SOUTH FLORIDA WADING BIRD REPORT

Volume 20 Mark I. Cook, Editor December 2014

SYSTEMWIDE SUMMARY

An estimated 34,714 wading bird nests were initiated in south Florida during the 2014 nesting season (December 2013–July 2014). This is 28% fewer nests than last year's estimate (48,291 nests), is below the average of the last 9 years[a] (42,782 nests), and is 60% lower than 2009 (87,564 nests), which was the best nesting season in south Florida since the 1940s.

Most wading bird species reduced nesting effort in 2014 (Figure 19, p. 36) but the extent of the decline varied. Of particular note are the small herons of the *Egretta* genus, which have shown consistent declines in nest numbers in recent years. Nesting effort by Little Blue Herons (LBHE), Tricolored Herons (TRHE), and Snowy Egrets (SNEG) continued to decline, with nest numbers down 83%, 42%, and 47%, respectively, relative to last year, and down 91%, 53%, and 57% relative to the 9-year average. These declines have been especially acute in the Everglades where numbers have steadily dropped from greater than a thousand nests per species for a typical year in the mid-2000s to only 4 LBHE, 7 TRHE, and 122 SNEG nests in 2014.

Roseate Spoonbills (ROSP) also exhibited reduced nesting effort in 2014. In Florida Bay, ROSP nesting effort (126 nests) was less than half that of recent years (e.g., 367 nests in 2013) and a third of the 30-year average (479 nests). In the central Everglades, ROSP nesting fell from over 200 nests per year during the last 3 years to only 50 nests in 2014.

Great Egret (GREG) and White Ibis (WHIB) nesting effort was also reduced but to a lesser extent than other species, down only 6% and 10% respectively from the 9-year average.

The only species that did not experience reduced nesting in 2014 was the Wood Stork (WOST), which produced 2799 nests, a 26% improvement over the 9-year average.

[a] A 9-year rather than a decadal comparison is provided as only 9 years of successive nest count data are available for Lake Okeechobee.

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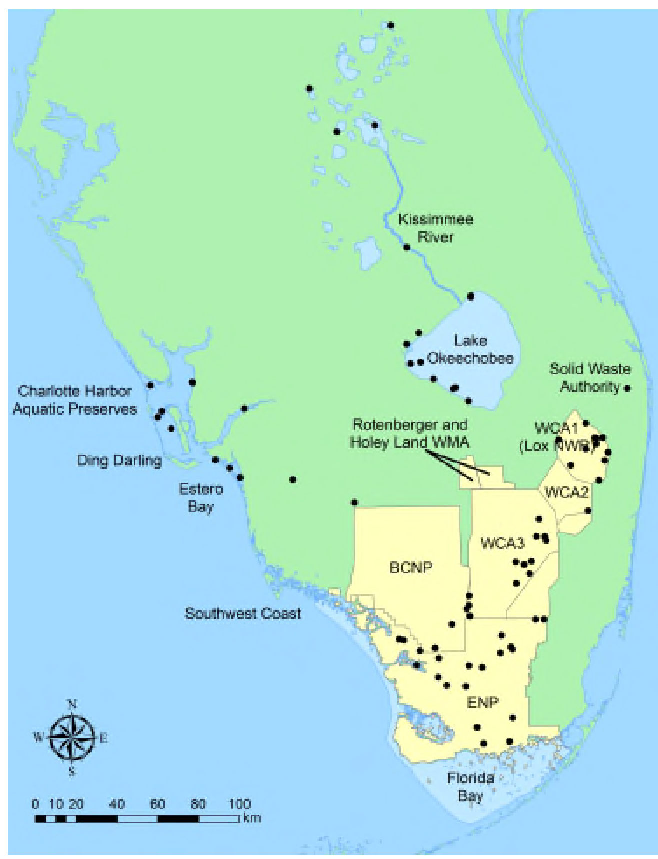
Most wading bird nesting in south Florida occurs in the Greater Everglades (Figure 1). During 2014, wading birds initiated an estimated 25,529 nests (74% of all nests in south Florida) in the water conservation areas (WCAs) and Everglades National Park (ENP). This nesting effort is 28% lower than last year (35,580 nests) and the decadal average (35,483 nests). Lake Okeechobee, another important nesting area, produced an estimated 3457 nests (about 10% of all nests in south Florida). This is fewer than half the 8461 nests that were initiated on the lake last year and is down 32% relative to the 9-year average[a]. In contrast to these declines, nesting WOST returned to Corkscrew Swamp Sanctuary and produced 270 nests. WOST have historically nested there in relatively large numbers, yet had not done so in 6 of the last 7 years.

Figure 1. Locations of wading bird colonies with 50 or more nests in south Florida, 2014.



BCNP: Big Cypress National Preserve; ENP: Everglades National Park; Lox NWR: Arthur R. Marshall Loxahatchee National Wildlife Refuge; WCA: Water Conservation Area; WMA: Wildlife Management Area

NESTING IN THE GREATER EVERGLADES

Distribution of Nests

The estuarine region of ENP was historically the most productive area of the Everglades ecosystem and supported approximately 90% of nesting wading birds. In recent decades, nesting has shifted towards inland colonies in the WCAs. An important goal of the Comprehensive Everglades Restoration Plan (CERP) is to restore the hydrologic conditions that will reestablish prey production and availability across the southern Everglades landscape that, in turn, will support the return of large successful wading bird colonies to these traditional rookeries. In 2014, ENP supported 25% of all nests in the Everglades, while WCA-3A and WCA-1 supported 40% and 34%, respectively. This represents a slight improvement in the proportion of birds nesting in the estuarine region relative to the decadal average (19%), but is only half of the 50% CERP target.

Timing and Success

WOST have a relatively long reproductive period (about 4 months) and it is critical they start nesting early in the dry season to ensure nestlings have time to fledge and gain independence prior to the onset of the rainy season in May or June. This is because their prey (fish) are easy to find and feed upon when concentrated at high densities in shallow water during the dry season, but are not available to birds when they disperse into the deeper marsh after water levels rise in the summer. Without the dry season supply of highly concentrated prey, parent birds are unable to support their offspring.

Historically, stork nesting started in November or December, but it shifted to January to March in recent decades. In 2014, WOST initiated nesting in mid- to late January at coastal colonies and late February to early March at inland colonies. These start times are later than last year (early January), and fall short of the CERP target date (December).

The timing of this year's stork nesting was unusually asynchronous within and among colonies. Storks exhibited a series of staggered nest initiations throughout the season in most colonies. The most extreme example of this occurred at Jetport S colony in WCA-3A where the first wave of egg laying started in late February and the last occurred in early June. This staggered nesting was likely due to a series of nest failure events (caused by rain-driven water level reversals) followed by renesting attempts. Renesting by storks is not uncommon in the Everglades, but typically does not occur at this magnitude or so late in the season. Nesting success for storks varied considerably among the different colonies, but overall it was relatively high compared with recent years.

Other early nesting species, such as GREG, also abandoned nests in large numbers after the rains, but they did not renest to the same extent as the storks. WHIB and *Egretta* herons, which tend to nest later in the season, appeared to delay nesting as a result of the rains, but once their nesting started it was generally successful. In Florida Bay, ROSP nesting started relatively late and was unsuccessful compared to recent years.

Role of Hydrology on Nesting Patterns

Wading bird reproductive patterns in the Everglades are driven principally by hydrology through its influence on aquatic prey production and availability to predation (Frederick et al. 2009). The 2014 breeding season was preceded by wetter than average conditions during 2013, which kept water levels above ground for extended periods across large areas of the Everglades. These wet conditions are generally good for producing and growing fish (Trexler et al. 2005), and large populations of fish may account for the observed early nesting and increased nesting effort by WOST in 2014. However, this does not explain why other large fish-eating species, such as GREG, fared relatively poorly. In contrast to fish, crayfish (*Procambarus fallax*) populations typically increase after moderately dry conditions. This is because crayfish populations are controlled by predatory fish populations, which decline after the marsh dries (Dorn et al. 2011, Dorn and Cook *in review*). The wet conditions during 2013 were probably better for producing fish than crayfish, and this might explain the reduced nesting by WHIB in 2014, which relies heavily on crayfish during reproduction (Boyle et al. 2014).

With regards to making this prey available, recession rates and water depths were generally ideal for foraging birds from October 2013 through January 2014, but several rain events from early February to early April promoted large-scale water level reversals that allowed for the dispersal of concentrated prey and limited the area with appropriate foraging depths. This probably accounts for the large proportion of nest abandonments by WOST and GREG that started nesting shortly after the reversal events in February and April. With regard to ROSP, Scientists at Audubon of Florida suggest that consistently high water levels in the coastal marshes, possibly as a result of sea level rise, may have been responsible for the season's poor nesting effort and success (see *Roseate Spoonbill Nesting in Florida Bay, p. 18-20*).

ABBREVIATIONS

Bird Species: Anhinga (ANHI, *Anhinga anhinga*), Black-crowned Night Heron (BCNH, *Nycticorax nycticorax*), Brown Pelican (BRPE, *Pelecanus occidentalis*), Cattle Egret (CAEG, *Bubulcus ibis*), Double-crested Cormorant (DCCO, *Phalacrocorax auritus*), Glossy Ibis (GLIB, *Plegadis falcinellus*), Great Blue Heron (GBHE, *Ardea herodias*), Great Egret (GREG, *Ardea alba*), Great White Heron (GWHE, *Ardea herodias occidentalis*), Green Heron (GRHE, *Butorides virescens*), Little Blue Heron (LBHE, *Egretta caerulea*), Reddish Egret (REEG, *Egretta rufescens*), Roseate Spoonbill (ROSP, *Ajaja ajaja*), Snowy Egret (SNEG, *Egretta thula*), Tricolored Heron (TRHE, *Egretta tricolor*), White Ibis (WHIB, *Eudocimus albus*), Wood Stork (WOST, *Mycteria americana*), Yellow-crowned Night Heron (YCNH, *Nyctanassa violacea*)

Regions, Agencies & Miscellaneous: Arthur R. Marshall (A.R.M.), Charlotte Harbor Aquatic Preserves (CHAP), Comprehensive Everglades Restoration Plan (CERP), Everglades National Park (ENP), Everglades Protection Area (EPA), Florida Atlantic University (FAU), Florida Department of Environmental Protection (FDEP), Kissimmee River Restoration Evaluation Program (KRREP), National Geodetic Vertical Datum of 1929 (NGVD29), National Wildlife Refuge (NWR), North American Datum of 1983 (NAD83), Northeast Shark River Slough (NE-SRS), Restoration Coordination and Verification (RECOVER), Solid Waste Authority (SWA), South Florida Water Management District (SFWMD), Water Conservation Area (WCA), Water Year (WY)

A 20-YEAR PERSPECTIVE

This is the 20th edition of the wading bird report. Such a long-term, continuous record of annual nesting dynamics at the spatial-scale of south Florida is essential for assessing and guiding Everglades restoration and management activities. The data reveal that several nesting responses used as indicators of restoration success have improved over the past 20 years, while others have not changed or are getting worse. In short, numbers of nests of ibises, storks, and GREG have increased over the past 15 years and are regularly meeting restoration targets. Moreover, the interval between exceptional ibis nesting years has met the restoration target (<2.5 years) for 8 of the past 10 years. The number of birds nesting at the historical coastal colonies has improved recently, but the proportion remains below the restoration target (5-year running average of 32.9% compared to 50% target).

Several measures are not improving and are cause for concern. The numbers of SNEG, TRHE, and LBHE are declining sharply, and the causes of these declines are not known. Also, despite improved WOST nesting effort, the timing of their nesting has remained relatively static and their nesting success is typically low and below what is necessary to sustain the population. The ratio of tactile to visual foragers has improved since the mid-2000s, but remains an order of magnitude below the restoration target (for more details on these long-term nesting responses see the *Status of Wading Bird Recovery* section of the report).

The improvement in some nesting responses suggests that conditions in the Everglades have become more favorable to birds, possibly as a result of a combination of altered water management regimes, decadal shifts in climate and hydropattern, and a reduction in mercury levels. On the other hand, the decline and stasis of other responses show that current conditions are not comparable with those prior to drainage, and in many respects are getting worse. Ecological deterioration is occurring across all parts of the ecosystem, and this increases the probability of irreversible ecosystem changes that limit our ability to recover the essential defining characteristics of the historical Everglades. Nesting targets might become unattainable if ecological conditions continue to degrade and the status quo is not improved upon soon. The consensus among the contributors of this report is that the future can be bright for wading birds if historic hydrologic conditions can be restored; however, the extent of that success may depend on the timescale of hydropattern restoration.

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EVERGLADES PROTECTION AREA HYDROLOGY

In general, rainfall for the Everglades Protection Area (EPA) hovered around the historical average and was slightly less than last year (Table 1). The amount of rain for Water Year 2014 (WY2014; May 1, 2013–April 30, 2014) was 2 to 9 inches less than last year but a few inches above the historical average, with one exception. In Everglades National Park (ENP), rainfall was 4.4 inches (8.0%) less than the historical average and 7.7 inches (13.2%) less than last year. Water Conservation Areas 1 and 2 (WCA-1 and WCA-2) experienced the smallest deviations from the historical average. Rainfall in WCA-1 and WCA-2 was 2 inches (3%) above the historic average and 8.9 inches (14.2%) less than last year. The rainfall in WCA-3 was 2.7 inches (5.3%) more than the historical average and 2.1 inches (3.7%) more than last year.

The slightly above-average rainfall in the WCAs translated into a small and proportional increase in mean stage in each WCA (Table 1). A similar proportional change in the average stage of ENP did not occur. Although ENP had less rain than the historic average and less rain than last year, its stage (6.63 ft) was higher than the historic average (6.0 ft) and last year (6.52 ft). This may have been due to a significantly wetter dry season in WY2014 than last year and the average. During the dry season (i.e., winter), evapotranspiration is lower and more water is available. This, in combination with the recently revised water management schedule (Everglades Restoration Transition Plan) that moves water south as much as possible, led to higher than predicted stages for ENP.

The hydropattern figures (Figure 2A-G) highlight the average stage changes in each WCA for the last 3 years in relation to recent historic averages, flooding tolerances for tree islands, drought tolerances for wetland peat, and recession rates and depths that support foraging and nesting success by wading birds. These indices are used by the South Florida Water Management District to facilitate weekly operational discussions and decisions. The flooding tolerance of tree islands is exceeded when depths on the islands are greater than 1 ft for more than 120 days. Drought tolerances are exceeded when water levels are greater than 1 ft below ground for more than 30 days (i.e., the criteria for Minimum Flows and Levels in the Everglades).

In the hydropattern figures, the wading bird nesting period is divided into three categories (red, yellow, and green) based on foraging observations in the Everglades. These categories are defined as follows:

- A red/poor label indicates recession rates that are too fast (greater than 0.6 ft/week) or too slow (less than 0.04 ft/week). A red label is also given when the average depth change for the week is positive rather than negative.
- A yellow/fair label indicates poor foraging depths (i.e., depths greater than 1.5 ft), a slow recession rate of 0.04 ft/week, or rapid recessions between 0.17 and 0.6 ft/week.
- A green/good label indicates water depth decreased between 0.05 and 0.16 ft/week and water depths are between 0.1 and 1.5 ft.

