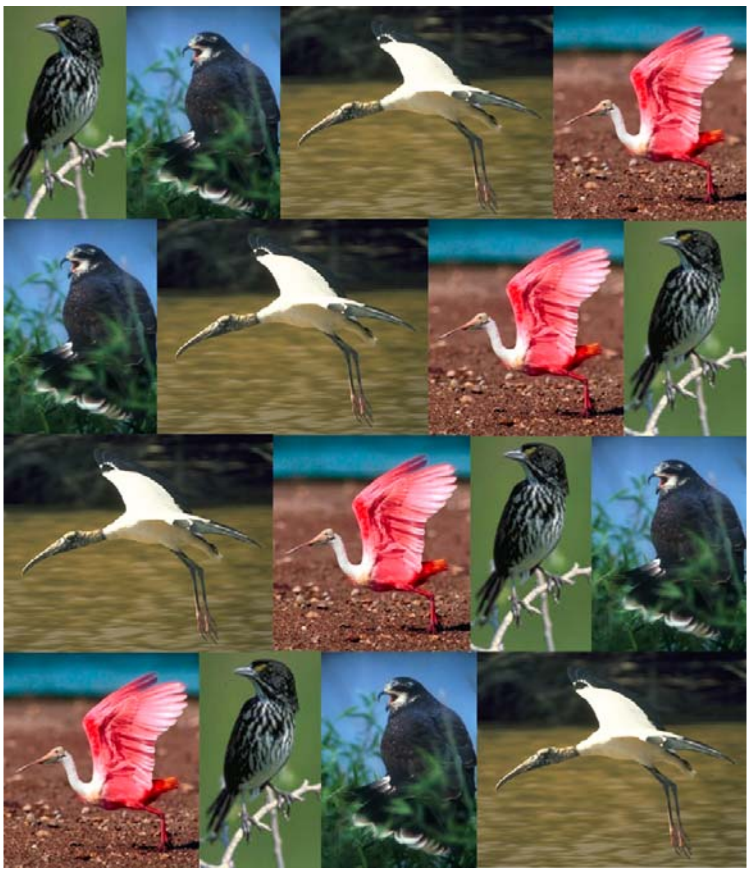
Sustainable Ecosystems Institute

Everglades Multi-Species Avian Ecology And Restoration Review

Summary of Findings and Recommendations



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Everglades Multi-Species Avian Ecology And Restoration Review Final Report, November 2007

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NOTE: Copies of the scientific presentations, digital voice recordings and forum summary are available from SEI. A DVD copy of the webcast is available through South Florida Ecosystem Restoration Task Force.

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INTRODUCTION

In August 2007, Sustainable Ecosystems Institute (SEI) convened an avian/ecosystem review group to address the ecology and management of federally listed endangered Cape Sable Seaside Sparrow, Everglades Snail Kite, and Wood Stork, and the state listed Roseate Spoonbill, particularly in relation to Everglades restoration. The effort was in response to a request from US Fish and Wildlife Service (USFWS) and sanctioned by the South Florida Ecosystem Restoration Task Force. This independent scientific review built on a previous Avian Ecology Workshop, held in March 2003 (SEI 2003).

On August 13-15th, 2007 in Marc Building Pavilion at Florida International University SEI assembled the panel of experts, scientists whose work has contributed to our knowledge of the species and system, decision-makers and other interested stakeholders. The format was based on the SEI process, an open and transparent science review method pioneered by SEI in order to help managers use the best science available in order to make critical decisions for species their habitats and entire ecosystems. Details can be found on the SEI website or by contacting SEI.

The overall goal of the workshop was to review new information gathered on the four species of concern and to provide scientific clarity that would allow managers to move forward with restoration. Additionally, the USFWS submitted specific questions relating to the science and management of the species (Questions provided in full report). Prior to the workshop, SEI contacted stakeholders to identify key information gaps and to gain insight on relevant issues involving these species and restoration. Copies of the scientific presentations, digital voice recordings and forum summary are available from SEI. A DVD copy of the webcast is available through South Florida Ecosystem Restoration Task Force.

This document is the summary of findings and conclusions of the panel. The full report is available separately from SEI.

CONCLUSIONS AND RECOMMENDATIONS

OVERALL CONCLUSIONS

There has been an impressive series of studies and new information produced since the last SEI multi-species workshop. This knowledge has enhanced our understanding of the species and ecosystem. Results from these studies suggest new ways for managing species through transition and help to indicate priorities for future research and management. These are discussed in detail in the summary below and in the specific sections of the full report.

The panel recognizes that some controversy persists over the importance of water flow versus water levels in shaping the Everglades. However, the material we examined presents a compelling argument for water flow being absolutely central to restoring the defining characteristics of the Everglades. Every effort should be made to move forward both Modified Water Deliveries to Everglades National Park (ModWaters) and Water Conservation Area 3 Decomparmentalization and Sheet Flow Enhancement (Decomp).

An overarching conclusion of the panel is that the Status Quo is not an option if the goal is to restore the ecosystem and prevent the extinction of critically endangered species. Incomplete implementation of emergency measures and failure to complete more major plans in a timely way increases the risks to endangered species. Moreover it makes it more difficult and more expensive to recover them.

