips.

Warmer air and water temperatures may result in an increased incidence of disease and range expansion of invasive species. Diseases and invasive species now deterred by cooler temperatures may become established farther north. That could lead to a further decline in wildlife and ecosystem health and increased mortality rates, particularly for those species already stressed by climate change or development impacts.

Sea level rise could lead to changed human settlement patterns and a resulting change in accessibility to resources. Sea level rise could lead to human populations moving inland. That movement could result in competition for limited land resources and conflicts with habitat management practices such as prescribed burning. A positive consequence could be that more hunters and fishermen would live closer to the species they harvest. Sea level rise also may cause changes in the coastal environment that could affect boating access to marinas, boat ramps or even fishing on historically used shorelines.

"Our intent is to maintain healthy and abundant resources that will support hunting and fishing for the long term. To do that in the face of climate change, we need to focus on getting the information that will enable us to detect changes as they occur. We will need to be flexible in our management approach so that we can use that information to adapt our policies and management strategies to the inevitable changes. And to do all of this, we will need to work closely with all of our stakeholders. The FWC cannot do this alone."

–Mark Robson

Opportunities

Increased awareness of climate change and its potential impacts on fish and wildlife may lead to broader stakeholder support and new funding opportunities.

Concerns

Workshop participants identified the following concerns related to the projected impacts of climate change.

Develop Florida-specific models and data. Florida-specific modeling tools, staffing capacity and data will be required to analyze at-risk habitats and game species and monitor and project climate change impacts. Models need to reflect the uncertainty of climate change impacts. Such uncertainty could lead to more conservative harvest management strategies and reduced hunting and fishing opportunities. Models demonstrating the potential recreational and economic impacts of a failure to act also are needed.

Practice flexibility with regard to the policies and management strategies used to address climate change. The uncertainties of climate change require the FWC to be flexible enough to change policies and management practices as the number of a particular species increases or decreases. To do that, regular – more than every 10 years – monitoring that looks at key indicators will be essential. Adaptive management needs to be the new norm.

Augment resources available through new partnerships. Adding the job of understanding and effectively addressing climate change impacts on harvested species could strain existing resources. During a time when state and other funding prospects are limited, dedicating resources to wildlife conservation and management may not be a high priority; consequently, the FWC will need to form new partnerships.

Increase communication with hunting and fishing stakeholders and involve them to collaboratively develop actions to reduce the potential impacts of climate change. Diversity among stakeholders is required. Hunters and fishermen in Florida have a strong conservation ethic that creates an opportunity to involve them in addressing climate change. First, however, they need to understand the issues; they also need to be engaged in developing the solutions so they can communicate them to others.

Desired future condition

The workshop participants brainstormed the following desired future conditions for fishing and hunting in Florida:

- Maintain rewarding experiences for hunters and fishermen.
- Maintain healthy habitat for fish and wildlife that supports productive breeding and nursery grounds and stable or increasing game populations and species variety.
- Preserve the fishing and hunting culture.
- Create policies that put hunting lands and fishing areas on equal footing with other land uses.
- Form public-private partnerships to create natural corridors that will facilitate fish and wildlife movements.
- Ensure adaptable access to hunting and fishing.
- Increase hunting and fishing opportunities using traditional methods.
- Secure adequate funding, resources and processes to identify and effectively respond to climate change impacts.

FWC actions to achieve desired future

Engage in continuous education. Given the complexities of the dynamic environment that may be created by climate change and the speed at which those changes could occur, early and continuous education will be required. The FWC should educate Florida hunters and fishermen, state leaders and stakeholders on the potential inpacts of climate change on hunting and fishing. This would build public understanding and support for monitoring and responding to climate-change impacts. Education also is needed to teach private landowners how to maintain species in the changing environment that could be created by climate change.

Mobilize hunters and fishermen. Particular attention should be given to using education and outreach to mobilize hunters and fishermen. Support from the hunting and fishing community will be important to the continued funding for fish and wildlife programs.

Incorporate hunting and fishing needs in planning and funding decisions. The FWC should incorporate hunting and fishing needs into a comprehensive plan that addresses climate-change impacts on fish and wildlife, including game species, and then allocate staffing and land acquisition and management resources according to that plan. To have sufficient resources, the FWC may need to aggressively secure new funding and expand political support.

Incorporate climate-change impacts in management decisions. The FWC's management practices should enable game and other species to adapt to climate-change impacts. Strategies should include protecting and developing appropriate corridors to help wildlife disperse. They should capitalize on opportunities created by potential new game species that result from climate change. If necessary, they also

should reduce existing harvest opportunities appropriately for game species whose populations are negatively affected. Climate-change impacts could be incorporated in the analysis of marine fisheries populations and assessments of boating access.

Monitor and conduct research on a dynamic environment. Planning and management decisions should be based on monitoring and accurate data. That information could be used to analyze species vulnerability and climate-change impacts on fish and wildlife and the habitats on which they depend. Research should continue current efforts to collect genetic information on species to determine if actions such as freezing eggs to produce species in the future are feasible and practical.

Designate an FWC climate-change point person. Florida potentially is more vulnerable to climate change and has more species to lose than any other state. That means the FWC should invest in a climate-change coordinator who can keep up with the modeling, policy developments, partnerships and education needs.

Communicate more and expand partnerships. The FWC should coordinate its activities to address climate change with other organizations working on those same issues. Those entities could include the National Climate Change and Wildlife Science Center, the Association of Fish and Wildlife Agencies' Climate Change Subcommittee, universities, other states, and other Florida state agencies and nonprofit organizations. Each such organization could name a climate-change liaison to work with the FWC.

Inland aquatic and semi-aquatic ecosystems

Leader: Darrell Scovell, director, FWC Division of Freshwater Fisheries Management

"Climate change could fundamentally change Florida's inland water systems – the lakes, rivers, streams, creeks and wetlands that we all enjoy and benefit from. The question will be, 'Can our inland aquatic systems survive the additional stresses of increased storm runoff, droughts and saltwater intrusion?' "

–Darrell Scovell

Key conclusions

- Avoid action paralysis because of uncertain climate impacts and timing.
- Include climate change in all FWC actions.
- Be adaptive and flexible in all actions.
- Evaluate actions against objective outcomes.
- Communicate research to stakeholders and partners.
- Engage in proactive research and communicate the results of that research to stakeholders and partners.

Our assumptions: climate change impacts

Florida's inland aquatic and semi-aquatic systems are sensitive to changes in temperature and to the quantity, duration, quality and timing of water-level changes and tides. These systems could be additionally stressed by the predicted impacts of climate change, such as increased temperatures, sea level rise, extreme fluctuations in rainfall, and extended periods of flooding and droughts.

Workshop participants identified the following specific potential impacts for fish and wildlife in Florida:

Increased temperatures

- Higher water temperatures combined with increased nutrients from storm runoff may result in increased invasive submerged and emergent water plants and phytoplankton, which are a foundation of the food chain and a good indicator of environmental changes.
- Higher water temperatures may create conditions suitable for the successful establishment of exotic freshwater fish. Central and North Florida may become a refuge for invasives from Central and South America as their former habitats to the south are lost.
- More frequent or prolonged algae (phytoplankton) blooms may result from longer growing seasons. Water holds less dissolved oxygen as temperatures rise and may cause a shift of fish populations from desirable species such as bass, crappie and bream to less desirable species such as shad, gar and mudfish, which are better equipped to tolerate lower dissolved oxygen levels.
- Fish adapted to cooler temperatures could migrate north as Florida's climate zones shift in that direction, which could impact the state's many fishermen and industries related to fishing. Some warmer temperatures also may lead to increased growth rates for some valuable sports species.

Inland aquatic and semi-aquatic ecosystems *(continued)*

More intense rain and drought periods

The predictions of more extreme fluctuations in rainfall raise several questions. How much water do Florida ecosystems require? When is the water needed? How much is needed and for how long annually? And what quality of water is needed?

More intense rain could lead to increased water runoff, flooding, greater water turbidity, nutrient loading and poor water quality, all of which could impact important fishing grounds, the health of aquatic ecosystems, and the quality of drinking water for humans. The need may arise to restore additional wetlands to handle storage and filtration and to develop more storage capacity.

Extended dry periods also may have negative impacts on semi-aquatic systems and surrounding vegetative communities, making them more vulnerable to wildfires. More intense rainfall and droughts may affect wading birds that depend on a less extreme combination of wet and dry cycles.

Sea level rise

Rising sea level and more intense and frequent storms may result in the inland migration of coastal residents. This migration may increase competition over an already limited inland supply of undeveloped land and water that is critical to fish and wildlife survival. In that competition, wildlife and fish could lose out to a growing inland human population. The result would be the increased development of wetlands and other important habitat.

Sea level rise may increase saltwater intrusion into freshwater systems and negatively impact freshwater fish and wildlife habitat as well as human water supplies. For example, Florida's popular largemouth bass fisheries would be greatly reduced as water salinity increases.

The cumulative result could have a significant economic impact on people whose livelihoods depend on inland fishing, such as fishermen, boaters and those in the tourism industry.