WATER CONSERVATION AREA 1

Water levels in WCA-1 at the start of WY2014 were abnormally high (Figure 2A). In April and May of 2013, the lack of a receding stage prevented wading birds from foraging and may have given small fish and other prey populations an opportunity to rebound from the drought of WY2012. What is interesting about the WCA-1 stage in WY2014 is the relative flatness of the entire year. Depths hovered around 1 to 1.5 ft from May 2013 until March 2014. There was a slight wet season peak in October when depths reach about 1.75 ft, after which, recession rates were excellent. The rapid drop in water level resulted in optimal foraging conditions in the northern section of WCA-1 where thousands of wading birds were observed foraging in January. However, two major reversals in the dry season caused birds to abandon these foraging grounds and delay nesting.

WATER CONSERVATION AREA 2A AND 2B

During WY2013, good recession rates in WCA-2A were long-lived and followed by a rapid and early return of the WY2014 wet season (Figure 2B). This rehydration rate during the wet season created a good environment for fish production. Recession rates were excellent starting in November, providing good foraging conditions but no nesting was observed. As in WCA-1, a large reversal occurred due to high rainfall in January and February. Good foraging recessions and depths began again in March and lasted until some small reversals in April and May. In general, WCA-2A was a good foraging location in WY2014 because the rehydration in WY2013 allowed for good fish production and the WY2014 hydrology created a relatively long foraging period from March to June. The 2012–2014 hydrograph (Figure 2B) continues to suggest a long-term trend of above-average foraging conditions.

Table 1. Average, minimum, and maximum stage (ft NGVD29) and total annual rainfall (inches) for WY2014 in comparison to WY2013 and historic stage and rainfall. (Average depths calculated by subtracting elevation from stage.)

Area	WY2014 Rainfall	WY2013 Rainfall	Historic Rainfall	WY2014 Stage Mean (min; max)	WY2013 Stage Mean (min; max)	Historic Stage Mean (min; max)	Elevation
WCA-1	53.92	62.80	51.96	16.31 (15.07; 16.83)	16.49 (15.50; 17.35)	15.66 (10.0; 18.16)	15.1
WCA-2	53.92	62.80	51.96	12.69 (11.63; 14.19)	12.45 (11.48; 14.43)	12.52 (9.33; 15.64)	11.2
WCA-3	54.10	56.15	51.37	10.23 (8.98; 11.59)	10.24 (9.18; 11.64)	9.59 (4.78; 12.79)	8.2
ENP	50.08	58.49	55.22	6.63 (5.80; 7.26)	6.52 (5.59; 7.38)	6.0 (2.01; 8.08)	5.1

WCA-2B tends to be used by wading birds only during large-scale droughts because it stays deeper for longer periods than the rest of the EPA. This was true in WY2009 when dry season water levels went below ground for most of the EPA and foraging birds moved to WCA-2B. This was not the case in WY2014 because water depths in WCA-2B remained above 2 ft from June 2013 until May 2014 (Figure 2C). Unlike many previous years, there was a short period in WY2014 (May and June) when recession rates and water depths in WCA-2B were excellent for foraging by wading birds.

WATER CONSERVATION AREA 3A

The stage changes in the northeastern region of WCA-3A (gauge 63, Figure 2D) nearly replicated WY2013. The WY2014 wet season began early and water levels rose quickly, stayed above average for most of the wet season, and exceeded the tolerance of tree islands for some 100 days. Unlike WY2013, the dry season started very early in WY2014. Recession rates were excellent starting in November, which is good for Wood Storks (WOST), and optimum depths started to appear around January. Recession rates and depths cued foraging and nesting in early January 2014 and might have resulted in an extended nesting season in WCA-3A if it were not for the big January–February reversal (evident from rainfall gauges in the region but not evident in Figure 2D due to missing data). Instead, this mid-dry season reversal caused prey populations to disperse and foraging to decline such that many early nesting storks abandoned their nests and others delayed nesting until later in the season (see the *Regional Nesting Reports*).

The hydrologic pattern in central WCA-3A (gauge 64) (Figure 2E) was almost exactly the same as in northeastern WCA-3A, except there was no large reversal evident in January and February and water depths were considerably deeper. Predictive models of wading bird foraging and nesting behavior suggested that the long hydroperiods and above-average water depths in WY2013 and WY2014 (water remained above ground in much of WCA-3AS from April 2012) would promote production of high standing stocks of fish in WCA-3A during 2014, potentially allowing for excellent wading bird foraging and nesting conditions. However, the January and February rain effectively halted water level recessions and depths remained too deep for foraging until late in the nesting season (March/April). This delay led to large-scale WOST nest abandonments in WCA-3AS during January and February when the prey needed to feed recently hatched nestlings was not available. The predicted glut of prey eventually became available later in the season prompting storks to renest in large numbers in April and May. This is very late and unusual for WOST. It typically results in nest failure because nestlings hatch during the wet season when water levels are rising and prey availability is limited. However, a very late and slow onset of the wet season allowed for an extended period of excellent late-season foraging conditions and many of these late nesting birds successfully fledged young.

WATER CONSERVATION AREA 3B

In WCA-3B, for the last 3 years water levels have receded at an almost steady perfect 0.10 ft/week during the dry season (Figure 2F). Last year's foraging activity during the dry season was relatively high, but limited by the quick return of the wet season in May. This year, the typical steady recession rate for WCA-3B was punctuated by a couple of relatively small, but significant reversals. We use the word "relatively" for WCA-3B because there are few sloughs in the area and, as a result, the amount of foraging habitat is limited. Data are limited in this region, but it is possible that the extended foraging season (April, May, and June 2014) helped counteract the negative influence of the two reversals. The dry season in WCA-3B ended in April in WY2013, thus making the foraging season very limited and causing wading birds in ENP colonies just south of WCA-3B to abandon their nests at above-average rates. This year, the colonies south of WCA-3B were expected to have higher nesting success than last year.

NORTHEAST SHARK RIVER SLOUGH

The wet season in WY2013 was relatively wet, and dry season recession rates were very good until May. This hydrology suggests that Northeast Shark River Slough (NE-SRS) was optimal in WY2013 for foraging wading birds because the aquatic prey had a year to return to pre-drought condition and because the nesting period was not cut short. In WY2014, the hydrology did not support an extended foraging period due to poor recession rates (Figure 2G). Water levels stayed flat in NE-SRS for some 10 months. Good recessions were observed in April and May and by June depths went below ground. Local colonies likely needed to forage further south in ENP to have a reasonably good nesting season.

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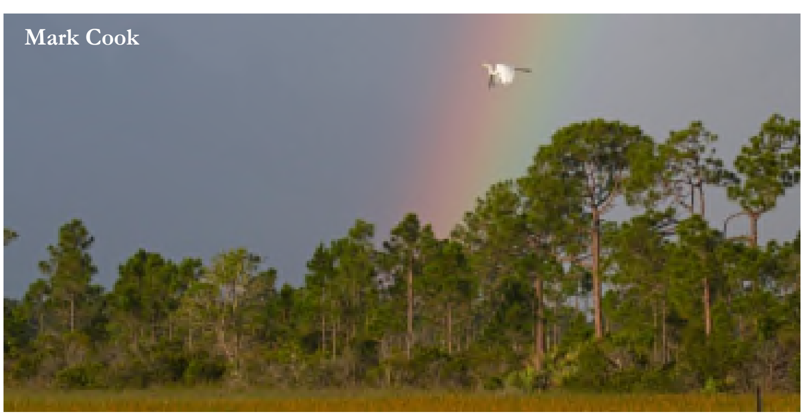
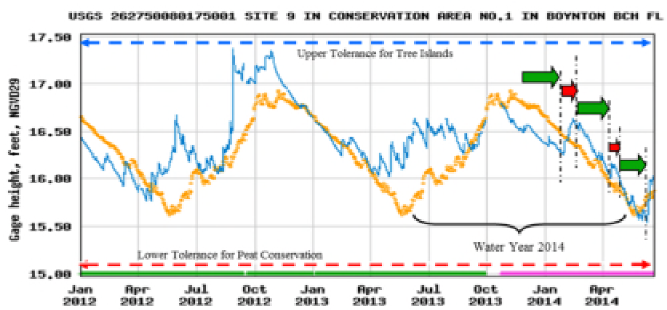
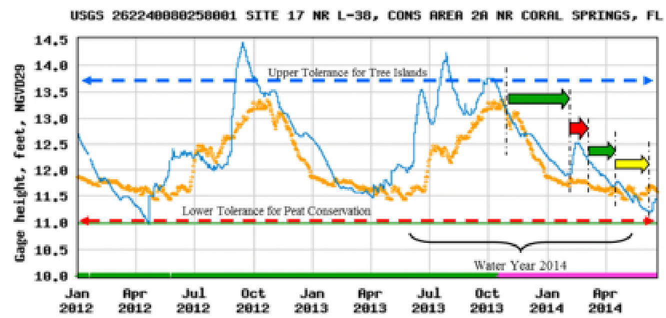


Figure 2. Hydrology in the WCAs and ENP in relation to average water depths (A: 19-yr avg, B: 14-yr avg, C: 19-yr avg, D: 20-yr avg, E: 20-yr avg, F: 12-yr avg, G: 25-yr avg) and indices for tree islands, peat conservation, and wading bird foraging.

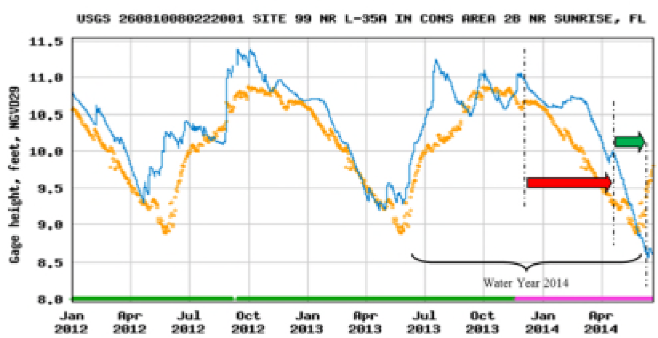
A. WCA-1 – Site 9



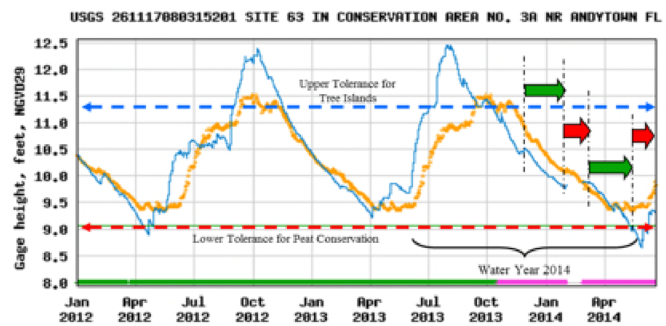
B. WCA-2A – Site 17



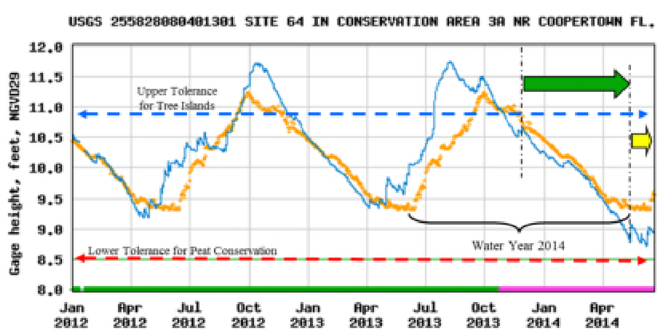
C. WCA-2B – Site 99



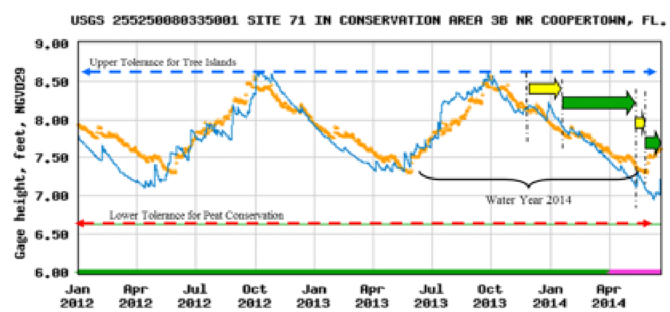
D. WCA-3A – Site 63



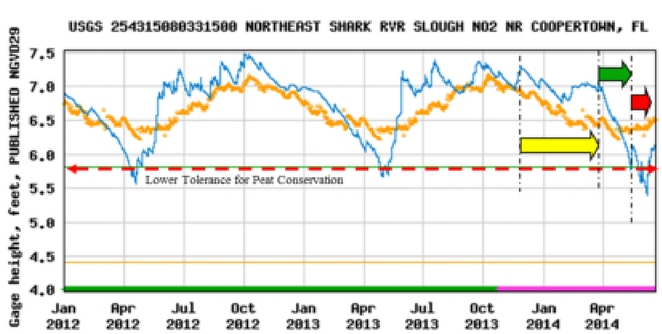
E. WCA-3A – Site 64

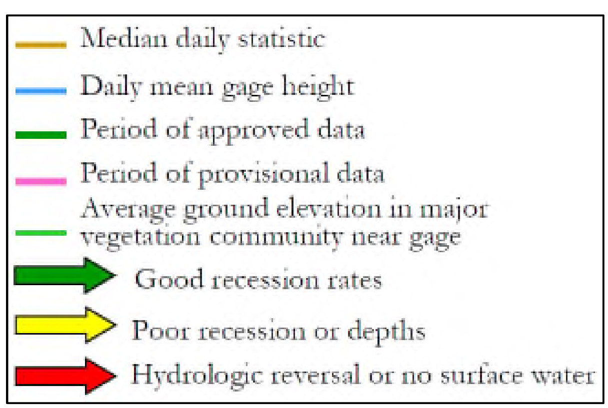


F. WCA-3B – Site 71



G. Northeast Shark River Slough





REGIONAL NESTING REPORTS

WATER CONSERVATION AREAS 2 AND 3, AND A.R.M. LOXAHATCHEE NATIONAL WILDLIFE REFUGE

The University of Florida Wading Bird Project continued its long-term monitoring of wading bird reproduction throughout Water Conservation Areas (WCAs) 2 and 3 and Arthur R. Marshall Loxahatchee National Wildlife Refuge (NWR, includes WCA-1) in 2014. We focused primarily on counts for Great Egrets (GREG), White Ibises (WHIB), Snowy Egrets (SNEG), and Wood Storks (WOST), the species that serve as bioindicators for the Comprehensive Everglades Restoration Plan and are most readily located and identified through aerial searches. Estimates for these and other species were determined from aerial and systematic ground surveys, as well as visits to nesting colonies and more intensive studies of nest success.