This forum focused on four species of concern, and most of the recommendations for specific actions address these species individually and within a multi-species approach. However many of the needs identified and recommendations proposed here are relevant to overall Everglades restoration. For instance the need for a conceptual multi-species approach, a stronger and more appropriate science framework, and attention to consequences of climate change will help solve issues beyond those of the four species of concern.

CAPE SABLE SEASIDE SPARROW

An impressive amount of new information on the Cape Sable Seaside Sparrow has been developed since the last SEI workshop. This has provided the panel with a broader and deeper understanding of the species. Several new conclusions have emerged which have implications for management.

<u>Current Situation and Population Trends</u>

Since the declines of the mid-1990s the population as a whole has been stable. But trends are not uniform across geographic areas. Subpopulation A has continued to decline, despite emergency measures to sustain it, and is currently less than 5% of its size in 1981/1992. Subpopulations B and E, the two remaining large populations, have been stable with an estimated 2500-3000 sparrows constituting 80-90% of the total population. Subpopulation C remains small but is the only one that has increased since the mid 1990s. Subpopulations D and F are the smallest and arguably on the verge of extirpation (since 2000, only 1-3 singing males have been detected).

The panel concludes that under current conditions the Cape Sable Seaside Sparrow population is sufficiently small and its range is sufficiently restricted that it is vulnerable to environmental stochasticity (which can lead to extirpation). Moreover the likelihood of the population increasing under current conditions seems remote.

<u>Water Management, Emergency Measures, and Progress towards CERP</u>

The 2003 SEI panel concluded that implementation of Comprehensive Everglades Restoration Plan (CERP) will benefit the sparrow. This conclusion has not changed. However the fundamental problem is not simply whether CERP will benefit the species but rather whether CERP will be implemented properly and in time to ensure the survival of the species. Ongoing failure to carry out measures fully and in a timely way (identified by scientists in several studies and previous panels) has not been resolved. In some cases, short term management has become long term management because no progress has been made in restoring flows to historic patterns in areas occupied by endangered species. Delays in restoring historic flow patterns continue to increase the risk to the sparrow as well as to other species.

Perhaps the most startling information presented to this panel was that emergency management (i.e. Interim Structural and Operational Plan (ISOP)/ Interim Operational Plan (IOP)) designed to alleviate the pressure on sparrows have not produced desired hydrologic conditions. It is notable that where management goals have been met (e.g. (NP205)) the population has responded positively. But elsewhere water levels have been detrimental to the population. Numbers have continued to decline especially in areas of unanticipated flows.

In the workshop, participants expressed concern about the effect of CERP on sparrow habitat based on new runs of the Natural System Model (NSM) which indicate wetter conditions in western Shark River Slough than did previous runs. The model coupled with empirical data suggest that at least some of the marl prairie occupied by subpopulation A will be converted (or revert back) to wetter habitat with the implementation of CERP. To address this situation, managers could adjust objectives and provide favorable conditions for sparrows rather than matching NSM output. But if it were the case that maintaining sparrow habitat compromised the restoration of the ecosystem (especially the ability to move water south to Everglades National Park and Florida Bay) this would be a legitimate reason to put some sparrow subpopulations at risk. That risk could be mitigated against, for instance by creation of new habitat and other interventions for the sparrow (see below).

One suggested option is to cease emergency management measures and once again allow regulatory releases of water through the S-12 structures during the sparrow's nesting season. The panel concludes that this action is likely to result in extirpation of subpopulation A and is unlikely to benefit or otherwise impact the other subpopulations. However, because of the interconnected structure of the subpopulations (see below) there may be unintended consequences for the other subpopulations.

<u>Population Structure</u>

Perhaps one of the more significant conclusions of the panel is that the model of population structure currently used to manage the sparrow is invalid. A fundamental change in the way that the Cape Sable Seaside Sparrow population structure is treated is appropriate.

The current model considers the populations more like a separate entity, but the panel concludes that the structure is probably best described as a connected set of subpopulations, in which the degree of connection is not yet fully known. Data, especially those collected since the 2003 workshop, indicate that populations are well connected, particularly those to the east of the Shark River Slough. There is likely to be sufficient movement that subpopulations can be “rescued” from extinction by dispersal from other subpopulations, as long as subpopulations are large enough to produce dispersers.

Several important conclusions and implications that follow from this important and new insight:

- The Cape Sable Seaside Sparrow has considerable capacity to colonize unoccupied suitable habitat.
- The Cape Sable Seaside Sparrow may be inherently more resilient than was previous suspected. Resilience will continue to decline, however, as population size and range size decline.
- Maintenance and creation of suitable habitat is more important than was previously recognized.
- Maintaining conditions that allow for population growth remains essential but an emphasis on birds only in areas where they currently occur is not the only option available and other options should be considered.
- The historic management approach of ensuring the maintenance of three distinct populations is invalid. *From a conservation biology standpoint, while data on movement indicate that the subpopulations are connected, there are increased risks to the species from having one interconnected set of subpopulations (e.g. environmental stochasticity) and thus additional populations, locations, and habitats are recommended (see below).*

Threats to the Species

Flooding and fire have long been recognized as among the main threats to the survival of the Cape Sable Seaside Sparrow. However, recent studies indicate that nest predation, particularly by rice rats and fish crows, may limit productivity. Nest predation rates increase when conditions are too dry or too wet, and thus it may be possible to improve nest success indirectly through water management, as well as directly through predator control. Work on other species suggests that mercury in the environment can affect nesting and mating behaviors at sub-lethal doses. Hurricanes have had major impacts in the past, and may again in the future. Climate change and accompanying sea level rise presents a new suite of challenges for managers (see below).