Opportunities

Federal legislation provides an opportunity to direct funding toward natural resource planning and protection as part of an integrated response to climate change. To take full advantage, fish and wildlife managers should be ready with plans. Residents of Florida (and many visitors) identify with "their" lake, wetland, or particular wildlife. The connection between inland water systems and how residents and visitors define Florida could help provide the foundation for the political support and planning decisions that could protect those valued systems. Conservation lands serve as carbon sinks and provide a way to bring an additional economic benefit to landowners through the sale of carbon credits. That added value could result in the addition of more conservation lands.

Concerns

Workshop participants identified the following concerns related to the projected impacts of climate change.

Focus on the impacts of sea level rise on inland water supplies and quality. Saltwater intrusion from potential sea level rise may result in more saline inland waters, which in turn means major changes in inland water ecosystems and a reduction in the amount of fresh water available for human and animal use. The shrinkage could create competition over which use gets priority, which could intensify as human populations

move inland because of sea level rise. Because the water supply crisis might be quite gradual, by the time the public fully comprehends the impacts, it could be too late for effective planning. The water crisis could be complicated if people moving inland choose to locate close to lakes, which could lead to negative impacts on aquatic and semi-aquatic habitat and water quality.

Involve fish and wildlife managers in the land use and infrastructure planning decisions as human populations move inland. Land and water resources could be impacted by the inland migration of coastal populations. Fish and wildlife managers need to be part of the planning for that movement to ensure fish and wildlife are considered. Plans to preserve the connected corridors and habitat areas that may be needed to allow wildlife to migrate and live inland could be put in place before the pressures mount to develop, potentially leading to relaxed conservation regulations.

Develop the political will to act before potential negative climate change effects impact fish and wildlife. Because the impacts and timing of climate change are uncertain, political leaders may be unwilling to act and allocate the needed resources until the crisis happens, which may be too late. One solution is to start now with integrating climate change into all aspects of planning, including developing responses as changes are detected. Florida is fortunate, workshop participants underscored, to have a governor who is leading proactively on climate change. Hearing from respected leaders about the importance of addressing climate change will go a long way in influencing public opinion and sustaining a positive attitude toward conservation.

Examine funding priorities and investments based on projected climate change impacts. Potential climate change impacts may change current funding priorities and the types of investments that are made. Participants cited two examples: Everglades restoration and coastal armoring. Less than a 1-meter increase in sea level means large portions of the lower Everglades could become a saltwater bay, which raises the question of whether restoration should continue as planned. Should we heavily invest in engineering solutions to keep the water out of coastal areas or focus more on where people and wildlife live?

Desired future condition

The desired Florida of the future has no net loss of wetlands and has good water quality and quantity, good partnerships and coordination between agencies and stakeholders, good species diversity and richness, and good science to support decision-making.

FWC actions to achieve desired future

Reduce the FWC's carbon footprint. The FWC, as an agency, should take steps to reduce its carbon footprint and become less dependent on fossil fuels.

Identify and engage partners to help create a common future vision. To reduce duplication and improve efficiency and effectiveness, the FWC should coordinate efforts and establish the mechanisms that will enable partners to work together toward a common vision. That can be achieved by integrating climate change into regular daily work, thereby avoiding the need to create an entirely new climate change initiative that would layer new work onto already stretched resources.

Inland aquatic and semi-aquatic ecosystems *(continued)*

Add climate change as an additional filter when monitoring. In addition to the FWC, others such as the Florida Department of Environmental Protection, University of Florida scientists, and water management districts monitor fish and wildlife and their habitats. To be able to plan for climate change within current resources, those already in the field gathering data also could collect information on climate change-related indicators. For example, when collecting data on the number and density of a species, information on climate impacts could be added, using that one monitoring activity to benefit different data needs.

Develop more Florida-specific models to better predict climate change impacts for Florida. At present, the models used to predict climate change and climate-change impacts are at the global or national scale. Models are needed that will allow the FWC to develop more precise predictions for Florida.

Consider climate change impacts when locating and designing coastal infrastructure and facilities. With sea level rise, the current location and design of coastal infrastructure and facilities may need adjustments.

Use incentives to promote desired actions. To protect inland aquatic resources, private landowner conservation incentives will be needed to stretch and complement funds to conserve land through acquisition. Incentives, coupled with education and participatory planning processes, also can be used to catalyze changes in public behavior. Educating youth is an important part of that process.

Invasive organisms on biodiversity in future climates

Leader: Greg Holder, regional director, FWC Southwest Region

"Exactly how and when invasive species will respond to climate change are still unknown. Some existing invasive species may be enabled and expand their range, and others could be introduced to a region as environmental conditions change. If we are to do a good job of restricting the movement of invasive species when the opportunities arise, we will need to be vigilant and more fully understand the potential impacts on native habitats and species."

–Greg Holder

Key conclusions

- Increase monitoring.
- Foster communication.
- Improve management planning.
- Form collaborative partnerships.
- Garner political support.

Our assumptions: climate change impacts

Invasive plant and animal species often have adverse impacts on native environments and often out-compete native species. Invasives often are more aggressive, do a better job than native species at defending themselves in their new host environment, and often have no natural predators.

Which species will thrive or fail to adapt to climate change is not yet known; however, predictions show the spread of invasives may accelerate with warmer temperatures and altered rainfall and humidity patterns associated with climate change. Only a minor change in the climate can facilitate existing invasive plants or animals to expand their range. That expansion brings with it other uncertainties: new disease vectors, habitat fragmentation acceleration as invasive species wedge into and separate native habitat, and increased stresses on native animal and plant populations.

Addressing the potential impacts of the expansion of invasive species in Florida requires better understanding of those impacts on already stressed native species. Because of Florida's different climate regions, what is native to one region may be exotic to another.

Florida native species and habitats – particularly those that are already imperiled – may be particularly vulnerable to the expansion of invasive species. Many native species and ecosystems are already stressed because of human impacts, which present a challenge that will continue as the human population continues to grow. The predicted effects of climate change could add an additional level of stress, which already is happening in some areas of the state. The introduction of an aggressive and harmful invasive could push some of these species and habitats to extinction.

Invasive organisms on biodiversity in future climates *(continued)*

Because Florida is composed of different climate regions, categorizing a species as invasive depends on its particular location. For example, a species that is not invasive in Southwest Florida may be invasive in Northwest Florida. With climate change, the range of invasive species may move inland in response to the impacts of sea level rise, and northward as the warmer temperature front line and the frost line move up the peninsula. That movement could shift the thermal limits that have held back many invasive species.

Florida, particularly South Florida, could experience invasive species from the Caribbean and Latin and South America. As their current native habitat constricts and becomes less hospitable and Florida's habitat becomes more inviting, invasive species may move from one island or country to the next.

Opportunities

To help with invasive species management, the FWC should take advantage of the current political climate. With the governor's emphasis on Florida's vulnerability to climate change and the growing national dialogue, the public is more aware of the need to take action. That awareness could create support for more research on which species may become invasive. State-based land management funds could be used as part of a comprehensive statewide plan to contain or stop the spread of invasive species on publicly owned and managed lands.

Concerns

Workshop participants identified the following concerns related to the projected impacts of climate change:

Proactively monitor the introduction of new species and the spread of existing invasive species. Because the timing and impacts of climate change are not certain, better predictive models will be required. To address the lack of information on the impacts of climate change in Florida, Florida-specific models are needed.

Develop scenario-based and adaptive plans for managing invasive species in advance of their expansion. Because climate impacts and timing are uncertain, well-thought out and adaptive management plans need to be in place ahead of time. Ad hoc plans may not work.

Collaborate across agencies and levels of government to achieve shared goals. To effectively monitor and limit the spread of invasive species in a changing environment, many levels of government and stakeholders need to be coordinated. A coordinated response should include monitoring standards that yield consistent outcomes and effective collaboration among state agencies, their federal and local counterparts, and conservationists.

Use education and communication to build public understanding and political support. Strong political and public support and an informed leadership may be required to put a comprehensive invasive species control strategy and a supportive regulatory framework in place. Consistent, carefully crafted and well-targeted communication and education will be needed.

Desired future outcome

Through collaboration, the desired future outcome would be to reduce the number and spread of invasive species.

To achieve this aim, proactive monitoring, collaborative partnerships, specific management plans, carefully messaged communications and education, and strong political support will be required.

FWC actions to achieve desired future:

Create, fund and prioritize proactive monitoring of recently introduced or expanding populations of invasive species. To create the necessary monitoring capacity, a number of actions may be required. They include standardizing GIS-based data collection and screening protocols, collecting the data needed to better inform decision makers about the long-term

Invasive organisms on biodiversity in future climates *(continued)*

effectiveness of new policies and regulations, limiting the introduction of invasive species by increasing screening, adopting more effective regulations, and securing better funding enforcement at ports of entry (requires Congressional changes to the Lacy Act), and evaluating the effectiveness of new control techniques in constraining species as they are introduced.