METHODS

We performed systematic aerial and ground surveys in 2014 to locate and characterize nesting colonies. On or about the 15th of each month from February through June, we performed aerial surveys to find active colonies using observers seated on both sides of a Cessna 182. We surveyed from an altitude of 800 ft above ground level along east-west oriented transects spaced 1.6 nautical miles apart. We have used these techniques since 1986 and they result in overlapping coverage under various weather and visibility conditions. In addition to contemporaneous visual estimates of nesting birds by the two observers, we took digital aerial photos of all colonies and counted nesting birds observed in these pictures. The reported numbers of nest starts are derived from a combination of information sources, including peak estimates of nests in any colony, supplemental information from monthly South Florida Water Management District surveys that were staggered by two weeks from ours, ground visits, and inference from observations across the season.

Since 2005, we have also performed systematic ground surveys in parts of WCA-3 that give an index of abundance for small colonies and dark-colored species that are not easily located during aerial surveys. During ground surveys, all tree islands within 16 500 m-wide belt transects comprising a total of 336 km^2 are approached closely enough to flush nesting birds. Nests were counted directly if visible or estimated from flushed birds. These totals were added to the numbers derived from aerial estimates. Since ground surveys were conducted on a subset of the total area, the resulting nest estimates should be used mainly for year-to-year comparisons and reflect minimum estimates for the total number of nesting pairs of Little Blue (LBHE), Tricolored (TRHE), and Great Blue (GBHE) herons.

RESULTS

Nesting Effort

We estimate 19,096 wading bird nests were initiated at colonies within WCA-1, WCA-2, and WCA-3 in 2014 (Table 2). This nesting effort was 68% of the average effort from the last 10 years and 74% of the average of the last 5 years. Nesting effort for WHIB was 87% of the 10-year average and 79% of the 5-year average. GREG nesting effort was 76% of the 10-year average and 70% of the 5-year average. WOST had a second strong year in a row with an effort 69% and 2% above average for the past 10 and 5 years, respectively. This increase was due largely to increased activity at Jetport and Jetport South.

Roseate Spoonbills (ROSP) nested at 6th Bridge and Alley North (40 nests total). This is consistent with most years since 2006 with the exception of 2011 and 2012, which had exceptionally high nesting. ROSP were also seen at numerous other colonies during aerial surveys but did not appear to be nesting. This was the fourth year they have been recorded at 6th Bridge.

The recent trend towards much smaller numbers of TRHE and LBHE nests in the study area continued with an all-time low of only 7 TRHE and 4 LBHE nests observed. The 2008–2014 average for LBHE and TRHE was reduced by 83% from 1996–2007 averages. These *Egretta* herons are not nesting in their former locations, which were small, discrete willow heads in WCA-3. This pattern could be the result of a general reduction in nesting by these species throughout the Everglades, or it could indicate that they are nesting elsewhere in the system, such as in larger colonies or in coastal areas. We are in the process of addressing competing hypotheses about the declines.

Reproductive Success

We monitored nest success at four colonies: Tamiami West, Joule, 6th Bridge, and Alley North. We monitored 27 GREG, 23 WOST, 63 WHIB and 86 *Egretta* heron nests at Tamiami West; 41 GREG nests at Joule; 47 GREG, 10 WHIB, 17 Glossy Ibis (GLIB), 5 ROSP and 32 *Egretta* heron nests at 6th Bridge; and 114 WHIB nests at Alley North. Overall nest success for these colonies (P: probability of fledging at least one young, Mayfield method) varied largely among species: GREG ($P=0.226$; $SD=0.0414$), *Egretta* herons ($P=0.753$; $SD=0.0437$), and WHIB ($P=0.481$; $SD=0.046$).

One of the most distinctive things about this season was the timing of nesting. Although storks initiated breeding somewhat earlier than in recent years (mid- to late January) in coastal colonies, much of the nesting in the WCAs was much later than normal. Some nest initiations (ibises, storks, and egrets) occurred as late as mid-May. In addition, nest starts were not very synchronous compared to previous years, occurring over a wide range of time both between and within colonies. This lack of synchronicity was probably due to the failure of early nesting attempts, resulting in waves of initiation later in the season.

Early WOST nests mostly failed in 2014. However, second nesting attempts in February and March appear to have been largely successful in the WCA colonies and Tamiami West, with many nests surviving to produce fledglings. In Tamiami West, overall nest success measures for WOST reflect the effect of early abandonments ($P=0.178$; $SD=0.078$).

Python Camera Traps

Burmese pythons (*Python molurus bivittatus*) are potential threats to wading bird nesting as large, non-native, nocturnal, and highly cryptic predators. Radio-tagged pythons have been observed moving towards initiating colonies and spend considerable time in colonies. Pythons are known to eat many species of aquatic birds, and small- and medium-sized snakes can climb small trees where the birds nest. A medium-sized python was observed on two occasions in 2014 in empty WOST nests in the Cuthbert Lake colony (Lori Oberhofer, pers. comm.). To measure the

potential effect of pythons as predators of wading bird nests, we placed trail cameras set on time lapse to monitor nests in the Tamiami West and Joule colonies this season. Cameras took a digital image once every 5 minutes (an infrared flash was used at night). A total of 24 nests (GREG=12, WOST=10, *Egretta* herons=1, GBHE=1) were monitored, with 11,505 nest hours recorded and screened. We detected no python activity. However, it is important to remember that at a predation rate of even 10% of nests, we would only have expected to see one to two predation events with these cameras and the difference between one and zero is not statistically significant. We plan to continue and expand camera monitoring in 2015.

Effect of Nest Monitoring on Persistence of Nests

We examined the effect of our disturbance on colonies by comparing disturbed and non-disturbed colonies and using the trend in numbers of nests in sequential months after disturbance as a measure of the effect. We predicted that if there were an effect, the numbers of nests would decrease over time more often in disturbed colonies. Trends in numbers of active nests were monitored using aerial counts. We found no differences due to disturbance in numbers of colonies with increasing or decreasing trends (Chi squared, n=66 colonies, p=0.887) or in degree of proportional decrease in nests (Mann-Whitney U, p=0.662). These results address only one of the predicted responses to disturbance (partial abandonment and lack of initiation), but do suggest that researcher disturbance does not limit growth of colonies once they have initiated.

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Table 2. Number of nesting pairs in A.R.M. Loxahatchee NWR (WCA-1), WCA-2, and WCA-3 during systematic surveys, February–June 2014.

Colony	WCA	Latitude	Longitude	GREG	WHIB	WOST	ROSP	SNEG	GBHE	LBHE	TRHE	GLIB	BCNH	Unid. Small Wht.	Unid. Small Dark	ANHI	Colony Total*
LOX 99	1	26.43822	-80.39053	500	3520	0	0	0	0	0	***	0	0	0	0	0	4020
LOX West	1	26.55014	-80.44268	330	1622	0	0	0	0	0	0	0	0	0	0	0	1952
New 4	1	26.5328	-80.2762	10	1500	15	0	0	0	0	0	0	0	0	0	0	1525
Lox Ramp	1	26.49511	-80.22533	170	254	0	0	0	0	0	0	0	0	0	0	0	424
186	1	26.55993	-80.24871	200	0	0	0	107	0	0	0	0	0	0	0	0	307
LOX 73	1	26.37187	-80.26597	217	0	0	0	0	0	0	0	0	0	0	0	0	217
New Colony 2	1	26.45857	-80.24032	140	0	0	0	0	0	0	0	0	0	0	0	0	140
194	1	26.55895	-80.28352	35	60	0	0	0	0	0	0	0	0	0	0	0	95
Wats	1	26.50985	-80.32375	0	0	0	0	0	0	0	0	0	0	64	0	0	64
188	1	26.62441	-80.32439	60	0	0	0	0	0	0	0	0	0	0	0	0	60
193	1	26.55607	-80.27551	60	0	0	0	0	0	0	0	0	0	0	0	0	60
Rhea	2	26.23782	-80.31280	124	0	0	0	0	0	0	0	0	0	0	0	0	124
Alley North	3a	26.20132	-80.52873	600	6000	0	20	0	0	0	***	0	0	0	0	0	6620
6th Bridge	3a	26.12428	-80.54148	300	326	0	20	***	13	***	***	0	0	0	0	0	659
Jetport South	3a	25.80510	-80.84902	85	0	400	0	0	0	0	0	0	0	0	0	0	485
Horus	3a	25.96052	-80.57207	250	0	0	0	0	0	0	0	0	0	0	0	0	250
163	3a	25.77328	-80.83469	0	200	0	0	0	0	0	0	0	0	0	0	0	200
Joule	3a	26.01230	-80.63233	97	0	0	0	0	***	0	0	0	0	0	0	0	97
Jerrod	3a	26.00012	-80.59513	86	0	0	0	0	0	0	0	0	0	0	0	0	86
Cypress City	3a	26.12408	-80.50438	84	0	0	0	0	0	0	0	0	0	0	0	0	84
Vacation	3a	25.91565	-80.63022	77	0	0	0	0	0	0	0	0	0	0	0	***	77
Andytown	3a	26.10715	-80.49802	74	0	0	0	0	0	0	0	0	0	0	0	0	74
Jupiter	3a	26.01557	-80.56272	64	0	0	0	0	0	0	0	0	0	0	0	0	64
Jetport	3a	25.86302	-80.83874	0	0	60	0	0	0	0	0	0	0	0	0	0	60
Hidden	3a	25.77353	-80.83722	60	0	0	0	0	0	0	***	0	0	0	0	0	60
Henry	3a	25.81913	-80.83983	51	0	0	0	0	0	0	0	0	0	0	0	0	51
Colonies > 50 nests				3674	13,482	475	40	107	13	0	0	0	0	64	0	0	17,855
Colonies < 50 nests**				441	3	22	0	15	159	4	7	4	584	0	2	626	1241
Totals by Species				**4115**	**13,485**	**497**	**40**	**122**	**172**	**4**	**7**	**4**	**584**	**64**	**2**	**626**	**19,096**

* Excludes ANHI
** Includes COUNT wading bird nesting pairs from ground surveys
***Present but not counted

EVERGLADES NATIONAL PARK

MAINLAND

This summary addresses colony monitoring within the slough and estuarine areas of Everglades National Park (ENP) during the 2014 wading bird breeding season. Wading bird nesting colonies in ENP are surveyed as part of a regional program to track nesting effort and success throughout the Greater Everglades ecosystem. Data collected during surveys and monitoring flights help guide ongoing ecosystem restoration projects. The long-term objectives of this monitoring are to:

- Collect data on wading bird nesting effort, locations, numbers of colonies, and timing of colony nesting
- Compile and share data with other agencies that monitor wading birds in south Florida with the ultimate goal of restoring and sustaining wading bird populations in the Florida Everglades

Methods

One or two observers conducted aerial site checks of known colony locations during January, March, April, May, June, July, and August 2014. Helicopter or fixed-wing aircraft flight altitude was maintained at 600–800 ft above ground level. During each flight, the observers made visual estimates of nest numbers by species and photographed colonies using a digital SLR camera with a 70–200 mm lens. Photos were later compared to visual estimates to assist with determining nest numbers, nesting stage, and species composition.

We also conducted a systematic colony survey on April 1 across Shark River Slough and Taylor Slough. Two observers, one on each side of a Quest Kodiak high-wing float aircraft, searched for colonies along 20 established transects oriented east to west and spaced 1.6 nautical miles apart. Flight altitude was maintained at 800 ft above ground level throughout the survey. The observers recorded coordinates of colony locations and photographed colony sites.

Species monitored included Great Egret (GREG), White Ibis (WHIB), Wood Stork (WOST), Snowy Egret (SNEG), Roseate Spoonbill (ROSP), Tricolored Heron (TRHE), and Little Blue Heron (LBHE). We also noted other birds found nesting in colonies, such as Great Blue Heron (GBHE), Anhinga (ANHI), Cattle Egret (CAEG), and Black-crowned Night Heron (BCNH).

Results

Nesting effort this season was monitored in 22 colonies (Figure 3) in ENP and was down 48% compared to the 2013 nesting season. The pooled nest estimate for all species was 6486 (Table 3). WOST had 1260 nests, a decrease of 37% compared to the 2013 season. GREG (N=1276) were down 57%, WHIB (N=3250) were down 51%, and SNEG (N=690) were up 11%.

The first monitoring flight was conducted on January 30 after ROSP were seen at the Paurotis Pond site. At this time, most colonies were just starting with most birds observed standing in pairs and some birds were starting to build nests. WOST and GREG at Broad River, Paurotis Pond, and Rodgers River Bay appeared to be ahead of other sites as birds were already incubating. A few GREG were also sitting on nests at Grossman Ridge West, while WOST at this site were paired up with no nest starts seen.

Several rain events during late January and early February temporarily halted WOST nesting activity in most colonies, but no effect was seen on other wading bird species nesting at the same sites. Prior to the storms, approximately 225 storks paired up and were building nests at Paurotis Pond while a few were standing on completed nests. On March 3, we saw 55 active nests with most birds again paired up on new, but empty nests. This was far fewer than expected given the number of paired birds observed in January. About 15 adult storks were sitting as if incubating or brooding, and 5 nests had small young visible in photos. In January, Broad River had about 275 birds with some new nests and a few incubating birds, but on March 3, only 65 active nests were seen. Most storks at this site were standing over empty nests and just a few were sitting as if incubating eggs. At Rodgers River Bay, about 250 storks were present in late January. Many were paired or already incubating and some eggs were seen in photos. On March 3, only 40 birds remained; about 15 were standing on empty nests, 15 were sitting as if incubating eggs, and 10 were roosting at the edge of the colony. In Grossman Ridge West, 50 storks were paired up on nest starts in January. On March 3, 16 nests were still active, some with very small young. Lostmans Creek had about 55 storks in the colony on January 30 with some paired up and a few nest starts visible in photos, but by March 3 storks had completely abandoned this colony. At Tamiami West, approximately 275 storks were present on January 30 with many birds paired and nest starts seen. On March 3, only about 35 storks remained on nests and several nests contained small young. At Cuthbert and Cabbage Bay, GREG had nests on March 3, but storks were not seen until March 20. Cuthbert Lake had 80 nests with adults mostly paired up and some standing on new nests. Cabbage Bay had about 40 nests; most birds were standing on nests with some incubating.

We noted a considerable increase in stork nests during our March 31 and April 17 survey flights. Broad River increased from about 65 nests in early March to 180 nests on March 31. By April 17, we saw 300 nests. Most storks in April were incubating or had small young with some medium-sized young seen as well. Cabbage Bay increased from 40 stork nests in March to 60 on April 17. Most birds were sitting as if incubating eggs or brooding small chicks. Paurotis Pond increased from 55 nests in early March to 270 on April 17. Most storks were sitting as if incubating eggs or brooding over small young. Rodgers River Bay went from 30 active nests in March to 100 nests on April 17; about half contained small young and the rest had birds on as if incubating or brooding. Cuthbert Lake, Grossman Ridge West, and Tamiami West contained the same number of stork nests as seen in early March, but now with larger young. No storks were seen in the Lostmans Creek colony in February or March, but 40 were there on nests on April 17.

On May 21, a wide range in WOST nest status was observed within each colony. Nests contained young ranging from small downy chicks to large, feathered young. A few fledged young were already perched above nests. GREG and SNEG nests were well ahead of WOST and contained mostly large young or fledged young already out of nests.