Habitat loss and habitat availability are key factors limiting the ability of the Cape Sable Seaside Sparrow to rebound. For instance, habitat change is clearly a factor in the decline of subpopulation A, although other factors may also be at play in this area. Habitat in subpopulation D remains largely unsuitable for sparrows. The Allee effect (whereby performance of individual sparrows declines below some population threshold, thereby hastening the trajectory towards extinction) may be a factor for the Cape Sable Seaside Sparrow.

New data necessitate a revised view of the impact of fire on Cape Sable Seaside Sparrow habitat. The data indicate that habitat quality as evidenced by sparrow density, survival, and reproduction is immediately reduced after fire and remains low for two or three years before returning to levels indistinguishable from unburned areas. There is no indication that unburned habitat becomes unsuitable over time due to plant succession in areas that have been monitored for more than a decade, but it may be the case that over longer time spans fire is necessary to maintain marl prairie habitat. Prescribed fire might be used to improve habitat conditions for the sparrows in subpopulations A and D by promoting conversion of marsh back to wet prairie.

Research and Science-Based Management Recommendations

Since the last workshop several promising areas of research have emerged, and additionally there remain areas of uncertainty. Some of the general research areas that would benefit management are as follows:

- A more detailed understanding of the causes of population declines and nest loss, including more information on the role of predation and environmental characterization of potentially important constituents such as mercury.
- The causes of the poor performance of subpopulation A are uncertain. Several alternatives have been proposed and disentangling them would help to identify specific actions that could be taken to mitigate against future declines. Moreover, it is important to recognize that it might be too late to determine why subpopulation A has not recovered from the population crash of the mid-1990s. This recognition should prompt preemptive research planning to test alternative explanations should other subpopulations begin to decline.
- The extent to which unoccupied but suitable sparrow habitat exists is unknown and should be investigated. It is also important to attempt to predict where new suitable habitat might arise as CERP is implemented, particularly west of Shark River Slough.
- Additional information on colonization of unoccupied habitat is warranted. This includes studies on movement and connectivity between subpopulations.
- The role of prescribed fire to improve habitat conditions in subpopulations A and D should be explored.
- An investigation into whether sparrow numbers are currently limited by habitat or productivity and whether the answer varies among different subpopulations and areas.

Specific Management and Science-Management Recommendations

A clear message from the panel is to implement restoration fully and in a timely way.

Evaluate management and recovery options for the species under the new population structure model proposed here. This includes developing an understanding of the amount and distribution of suitable habitat and the development of options that increase the number and distribution of sparrow subpopulations (e.g. by translocation or habitat creation).

Recommendations by Topic

Water and Fire Management

- Continue ISOP for foreseeable future, until principal water flows to northeastern Shark River Slough can be re-established.
- Determine reasons for increased flows to western portions of subpopulation A under ISOP and adjust accordingly.
- Complete C-111 and "leaky reservoir project" as soon as practicable and monitor associated effects on water flows and vegetation.
- Improve modeling tools by downscaling insights such as those gained from the more regional models to scales important to the Cape Sable Seaside Sparrow.
- Examine less costly alternatives to secure principal flows to northeastern Shark River Slough and explore means to preserve subpopulation A without sacrificing ecosystem restoration objectives using Incremental Adaptive Restoration (IAR) process suggested by National Research Council (2006).
- Continue long-term studies on vegetation changes in marl prairies as a result of the interactions among hydrological conditions, fire, periphyton and soil (marl or peat) formation.
- Determine if fire is needed to convert marsh to wet prairie habitat in marl prairies.
- Continue to monitor amount and distribution of sparrow habitat using remote sensing, aerial photographs, and ground plots.
- Manage water flows during the transition to CERP to prevent conversion of existing marl prairies to marsh and promote sparrow survival and reproduction, and support research to understand how and where additional marl prairie might be restored as projects within CERP come on line and further modify water flows.
- In order to maximize the likelihood that CERP will result in a spatially and temporally dynamic mosaic of communities that support sparrows, additional paleo-ecological studies need to be undertaken over a greater area.

Annual Censuses

- Continue annual helicopter surveys and ongoing studies to improve population estimates in low density situations.
- Continue to assess population and subpopulation trends based on presence/absence criteria.
- Determine detection probabilities in both high and low density circumstances.
- Refine multipliers used to estimate population size by extrapolation, to estimate uncertainty and account for variation among areas with different numbers of birds.
- Develop ground survey methods appropriate for surveying sparrows in low density situations.

Demography and Movement

- Collect basic demographic information with respect to habitat within all subpopulations on an annual basis.
- Capture and band juveniles and adults within established study plots in all subpopulations on a routine basis.
- Determine sex of banded birds via DNA from blood or feathers collected at time of banding.
- Conduct regular surveys for marked individuals outside of study plots to improve estimates of movement and survival.