Require and facilitate more collaboration among all levels of government. More inclusive structures, such as an interagency, inter-organization working group, will be needed to facilitate collaboration among federal, state and local governments, conservation nonprofit organizations, and the regulated community, including hunters and fishermen.

Develop adaptive invasive species management plans that are "vector vigilant," which will prevent invasive species from coming in. Because of the unpredictable extent of climate change in Florida and effects of that change on invasive species, management plans may need to include a range of responses to address various climate change scenarios. They must contain the capacity to adapt as the science improves and conditions change. For example, while a particular habitat may change in function, it could retain its ecological value even though it changes. Changing conditions and science may necessitate revisiting current conservation and species control measures, priorities and management plan actions.

Establish a comprehensive education initiative for invasive species. Consistent, carefully crafted and well-targeted communication and education initiatives will be needed to inform policy decisions and shape public opinion. They may include application of technology such as an invasive species listserv or blog, or consumer information initiatives such as Green Thumb Certified Nurseries, which serves as a good example of how communication can be used to create public awareness and change behavior and how a non-regulatory method can help the public make more informed choices.

Engage all levels of government in invasive species management and control. Well-informed political and public support is a prerequisite to successful invasive species management, particularly in view of the unknown impacts of climate change. Regularly scheduled climate change summits are one way of getting out information and building strong collaborative partnerships, with all levels of government.

Marine, estuarine and coastal ecosystems

Leader: Gil McRae, director, FWC Fish and Wildlife Research Institute

"The sea level rise resulting from climate change will place an unprecedented stressor on Florida's marine, estuarine and coastal systems and the many services they provide. Although the timing and magnitude of those impacts might be uncertain, they have already started and will continue to occur."

–Gil McRae

Key Conclusions

- Abandon "decision paralysis" because of uncertainty (the uncertainty of climate change impacts cannot be used as an excuse not to act).
- Integrate climate change in all FWC actions.
- Recognize that all actions should be adaptive and flexible, which means more frequent monitoring.
- Evaluate actions against objective outcomes.
- Engage in proactive research and communicate the results of that research to stakeholders and partners.

Our assumptions: climate-change impacts

Florida's marine, estuarine and coastal ecosystems are vulnerable to the impacts of climate change. Sea level rise, more intense storms, warmer temperatures and extreme fluctuations in rain may significantly alter the state's coastal and marine environments as they exist today.

Workshop participants identified the following specific potential impacts for fish and wildlife in Florida:

Ecological

Ecological impacts may result from changes in frequency, duration, timing and intensity of rainfall events, increases in temperature and acidification of marine waters. Workshop participants concluded that these non-historic climate changes are already affecting Florida's marine and coastal systems, adding to the stress on much of the state's fish and wildlife.

Examples of the potential ecological impacts of climate change include alteration of the following:

- Species abundance and distribution,
- Food webs impacting a species' resilience and ability to survive,
- Life history event timing, such as changed reproduction or food cycles,
- Habitat, degraded or lost because the supportive environmental conditions are not there,
- Incidence of increased disease.

Meteorological/Hydrological

Changes in meteorological and hydrological conditions may create an environment that fish and wildlife are either not adapted to or cannot adapt quickly enough to survive.

Examples include:

- More severe storms, which may alter the coastal habitat structure and function and relocation of animals.
- Changes in the quantity, quality and timing of freshwater flows into estuarine systems, which may negatively impact the health of the fish and wildlife and alter the habitat.
- Changed evaporation patterns from warmer temperatures, which is predicted to result in heavier or unpredictable rainfall and severity and affect marine habitats.
- Sea level rise and more intense storms may alter coastal habitat and infrastructure and increase intrusion of salt water into coastal freshwater supplies.

Socioeconomic

Climate change could have profound social and economic impacts on coastal areas, which are currently home to 80 percent of the state's population. These impacts include:

- Shifts in human population and coastal-dependent industries inland, further reducing available habitat for fish and wildlife.
- Loss of highly valued ecosystem services, such as boating, birding and beach-going activities.
- Movement of coastal residents inland, producing a domino effect that could create potential conflicts when deciding how land should be used for people and wildlife habitat.

Opportunities

The current interest in climate change presents an opportunity to stimulate dialogue in environmental issues and enhance greater intra- and interagency cooperation. The climate change scope also provides an opening to capitalize on the emerging green economy and create new partnerships of citizen-science networks through grassroots organizations devoted to protecting and promoting science education.

Concerns

Workshop participants identified the following concerns related to the projected impacts of climate change:

Improve the collection, analysis and distribution of data to better understand the ecological impacts of climate change and reduce some of the uncertainties. Baseline data are essential to evaluating changes and understanding the vulnerabilities of current species to changes, such as the temperature tolerance of larval fish. Because the timing of projected climate impacts is unpredictable, regular monitoring will be important to detect changes as they occur.

Develop finer scale data. Climate change impacts most likely will occur locally, but Florida-scaled data are not yet well-developed.

Assess whether current management, regulatory and planning frameworks are sufficiently adaptive to address the impacts of climate change. Examples of such changes could be seawall construction and beach nourishment restrictions and regulations that establish where and how coastal development and marinas might (or might not) occur.

Examine potential implications of climate change effects on endangered species. As climate change occurs, more species likely will be added to imperiled species lists. When this occurs, more restrictions could be placed on the lands that host listed species. Such restrictions could lead to conflicts at a time when habitat will be critical for conservation uses because of climate change.

Marine, estuarine and coastal ecosystems *(continued)*

Help public officials value addressing long-term issues. Most public officials are elected for two- to four-year terms, making their planning horizon short-term. That makes it difficult to deal with such a long-term issue as climate change, since some impacts might not occur for 100 years or more.

Revisit acquisition and restoration priorities. Current acquisition and restoration policies may not take into account the impacts of climate change. For example, we need to decide whether areas that might be inundated from sea level rise should be restored or acquired as planned now, or if the priority should shift to uplands that could provide the travel path needed by coastal wildlife as a result of increases in sea level.

Coordinate with other agencies and establish an inclusive management outlook. Effectively planning for climate change will take the coordination of many agencies and will require more holistic and multi-disciplinary approaches.

Develop effective messages. Climate change impacts are complex and difficult to understand and could occur over a long-term horizon. Messages should be developed that clearly communicate what climate change means to Florida resources and the need to act now.

Desired future condition

A future with protected, healthy and resilient ecosystems includes a flexible, adaptive and accountable management framework, an understanding and supportive public, the availability of sufficient tools and resources, and a planning system that supports both people and wildlife.

FWC actions to achieve desired future

- Facilitate interagency coordination.
- Support research and monitoring (including vulnerability assessments) that will inform policy and management decisions.
- Coordinate with and educate stakeholders and the public.
- Reduce environmental stressors to increase ecosystem resiliency.
- Integrate climate-change issues into existing state activities, including the FWC's Wildlife Action Plan and Cooperative Conservation Blueprint (CCB) and the underlying Critical Lands and Waters Identification Project (CLIP) data layers. For example, consider how best to prioritize the protection of upland areas in relation to coastal lands that will likely be inundated with sea level rise and more intense storm surges.
- Encourage the Florida Acquisition and Restoration Council to strategically use state-based land management funds to protect the habitat that will allow marine life to adapt to climate change.
- Consider the use of Marine-Protection Areas to help protect functioning natural systems.
- Develop economic incentives to encourage informed decisions and management practices and policies.
- Develop a comprehensive and adaptive planning, management and regulatory framework that includes climate change projections to reduce the negative impacts of climate change.

Native terrestrial species, communities and ecosystems

Leader: Tim Breault, director, FWC Division of Habitat and Species Conservation

"The additional stress of unusually rapid climate change might mean that Florida's already stretched ecosystems need to go on life support. A new, more adaptable conservation paradigm is demanded. That new paradigm requires no longer assuming that climate can be considered a static variable when managing wildlife and habitats. It also requires becoming more involved in land-use planning and reassessing current conservation priorities and methods."

–Tim Breault

Key Conclusions

- Recognize that change from climate change is inevitable and unpredictable, and that the FWC will need to be adaptive and flexible in its responses.
- Make the necessary land-use habitat planning connections to establish connected wildlife-transit corridors and habitat refuges.
- Inform and engage the public to build political support and the will to act.
- Increase monitoring to identify in advance direct and indirect climate-change impacts on wildlife.
- Form collaborative partnerships among diverse stakeholders.
- Foster interagency and inter-organization communication.

Our assumptions: climate change impacts

The impacts of rapid climate change could profoundly change and disrupt Florida's climate-sensitive, and already stressed, native terrestrial species and the habitat they depend on. Potential impacts include:

- Extreme periods of rainfall and drought, leading to an overabundance of water at times and an underabundance of water at other times - an issue for a storm-prone, highly developed state.
- Warmer temperatures – a 3- to 4-degree change in temperature could lead to a loss of one-third of Florida's biodiversity. (Intergovernmental Panel on Climate Change, 2007)
- Sea level rise – a 1-meter rise in sea level would impact 45 of Florida's 67 counties and 49 percent of its population. It also would lead to the loss of 20 percent of existing conservation lands, 13 percent of priority rare-species habitat and 17 percent of priority strategic habitat. (Reed Noss, Davis-Shine professor of Conservation Biology at the University of Central Florida)

Climate-change impacts could dramatically alter wildlife habitat, life histories, health, food base, reproductive biology and populations. Specific examples of climate-change impacts are increased vulnerability to native species; altered wildlife and vegetation ranges; and less usable land for animals and humans, habitat transit corridors, and altered habitat.