WHIB nesting status also varied by colony, with some birds incubating (Alligator Bay) while birds in other colonies were both incubating eggs and brooding small young (Cabbage Bay, Lostmans Creek, Otter Creek, Tamiami West). Colonies at

Rookery Branch and Lostmans Creek already had fledged young roosting in trees. Finally, the 300 ibis roosting in the Broad River colony during the April 17 flight apparently never nested and were gone when checked in May. Ibis were not observed nesting at Paurotis Pond this season.

A new colony was spotted during the May 21 flight that was near the existing Alligator Bay site and in similar habitat (mangroves). A few GREG nests with large chicks were seen; however, the rest of colony consisted of small dark herons. Nest numbers could not be determined, but at least 50 fledged LBHE chicks were seen with several being fed by adult birds. Fledged TRHE chicks and adults were seen in photos.

The Madeira Ditches colony consisted mostly of LBHE and TRHE. Again, nest numbers could not be determined but adult birds and fledged young were seen in photos.

On June 18 and across most colonies, GREG chicks were fledged from nests with many still standing in the tree canopies. Water levels had not risen significantly enough for WOST to abandon nests. Stork chicks ranged in size from downy young to large chicks standing on and off nests. Some fledged chicks were standing in the marsh near Paurotis Pond and Cuthbert Lake. While conducting alligator nesting surveys during the week of June 23, fledged storks were seen in marshes near Broad River, Tamiami West, and Grossman Ridge West.

On July 17, most colonies were nearly empty with the exception of Alligator Bay. We observed 200 WHIB sitting on new nests. Some of these contained small downy (black) young that were seen in photos. Fledged GREG and SNEG were still roosting in several colonies, but most nesting was finished. We had one last flight on August 28 and saw newly fledged WHIB young and some adult birds still roosting at the Alligator Bay colony.

Figure 3. Active wading bird nesting colonies in ENP and southern Big Cypress National Preserve, January–August 2014.

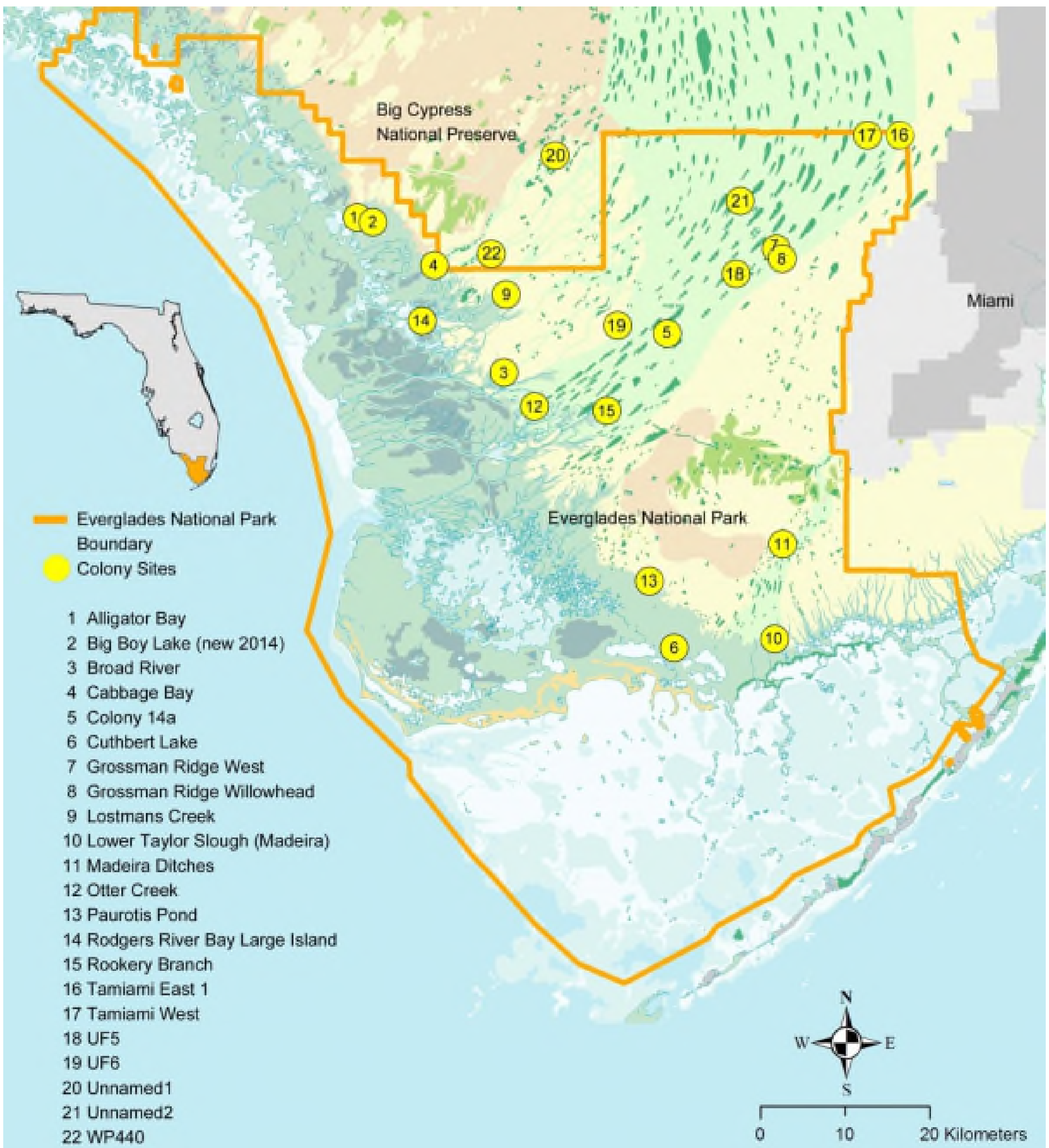

Table 3. Peak numbers of wading bird nests found in ENP colonies through August 28, 2014.

Colony	Latitude NAD83	Longitude NAD83	GREG	WOST	WHIB	SNEG	ROSP	TRHE	LBHE	BCNH	Total
Alligator Bay	25.67099	-81.14714	45	0	350	25	0	0	+	0	420
Big Boy Lake (new 2014)	25.66581	-81.12668	5	0	200	0	0	+	+	0	205
Broad River	25.50292	-80.97440	70	300	300	50	+	+	+	+	720
Cabbage Bay	25.62000	-81.05612	115	60	300	75	10	0	0	0	560
Colony 14a	25.54593	-80.78156	15	0	0	40	0	0	0	0	55
Cuthbert Lake	25.20933	-80.77500	50	130	0	+	0	0	0	0	180
Grossman Ridge West	25.63627	-80.65275	100	50	0	10	0	0	0	0	160
Grossman Ridge Willowhead	25.62613	-80.64582	10	0	0	0	0	0	0	0	10
Lostmans Creek	25.58723	-80.97204	75	40	400	+	+	+	0	0	515
Lower Taylor Slough (Madeira)	25.21932	-80.65945	30	0	0	50	+	+	+	0	80
Madeira Ditches	25.32316	-80.64566	0	0	0	+	0	+	+	0	+
Otter Creek	25.46780	-80.93772	150	0	600	75	+	0	0	0	825
Paurotis Pond	25.28150	-80.80300	110	270	100	+	+	+	+	0	480
Rodgers River Bay Large Island	25.55667	-81.06984	70	110	0	10	0	0	0	0	190
Rookery Branch	25.46356	-80.85256	150	0	600	20	+	0	0	0	770
Tamiami East 1	25.75762	-80.50801	1	0	0	0	0	0	0	0	1
Tamiami West*	25.75745	-80.54502	200	300	400	300	0	+	+	+	1200
UF5	25.61001	-80.70021	33	0	0	15	0	0	0	0	48
UF6	25.55478	-80.84016	10	0	0	20	0	0	0	0	30
Unnamed1, 2014	25.73651	-80.91387	15	0	0	0	0	0	0	0	15
Unnamed2, 2014	25.68756	-80.69525	7	0	0	0	0	0	0	0	7
WP440	25.63144	-80.98875	15	0	0	0	0	0	0	0	15
Total			**1276**	**1260**	**3250**	**690**	**10**	**+**	**+**	**+**	**6486**

\+ Species present and nesting, but unable to determine numbers
* Data from University of Florida

Florida Bay

We conducted aerial wading bird and water bird nesting surveys in ENP across Florida Bay on March 3–4, March 31, April 2, and April 17–18 using a Quest Kodiak high-wing float aircraft. Target species were Great White Heron (GWHE), GREG, SNEG, WHIB, Brown Pelican (BRPE), Bald Eagle, and Osprey (eagle and osprey data are not presented here). Nest counts for wading birds and pelicans were recorded by island or island group. Since we were unable to survey earlier in the nesting season, the nest numbers we recorded should be considered a minimum count. This is especially so for GWHE as recently used but empty nests were seen on March 3–4.

Results

The survey area included 105 islands and island groups within Florida Bay (Figure 4). Of those, 38 islands had GWHE, GREG, or BRPE nesting activity (Table 4). WHIB and SNEG were not seen during the surveys. The large colony that previously nested on Frank Key has not been active in recent years; however a smaller colony has been nesting on nearby Clive Key.

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Figure 4. Great White Heron, Great Egret, and Brown Pelican nesting locations in Florida Bay, March–April 2014. (See Table 4 for island names.)

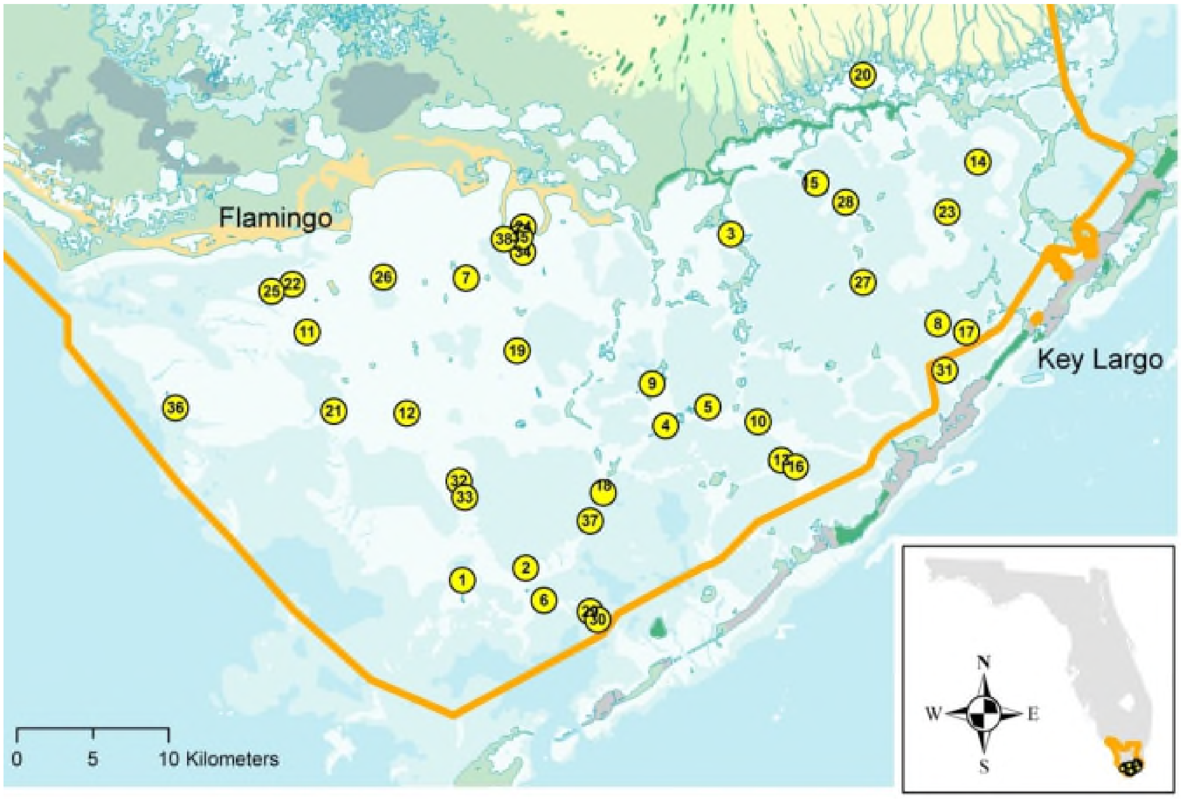


Table 4. Great White Heron, Great Egret, and Brown Pelican nests in Florida Bay.

Site	Island Name	Nests GWHE	Nests GREG	Nests BRPE
1	Arsnicker, Upper	3	0	0
2	Barnes Key, Big	3	0	0
3	Black Betsy Key, NW	1	0	0
4	Bob Allen Key, E	2	0	0
5	Bob Allen Key W, small	3	0	0
6	Buchanan Key, East	0	0	30
7	Buoy Key, SE	1	0	0
8	Butternut W, Big	1	0	0
9	Calusa Keys	11	0	0
10	Captain Key	4	0	0
11	Clive Key	3	40	31
12	Cluett Key	3	0	0
13	Crane Keys	5	0	0
14	Duck	2	0	0
15	Eagle	2	0	0
16	East Key	3	0	0
17	East of Big Butternut	1	0	0
18	Gopher Keys	2	0	0
19	Jim Foot Key	1	0	0
20	Joe Bay Island	0	60	0
21	Man of War Key	1	0	0
22	Murray Key	5	0	0
23	Nest, North	2	0	0
24	Otter Key	1	0	0
25	Oyster, West	0	0	45
26	Palm Key	10	10	0
27	Park Key, S	0	0	20
28	Pass Key	3	0	0
29	Peterson, Middle	3	0	0
30	Peterson, SE	5	0	0
31	Pigeon Key	4	0	0
32	Rabbit, Big	4	0	0
33	Rabbit, Little	2	0	0
34	Rankin, Big	1	0	0
35	Rankin, Little	1	0	0
36	Sandy Key	10	20	0
37	Twin Keys	1	0	0
38	Umbrella Key, Big	2	0	0

Note: No nests were found on Arsnicker, Lower; Barnes Key, Little; Big Key, Middle; Big Key, North; Big Key, South; Black Betsy Key; Bob Allen Key, M; Bob Allen Key, W, big ; Bob Keys; Bottle Keys; Brush Keys; Buchanan Key, East small; Buchanan Key, West; Buoy Key, N; Butternut W, Little; Buttonwood Keys; Camp Key; Catfish Key; Club Key; Coon Key; Corinne Key; Cormorant Key; Cowpens Key; Crab Keys; Curlew Key; Dead Terrapin; Deer Key; Derelict Key; Dildo Key; Dump N; Dump S; End Key; Frank Key; Green Mangrove Key; Jimmy Channel 1 (N); Jimmy Channel 2 (Big); Jimmy Channel 3 (Middle); Jimmy Channel 4 (S); Joe Kemp Key; Johnson; Lake Key; Low Key; Madeira Key; Manatee Key; Miele Key; Nest, South; Oyster, East; Panhandle Key; Park Key, N; Pelican Keys; Peterson, NW; Pollock Keys; Porjoe Key; Roscoe Key; Russell Key; Samphire Keys; Shell Key; Sid Key; Spy Key; Stake Key; Swash Keys; Tern Keys; Topsy Key; Triplet Key; Umbrella Key, Little; West Key; Whaleback Key; or Whipray Keys.