Nest Predation

- Determine causes of increased nest loss associated with dry conditions and short-term increases in water levels.
- Increase nest monitoring to determine array of nest predators.
- Determine *Oryzomys* densities and movements in and around sparrow nesting habitat.
- Conduct studies of the potential for improving sparrow nest success using predator barriers.

Conspecific Attraction

- Conduct experiments to determine if sparrows can be attracted to suitable but unoccupied habitat using decoys and playbacks.
- Determine if sparrows adjust their territories or space use in response to playback and/or decoys.

Translocation

- Conduct experimental translocations of wild sparrows into suitable habitat to sustain distributions within Everglades National Park and test translocation protocols.

SNAIL KITE

Snail Kites (*Rostrhamus sociabilis*) are found in southern Florida, Cuba and Central and South America. However the subspecies in the USA (*Rostrhamus sociabilis plumbeus*) occurs only in southern Florida where it inhabits freshwater prairie and slough habitats of the Everglades, Lake Okeechobee, Kissimmee Chain of Lakes and other freshwater bodies.

Current Situation

Snail Kites use the network of heterogeneous wetland units located in central and southern Florida, which often serve as refugia during times of drought. Their dispersal probabilities are higher when prey are more plentiful and are not related to water levels as was once assumed. Recent studies suggest that bird movements are strongly influenced by habitat fragmentation, with kites moving extensively among contiguous wetlands but less so among isolated wetlands. Thus fragmentation can reduce dispersal which could be detrimental to the population during times of low water and/or times of poor food availability.

The Florida Snail Kite has declined significantly in recent years. A number of factors are believed to be responsible including elimination of Lake Okeechobee as a major breeding site, a region-wide drought in 2000-2001, and intensive drawdown in the Upper Kissimmee Chain of Lakes in the aftermath of the drought. Survival rates of juveniles are down, and nesting performance has been reduced. Declining recruitment has also become a major concern, particularly lack of recruitment of young into breeding populations. This may be the limiting factor for population growth and recovery of the species.

Conclusions and Recommendations

These conclusions and recommendations are divided into three main sections: general conclusions; Snail Kite nesting and foraging habitat; and Apple Snails. Responses to specific queries from the Task Force/USFWS are provided at the end of the full report (see appendix).

General Conclusions

Snail Kite populations have clearly been affected by recent climatic and human impacts. These have resulted in changes in the vital rates of birds. However, the panel feels that the magnitude of their population decline may not be as great as reported.

More research is needed to resolve the discrepancy between the high adult survival rates (nearly 90%) and the reported precipitous decline in population numbers. Despite low production of young, it is not clear how there can be such a significant decline when adult survival is so high.

Previous radio tracking provided valuable insights; however, intensive efforts to monitor the movement patterns of adult kites using telemetry data have inexplicably been discontinued. These types of data are needed for managing the species through transition to CERP and beyond.

Recommendation

- Initiate intensive radio-telemetry research to document the movement patterns of adult Snail Kites under current environmental conditions. The primary goal should be to document relevant vital rates of the population and examine the veracity of recent estimates of population decline.

Nesting and Foraging Habitat

The required habitats for Snail Kites in Florida have been well documented. Birds typically nest over open water where depth is greater than 20 cm deep. They select areas to increase their proximity to their prey (Apple Snails) and to minimize exposure to predators.

Water Conservation Area 3A has consistently been the area to produce the largest proportion of Snail Kite offspring since the mid 1990s. This is in part because of water management in the Everglades. However, higher water levels in Water Conservation Area 3A now appear to be adversely affecting the bird.

Recommendation

- Water Conservation Area 3A is currently important to the persistence of Snail Kites in the Everglades. The panel feels that management should be adapted to account for the nesting and foraging requirement for the species. Water management should maintain lower water levels during the fall/winter months (Sept-Dec) to mitigate effects of longer hydroperiod and deeper water on vegetation, and should maintain higher water levels during the spring/summer (March-July) to provide for better conditions during the Snail Kite breeding season. These requirements should be formally entered into the Army Corps of Engineers (USACE) Systemwide Operations Manual due for revision in 2010.

Apple Snails

Apple Snails (*Pomacea paludosa*) are the nearly exclusive prey of the Snail Kite. In the past decade significant advances have been made in our ability to sample snail populations. Snails are more abundant in wet prairies than in open sloughs. Contrary to previous understanding, Apple Snails are adapted to and can survive periodic dry downs, but timing is critical. Drying every 2-3 years for 1-2 months will not adversely affect snail populations - a critical finding, given our current understanding that periodic dry downs are needed to maintain wet prairie habitats important to both Snail Kites and Apple Snails. Conversely, high water during the Apple Snail breeding season delays egg production, which can result in their destruction during summer rainy season.

The panel concludes that:

- High water levels are detrimental to Apple Snail reproduction as are extended dry down events.
- Continued flooding of WCA 3A followed by extreme dry downs will further reduce Apple Snail populations and increase stress on the Snail Kite.
- It is unknown whether or how the larger Apple Snail (*Pomacea insularum*), a recent non-native invader, will impact the Snail Kite. It has been suggested that young Snail Kites have difficulty handling the larger snail. This situation needs to be monitored.