Native terrestrial species, communities and ecosystems *(continued)*

Workshop participants identified the following specific potential impacts for fish and wildlife in Florida:

More vulnerable native species. Florida's wildlife and their habitats already are under stress from the state's rapid rate of population growth and its development patterns. Climate change could lead to additional stresses. When wildlife and their habitat experience increased stress, they become more susceptible to emerging diseases and invasive species that may thrive in new environments and often out-compete native species.

Altered wildlife and vegetation ranges. The altered rainfall and temperature patterns and sea level rise anticipated from climate change could transform wildlife and vegetation ranges. Those species limited to narrow geographic areas and those species that have limited capacity to move or migrate and could not respond rapidly to change would be the most affected.

Less usable land for animal and human habitat. Habitats that are suitable for humans and animals could be greatly reduced by the impacts of climate change. In Florida, if humans and wildlife retreat inland to escape the impacts of sea level rise and more intense and frequent storms, the retreat could cause competition between humans and wildlife for uses of the remaining undeveloped land. Less available land also could increase human-wildlife interactions.

Habitat transit corridors. Florida wildlife may need to move as a result of climate change impacts. That means acting now to protect and create appropriate habitat corridors so species can migrate north because of warmer temperatures and inland because of sea level rise.

Altered habitat. Climate change-induced alterations in rainfall patterns could have numerous effects on terrestrial species' habitats. Examples of those potential impacts include too much or too little groundwater compared to historic patterns, soil erosion, wetland fragmentation or loss, and more intense and frequent fires.

Opportunities

Florida's wildlife managers are positioned to put in place the planning paradigm that will enable them to more effectively monitor and plan for climate change impacts. Those opportunities are:

Build on the many climate change and natural systems planning initiatives and partnerships already under way. Florida has a governor who is taking the lead in addressing climate change. The Century Commission for a Sustainable Florida's Critical Lands and Waters Identification Project (CLIP) and the FWC's Cooperative Conservation Blueprint (CCB) also provide good vehicles for planning for climate change. Florida's Wildlife Legacy Initiative and Wildlife Action Plan also present opportunities to integrate climate change into current activities.

Use Florida's public stewardship ethic and public awareness of climate change to leverage political action. Florida's residents have a long history of supporting conservation planning; they are now paying attention to the topic of climate change and want to learn more about its impacts. A public that is well-grounded in the science of climate change will be an effective partner in promoting the needed political actions.

Dominick Martino

Expand the dialogue. Climate change is an important enough issue to bring many disparate people to the table. Collaboration among many levels of government, nonprofit conservation organizations and regulated communities is a prerequisite to success.

Use the economic slowdown to buy land that will be needed for Florida's wildlife to adapt. Wildlife managers and conservation organizations should use this time of reduced development pressures to start strategically purchasing critical habitat, starting with the conservation corridors that will enable wildlife to migrate inland as sea levels rise and north as temperatures warm.

Use the impetus of climate change to improve the state's regulatory framework. The urgency to prepare for and reduce the impacts of climate change presents an opportunity to update a legal framework that often goes back to the 1960s and 1970s and tends to limit options. The result would be more efficient and effective environmental regulations.

Concerns

Workshop participants identified the following concerns related to the projected impacts of climate change:

Put in place coordinated education and communication programs designed to increase public understanding and support. The public can be a strong partner in addressing climate change. The public and decision-makers must understand the potential impacts of climate change and how those impacts will affect their lives. They also need to learn what they can do to address those impacts.

Use limited resources efficiently and strategically and design strategies that benefit multiple interests. The need to address climate change comes at a time when state resources are limited, creating the potential for competition between investing in human and wildlife needs. That conflict can be avoided by plans that integrate wildlife planning with state and local land-use and infrastructure planning.

Establish connected wildlife habitat corridors and landscapes. To adapt to climate change, terrestrial wildlife may need connected north-south and east-west habitat transit corridors and large, healthy conservation landscapes. Terrestrial habitat systems also may need to be interconnected with freshwater, estuarine and marine environments.

Work through partnerships. The FWC alone cannot minimize species loss and optimize wildlife value and habitat in the face of climate change. To accomplish that, broad partnerships across all stakeholders and agencies will be needed.

Use research to better understand Florida-specific climate change impacts. The majority of current data about climate change are at the global or national levels. To effectively understand and plan for the impacts of climate change on Florida's fish and wildlife, more state-specific data will be needed, particularly given the uncertainty around the timing and scale of impacts and the ecological and human responses to those impacts.

Change the conservation planning paradigm. Climate change is occurring at a faster rate than previously anticipated. That means wildlife managers need to shift to planning based on future conditions rather than those of the past.

Update Florida's regulatory framework. The current regulatory framework often gets in the way of efficiently addressing climate change and frequently limits options. Therefore, part of preparing for climate change should include updating state planning regulations.

Desired future conditions

A Florida with connected and resilient terrestrial systems that contains diverse biotic communities and offers optimal adaptation to change is the desired future for this state. That future would be enabled by strong public action and support, compatible future development, and complementary management of private and public lands.

FWC actions to achieve desired future

Educate all segments of the public as well as public and private decision-makers. Many Floridians are here because of their love for the environment. Understanding how climate change affects the environment they value could expand the number of those actively involved. Media can be a useful part of the education process. The FWC's editorial board briefings could be a valuable approach.

Develop the integrated data needed for the FWC to monitor, understand and adaptively manage climate impacts. Additional data about climate change impacts on wildlife, plants and their habitats are essential. The data need to be calibrated for Florida's different climate zones and yield the information that will help public officials make priority decisions in the future. The data also should feature the early warning indicators that will enable wildlife managers to have a range of options in place before they are needed.

Put in place a targeted, effective communication strategy and plan. The social sciences can be used to more effectively reach out to the public, conduct surveys to better understand values and attitudes, and craft the most effective messages for different target markets. The first question to ask is, "Does the public care?" Another issue is whether the message needs to be different for different groups in view of Florida's increasingly diverse population.

Develop and implement an integrated climate-change conservation action plan that focuses on resilience and adaptation. To effectively anticipate and manage the impacts of climate change, a coordinated state conservation action plan is needed. That plan should prioritize creating and maintaining a statewide interconnected conserved landscape composed of priority habitats.

Integrate energy planning with habitat planning. Florida's wildlife habitats have the capacity to sequester carbon as part of a cap and trade system. Sequestering carbon reduces overall greenhouse gas emissions and provides a potential new source of income for landowners.

Involve land-use planners in protecting habitat. Climate change puts the pressure on protecting the habitat needed to help wildlife adapt to climate change. That urgency increases with the shrinking amount of undeveloped land available for human or wildlife use. Useful planning tools include time-limited conservation easements to protect land for the shorter periods of time that might be necessary because of altered landscapes resulting from climate change. Land swaps and private landowner conservation incentives also could be useful components of the tool kit.

Lead by example. The FWC should integrate planning for climate change into its everyday actions and guiding policies. The FWC also should engage in climate-change forums, sharing its expertise with others.

Natural resource management and land-use planning

Leader: Jerrie Lindsey, director, FWC Office of Recreation Services

"Our overriding concern is that we need to act now. Land-use planning and targeted acquisitions can help humans and wildlife adapt to the impacts of climate change, but our options are diminishing in the face of a shrinking natural landscape. Time is of the essence."

–Jerrie Lindsey

Key Conclusions

- Recognize that climate change and resulting changes in habitats are inevitable.
- In anticipation of those changes, seek to catalyze an integrated land-use planning and natural-resource management system that is flexible, adaptive and based on monitoring.
- Utilize integrated land-use planning and natural-resource management system to develop a protected and connected green infrastructure network, linking to nodes of carefully planned developments interconnected by multi-modal mass transit.
- Inform and engage the public, all sectors of the economy, and public-private partnerships.

Our assumptions: climate change impacts

Workshop participants focused primarily on the predicted need for wildlife and human populations to move in response to sea level rise and changes in habitat conditions. That need, coupled with continued human population growth, will further intensify the current competition for the state's remaining undeveloped and primarily privately owned agricultural and natural lands.

Without better land-use planning, wildlife may be reduced by the competition for land and water resources. The competition could further decrease, fragment and degrade already limited habitat available for wildlife corridors, limiting the ability of the state's wildlife to adapt to the impacts of climate change. The threat is exacerbated by the current rate of climate change coupled with the possible failure to take management action promptly.

Opportunities

The opportunities discussed focused on embedding climate change into current state planning processes and the need to plan now, not later, for conservation corridors that will enable wildlife to migrate. The intent is to prevent land-use decisions today that will fragment or block those corridors. Embedding wildlife conservation issues into current land-use planning programs maximizes current dollars and staff energy.