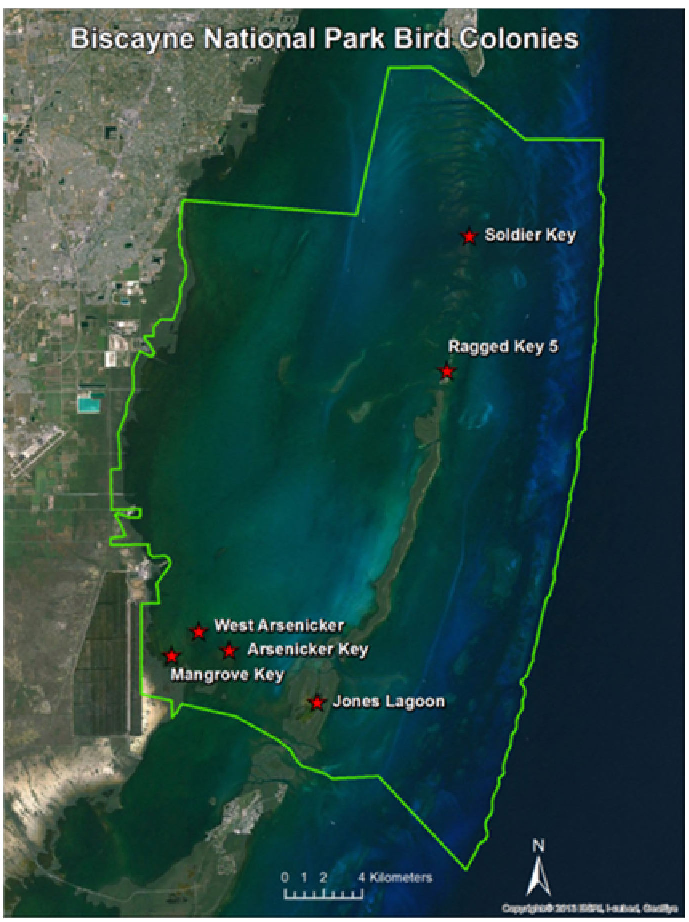
BISCAYNE NATIONAL PARK

Nesting colonies of wading birds and seabirds are important indicators of ecosystem health as they respond to changes in food abundance and quality, contaminants, invasive species, and disturbances. The acts of selecting mates, building nests, laying eggs, and rearing chicks are energy intensive. If the habitat is insufficient to support these activities, nesting success suffers and may indicate a problem in the ecosystem. The South Florida/Caribbean Inventory and Monitoring Network of the National Park Service is monitoring colonial nesting birds in Biscayne National Park and this report summarizes the results from 2010 to 2013. Monthly nesting data are also provided for January–June 2014.

The specific objectives of this monitoring program are to determine status and long-term trends in:

- The number and locations of active colonies of colonial nesting birds with a special focus on Double-crested Cormorants (DCCO), Great Egrets (GREG), Great White Herons (GWHE), Great Blue Herons (GBHE), White Ibis (WHIB), and Roseate Spoonbills (ROSP)
- The annual peak active nest count of colonial nesting birds in Biscayne National Park with a special focus on the previously mentioned species
- Changes in the timing of peak nest counts for the focal species

Figure 5. Colonies monitored within Biscayne National Park.



METHODS

The monitoring process consists of an annual aerial survey via helicopter to locate nesting colonies of wading birds and seabirds within Biscayne National Park. This is followed by monthly aerial surveys of the nesting colonies. Currently, six nesting colonies (Figure 5) are photographed from the helicopter. These photographs are geotagged and analyzed to identify active nests by species. Approximately 300 photographs are taken each month. Additionally, an observer records counts of both nesting and non-nesting birds observed during the flight. Peak nest counts are calculated by colony and then summed across all colonies. Complete methods are described by Muxo et al. (2014).

RESULTS AND DISCUSSION

Over 4½ years, peak active nest numbers varied by species and colony (Figure 6, Table 5). In 2010, WHIB and GREG had their highest number of active nest (92 and 21, respectively). In 2011, GWHE and ROSP had their highest number of active nest (29 and 12, respectively). In 2012, GBHE had their peak number of active nest (13). We first observed ROSP nesting in Biscayne National Park in 2009 and they have nested every year since. In 2014, DCCO had their highest number of active nest (1285) and there were 94 wading bird nests (all species combined).

DCCO were present at all colony sites and had the highest quantity of nests at all sites except at West Arsenicker Key (Figure 7). Mangrove Key colony nest numbers dropped from approximately 100 active nests to 0 nests over the 4-year survey. West Arsenicker Key and Jones Lagoon colonies supported five different species over the 4 years. In general, Ragged Key 5 and Arsenicker Key had the highest peak nesting and were typically dominated by DCCO (Figure 7). Double-crested Cormorants appear to have year-round nesting, with spring and summer peaks occurring each year (Table 6). This would suggest that the DCCO resident population is dominating the nesting in Biscayne National Park. This finding is similar to observations in the late 1970s in Florida Bay (Kushlan and McEwan 1982) and 1980s in Biscayne Bay (Cummings 1987) that there are spring and summer peaks to nesting. It appears that the herons and egrets (GBHE, GWHE, and GREG) have peak nesting in during winter and spring. ROSP nesting is restricted to the winter months, whereas WHIB nesting occurs during the summer (Table 6). This monitoring program suggests that Biscayne National Park is supporting colonial bird nesting activities throughout the year.

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Table 5. Peak nest counts for each species, 2010–2014.

Colony	DCCO	GBHE	GWHE	GREG	ROSP	WHIB
2010 Peak Nest Activity						
Arsenicker Key	142	0	6	0	0	0
Jones Lagoon	96	3	9	0	4	0
Mangrove	93	0	0	0	0	0
Ragged Key 5	299	0	2	0	0	0
Soldier Key	114	1	0	0	0	0
West Arsenicker	2	1	4	21	0	92
Total Active Nests	**746**	**5**	**21**	**21**	**4**	**92**
2011 Peak Nest Activity						
Arsenicker Key	257	2	6	1	0	55
Jones Lagoon	135	2	10	0	12	0
Mangrove	115	0	0	0	0	0
Ragged Key 5	413	1	4	0	0	0
Soldier Key	142	1	3	0	0	0
West Arsenicker	10	4	6	14	0	0
Total Active Nests	**1072**	**10**	**29**	**15**	**12**	**55**
2012 Peak Nest Activity						
Arsenicker Key	179	0	3	1	0	28
Jones Lagoon	133	8	8	1	3	0
Mangrove	26	0	0	0	0	0
Ragged Key 5	394	0	3	1	0	0
Soldier Key	157	2	3	0	0	0
West Arsenicker	0	3	3	11	0	0
Total Active Nests	**889**	**13**	**20**	**14**	**3**	**28**

Colony	DCCO	GBHE	GWHE	GREG	ROSP	WHIB
2013 Peak Nest Activity						
Arsenicker Key	175	0	2	1	0	60
Jones Lagoon	72	5	7	0	7	0
Mangrove	0	0	0	0	0	0
Ragged Key 5	385	1	7	0	0	0
Soldier Key	156	2	2	1	0	0
West Arsenicker	1	4	5	16	0	0
Total Active Nests	**789**	**12**	**23**	**18**	**7**	**60**
2014 Peak Nest Activity (through July)						
Arsenicker Key	123	0	3	2	0	38
Jones Lagoon	113	5	7	0	4	0
Mangrove	0	0	0	0	0	0
Ragged Key 5	706	0	5	1	0	0
Soldier Key	342	1	2	0	0	0
West Arsenicker	1	5	1	20	0	0
Total Active Nests	**1285**	**11**	**18**	**23**	**4**	**38**

Figure 6. Peak numbers of nests detected per colony through time. Peak nest counts by colony were summed to create total peak nest counts across all colonies for the six focal species.

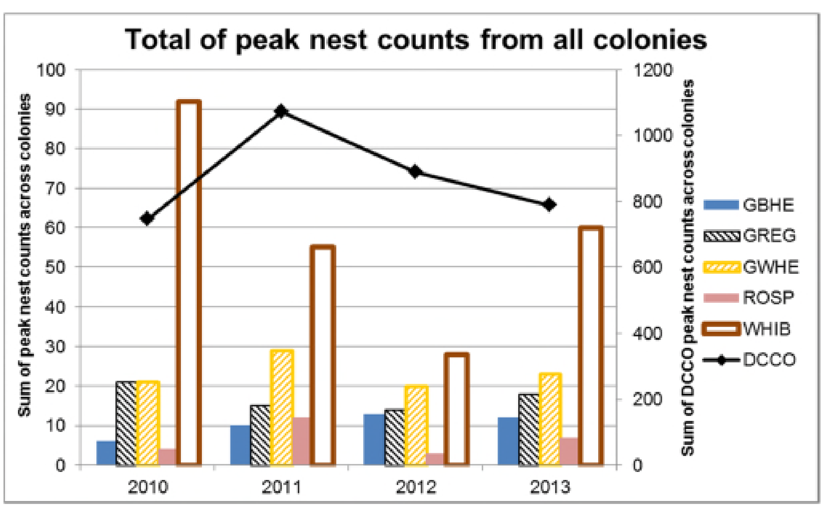

Figure 7. Peak nest counts at each colony for species present.

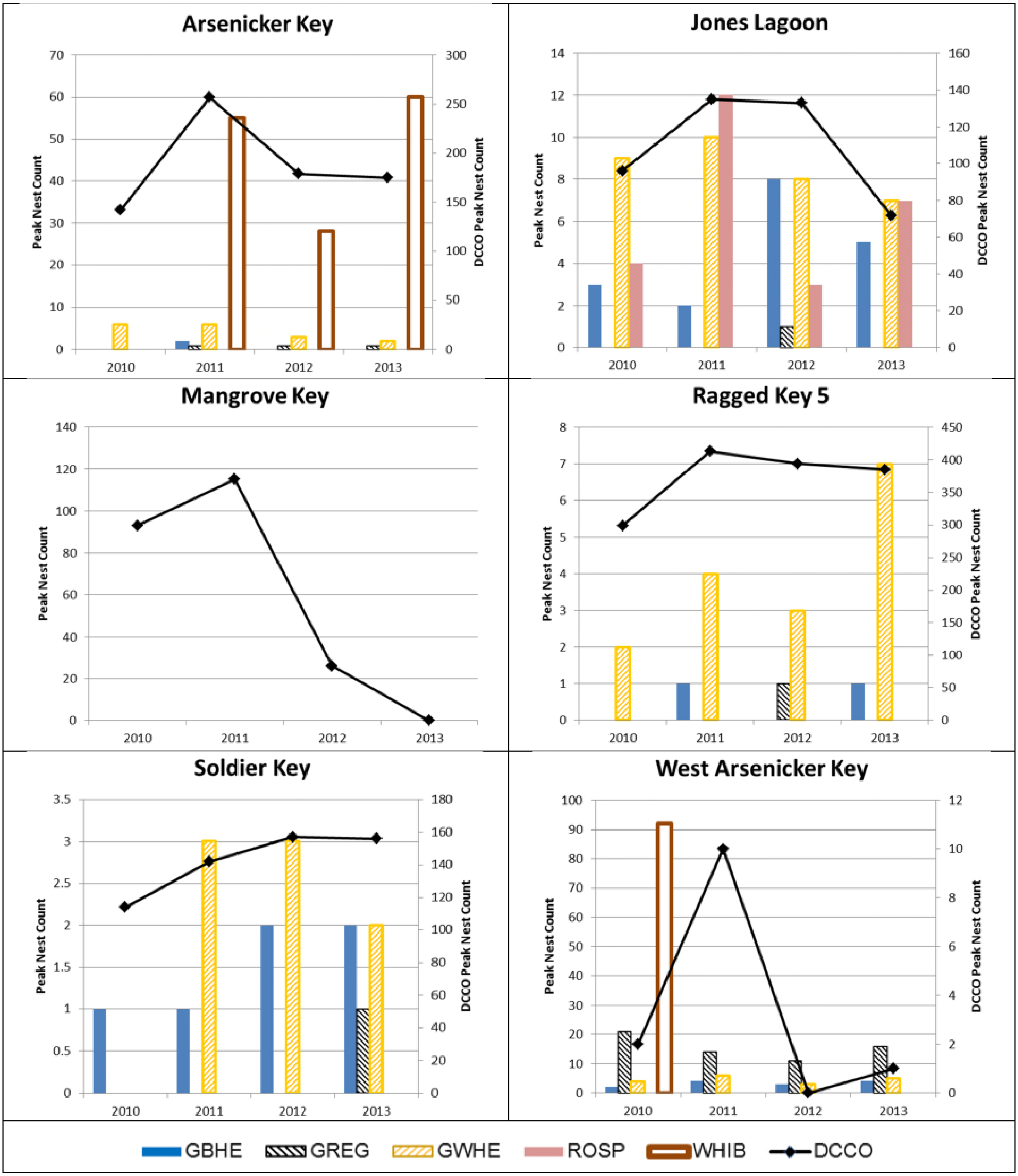

Table 6. Total active nests photographed monthly by year and species
(Bold values represent the peak monthly count, NS indicates "No Survey").

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Double-crested Cormorant												
2010	276	272	319	460	407	**643**	407	474	393	227	37	80
2011	218	261	**797**	725	644	471	409	732	455	172	202	188
2012	NS	477	403	296	NS	408	**614**	NS	505	NS	381	126
2013	NS	511	584	383	397	413	**648**	477	333	NS	NS	204
2014	486	504	803	**1048**	181	439						
Great Blue Heron												
2010	0	0	0	2	0	0	0	0	0	1	2	**4**
2011	5	**7**	**7**	5	5	1	0	0	0	0	1	0
2012	NS	2	2	1	NS	3	0	NS	0	NS	1	**9**
2013	NS	5	6	5	**7**	2	0	0	0	NS	NS	0
2014	0	5	**11**	4	0	1						
Great Egret												
2010	0	0	**21**	19	0	7	5	0	0	0	0	0
2011	0	0	**14**	8	6	0	0	0	0	0	0	1
2012	NS	1	5	10	NS	**12**	0	NS	0	NS	7	0
2013	NS	**16**	9	6	10	**16**	12	2	1	NS	NS	0
2014	0	0	4	13	**20**	5						
Great White Heron												
2010	14	6	0	5	2	5	0	0	1	13	**15**	14
2011	**25**	16	11	5	4	3	0	0	3	1	8	9
2012	NS	**14**	4	5	NS	6	0	NS	6	NS	8	9
2013	NS	**21**	12	10	6	2	4	0	0	NS	NS	15
2014	13	13	**17**	4	1	0						
Roseate Spoonbill												
2010	2	1	0	1	0	0	0	0	0	1	**4**	2
2011	**12**	3	2	1	0	0	0	0	0	0	0	3
2012	NS	**3**	0	0	NS	0	0	NS	0	NS	0	1
2013	NS	**7**	0	0	0	0	0	0	0	NS	NS	1
2014	3	**4**	2	1	0	0						
White Ibis												
2010	0	0	0	**92**	0	35	22	0	0	0	0	0
2011	0	0	0	21	11	**55**	3	0	0	0	0	0
2012	NS	0	0	0	NS	**28**	18	NS	0	NS	0	0
2013	NS	0	0	0	0	49	**60**	22	0	NS	NS	0
2014	0	0	0	0	0	0						

SOUTHWEST FLORIDA

The National Audubon Society gathered nesting data for five rookeries in 2014. Wood Storks (WOST) were the primary focus of the monitoring effort, but we also collected data on other wading birds in most colonies.