Recommendations

- It is essential to fully integrate the excellent ongoing studies on the effects of water levels and hydroperiod on vegetation communities, Apple Snails and Snail Kites (see Governance section for more details). Currently these studies are not well connected. This step is key to linking the specific hydrological and ecological conditions needed to restore the native Apple Snails, Snail Kite populations, and their preferred habitats. This integration is needed to provide more effective guidance to managers.
- We suggest developing an integrated suite of recommendations that identifies the range of acceptable water management strategies and expected outcomes, with respect to their short term and long term effects on the status of the vegetation communities, Apple Snails and Snail Kites, and their interactions.

WOOD STORK

Current Situation

Historically, Wood Storks in the U.S. nested regularly only in south Florida, and shifted northwards at least partially in response to water management in the Everglades. It is generally believed that there were between 5,000 and 10,000 pairs nesting in south Florida in the 1930s. Wood Storks shifted generally north in the Everglades in the 1970s, associated with water management. Between the 1930s and 2001 there was a 61% decline in the proportion of nests in coastal mangroves and a 46% increase in the proportion of nests in the central-northern Everglades. The first recorded nesting by Wood Storks in the Water Conservation Areas occurred in 1989. The current Recovery Plan for Wood Storks calls for three-year running averages of 10,000 nesting pairs in the population as a whole, with 2,500 nesting pairs in Everglades National Park (or Everglades system as a whole) and Big Cypress Preserve combined. Total nests exceeded 9,000 in 2002 and 2003, with 1191 nests in the Everglades system (which includes the Water Conservation Areas). It is worth noting that Wood Stork populations have increased to near recovery goals in the absence of progress on CERP. The reasons for this increase are unknown.

Numbers of nesting pairs fluctuate over nearly three orders of magnitude among years, associated with suitability of hydrological conditions. Nest and chick rearing success are also highly variable, breeding attempts are largely abandoned in years when water levels rise after nests are initiated. In recent years, substantial numbers of juvenile Wood Storks have been tagged with satellite transmitters and results demonstrate the potential for genetic and demographic interchange throughout the breeding range of Wood Storks in the United States. Because few adults were tagged, migration patterns of adults are more poorly understood. No good estimates of adult survival exist.

Dependence of Wood Storks on dry down conditions for successful breeding is well established. Wood Storks are primarily piscivorous, although they eat a variety of organisms found in aquatic habitats. Wood Storks are especially dependent on high concentrations of small fish (2-25 cm long) when feeding chicks, and in the absence of water recession, prey densities and prey capture rates are insufficient to support chick growth and Wood Storks either do not nest or their nests fail.

Wood Storks require trees either on islands or surrounded by water for nesting. The principal requirement seems to be protection from predators. Historically, nesting in south Florida typically began in December-January but since the 1970s most nests have been initiated in February and March or later. Such delayed nesting pushes chick rearing into the wet season, and may have increased frequency of breeding failure in south Florida.

Conclusions and Recommendations

The overall outcome of water management in the Everglades system is that water recession, producing the numerous shallow pools with highly concentrated fish, occurs in fewer years and in fewer areas. By constraining the area that is hydrologically connected, this system has reduced topographic variation. Canals and water removal have reduced natural flows through the system, increasing the frequency of dry conditions. Levees have created artificial impoundments which maintain artificially deep water in other areas for longer periods of time. Water management for flood control and water availability has exacerbated deviations from "natural" hydrological patterns; some areas are too wet, while others are too dry. Reduced flows have also increased saltwater intrusion into coastal mangrove habitats, which affects prey density.

An important paradox in our understanding of Wood Stork population dynamics is the recovery of the south Florida Wood Stork nesting population to near recovery goals during the late 1990s- early 2000s, before implementation of the CERP. It is possible that increased reproductive effort and success during this period merely reflects drought conditions in south Florida during this period, which reduced the frequency of hydrological reversals during the spring breeding period. The longer term need for deeper water to produce prey fish, however, suggests that if recent drought has increased reproductive success, this pattern cannot be counted on as a long term solution for stork management.

Recommendations: Data Needs for Management

Knowledge of the relationship between specific water management practices and favorable hydrological conditions for stork breeding require refinement. Spatial scale of current hydrological modeling efforts may not be adequate to predict timing and location of pools containing concentrated prey necessary for successful breeding.

Additional uncertainty exists about the importance of longer term hydrological patterns. It is important to note that current hydrological models of the Water Conservation Areas do not appear to indicate sufficient water recession in most years to support successful breeding by storks.

An improvement in our understanding of the direct relationship between hydrological conditions and initiation of nests by storks is needed.

There are gaps in our understanding of the demography of Wood Storks. Currently, no reliable estimate of adult survival exists. Temporal-spatial patterns of breeding suggest that individual birds have some flexibility to respond to local breeding conditions, but the extent to which individuals move among breeding locations is unknown. Understanding of such dynamics is key to understanding how storks might respond to specific management actions over the period of a decade or so.