Take advantage of the attention to climate change. The importance of addressing climate change is being discussed by many scientists. In addition, national and state climate change-related legislation presents opportunities for potential funding.

Incorporate planning for climate change impacts into the FWC's Wildlife Action Plan. The data gathered for the FWC's Wildlife Action Plan should include the information needed to monitor climate change impacts on indicator wildlife and their habitat. Grants made through the plan

could be used to incentivize local acquisition of key habitat that will enable wildlife to better adapt to climate-change impacts.

Integrate planning for habitat into existing state planning programs. Florida's growth-management programs present opportunities to put in place local plans and policies that will protect the habitat needed for wildlife. Examples include Developments of Regional Impact, Optional Sector Plans, and local Comprehensive Plans and Evaluation and Appraisal Reports.

Include corridors that will enable wildlife to migrate as the climate changes. The FWC's Cooperative Conservation Blueprint and the companion Critical Lands and Waters Identification Project present an opportunity to add data layers that identify and prioritize those lands that will be needed to help wildlife migrate and adapt. A complementary opportunity involves using conserved military lands to provide that habitat.

Target state-based land-management funds to acquire the habitat lands that will be needed to help wildlife migrate and adapt. Funds could be prioritized to acquire those lands now in order to avoid their future development. Such development could very well disconnect the connected wildlife corridors that will be needed if Florida's wildlife is to migrate and adapt to the predicted impacts of climate change.

Concerns

Workshop participants identified the following concerns related to the projected impacts of climate change:

Galvanize the public. Public support will be needed to build the will for political action. Gaining that support means that the public must understand the possible climate-change threats to Florida's wildlife. Consequently, ongoing public education and involvement are essential to put a wildlife face on climate change.

Provide strong, timely and inclusive leadership. Strong leadership is needed from all the groups that have a stake in the outcome, if we are to take the steps that are needed, particularly owners of land who have important habitat now or could, through restoration, have it in the future. Leaders must work together, not separately; leadership needs to be inclusive of all stakeholders and involve those not currently active.

Recognize we cannot buy all the land that we need. There is not sufficient public money to buy enough land to provide the habitat that will be needed. Since private landowner conservation incentives are an important part of addressing climate change, private landowners need to be involved when climate change actions are planned. In addition to landowners with important wildlife habitat, coastal landowners need to be involved when talking about coastal areas facing sea level rise and more intense storms. While owners of coastal real estate might look to shoreline armoring for protection, that armoring could be detrimental to wildlife.

Make priority decisions based on future, not current, conditions. Planning and acquisition decisions can no longer be based on the "here and now." They need to be made by looking forward to conditions that will exist as Florida experiences the impacts of climate change.

Put in place a coordinated state response. The FWC has a limited regulatory reach, which means that to succeed the agency will need to work with other agencies. State, regional and local governments may need to rework regulations and plans so that they are aligned. Similarly, acquisition dollars (regardless of agency) should be directed at acquiring the lands that will enable wildlife to respond to climate and resulting habitat changes.

Create a culture of flexibility and nimbleness. Land-use planning has assumed static conditions that are no longer appropriate in this period

Natural resource management and land-use planning *(continued)*

of more rapid climate change. In a time of fluctuating conditions when the future is hard to predict, agencies and their rules and regulations will need to be flexible and nimble.

Recognize that Florida's wildlife are already stressed and some species are on the brink of extinction. Florida's growth already has resulted in the development and fragmentation of important wildlife habitat and, in many places, has degraded water resources. Even if the rate of growth slows, plans should be put in place now that show what lands need to be conserved and how they should be preserved, to provide the necessary wildlife habitat in the future. By doing that, future development can be planned that is compatible with the protected habitat.

Desired future condition

Florida's future includes resilient functional ecosystems with the greatest possible diversity of native species in balance with the needs of people.

Achieving the desired future condition requires horizontal planning across state agencies and vertical planning across state, regional and local governments. That future also will require a new planning paradigm that results in the retention - and creation through restoration, where needed - of a healthy, connected and protected habitat network that will enable Florida's wildlife to adapt to the impacts of climate change.

FWC actions to achieve desired future

Form an interagency and inter-organization climate change team. To be effective, to present a unified message to the Legislature and to obtain the necessary funding, it is important to have interagency and inter-organization coordination. The FWC needs partners to help make this happen successfully.

Integrate the work of this summit into everyday jobs, contacts and networking. Helping wildlife adapt to climate-change impacts should be integrated into everything we do.

Develop white papers that outline early warning indicators. To make sound management decisions, the FWC and its partners will need to have a process for identifying climate-change impacts as they occur. The early warning white papers and subsequent setting of priorities should be based on the best available data.

Seek the governor's involvement in submitting the Summit outcomes to the new Commission on Energy and Climate. Hearing from the governor about the importance of integrating wildlife-adaptation planning will impact decision-making. It also is important to establish centralized, integrated modeling that feeds information to the Commission on Energy and Climate.

Involve stakeholders early in developing climate change response goals and strategies. Involve a diverse array of stakeholders to identify themes and important messages. Media can be used as an outlet.

Provide private landowner incentives. Funding to acquire critical links of land is an important piece of the puzzle. However, because there are insufficient funds to acquire all high priority, privately owned habitat, providing incentives to encourage private landowners to conserve important natural systems is an equally important part of the solution.

Act now. To provide the connected, functional migratory wildlife corridors that may be needed as climate change occurs, the state should act now with targeted funding and incentives. The critical corridors should be identified and protected now, before more development occurs. The alternative will be fragmented, instead of connected, wildlife corridors and inefficient, sprawling developments.

Summit Summary

Common themes

The Summit had two key messages for fish and wildlife managers: 1) Climate change is not only inevitable, it is coming faster than anticipated, and its impacts in Florida are already occurring; and 2) the state's fish and wildlife and the habitats they depend on may be negatively impacted.

The Summit participants identified the impacts that should drive the FWC's climate-change actions:

The state's vulnerability to the projected threats of climate change. Florida's geographic location, flat topography and extensive coastline make it particularly susceptible to the impacts of climate change – namely sea level rise, more frequent and intense hurricanes and tropical storms, more extreme fluctuations in freshwater levels and precipitation, and warmer land, air and water temperatures. In response to those changes, fish and wildlife will have to adapt, shift their range (which requires putting the connected migratory corridors in the right place), or become extinct. Each of those outcomes could have significant impacts on Florida. For example, even a 3- to 4-degree change in temperature could lead to a loss of one-third of Florida's biodiversity. (Intergovernmental Panel on Climate Change, 2007)

The rate that climate change and corollary impacts are occurring. The speed at which climate change is occurring could outpace the ability of many fish and wildlife species to adapt, particularly those that have a limited geographic distribution or low dispersal rate, are associated with habitats that will likely be eliminated, or are more susceptible to emerging diseases or impacts from invasive species. The result could be an expansion of the number of imperiled species. The rate and unprecedented impacts of climate change also mean that fish and wildlife management decisions based on restoring habitat to prior conditions may no longer apply.

The already stressed condition of much of the state's fish and wildlife and their habitats. Climate-change impacts are occurring on ecosystems already under stress from years of high human population growth. Today, Florida's fish and wildlife must co-exist with more than 18 million residents – a figure that will almost double by 2060 – and millions of visitors who use the same natural landscapes and water resources. That competition will likely increase when coastal residents and wildlife retreat inland as their habitat is altered by sea level rise and more intense storms, raising the concerns that human needs will outweigh wildlife needs and that inland conservation lands will be converted to human uses.

The cumulative consequences could be profound. For example, a 1-meter rise in sea level, which could occur by 2100, would impact over two-thirds (45 of 67) of the state's counties and 49 percent of its human population. This level of impact would lead to significant environmental and corollary economic losses, including destruction of

- 20 percent of existing conservation lands,
- 13 percent of priority rare-species habitat,
- 17 percent of priority strategic habitat,
- 16 percent of Florida Ecological Greenways Network priority lands,
- 23 percent of panther habitat.

Florida's position on the front line of climate change puts the FWC at the forefront of climate-change issues, Summit participants concluded. That position will require a new conservation paradigm that integrates climate change into everything the FWC does, from its monitoring to its management plans and grant-making. It also will require that the FWC communicate and collaborate with other fish and wildlife managers.

Key actions

The participants produced the following key actions for the FWC's next steps in developing climate-change strategies:

Change from a static to a dynamic view of climate when making fish and wildlife management decisions. The rapid rate and unpredictable impacts of climate change mean that climate can no longer be treated as a constant when managing fish and wildlife. Management strategies that seek to restore habitats to historic conditions will most likely no longer apply. Operating in a changing

climate environment will require that the FWC quickly adapt its management practices.

Customize predictive models to a Florida or regional scale. Preparing for the very Florida-specific impacts of climate change requires Florida-specific predictive models. In order to understand and plan for the predicted climate impacts, fish and wildlife managers need the right data, at the right time. In particular, Florida models are needed for rainfall and temperature changes.