METHODS

We completed aerial surveys using a fixed-wing Cessna 172/182 at an altitude of 500–1000 ft on January 10, February 17, March 18, and April 28. We took digital photographs of the colonies using a Canon 30D with a 70–300 mm image-stabilized lens for the first two survey flights and switched to a Nikon D700 with a 80–200 mm lens plus 2x teleconverter (giving equivalent 160–400 mm) for latter flights due to a malfunction with the Canon camera. We examined the images to estimate the number of apparent nest starts, successful nests, and chicks produced. In each survey set, we were unable to identify varying numbers of image features. While some may have been active nests, they were not included in the analysis. Additionally, camera failure during the January and February surveys led to an underestimate of nesting effort. Consequently, our results are conservative, as only verifiable nests were counted.

HYDROLOGY

The 2013 wet season (June–September) rainfall totaled 54.38 in. This compares to a median wet season rainfall of 35.78 in. The peak water level recorded at Corkscrew Swamp Sanctuary during this time was 3.46 ft, which was slightly greater than the median peak water level of 3.33 ft. Water levels receded steadily throughout late 2013. On January 8–10, we received over 1.5 in of rain and water levels rose 0.17 ft over the following three days. Water levels returned to pre-storm conditions by January 21. On January 29–30, an additional 3.22 in of rainfall caused water levels to rise 0.45 ft over the following 3 days. The late January rainfall event coincided with the approximate hatching time of Corkscrew's first cohort of WOST chicks. Water levels did not return to pre-storm conditions until March 14.

RESULTS

Corkscrew Swamp Sanctuary – N26.375033, W81.616417

This colony is in an old-growth bald cypress forest at National Audubon Society's Corkscrew Swamp Sanctuary. The colony is usually dispersed throughout the forest, often with noticeable nesting aggregations or sub-colonies that vary in location from one nesting season to another. The 2014 season saw nesting concentrated at the following coordinates:

- N26.367156, W81.615681
- N26.386374, W81.613183
- N26.381208, W81.621255
- N26.381610, W81.608620

Because nesting aggregations at Corkscrew vary considerably, both within and among nesting seasons, we report a centralized point for the colony.

WOST nest initiation occurred near the first of January 2014, totaling 200 active nests. The failure of approximately 30% of these nests correlates with the heavy rainfall event later in the month; however, the loss was partly compensated by a second cohort (February nest initiation). Overall, we estimate 160 successful WOST nests and 300 fledged storks for the 2014 season (Table 7).

In addition to storks, we observed more than 12 successful Great Egret (GREG) nests, 8 Roseate Spoonbill (ROSP) nests, and an uncounted number of Anhinga nests. Nests of these birds were observed during ground surveys around the nesting areas and in some photos from observational (non-survey) flights.

Lenore Island (Caloosahatchee West) – N26.688867, W81.830150

This colony (called Caloosahatchee West in some prior reports) is on a mangrove island in the Caloosahatchee River. WOST nesting is believed to have begun in early January; however, one survey photo from January 10 revealed two chicks of at least the 2-week age class, suggesting that some nesting began in mid-December 2013. Those storks that initiated nesting in early January produced successful nests and fledged young (Table 7). Our April 28 flight revealed 99 new WOST nests, but we did not make subsequent survey flights to determine their fate.

Caloosahatchee East – N26.696583, W81.794950

This colony is on a mangrove island in the Caloosahatchee River. A limited number of GREG used this site for nesting during the 2014 season (Table 7).

Collier/Hendry County Line – N26.370383, W81.272717

This colony is in a uniquely shaped cypress head along the border of Collier and Hendry counties. No wading bird nesting occurred at this site in the 2014 season.

Barron Collier 29 – N26.273050, W81.343883

The Barron Collier 29 colony is on a spoil island within a man-made lake in eastern Collier County. Nests are built on nonindigenous Brazilian pepper trees. We believe nest initiation occurred in early January 2014, as evidenced by the age of observed WOST chicks. This colony also supported numerous GREG, Cattle Egrets, and Anhingas (Table 7).

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Table 7. Summary of 2014 wading bird nesting effort in southwest Florida.

	WOST							
Colony	Nests	Successful	# Chicks Fledged	GBHE	GREG	Small White	Small Dark	Total
Corkscrew Swamp	270	160	300	0	12	0	0	282
Lenore Island	140	25	35	39	2	11	1	193
Caloosahatchee East	0	0	0	0	13	0	1	14
Collier-Hendry Line	0	0	0	0	0	0	0	0
Barron Collier 29	68	60	90	0	40	18	8	134
Total	**478**	**245**	**425**	**39**	**67**	**29**	**10**	

SOLID WASTE AUTHORITY OF PALM BEACH COUNTY ROOKERY

METHODS

Breeding bird censuses are conducted typically from February–July in the Solid Waste Authority (SWA) Rookery by two observers every 8-10 weeks, representing approximately 12 man-hours. During the census, all islands in three abandoned shell pits are systematically surveyed from a small boat and the number of nests for each species is recorded. Surveys are conducted during the morning to minimize the disturbance caused by the observers. The resulting peak nest numbers are compiled from early season boat counts and visual counts from observation towers.

LOCATION & STUDY AREA

The SWA Rookery is on spoil islands in abandoned shell pits that were mined in the early 1960s in Palm Beach County (26°46'42.22"N, 80°08'31.15"W NAD83). The spoil islands range from 5 to 367 m in length, with an average width of 5 m. Islands are separated by 5–6.5 m with vegetation touching among close islands. The borrow pits are flooded with fresh water to a depth of 3 m. Dominant vegetation are non-native Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casurina* spp.), and melaleuca (*Melaleuca quinquenervia*). Local features influencing the roost include the North County Resource Recovery Facility and landfill and the city of West Palm Beach's Grassy Waters Preserve, a 44-km^2 remnant of the Loxahatchee Slough.

RESULTS

This report presents a partial data set for the 2014 breeding season. Because of adverse weather, the number of nest surveys was limited. Typically, nesting activities have been observed at this colony in February–September. Wood Stork (WOST) monitoring and productivity was conducted by Rena Borkhataria. WOST peaked at 304 nests in April. Heavy rains during the season seemed to contribute to nest abandonment.

The estimated total number of wading bird nests for the SWA Colony is 1190. There were nests of Great Egrets (GREG), Cattle Egrets (CAEG), WOST, White Ibises (WHIB), Tricolor Herons (TRHE), Roseate Spoonbills (ROSP), Snowy Egrets (SNEG) and Anhingas (ANHI) (Table 8).

Table 8. Peak number of wading bird nests in the SWA Rookery from February to July 2014.

GREG	SNEG	CAEG	WOST	WHIB	ANHI	TRHE	ROSP	Unident	Total
15	29	188	304	292	199	12	14	137	**1190**

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ROSEATE SPOONBILL NESTING IN FLORIDA BAY

METHODS

Roseate Spoonbills (ROSP) have used 44 keys in Florida Bay and 2 mainland sites adjacent to Florida Bay as nesting colonies. We divided these colonies into five distinct nesting regions based on the primary foraging locations used by the birds (Figure 8, Lorenz et al. 2002). During the 2013–2014 nesting season (November 2013–May 2014), complete nest counts were performed in all five regions of the bay by entering the colonies and thoroughly searching for nests. We performed mark and revisit surveys at the most active colony or colonies within each region to estimate nesting success. These surveys entailed marking as many nests as possible shortly after full clutches had been laid and then revisiting the colonies on a 10- to 21-day cycle. Nests were monitored until failure or until all surviving chicks reached at least 21 days of age, which is when chicks begin branching and can no longer be assigned to a nest. A colony was considered successful if it averaged at least one chick to 21 days per nesting attempt (c/n). Mean laying and hatching dates refer to the first egg laid and hatched in each clutch. We present our results in the context of ROSP nesting activities in Florida Bay since 1984, the year that the South Dade Conveyance System was completed, which has direct water management implications on Florida Bay (Lorenz et al. 2002, Lorenz 2013).

RESULTS

Northwest Region

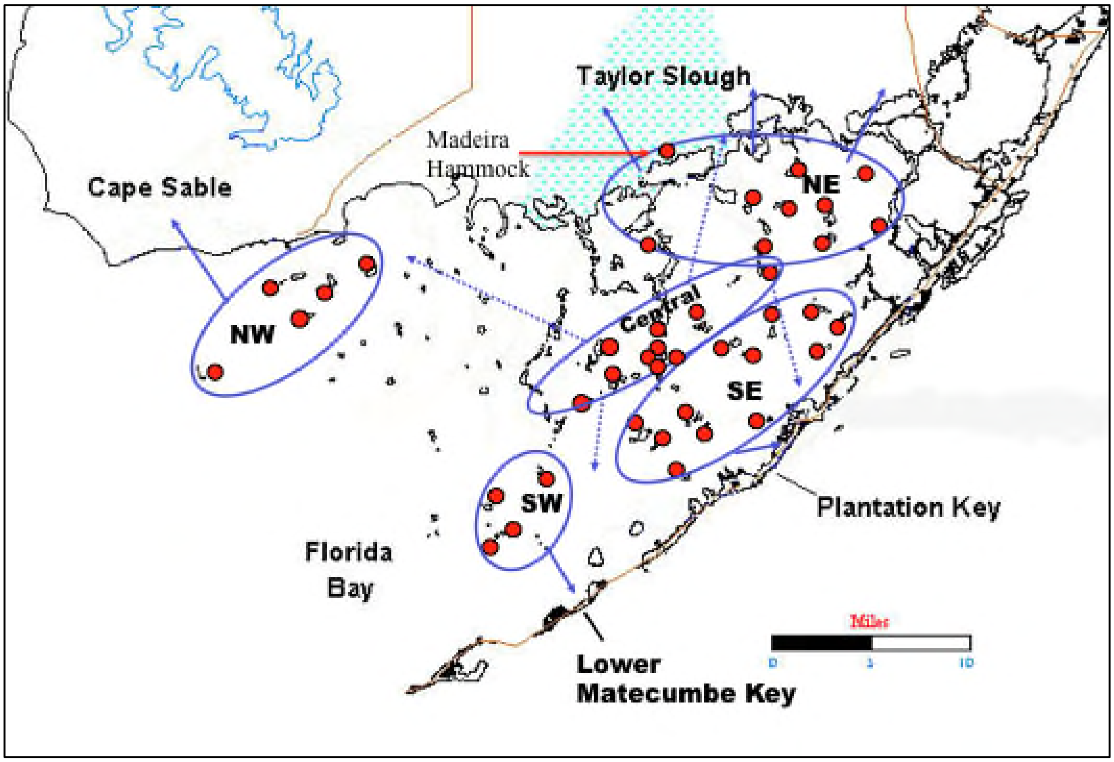
Three of the five historical colonies and one new colony in this region were active and produced 70 nests. This is a little more than half of last year's efforts and is well below the average of 197 nests for the previous 26 years (Table 9). Of the 57 nests with known fate, 23 produced chicks to at least 21 days (40% success rate), a mean production of 0.47 c/n (Table 10), which is well below the region's mean (Table 11) and the level considered successful. Total production for the Northwest was estimated at 33.2 young to 21 days (Table 10). The mean lay date was December 23 and the mean hatch date was January 15 (Table 10).

Northeast Region

In the Northeast, 3 of the 10 colonies were active this year. They produced 26 nests, well below the average since 1984–1985 (Table 9). Only one nest was successful with two chicks surviving to 21 days. The production rate was 0.08 c/n with 4% of nests having at least one chick to 21 days (Table 10). The production rate is well below the mean rate of 0.96 c/n for this region since 1984–1985 and is well below what is considered successful.

Everglades National Park's annual surveys of the Madeira Hammock colony (Figure 8) indicate that the colony became active in 2009–2010 for the first time since 1989 and that spoonbills nested at this colony in 2010–2011 as well. Access to this colony is extraordinarily difficult so there are no nest counts for 2009–2010 or 2010–2011. Beginning in 2011–2012, the colony was periodically surveyed. This year the colony was surveyed three times. Due to unusually high water levels and lack of bird sightings in the area, the first survey occurred on March 6; it revealed little to no spoonbill nesting activity. The second survey (May 3) indicated around 50 nests with full clutches

Figure 8. Roseate Spoonbill colony locations (solid red circles) and nesting regions (open circles) in Florida Bay. Arrows indicate the primary foraging area for each region. The dashed lines from the Central Region are speculative.



ranging from eggs to branchlings. The last survey (May 30) found around 50 chicks successfully raised to 21 days, indicating a moderate to high degree of success. Using the methods of Lorenz et al. (2002), this colony falls into the Northeast Region. The relatively high estimated number of nests at this colony casts doubts on the accuracy of total estimates reported for 2009–2010 and 2010–2011 (Northeast: 41 and 3; Baywide: 233 and 69, respectively).

Southeast Region

The Southeast produced 10 nests this year, well below the mean of 64 nests since 1984–1985 (Table 9). Pigeon Key produced 7 nests, all of which failed. There were 2 estimated chicks fledged for the region, 1 from Low Key and 1 from Middle Butternut. The production rate was 0.2 c/n with 20% of the nests raising at least 1 chick to 21 days (Table 11). This is the tenth time in the last 16 years that the Southeast colonies failed. The estimated mean lay date was January 18 (Table 10).

Central Region

This region yielded 19 nests, much lower than the average 47 nests for this colony since 1984–1985 (Table 9). Estimated total production was 10.6 chicks fledged with 50% of nests successfully raising chicks to 21 days (Table 10). Most nests were at West Bob Allen Key and Captain Key; both had about a 50% success rate and produced 0.5 c/n. The regional 0.56 c/n is little more than half of the long-term mean for the area (Table 11). This was the ninth year of the last 16 that spoonbills were unsuccessful in this region. The mean lay date was January 9, 2014, and the mean hatch date was February 1 (Table 10).

Southwest Region

All four colonies in the Southwest were surveyed in 2013–2014, but only one had a nest (Table 9). The nest produced 1 chick to 21 days, giving the region a success rate of 100% with a production of 1 c/n and 1 chick fledged for the region (Table 9). The mean lay date was December 1, 2013, and the mean hatch date was December 24 (Table 10).

BAYWIDE SYNTHESIS

ROSP nest numbers were well below the average since 1984 and well below historical numbers (Table 9). Each region had much lower nesting attempts than their averages since 1984 and average nest production was 0.38 c/n with 32% of nests successfully raising at least one chick to 21 days (Table 10). The mean lay date for Florida Bay was December 29, 2013, but some nests had lay dates as late as April, indicating that environmental cues to initiate nesting were unclear. The low nesting attempts and success rates indicate poor health conditions of Florida Bay and the Southern Everglades. This is not surprising considering water levels were abnormally high until very late in the year and did not reach the critical 13 cm point where prey begin to concentrate (Lorenz 2013) until April.