ROSEATE SPOONBILL

Current Situation

The Roseate Spoonbill is one of six species of spoonbills worldwide, and the only species that occurs in the western hemisphere. Breeding colonies in the United States are restricted to coastal and a few inland sites in Louisiana and Texas, and the southern half of peninsular Florida. Breeding sites in Florida historically have encompassed coastal and inland sites from Tampa Bay on the Gulf Coast to Brevard County on the Atlantic coast and south to Florida Bay. Since 1992, Roseate Spoonbills have resumed breeding at several inland sites in the Everglades (e.g., Water Conservation Area 3A). The Roseate Spoonbill is a key indicator species for the restoration of the Florida Bay ecosystem under the CERP, because its reproduction is closely tied to regional patterns of hydrology.

Plume collectors and subsistence hunters caused spoonbill numbers to plummet and the population was believed to number fewer than 200 pairs by the early 1930s. Protection resulted in increases in the population and by 1978-79 numbers had reached 1,254 breeding pairs. Audubon scientists and staff have continued to monitor spoonbill nesting activities and success in Florida Bay since the 1984-85 breeding season. Numbers have generally ranged between 400 and 500 pairs each year (although there are wide fluctuations). No detailed population estimates exist for spoonbills other than the annual nest counts provided by regional ground and aerial surveys. There appears to be a close link between conditions in Florida Bay and the production of young and recruitment within Florida.

In Florida, mainland populations normally breed in the winter through the spring (late February or early March to June), whereas breeding in Florida Bay populations normally occurs in the fall and winter (November-March), albeit the timing in the latter colonies has become more irregular during the past 2-3 decades with human alteration of the natural water flows. Nesting by spoonbills in Florida Bay is timed closely with the seasonally low-water depths that occur during the dry season when abundant prey are concentrated into the remaining pools, creeks, and sloughs. Roseate Spoonbills consume a wide variety of small aquatic animals, including fish, crustaceans, and insects. Gradual and consistent declining water levels throughout the nesting period appear critical for adults to secure and supply the food necessary to raise young. Breeding success is high during seasons with gradual dry downs, and poor during seasons with high or fluctuating water levels.

Spoonbills nesting in Florida Bay seem to use about 11 major foraging locations within the coastal wetlands at any one time. It was previously believed that these birds left the Everglades in non-breeding periods. However, recent results using satellite telemetry suggest that many of the birds simply disperse across interior habitats where they are hard to observe.

As this species is a key indicator for Everglades restoration, there are additional data needs that will help inform restoration.

Recommendations

- Satellite telemetry should be continued to ascertain details of movements and micro-habitat use in the breeding and non-breeding seasons.
- Feather and/or blood samples should be collected from birds captured for satellite telemetry to determine sex via DNA analysis. Such analyses can be completed without risk and are commercially available.

MULTI-SPECIES

The challenges of managing for multiple species have emerged as an important theme in Everglades restoration. Multi-species concerns involve two key factors. 1. A conceptual approach to the science and management of multiple species and 2. The potential for tradeoffs among species as actions are taken to restore more natural water flows and restore the ecosystem.

- An overarching conceptual framework for multi-species management is lacking for Everglades restoration. Additionally the scientific approach lacks the overarching framework needed to adequately address multi-species. A more integrated approach that fosters greater interaction among research groups, with the objective of finding solutions that optimize across the entire suite of restoration and legislated goals is recommended (see also governance below).

Multi-Species Management through Transition: Potential Tradeoffs

The 2003 SEI panel concluded that restoration would fully benefit all four species of concern. This panel concludes the same although new information adds to the underpinning of this conclusion. However specific management actions are needed to shepherd the species through transition to full restoration.

- The panel concludes that there are no true conflicts between the needs of these species, but until the desired water management system is created, there will be tradeoffs over which of the four species to allow to suffer most from ongoing ecosystem degradation.

All four species will benefit from restored water flows. However, the panel has some specific recommendations for managing transitions and addressing needs of multiple species.

- Managing water so that water levels peak in the WCAs during the wet season (June-September) followed by dry down beginning as early as October and release of water through Shark River Slough provide the best opportunity to produce hydrological conditions favorable to the four species addressed in this forum.

- CERP likely will result in wetter conditions for subpopulation A which may put that population at risk. Given the benefits to ecosystem restoration, the panel feels that this is an acceptable tradeoff, although we recommend attempting to minimize risk to subpopulation A through the incremental adaptive restoration process. Changes created through the implementation of CERP, are not comparable to opening the S-12 structures to release water within the existing water management system. (Opening the S-12 structures likely would extirpate subpopulation A).

- All four avian species require similar cycles of rising water and dry down, and CERP attempts to recreate this regime. In contrast, the panel is not convinced that release of water through the S-12 structures alone can create the desired extent and timing of water-pulse/dry down to produce the foraging conditions in the southern Everglades that storks and spoonbills require.

- The Snail Kite situation is more complex. The panel is not convinced that ponding in WCA-3A has adversely impacted them, when they have shifted into WCA-3A following ISOP implementation. The panel recognizes that there are legitimate reasons why continuing to protect the sparrows is problematic to restoration, but is not convinced that protecting Snail Kites is one of them.

- New information about Apple Snails, combined with studies of the Snail Kites themselves, indicate that the kites require particular dry down cycles in specific habitats in order to thrive. The appropriate conditions could be created in many locations within the Everglades, not only in WCA-3A. For instance, the area that contributed most to successful nesting in 2006 was Everglades National Park. Importantly, benefiting Snail Kites is not a simple matter of releasing water through the S-12s within the current water management system, and thus does not represent a clear tradeoff with protection of sparrow subpopulation A.