Develop the integrated data and appropriate monitoring needed for the FWC to adaptively manage climate impacts. The unpredictability and speed of climate change and the adaptive decision-making required by fish and wildlife managers will require integrated data, starting with baseline data, and appropriate monitoring. Monitoring needs to provide timely feedback, be in a form that enables swift decisions, and span appropriate Florida plant and animal species, habitats and climate zones. Data must be efficiently collected and easily accessible by more people. One solution would be to add the information needed to monitor climate change impacts and the effectiveness of the FWC's management practices to other data-collection activities. Another approach is to establish a central data portal to facilitate information sharing.

Build broad support and action through continuous education, two-way outreach and the appropriate messages. Climate-change impacts are often difficult to understand and will occur over a long-term horizon through multiple changes in public and private leadership and professional staff. That means education must be continuous and provide for two-way outreach that focuses on getting timely information out from and back into the process. To generate messages that resonate and motivate changes, social science researchers need to tailor approaches to what is important to today's Floridians, many of whom come from different cultural and ethnic backgrounds and are more plugged into the Internet than they are to nature.

Nurture a coordinated state response and facilitate the climate change dialogue. The multi-faceted impacts of climate change require inclusive multi-agency, multi-disciplinary partnerships. To be more effective, and make more efficient use of resources, all agencies and partners need to be involved and pulling in the same direction. Increase communication and collaboration with organizations and agencies that deal with growth management and land-use planning to ensure fish and wildlife needs are considered.

Manage the landscape for wildlife resiliency, which means involving the FWC in land-use planning. To ensure the right habitats are in the right places as climate-change impacts occur, the FWC needs to get involved in land-use planning strategies, such as conservation design and Florida's Rural Lands Stewardship Plans, that enable large, connected areas of priority land to be conserved while at the same time providing for development. Those conserved areas could be reinforced by a continuum of uses that range from preserved land to low-intensity conservation communities. Marine Protected Areas can be used to manage activities that could reduce the ability of marine life to adapt to the added stresses of climate change.

Protect the landscape corridors that will allow wildlife to move freely as the climate changes their habitat. Wildlife will need the ability to migrate to more suitable territory as their habitat changes or disappears because of climate-change impacts. In Florida, north-south migratory corridors will be needed because of warmer temperatures, and inland east-west corridors because of sea level rise and more intense storms. Being able to migrate freely will reduce vulnerability and, therefore, require less direct management. Creating and maintaining habitat corridors will require supportive land use, transportation and conservation investment decisions. A place to start is the priority natural areas depicted in the FWC's Cooperative Conservation Blueprint (CCB).

Review conservation methods and priorities in light of a dynamic environment. A rapidly changing climate will require a re-examination of conservation tools and investment priorities. Long-term leases would allow the FWC to relinquish

land for development and conserve other land when environmental conditions change. Land swaps and rolling easements could be used to achieve that same purpose. Another approach is to make greater use of incentives that encourage private owners to conserve land, because relying on regulations alone will not work. On the investment side, the FWC needs to look at priorities in light of changing environmental conditions. For example, it might be wise to invest fewer funds in restoring and protecting areas that may be inundated with sea-level rise, and direct more funds toward creating the upland connected habitat corridors that will enable wildlife to migrate.

Build on strategic and funding opportunities. Florida is ripe with opportunities to meaningfully address climate change, workshop participants observed. One set of opportunities involves state and national climate change leadership and legislation. Florida has a governor who has been at the forefront of state and national climate leadership and a legislature that in 2008 approved a wide-ranging energy bill that established a Florida Energy and Climate Commission. The energy-related provisions of the federal American Recovery and Reinvestment Act could also present opportunities. Another set of opportunities builds on the state's 50-year history of conserving land that underscores a strong public stewardship ethic. The state has dedicated $300 million each year through Florida Forever to land conservation – an investment level that has made Florida the national leader when it comes to land conservation. Florida's growth-management history also presents an opportunity. Planning tools, such as Developments of Regional Impact and Optional Sector Plans, could be used to protect migratory habitat corridors that will be required by wildlife migrating to more welcoming habitats. Those corridors could also be prioritized in the CCB and underlying CLIP.

Provide inspired leadership in the face of uncertainty. Uncertainty about future conditions should not be used as reason for inaction. The impacts of climate change are occurring too rapidly to wait until all data are in. Unforeseen impacts may arise quickly. A species' survival might depend on what one Summit participant called a quick "gestalt pop – those heroic assumptions made by inspired leaders." Those leaders will need to be adaptive in their thinking, accept change along with conditions, and remain inclusive of all views. Leaders also can no longer afford to work in their isolated disciplines and will need to ensure that climate change does not become a fad that disappears in a few years. Climate-change planning cannot be looked at as a mere task; rather, it needs to be a seamless part of the FWC's overall planning and incorporated into what staff does on a daily basis in their specific areas of expertise.

Conclusion

The workshop participants developed a statement to help guide the FWC's actions.

Our vision of Florida is state where protected healthy, functional, adaptive and richly diverse connected ecosystems are in balance with the needs of people. Those ecosystems are part of a protected and connected green infrastructure system that is reinforced and complemented by designs with environmental considerations at the forefront and contained development that considers wildlife landscape corridors. The FWC's prioritization efforts will help current fish and wildlife populations become healthier and more resilient through a flexible, adaptive and accountable management framework that integrates the following:

- Land-use and natural-systems planning.
- Regular monitoring of conditions using key indicators to measure change.
- Sufficient tools and resources.
- Strong partnerships with other state agencies and stakeholders.
- The public and public leaders who are informed, engaged and supportive.

Epilogue

Next steps: The FWC leading by example

The FWC took steps to keep the dialogue going and started to move from learning to action immediately after the Summit.

The FWC posted materials from the Summit on the Web and briefed FWC commissioners, other state agency heads and the governor's Action Team on Energy and Climate.

The FWC also formed a Climate Change Oversight Team housed within the Office of the Executive Director. The team is charged with integrating climate change into the FWC's organizational culture, its structure and all aspects of its work. The FWC is making climate change an integral part of the FWC's ongoing agenda.

The key steps to integrating climate change into the FWC's thinking and activities includes:

- Develop an approach that will incorporate climate change into the FWC's strategic and operational plans and existing structure and can be used as a vehicle for internal and external communication.
- Ensure that all levels of agency staff are aware of, and appropriate staff engaged in, climate-change initiatives.
- Update and align FWC actions with regional and national climate-change initiatives as appropriate.
- Work with stakeholders and partners on fish and wildlife adaptation and mitigation.
- Prepare an internal and external outreach strategy to communicate climate change issues.
- Develop clear and measurable indicators to track the results of the FWC's climate change efforts.

To accomplish its mission, the Oversight Team created five sub-teams to develop ideas from those working on the ground:

- Policies and New Opportunities – focus on grants, legislation, partnerships and strategic planning.
- Research and Monitoring – focus on standardized monitoring protocols and Florida-specific data (including gaps) and predictive modeling.
- Communication and Outreach – focus on the FWC's messages and a climate change communication plan.
- Adaptation – focus on the activities related to unavoidable climate-change impacts on fish and wildlife.
- Operations – focus on positioning the FWC as a leader by reducing the agency's carbon footprint, improving its energy efficiency and decreasing operational costs.

The FWC is positioning itself to efficiently and effectively create ecosystem resiliency amongst unpredictable and possibly devastating environmental degradation. The discussions from the 2008 Summit, Florida's Wildlife: On the front line of climate change, are serving as the foundation for that effort.

Appendix A

Resolution

Resolution

The Board of the Florida Fish and Wildlife Conservation Commission hereby declares on this 12th day of September in the year 2007:

WHEREAS, the Florida Fish and Wildlife Conservation Commission is a constitutionally created governmental agency dedicated to the cause of fish and wildlife conservation for the benefit of Florida residents and visitors, and

WHEREAS, a growing body of science indicates there has been a global rise in temperatures over the past half-century, and

WHEREAS, human activities are at least partially responsible for global climate change, and

WHEREAS, global climate change can affect Florida's fish and wildlife and their habitats, and

WHEREAS, global climate change creates an intensified hydrological cycle, resulting in an increase in extreme precipitation, flooding and droughts, and

WHEREAS, global climate change can disrupt Florida's unique natural systems and affect unique species of the fish and wildlife that depend on these systems, and

Florida Fish and Wildlife Conservation Commission

WHEREAS, global climate change can cause ocean temperatures and levels to rise thereby altering coastal wetlands, estuaries and barrier islands, and increasing saltwater intrusion, and

WHEREAS, the mostly subtropical non-native invasive plants and animals in Florida will spread unchecked by warming trends, hurricanes, and hydrologic changes, and

WHEREAS, the State of Florida includes 53,927 square miles of land, 10,550 miles of rivers and streams, over 7,700 lakes, reservoirs and ponds, 663 miles of beaches, 2,276 statute miles of tidal shoreline, and more coastline than any other state, except Alaska, and

WHEREAS, owing to its geographic location, subtropical to temperate flora and fauna, peninsular configuration and low topography, Florida and its fish, wildlife and ecosystems are likely to be more affected than other states to changing sea levels, climatic extremes, and warming trends, and

WHEREAS, Florida's fish and wildlife resources and boating generate over $30 billion in economic impact and over 338,000 jobs for Florida's economy, and

WHEREAS, all Floridians depend on healthy fish, wildlife and ecosystems, which are of critical economic importance to the State of Florida,

NOW THEREFORE, be it resolved by the Florida Fish and Wildlife Conservation Commission in a duly constituted and assembled meeting:

1. That we do hereby express our deep concern as to the potential effects of ongoing global climate change on the fish and wildlife resources of the State of Florida.