Mean sea level in the Gulf of Mexico has a profound impact on the water level of spoonbills' foraging habitats north of Florida Bay. As cooler temperatures prevail in the dry season, gulf waters cool and contract, thereby lowering water levels. This contraction draws water out of the coastal wetlands, lowering water levels and concentrating fish into the remaining wetted habitat. This makes them highly available to spoonbills that coordinate their nesting cycle with the low water and high fish concentration period. In recent years, higher mean sea level in the gulf has resulted in

higher water levels on foraging grounds causing reduced and delayed nesting in Florida Bay's ROSP population. Evidence of the increase in mean sea level for the gulf is apparent in the sea surface record from Key West Harbor (Figure 9) and it appears that the increase has become more rapid since about 2000. Figure 10 shows the mean daily water level at Taylor River, which is centrally located in Taylor Slough where spoonbills feed. It compares the last two hydrologic years with the mean from 1986–1987 to 2011–2012. It also compares these to 1994–1995, which was an El Niño event that held water levels at record heights throughout the Everglades. These data clearly indicate that the last two years had extraordinarily high water levels in Taylor Slough. This was not true throughout the Everglades, but was more pronounced in the coastal habitats, thereby indicating the influence of sea level rise on these habitats. This likely explains the low nesting effort, delayed nesting, and overall low productivity of ROSP in 2013–2014.

NESTING ACTIVITY OF WATER BIRDS ON SPOONBILL COLONY KEYS IN FLORIDA BAY 2013–2014

While surveying known spoonbill colonies throughout Florida Bay, we noted other water bird nesting activity on the keys we investigated. We encountered 15 species of water birds nesting on these islands and did our best to enumerate nests (Table 12). These findings are not a thorough or exhaustive survey of water birds in the bay as many keys were not surveyed because spoonbills did not nest on them and also we did not search beyond areas where spoonbills nested.

That stated, we did our best to find all Reddish Egret (REEG) nests. REEG have become a species of interest at both the state and local level in recent years and we are now trying to find all nests and document productivity. The REEG estimates are likely an accurate representation of effort for this species in Florida Bay.

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Table 9. Number of Roseate Spoonbill nests in Florida Bay (November 2013–April 2014). Second nesting attempts are not included.

	Colony	2013-2014	Summary since 1984-85		
			Min	Mean	Max
Northwest	Clive	3	6	24	52
	Frank	0	0	41	125
	Han Van	0	0	11	18
	Oyster	0	0	5	45
	Palm	8	0	29	87
	Sandy	51	23	138	250
	Cape Sable	8	N/A	N/A	N/A
	Region Subtotal	**70**	**48**	**197**	**325**
Northeast	Deer	0	0	4	15
	Duck	13	0	11	100
	Little Betsy	0	0	4	21
	Madeira Hammock	50	0	?	164
	North Nest	0	0	1	8
	North Park	0	0	14	50
	Pass	0	0	1	7
	Porjoe	0	0	23	118
	South Nest	5	0	16	59
	Tern	0	0	86	184
	Eagle	8	8	8	8
	Region Subtotal	**76**	**3**	**145**	**333**
Southeast	Bottle	0	0	10	40
	Cotton	0	0	0	0
	Cowpens	0	0	4	15
	Crab	0	0	2	8
	Crane	1	0	10	27
	East	0	0	3	13
	East Butternut	0	0	5	27
	Low	1	0	0.4	9
	Middle Butternut	1	1	17	66
	Pigeon	7	0	8	56
	Stake	0	0	5	19
	West	0	0	2	9
	Region Subtotal	**10**	**5**	**64**	**117**
Central	Calusa	3	0	10	21
	Captain	4	0	4	13
	East Bob Allen	1	0	11	35
	First Mate	0	0	3	15
	Jimmie Channel	0	0	17	47
	Little Jimmie	0	0	2	12
	Manatee	0	0	0.14	3
	North Jimmie	0	0	0.6	2
	Pollock	0	0	1.5	13
	South Park	0	0	9	39
	West Bob Allen	9	0	2.5	5
	Central Bob Allen	2	2	7	12
	Region Subtotal	**19**	**3**	**47**	**96**
Southwest	Barnes	0	0	0.2	3
	East Buchanan	0	0	5	27
	Twin	1	0	1.6	8
	West Buchanan	0	0	2.5	9
	Region Subtotal	**1**	**0**	**8**	**35**
Florida Bay Total		**176**	**87**	**479**	**880**

Table 10. Breakdown of colonies by region of all monitoring data collected.

Colony	Nests	Chicks to 21 Days	Nests with Known Fate	Est. Prod.	Est. Chicks Fledged	Nests with at Least One Chick to 21 Days	% Success	Mean Lay Date	Mean Hatch Date
CBA	2	3	2	1.50	3.0	2	100%	2/25/14	3/20/14
EBA	1	0	1	0.00	0.0	0	0%	1/3/14	1/26/14
WBA	9	4	8	0.50	4.5	4	50%	1/1/14	1/24/14
Calusa	3	1	3	0.33	1.0	1	33%	1/2/14	1/25/14
Captain	4	2	4	0.50	2.0	2	50%	1/6/14	1/29/14
CENTRAL	**19**	**10**	**18**	**0.56**	**10.6**	**9**	**50%**	**1/9/14**	**2/1/14**
Sandy	51	15	38	0.39	20.1	12	32%	12/17/13	1/9/14
Clive	3	0	3	0.00	0.0	0	0%	12/26/13	1/18/14
Palm	8	4	8	0.50	4.0	3	38%	1/22/14	2/14/14
Cape Sable	8	8	8	1.00	8.0	8	100%	1/4/14	1/27/14
NORTHWEST	**70**	**27**	**57**	**0.47**	**33.2**	**23**	**40%**	**12/23/13**	**1/15/14**
Duck	13	2	13	0.15	2.0	1	8%	1/5/14	1/28/14
Eagle	8	0	8	0.00	0.0	0	0%	12/31/13	1/23/14
Madeira Hammock	50	50	0	unknown	unknown	unknown	unknown		
S. Nest	5	0	5	0.00	0.0	0	0%	1/30/14	2/22/14
NORTHEAST	**76**	**52**	**26**	**0.08**	**2**	**1**	**4%**	**1/1/14**	**1/28/14**
Low	1	1	1	1.00	1.0	1	100%	12/27/14	1/19/15
Pigeon	7	0	7	0.00	0.0	0	0%	1/8/14	1/31/14
Mid Nut	1	1	1	1.00	1.0	1	100%	4/6/14	4/29/14
Crane	1	0	1	0.00	0.0	0	0%	1/3/14	1/26/14
SOUTHEAST	**10**	**2**	**10**	**0.20**	**2.0**	**2**	**20%**	**1/18/14**	**2/10/14**
Twin	1	1	1	1.00	1.0	1	100%	12/1/13	12/24/13
SOUTHWEST	**1**	**1**	**1**	**1.00**	**1.0**	**1**	**100%**	**12/1/13**	**12/24/13**
Total	**126**	**42**	**112**	**0.38**	**47.3**	**36**	**32%**	**12/29/13**	**1/21/14**

Table 11. Mean number of chicks surviving to 21 days per nesting attempt and the percentage of nests that were successful for each region. Summary data indicate the overall minimum, mean, and maximum production rates (c/n) to 21 days and the percentage of years that the region has been successful since 1984-1985. Numbers in parentheses indicate how many years each region has been surveyed since 1984-1985. Success is defined as a mean of at least one chick to 21 days per nesting attempt. Summary figures refer to the colony or colonies surveyed in each year. Second nesting attempts are not included.

	2013–14 Nesting Season		Summary since 1984–85			
Region	Mean Production Per Nest	% Successful Nests	Min	Mean	Max	% Years Successful
Northwest	0.47	40%	0	1.27	2.5	62% (n=27)
Northeast	0.08	4%	0	0.96	2.2	54% (n=27)
Southeast	0.2	20%	0	0.92	2.09	40% (n=16)
Central	0.56	50%	0	0.86	1.857	47% (n=16)
Southwest	1	100%	0			

Figure 9. Mean annual sea level at Key West Harbor from 1913–1914 to 2013–2014. Mean lower low water (MLLW) is the average height of the lowest tide recorded at a tide station each day during the recording period.

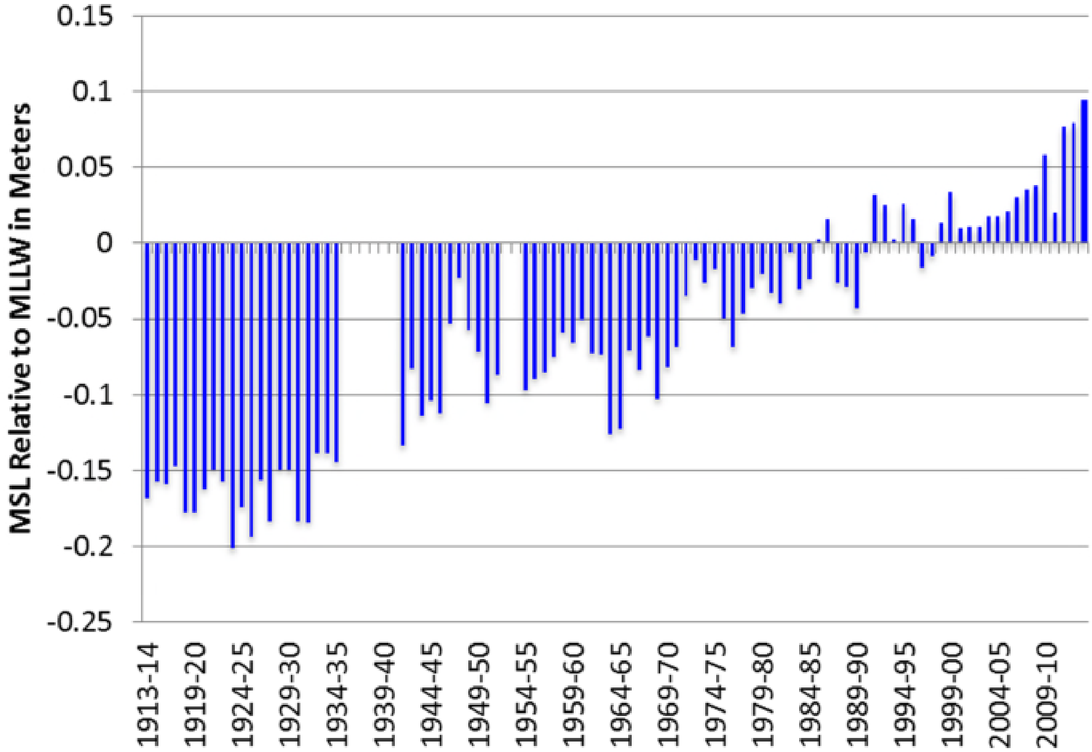


Figure 10. Annual water level cycle relative to the surface of the wetland at the Taylor River hydrostation. Note that 2013-2014 was much higher than mean except for a few days in April and that they were also higher for most of the dry season than in 1994-95 a notoriously high water year attributed to El Niño cycle.

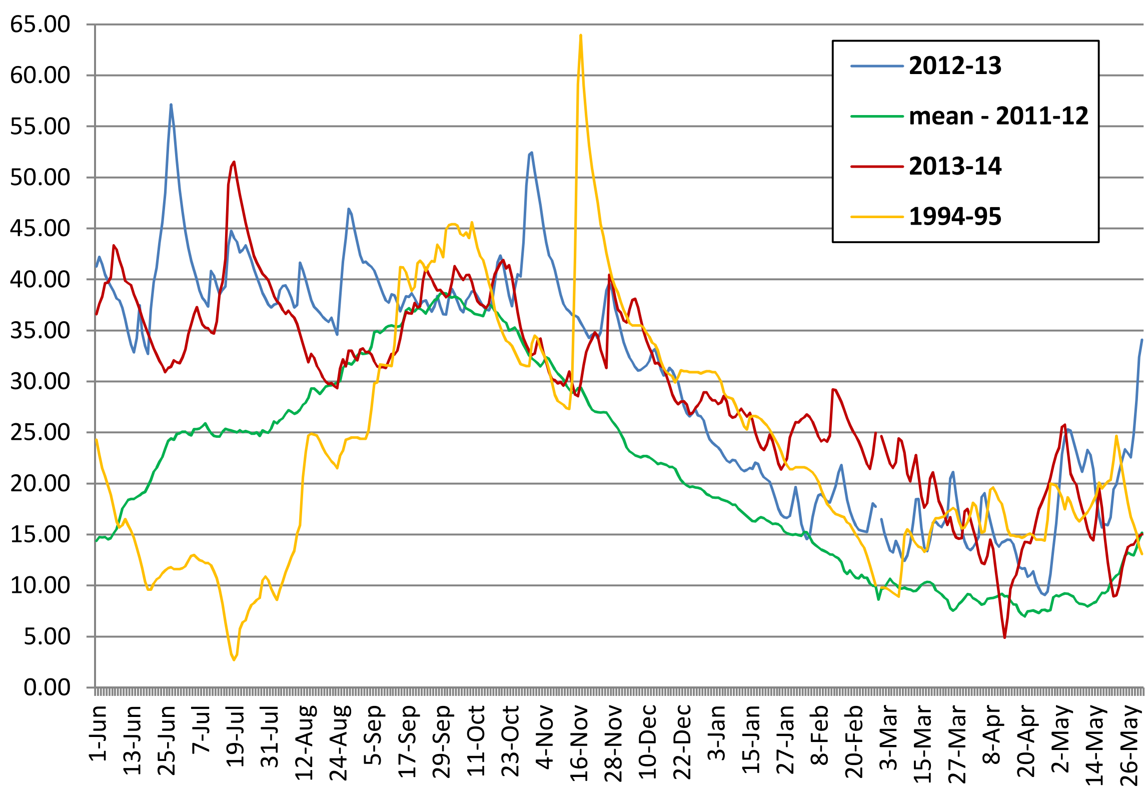


Table 12. Water bird nesting activity in Florida Bay.