- A better solution is to create a water management system that results in the possibility of appropriate conditions for Snail Kites in many areas throughout the system, such that they likely will exist somewhere each year but not necessarily in the same location each year. This mosaic of conditions will allow them to be successful under a highly variable rainfall regime. For instance, it is as important to restore appropriate conditions for kites in Lake Okechobee, WCA-3B, and other areas as it is to do so in WCA-3A. These same changes to the system promise to create the foraging conditions that storks and spoonbills require to nest successfully in the southern Everglades. They also promise to improve conditions for sparrow subpopulations B-F.

- The most disturbing information the panel received was that the design of ModWaters, has been compromised such that it will produce much less movement of water east and south than originally envisioned because the Tamiami Trail will remain an obstacle to desired flow patterns The single most positive step that could be taken to conserve the four bird species is to find the resources to fully implement ModWaters. The second is to accelerate implementation of Decomp. Until these two projects are completed conservation of these four species will be a challenge.

SCIENCE-POLICY INTERFACE
Finally, we recognize that ecosystem restoration operates under several laws, policies, and mandates including, for instance, the Endangered Species Act. These laws offer little guidance to managers who must balance legal requirements for individual species management against constraints and consequences of ecosystem restoration. It is outside the scope of this review to address this issue but we raise it here to indicate the need for greater policy guidance on acceptable risks and decision making during restoration in Everglades and other comparable ecosystems.

HYDROLOGY

The panel addressed hydrology and hydrological modeling within the framework of the species of concern. The panel views the current modeling efforts as a necessary and appropriate tool for what they were primarily intended to do: simulate hydrologic response at the entire system scale. Regional models are suited for regional questions however, and there are local-scale ecological thresholds that appear to require simulations of hydrologic response at a smaller scale than the larger-scale models presented to the panel.

Based on our review, the panel highlights the following points and recommendations on hydrological modeling:

Conceptual frameworks and recent work on these species show that the timing and magnitude of water flows are important forcing functions; because timing and magnitude of hydrologic flows are tractable goals of modeling, quantified results from a properly scaled and constructed model can inform better management of the overall system.

Use of models commonly falls primarily into two overarching activities; models are used for providing: 1) a quantified framework to look at the range of present conditions (“constrain the arm waving”); and 2) predictions of how the system responds when system drivers are outside the range of the calibrated conditions.

Models are by definition a simplification of reality. But, this simplification can involve different things depending on the <u>objective</u> of the model. Thus, this objective drives the initial discussion of what to include in the conceptual model that forms the basis of model construction.

The hydrologic models need to balance complexity of process simulation with needs of the decision makers.

Climate change is affecting the hydrology of the Everglades but current hydrologic modeling (and management) assumes no long-term trends in precipitation, temperature, or sea level.

Because models can have multiple uses/predictions, it is important to not focus on "one model depiction of the world that gives all answers." A superior approach is to test various hypotheses of important processes early in the modeling effort, and have all members of the team vet the models.

Currently there appear to be four project objectives where models could be usefully applied:

- To provide hydrologic conditions for "backcasting" of what the system was in the past so as to better understand the historic species response.
- To help understand presence/absence of species in different parts of the system during different periods of time in the past.
- To provide hydrologic information to decision makers such that system operations can be targeted to meeting ecological thresholds when not in conflict with more critical operation goals.
- To allow project members to overlay ecological field data on a quantitative depiction of the physical system that "fills the holes" where data could not be obtained and is constrained by the underlying physics and calibration data.

The panel believes that the species of concern might benefit from the following actions.

a. Developing a process/forum/workshop to allow ecological concerns to be formally considered in the 2010 Systemwide Operations Manual revision. Formally interjecting consideration of ecological hydrologic goals/thresholds into the revision of the operating rules will help ensure that the best understanding of the ecological thresholds are heard, which in turn will allow them to be balanced against competing needs, and more likely to be enacted when not in competition thus facilitating adaptive management.
b. Develop or modify existing modeling approaches to provide hydrologic timing, duration, and magnitude of the appropriate scale for the ecological thresholds provided. In addition, a system should be developed whereby a decision maker can request a model run and have the results be internally

released in a more real-time fashion even if with the qualifier "provisional results subject to revision".

c. Evaluating the present or future models should include post-audits using field data collected at the scale appropriate for the species. Because much of the previous modeling involved large scales not optimum for the ecological thresholds available, goodness of the smaller scale model calibration cannot necessarily be judged by the calibration or calibration approach used in the larger scale regional models which are extensively documented.

OTHER FACTORS AND THREATS

VEGETATION

To the extent that vegetation – including species composition, relative abundance, productivity, and spatial distribution – affects the habitats and behaviors of the four avian species at issue, managing Everglades vegetation should be part of efforts to manage the birds.

Recent research has done little to change long-standing scientific understanding of the types and spatial distribution of plant communities within the larger Everglades system.