2. That we hereby encourage and support science and management that will effectively assess the future effects of global climate change on Florida's fish, wildlife and ecosystems.

3. That we hereby direct the staff of the Commission to engage with other experts from government, academia, industry and conservation organizations to develop recommendations for conserving fish and wildlife in the face of global climate change.

4. That we support state, federal and international programs that will reduce or abate human-induced causes of global climate change.

5. That we do hereby record the sentiments of this resolution forevermore in the minutes and records of the Florida Fish and Wildlife Conservation Commission.

DONE AND RESOLVED at St. Petersburg, Florida this 12th day of September, 2007.

Chairman Rodney Barreto | *Commissioner Ronald M. Bergeron*

Commissioner Kenneth W. Wright | *Commissioner Kathy Barco*

Commissioner Richard A. "Dick" Corbett | *Commissioner Brian S. Yablonski*

Commissioner Dwight Stephenson | *Attest:*

Appendix B – The Summit's Agenda and Participants

PowerPoint presentations for each of the presenters and workshops are available at *www.ces.fau.edu/floc/agenda.php.*

Wednesday, October 1

Welcome

Chuck Collins, Regional Director, FWC and Summit Facilitator

Nick Wiley, Assistant Executive Director, FWC

Kenneth Wright, Commissioner, FWC

Keynote Speakers

Climate change impacts climate science and reports from Intergovernmental Panel on Climate Change (IPCC) – Virginia Burkett, Senior Climate Change Scientist, Global Change Research, USGS

Florida, current and anticipated changes and uncertainties – Thomas Crisman, Patel Professor of Environment, Patel Center for Global Solutions at University of South Florida

Florida's wildlife and their changing community – Thomas Eason, deputy director, Division of Habitat and Species Conservation, FWC

Biodiversity: Species on the front line

Characteristics of terrestrial climate sensitive species (necessity of adaptive land corridors – Reed Noss, Davis-Shine Professor of Conservation Biology, University of Central Florida.

Managing terrestrial exotic species – Scott Hardin, Exotic Species coordinator, Division of Habitat and Species Conservation, FWC; Greg Jubinsky, program manager, Invasive Plant Management, Division of Habitat and Species Conservation, FWC

Future of agriculture: Conflicts and opportunities – Keith Ingram, coordinator, Southeast Climate Consortium and Scientist, UF/IFAS, Agricultural and Biological Engineering

Ocean effects – Hal Wanless, professor/chair of Department of Geological Sciences, University of Miami

Charactertistics of marine climate sensitive species (marine, coral reefs and fish habitat) – Robert van Woesik, professor, Department of Biological Sciences, Florida Institute of Technology

Moderator: Len Berry, director, Center for Environmental Studies at Florida Atlantic University

Policies and Communication

Panel discussion on policy issues related to habitat and species management, human needs, hunting, fishing, boating and outdoor recreation; linking climate change initiatives with the conservation community; congressional climate change and cap and trade legislation; communication issues: increase awareness of climate change impacts and our capacity to respond, including education and outreach (intra-agency, inter-agency, general public).

Panelists: Tim Breault, director, Division of Habitat and Species Conservation, FWC; John Cooper, senior advisor to the Bipartisan Policy Center; John Kostyack, executive director, Wildlife Conservation and Global Warming, National Wildlife Federation; Margo Stahl, refuge manager, Hobe Sound National Wildlife Refuge; Dan Walker, assistant director for environment, White House Office of Science and Technology Policy.
Moderator: Stacy Small, conservation scientist, Environmental Defense Fund

Thursday, October 2

Keynote Speaker

Wildlife Response to Climate Change and the Management Challenge to Help Species Adapt – Dr. Jean Brennan, Defenders of Wildlife, senior climate change scientist and recognized member recipient of the 2007 Nobel Peace Prize Award to the IPCC.

Six Concurrent Workshops with FWC Leaders

Friday, October 3

Reports on Workshops from the Florida Fish and Wildlife Conservation Commission

FWC's Directive for Florida's Wildlife – Tim Breault, director, Division of Habitat and Species Conservation

The Summit's Participants

Aaron Adams, Mote Marine Lab

Nicole Adimey, U.S. Fish and Wildlife Service

Doug Alderson, Florida Department of Environmental Protection

Christy Alligood, Disney's Animal Kingdom

Paul Anderson, Florida Aquarium

David Anderson, Audubon of Florida

Kelley Anderson, College of Marine Science, University of South Florida

Gary Anderson, Carribbean Conservation Corporation

Karen Bareford, Florida Department of Environmental Protection

Jennifer Barnes, South Florida Water Management District

Mary Barnwell, Southwest Florida Water Management District

Len Berry, Florida Center for Environmental Studies

Ronnie Best, U.S. Geological Survey

Holly Binns, Pew Environment Group

Daniel Bourg, Wildlife Foundation of Florida

Jean Brennan, Defenders of Wildlife

Tammy Brister, Walt Disney World

Virginia Burkett, U.S. Geological Survey

Rayburn Butts, Florida Power & Light

Kalani Cairns, U.S. Fish and Wildlife Service

Sarah Chasis, Natural Resources Defense Council

Ron Clark, National Park Service

Alice Clarke, Everglades National Park

Danny Coenen, University of Florida

Christy Coghlan, South Florida Water Management District

John Cooper, Bipartisan Policy Center and Wildlife Management Institute

F.G. Courtney, National Wildlife Federation

Veronica Craw, Southwest Florida Water Management District

Thomas Crisman, Patel Center for Global Solutions - University of South Florida

Duane De Freese, University of Central Florida

Joel DeAngelis, Southwest Florida Water Management District

Debbie DeVore, U.S. Fish and Wildlife Service

Craig Diamond, Department of Community Affairs

Doreen DiCarlo, Florida Center for Environmental Studies

Terrence Dolan, Lykes Land Investments, Inc.

Thomas Dreschel, South Florida Water Management District

Pete Dunkelberg, Florida Citizens for Science

Kellyn Eberhardt, Environmental Defense Fund

Mary Echols, Palm Beach County Health Department

Serena Edic, Florida Center for Environmental Studies

Nina Fascione, Defenders of Wildlife

Rory Feeney, Miccosukee Tribe of Indians

Elizabeth Fleming, Defenders of Wildlife

Manley Fuller, Florida Wildlife Federation

Holly Gaboriault, U.S. Fish and Wildlife Service

John Galvez, U.S. Fish and Wildlife Service

Kim Garcia, St. Johns River Water Management District

Laura Gemery, U.S. Geological Survey

Laura Geselbracht, The Nature Conservancy

Wendy Gierhart, U.S. Fish and Wildlife Service

Jodie Gless, Florida Power & Light

Patty Glick, National Wildlife Federation

Gunda Griffin, St. Johns River Water Management District

Tonya Guadalupe, St. Johns River Water Management District

Christine Haddock, WilsonMiller

Layne Hamilton, U.S. Fish and Wildlife Service

Dennis Hanisak, Harbor Branch Oceanographic Institute

Dave Hanka, U.S. Fish and Wildlife Service

Catherine Harrelson, Trust Source INC

Terra Hernandez, Florida Power & Light

Alison Higgins, The Nature Conservancy

Ron Hight, Merritt Island National Wildlife Refuge

Maran Hilgendorf, Charlotte Harbor National Estuary Program

Thomas Hoctor, University of Florida - GeoPlan Center

Todd Hopkins, U.S. Fish and Wildlife Service

Craig Huegel, Biological Research Associates

Keith Ingram, Southeast Climate Consortium/UF-IFAS

Dawn Jennings, U.S. Fish and Wildlife Service

Pete Jerome, U.S. Fish and Wildlife Service

MacKay Jimeson, WRScompass

Rosalyn Johnson, University of Florida

Paul Johnson, REEF RELIEF

Jo Ann Jolley, Florida Center for Environmental Studies

Austin Kane, National Wildlife Federation

John Kasbohm, U.S. Fish and Wildlife Service

Brian Keller, NOAA

Patricia Kiesylis, Defenders of Wildlife

Dan Kimball, Everglades National Park

Captain Dan Kipnis, Florida Wildlife Federation

George Kish, U.S. Geological Survey

Gary Knight, Florida Natural Areas Inventory

Kelly Knight, Eglin AFB Natural Resources

Vickie Larson, Ecospatial Analysts, Inc.