A more refined understanding, however, of the factors controlling broad spatial patterns in wetland vegetation has emerged only quite recently. There is call for renewed attention to the roles of fire and water flow in shaping vegetation patterns. Studies presented to this committee show that vegetation can change rather rapidly in the face of strong hydrologic forcing.

Recent paleoecological studies hold the potential for transforming how we have conceived the controls on vegetation dynamics in the marl prairies and ridge-and-slough landscape and on tree island formation and degradation. Efforts should be made to synthesize and integrate the results of existing studies, and similar studies should be continued and supported over larger areas within these iconic landscape features of the Everglades.

Decrease in the extent of the marl prairies, and the loss of connectivity caused by levees bounding and dissecting marl prairies, especially the eastern portion of the southern marl prairies, severely constrain options for managing existing marl prairies. This argues for a more refined understanding of the relationship between the suite of communities that comprise the marl prairies and hydrology.

Recommendations

- The linkage between vegetation, hydrology and the fate of the four species of concern needs to be much strengthened.

- Vegetation is clearly dynamic. Data on patterns and causes of historical vegetation changes needs to be better understood and incorporated into planning.

CLIMATE CHANGE AND VARIABILITY IN RELATION TO RESTORATION AND THE SPECIES OF CONCERN

During the past 40 years the climate of the southeastern United States has grown warmer and wetter, and most climate models suggest that this trend will intensify during the 21st century. The effects of increases in temperature will cascade among physical and biological systems in south Florida with impacts ranging from changes in the abundance of Apple Snails to large-scale changes in the structure and extent of wet prairies, aquatic sloughs, and mangrove forests.

Conclusions and Recommendations

Temperature and Precipitation

The monthly mean minimum and maximum temperatures in south Florida increased during the past century. An increase in temperature has several direct and higher-order effects on the Everglades system that are relevant to restoration design and operations planning. Three overarching messages emerge concerning temperature and precipitation trends and projections for Everglades water managers:

1) Droughts and flood events appear likely to intensify,
2) Efforts to restore more natural hydrologic regimes in the Everglades system will require greater water delivery flexibility than in a system absent climate change, and
3) Extrapolation of historic trends will likely underestimate future change.

Hurricanes and Lesser Tropical Storms

There is evidence that some species have already been impacted by past hurricanes and storms. Additionally, there is high confidence on the effects of hurricanes on forests. In the Everglades, Wood Storks and Roseate Spoonbills and other wading birds are dependent on woody structure and would be most likely to be impacted. If hurricane intensity increases as projected, future mangrove forests are likely to be diminished in average height and will contain a higher proportion of red mangroves.

Sea Level Rise

Considering the present trends and the consensus among scientists that an acceleration in the rate of sea level rise during this century is very likely, the following messages are relevant to Everglades restoration and management:

- As sea level rises, salt water will intrude further inland, thereby restructuring freshwater and brackish water plant and animal communities.

- Even if storms do not intensify as the climate and sea surface warms, accelerated sea level rise alone will amplify the effects of storm surge on coastal shorelines, wetlands and other low-lying features.
- Transition to more saline environments, inland expansion of mangroves, and contraction of freshwater and mesohaline habitats in the south Everglades appears inevitable and there are few practical coping strategies.
- The importance of freshwater flows to the gradual adaptation and sustainability of coastal brackish and freshwater habitats will increase as sea level rises.

It is also important to note that cumulative effects will likely have "surprising" impacts on species and ecosystems. While there is considerable uncertainty about the rates of change, there is fairly strong consensus regarding the direction of change for most of the climate variables that affect the south Florida ecosystem.

OVERARCHING SCIENTIFIC SUPPORT FOR MANAGEMENT AND POLICY: GOVERNANCE AND ADAPTIVE MANAGEMENT

Effective research efforts and integration of results into management and policy is essential to the success of the Everglades restoration. In this section, we offer some insights and suggestions for improving this link.

<u>Conclusions and Recommendations</u>

The current approach to research and integration is completely inadequate to meet the needs of Everglades restoration. There has been much emphasis on traditional research approach of an individual researcher with his/her team of post-docs and students. While the quality of individual research is generally high, this approach does not work for such a large and complex effort. Indeed it contributes to some of the information challenges faced by managers and policy makers. We strongly recommend a more integrated effort where researchers integrate science, results, and convene to decide on research priorities in order to gather the science required by policy makers and managers.

A consortium approach would help to solve many of the "piecemeal" issues that arise when individual researchers with small teams are trying to tackle large scale multi-disciplinary problems.

A consortium structure can be built around a group of established scientists who represent a breath of approaches to Everglades restoration (e.g. endangered species, hydrology, vegetation, climate change, etc.). The role of the science consortium would be to integrate research across scientists, to identify priorities for research, and to facilitate interactions and training among more junior scientists. Senior scientists would have roles similar to managing partners in the consortium, while an external advisory body helps provide oversight and independent advice. The PISCO program (Partnership for Interdisciplinary Studies of Coastal Oceans) offers a model approach that could be adapted to Everglades restoration.

There is currently no adequate framework for senior scientists to participate effectively at the executive decision-making level. This oversight greatly hampers progress at the scientific and management levels and should be remedied.

Adaptive management has remained more of a concept than a working tool for restoration. There are several steps that could improve this process so that it will work as envisioned.