Tom Lee, University of Miami

Jay Liles, Florida Wildlife Federation

Ralph Lloyd, Merritt Island National Wildlife Refuge

Chris Lockhart, Habitat Specialists, Inc.

Laurie Macdonald, Defenders of Wildlife

T. J. Marshall, Florida Coastal & Ocean Coalition

Joyce Mazourek, J.N. "Ding" Darling National Wildlife Refuge

Catherine McCall, Maryland Department of Natural Resources

Eric Michel, Mosaic

Darla Miller, MSCW

Anne Morkill, Florida Keys National Wildlife Refuge

Julie Morris, Wildlands Conservation

Mark Morton, Lykes Land Investments, Inc.

Jim Muller, Muller and Associates, Inc.

Sue Mullins, Vanguard Partnership

Joe Murphy, Gulf Restoration Network

Reed Noss, University of Central Florida

Tim O'Neil, Wildlife Foundation of Florida

Jon Oetting, Florida Natural Areas Inventory

Michelle Owen, Environmental Defense Fund

Randall (Randy) Parkinson, RWParkinson Consulting, Inc.

Ann Paul, Audubon of Florida

Leonard Pearlstine, Everglades National Park

Dan Pennington, 1000 Friends of Florida

Forrest Penny, GTM Research Reserve

Larry Perez, Everglades National Park

Winifred Perkins, Florida Power & Light

Barbara Jean Powell, Everglades Coordinating Council

Nanciann Regalado, U.S. Army Corps of Engineers

Joe Reinman, U.S. Fish and Wildlife Service

Carol Rizkalla, Disney's Animal Kingdom

Keith Rizzardi, South Florida Water Management District

Mark Rizzo, Orange County Environmental Protection Division

Andrew Roberts, Allstate Resource Management, Inc.

Stephanie Romanach, U.S. Geological Survey

Barry Rosen, USGS, Florida Integrated Science Center

Perran Ross, University of Florida

Cindy Schulz, U.S. Fish and Wildlife Service

Florence Sergile, University of Florida

Jamie Serino, Shaw Environmental & Infrastructure

Vicki Sharpe, Florida Department of Transportation

Will Sheftall, University of Florida Extension

Tom Sinclair, U.S. Fish and Wildlife Service

Stacy Small, Environmental Defense Fund

Elizabeth Souheaver, U.S. Fish and Wildlife Service

Margo Stahl, U.S. Fish and Wildlife Service

Matthew Stamatoff, Executive Office of the Governor

Andy Stamper, Walt Disney World Animal Programs

Marilyn Stoll, U.S. Fish and Wildlife Service

Tina Sullivan, The Nature Conservancy

Dave Sumpter, Wildlands Conservation

Hilary Swain, Archbold Biological Station

Kate Theoharides, Defenders of Wildlife

Stephen Tonjes, Florida Department of Transportation

Steve Traxler, U.S. Fish and Wildlife Service

Katie Tripp, Save the Manatee Club

Paul Tritaik, J.N. "Ding" Darling National Wildlife Refuge

Panagiati Tsolkas, Palm Beach County Environmental Coalition

Oliver van den Ende, Dynamac

Robert van Woesik, Florida Institute of Technology

Ann Vanek-Dasovich, White House Office of Science and Technology Policy

Harold Wanless, University of Miami

Ron Warnken, National Wildlife Federation

Margaret Wilson, U.S. Fish and Wildlife Service

Trudy Wilson, John Pennekamp Coral Reef State Park

Wayne C. Zahn, Lykes Bros, Inc.

Georgia Zern, Volusia County Environmental Management

Dorothy Zimmerman, Florida Sea Grant College Program

FWC participants

James Antista
David Arnold
Patricia Behnke
Joe Benedict
Brian Branciforte
Tim Breault
Chuck Collins
Richard Corbett, *FWC Commissioner*
Don Coyner
Kat Diersen
Tim Donovan
Terry Doonan
Thomas Eason
Diane Eggeman
Mark Endries
Gabriella Ferraro
Ann Forstchen
Sarah Franklin
Kipp Frohlich
Grant Gaughf
Chris Gudeman
Kate Haley
Scott Hardin
Greg Holder
Bill Hunter
Julie Jones
Greg Jubinsky
Carol Knox
Jan Landsberg
Janet Ley
Jerrie Lindsey
Anna Liner
Sharon Lobello
Jessica McCawley
Gil McRae
Tom Ostertag
Doug Parsons
Mary Ann Poole
Ron Mezich
Timothy O'Meara
Kelly Rezac
Lisa Robertson
Mark Robson
Stephanie Rousso
Nuria Sancho
Scott Sanders
Don Schmitz
James Schuette
Darrell Scovell
Carla Shaw Monroe
Lora Silvanima
Kent Smith
Dwight Stephenson, *FWC Commissioner*
Beth Stys
Robbin Trindell
Melissa Tucker
Jennifer Wheaton
Kenneth Wright, *FWC Commissioner*
Brian Yablonski, *FWC Commissioner*

Appendix C - Poster Abstracts

The following are poster abstracts displayed by several organizations during the Summit, which highlighted some very specific potential impacts of climate change in Florida and the Southeastern United States.

"Use of Supplemental Nest Structures by Key Largo Woodrats"

Christina Alligood, Disney's Animal Kingdom

The data gathered from this study support the contention that supplemental nest structures are readily used by the Key Largo woodrat population in the Crocodile Lake National Wildlife Refuge. This type of structure may become an increasingly important management tool as climate change impacts ecosystem health in the Florida Keys.

"Ocean Acidification, Bioindicators and Florida Reefs"

Kelly Anderson, University of South Florida

Ocean acidification is an emerging climate change concern. Florida's economic reliance on tourism and fishing should make acidification a high research priority. The Reef Indicators Lab at the University of South Florida is collaborating with researchers and managers in the Environmental Protection Agency, NOAA, the U.S. Geological Survey and other agencies to further develop promising tools for long-term monitoring.

"Utilizing LIDAR to Model Sea Level Rise Effects in the Florida Keys"

Alison Higgins, The Nature Conservancy

Light Detection and Ranging (LIDAR) is a technological system used to obtain very accurate elevation maps of an area. The Florida Keys are home to 24 federally endangered and more than 100 state-listed plant and animal species. Technological tools, such as LIDAR, that provide precise elevational ranges, can help land managers prioritize their efforts for habitat management and acquisition. LIDAR is beneficial because of its speed and precision of measurements.

"A Plant Phenology Network for the Southeastern United States"

George R. Kish, U.S. Geological Survey

Plant phenology is increasingly recognized as a vital approach for understanding how ecosystems respond to climatic changes. The USA National Phenology Network has been established to integrate phenological event observations on a national level with remotely sensed weather vegetation data.

"Modeling Landscape Habitat Shifts from Climate Change in Everglades National Park"

Leonard Pearlstine, National Park Service, Everglades National Park

Both Everglades restoration and sea-level rise may cause substantial spatial changes in habitat availability and location in Everglades National Park. This study is one part of developing a climate change program to provide spatial decision-support assessment tools for the landscape-scale assemblages of habitats needed to support Everglades National Park fish and wildlife resources.

"Wildlife Habitat Planning Strategies, Design Features and Best Management Practices for Florida Communities and Landowners"

Dan Pennington, 1000 Friends of Florida

1000 Friends of Florida developed a document addressing wildlife-habitat-planning strategies, design features and best management practices for Florida communities and landowners.

"A Tale of Two Seawalls: A Case Study of the Impact of Coastal Armoring on Loggerhead Sea Turtle Nesting"

Carol E. Rizkalla and Anne Savage, Disney's Animal Kingdom

The data from this study suggests that regardless of the width of beach in front of seawalls, sea turtles deposit fewer nests in front of seawalls than unarmoured beach. With the high incidence of storms that occur each year in Florida, seawalls continue to negatively impact the survival of sea turtles and pose a threat to their long-term survival.

"Role of Climate in Predicting Invasion Dynamics of Two Exotic Invaders in a North Florida Forest Ecosystem"

Nitesh Tripathi, University of Florida

Florida has become the national epicenter of alien plant introductions, and climate plays an important role in the introduction and spread patterns of invasive species. The model developed through this study can be calibrated and used for the entire state or elsewhere in the Southeastern United States and can serve as a tool to predict invasion patterns of other invasive plants as affected by climate of the region.

"Global Climate Change and Its Effects on Large Carnivore Habitat in Florida"

Andrew Whittle, University of Kentucky Department of Forestry

Florida is an example of the potential negative impacts of climate change on biodiversity. This study applied several prominent climate change models to the habitats of Florida black bear and Florida panther. Cost-surface analyses identified likely migration routes that would link South Florida bear and panther populations to suitable habitat to the north.

Wiregrass Savanna (Apalachicola National Forest) – *Philip Juras (*philipjuras.com)

The printed version of this report was generously funded by the following organizations:

Defenders of Wildlife
(www.defenders.org)

National Wildlife Federation
(www.nwf.org)