Colony	OSPR[3]	GBHE	GWHE	GREG	REEG	GRHE	BRPE	DCCO	SNEG	TRCH	BAEA[3]	WHIB	ANHI	YCNH	WOST
Clive	3	5	1	0	1	0	5	100	0	0	1	0	0	0	0
Han Van	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Oyster	2	1	2	0	0	0	15	0	0	0	0	0	0	0	0
Palm	3	0	1	0	5	0	0	50	0	0	0	0	0	0	0
Sandy	3	0	4	0	8	1	0	0	0	5	1	0	0	0	0
Murray	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deer	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0
Duck	2	0	1	0	12	0	0	10	0	0	0	0	0	0	0
Little Betsy	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0
North Nest	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Nest	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tern	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eagle	2	0	5	1	7	1	0	0	0	0	0	0	0	0	0
Madeira Hammock[1,2]	0	0	2	7	0	0	0	0	30	150	0	150	5	0	0
Bottle	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0
Cowpens	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0
Crab	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crane	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
East	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Low	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Pigeon	0	0	4	0	1	0	0	20	0	0	0	0	0	0	0
Stake	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calusa	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Captain	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0
East Bob Allen	2	0	1	0	3	0	0	0	0	2	0	0	0	0	0
First Mate	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jimmie Channel	3	0	1	0	2	0	0	0	1	0	0	0	0	0	0
Little Jimmie	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0
Manatee	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Jimmie	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
South Park	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0
West Bob Allen	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Central Bob Allen	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0
East Buchanan	0	0	0	0	0	0	25	25	0	0	0	0	0	0	0
Twin	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shell	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paurotis[2]	0	0	0	0	0	0	0	0	0	100	0	100	5	0	250
Russel	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Joe Bay Island	0	0	0	2	5	0	0	0	0	10	0	0	0	0	0
Total	**59**	**7**	**32**	**10**	**52**	**4**	**48**	**235**	**31**	**268**	**2**	**250**	**10**	**4**	**250**

1. Present number of nests is unknown
2. Also surveyed by Everglades National Park
3. BAEA: Bald Eagle; OSPR: Osprey

Note: No nests were found on Frank, North Park, Pass, Porjoe, Cotton, East Butternut, Middle Butternut, Pollock, Barnes, and West Buchanan.

CHARLOTTE HARBOR AQUATIC PRESERVES AND J.N. "DING" DARLING NATIONAL WILDLIFE REFUGE COLONIAL WADING AND DIVING BIRD NEST MONITORING

For 7 consecutive years, staff at Charlotte Harbor Aquatic Preserves (CHAP), a field site of the Florida Coastal Office of the Florida Department of Environmental Protection (FDEP), and J.N. "Ding" Darling National Wildlife Refuge (NWR) have conducted colonial nesting bird surveys within the Ding Darling NWR Complex, and the Matlacha Pass, Pine Island Sound, Gasparilla Sound-Charlotte Harbor, Cape Haze, and Lemon Bay Aquatic Preserves (Figure 11). Colonial wading and diving bird nest monitoring began in 2008 with 9 islands and expanded to 34 islands in 2011. This year, 33 islands were monitored and 25 identified as active wading and diving bird nesting sites. Goals of this study include documenting population trends, biodiversity on islands, and shifts of wading and diving bird nesting efforts. Future goals include a detailed trend analysis of nesting efforts by species throughout the greater Charlotte Harbor Estuary System.

METHODS

The study area was divided between the two agencies based on location. J.N. "Ding" Darling NWR staff monitored islands in South Matlacha Pass, San Carlos Bay, and South Pine Island Sound. FDEP/CHAP staff monitored islands in North Matlacha Pass, North Pine Island Sound, Gasparilla Sound, Lemon Bay, and Cape Haze. Both agencies employed a direct count method with a primary observer, secondary observer, boat captain, and data recorder. Islands were circled by boat and individual nests were recorded according to species. Nests were recorded as *incubating* (an adult was sitting on the nest in a crouched position shading the nest), *chicks* (juvenile birds were visible in or near the nest), or *unknown* (nesting stage could not be determined). The chicks category was counted as a nesting stage, incubating, or chicks in the nest, and was not a measure of productivity. Data collected from March through July 2014 were analyzed for this report. Peak numbers reflect the highest number per species throughout the survey period. The total number of peak nests was calculated for each island as well. Monthly surveys will continue through 2014 for islands that remain active.

RESULTS

The peak estimate for 14 species of colonial nesting birds from all islands combined was 1011 nests (Table 13). Approximately 32% (323) of the nests were for wading birds while the remaining 68% (688) were for diving bird.

SPECIES SUMMARIES

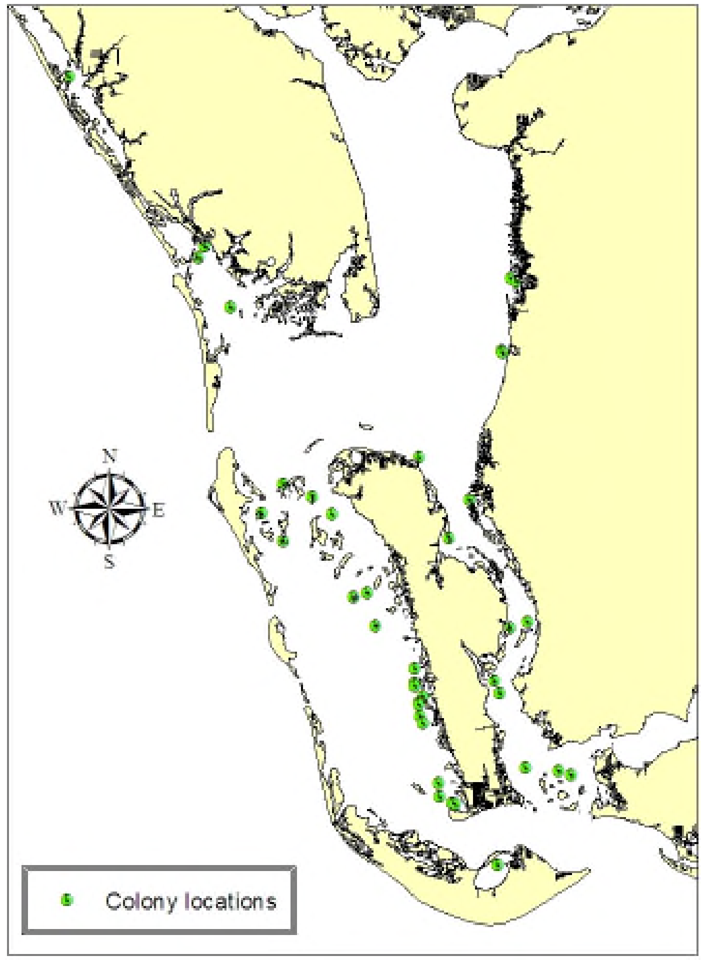
Double-crested Cormorant (DCCO)

DCCO nesting peaked at 483 nests, comprising approximately 48% of nests in the 2014 season. Nesting was documented on 19 islands with the highest count (149) occurring on Hemp Key.

Brown Pelican (BRPE)

BRPE nesting peaked at 205 nests and was documented on 12 islands. The highest peak nest count occurred at Useppa Oyster Bar in July. The nest count was 53 and 43 of these were documented as chick.

Figure 11. Locations of monitored colonial rookeries in the CHAP and J.N. Ding Darling NWR Complex.



Great Blue Heron (GBHE)

GBHE nesting was documented on 17 islands. The peak nest count for GBHE was 73 with 42% of nesting effort occurring on two islands, Hemp Key (19) and E. of Chadwick Cove (12). Both islands peaked for this species in February.

Tricolored Heron (TRHE)

TRHE nests were documented on 11 islands with a peak nest count of 48. The most abundant peak nest count occurred on Bodifer Key in June.

Little Blue Heron (LBHE)

LBHE nesting peaked at 5, 3 nests on Broken Islands, 1 on Hemp Key, and 1 on Pirate Harbor SE.

Snowy Egret (SNEG)

SNEG nesting occurred on 10 islands with a peak nest count of 46. Ten were on Pirate Harbor N.

Great Egret (GREG)

GREG nesting peaked at 61 with approximately 48% of nests on Hemp Key in May. GREG nested on 10 islands.

Reddish Egret (REEG)

REEG nested on 8 islands with a peak count of 16. Gasparilla Marina S. had the highest nest count at 4 in May.

Yellow-crowned Night Heron (YCNH)

YCNH nesting peaked at 9, 4 of the nests were on Burnt Store Marina S. YCNH nesting occurred on 5 islands.

Black-crowned Night Heron (BCNH)

BCNH nesting was documented on 4 islands and peaked at 6 nests. Four of the nests were found on Pirate Harbor N. and Pirate Harbor SE.

Green Heron (GRHE)

GRHE nesting peaked at 4. Three-quarters of the nests were documented in Pine Island Sound.

White Ibis (WHIB)

WHIB nesting occurred on 2 islands with a peak count of 16. Ten of the nests were on Broken Islands, all identified as chicks.

Cattle Egret (CAEG)

CAEG nesting peaked at 23 with approximately 56% (13) on Pirate Harbor SE.

Anhinga (ANHI)

ANHI nesting occurred on 7 islands with a peak nest count of 16. The highest nest count occurred on Pirate Harbor N.

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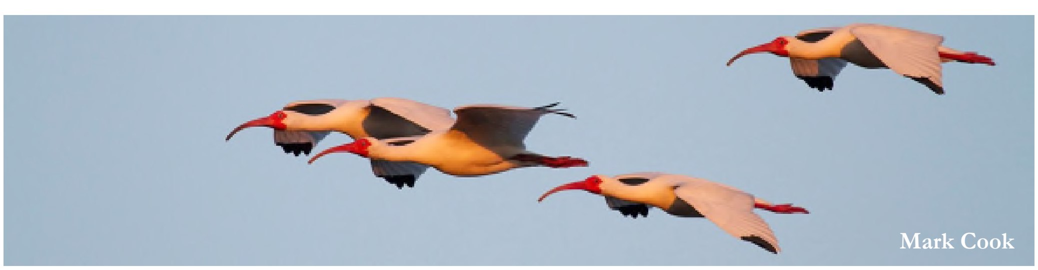
Table 13. Colonial nesting bird peak counts for CHAP and J.N Ding Darling NWR complex, March–July 2014.

Colony (Island)	Lat	Long	GBHE	TRHE	LBHE	SNEG	GREG	REEG	CAEG	YCNH	BCNH	GRHE	WHIB	BRPE	DCCO	ANHI	Total
Bodifer Key	26.4977	-82.1124	1	11	0	4	1	1	1	0	0	0	0	17	2	1	**39**
Broken Islands	26.6777	-82.1940	2	6	3	3	1	2	1	0	0	0	10	36	77	0	**141**
Burnt Store Marina N	26.7625	-82.0669	2	0	0	0	0	0	0	1	0	0	0	0	0	0	**3**
Burnt Store Marina S	26.7611	-82.0660	0	0	0	0	0	0	0	4	1	0	0	0	0	0	**5**
Clam Key	26.5063	-82.1128	2	0	0	0	0	1	0	0	0	0	0	7	4	0	**14**
Cork Island	26.5742	-82.1273	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**1**
E. of Chadwick Cove	26.9289	-82.3511	12	0	0	2	6	0	0	0	0	0	0	0	6	0	**26**
Fish Hut Island	26.5467	-82.1245	0	5	0	3	2	2	1	0	0	0	0	0	20	1	**34**
Gasparilla Marina S	26.8269	-82.2625	1	5	0	6	4	4	0	0	0	1	0	16	7	0	**44**
Givney Key	26.5145	-82.0553	6	0	0	0	0	0	0	0	0	0	0	9	20	1	**36**
Hemp Key	26.5999	-82.1532	19	0	1	1	29	0	0	0	0	0	0	29	149	0	**228**
N. of Mason Island	26.5581	82.1219	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**1**
N. of York Island	26.4945	82.1043	2	4	0	0	0	0	0	0	0	0	0	9	16	2	**33**
NE. of York Island	26.4940	-82.1021	0	3	0	0	0	0	0	0	0	0	0	7	2	0	**12**
NW of Mason Island	26.5543	-82.125	0	0	0	0	0	0	0	0	0	0	0	0	14	0	**14**
NW. of Pumpkin Key	26.5660	-82.1279	2	1	0	0	0	1	0	0	0	0	0	0	0	0	**4**
Pirate Harbor N	-82.0597	26.8052	6	3	0	10	13	0	7	0	2	0	0	0	7	5	**53**
Pirate Harbor SE	-82.0565	26.8037	3	5	1	4	0	0	13	2	2	0	0	9	29	4	**72**
Skimmer Island	26.5104	-82.0250	0	1	0	0	0	0	0	0	1	0	6	0	2	0	**10**
SW. of Mason Island	26.5534	-82.1250	2	0	0	0	0	0	0	0	0	0	0	0	8	2	**12**
SW. of Pumpkin Key	26.5640	-82.1275	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**1**
Tarpon Bay Keys	26.4577	-82.0744	1	4	0	7	2	2	0	1	0	0	0	10	13	0	**40**
Upper Bird Island	26.5592	-82.0714	4	0	0	0	1	0	0	0	0	0	0	3	7	0	**15**
Useppa Oyster Bar	26.6513	-82.2134	1	0	0	0	0	0	0	0	0	0	0	53	69	0	**123**
White Pelican Island	26.7905	-82.2463	7	0	0	6	2	3	0	1	0	0	0	0	31	0	**50**
Total			**73**	**48**	**5**	**46**	**61**	**16**	**23**	**9**	**6**	**4**	**16**	**205**	**483**	**16**	**1011**

Note: No nests were found on Bird Rookery Keys, Crescent Island, Limpkin Island, Lower Bird Island, Masters Landing, N. Regla, or N. of Big Smokehouse.



ESTERO BAY AQUATIC PRESERVE COLONIAL NESTING WADING AND DIVING BIRD MONITORING AND PROTECTION PROGRAM

Estero Bay Aquatic Preserve was designated as Florida's first Aquatic Preserve in 1966. Established by law, aquatic preserves are submerged lands of exceptional beauty and biological, aesthetic, and scientific value that are to be maintained in their natural or existing conditions for the benefit of future generations. Estero Bay Aquatic Preserve covers 11,000 acres in Lee County that are bordered on the east by Fort Myers, Estero, and Bonita Springs and on the west by Estero Island, Long Key, Lovers Key, Black Island, Big Hickory Island, and Little Hickory Island. Estero Bay is a shallow estuary fed by five minor tributaries that contains extensive seagrass beds, oyster reefs, and hundreds of islands dominated by mangroves. Wading and diving bird nesting has been documented on 24 islands.

METHODS

Surveys between 2008 and 2014 were conducted once mid-month throughout the nesting season. Each year, surveys were initiated when birds were observed carrying nesting materials and concluded when all chicks had fledged. Since 2012, surveys have been conducted year-round due to the extended period of nesting. Surveys were conducted by boat using a direct count method as described by Audubon of Florida (2004). Islands were surveyed at a distance of 30–45 m by two observers; nests were documented by species and nesting stage. The primary observer, an aquatic preserve staff member, was consistent throughout the study period. Trained volunteers conducted secondary observer counts. The average of the two observers' counts was reported. Monthly counts from 2014 are compared only with corresponding monthly counts from 2008–2013. Mean peak nest counts for surveys conducted 2008–2013 represent the 6-year average for Estero Bay.

In 2014, surveys were conducted January 9, 14, 15 and 16; February 12, 17 and 18; March 12, 17, 18, 24 and 27; April 9, 14, 15, 16, 21 and 22; May 13, 14, 18, 19 and 26; June 16, 18, 23 and 25; and July 14, 16 and 21. Three additional nesting islands were documented in April: Denegre Key, Estero River North, and Estero River South.

RESULTS

In January, six islands were active with Double-crested Cormorant (DCCO, n=17), Brown Pelican (BRPE, n=7), Great Blue Heron (GBHE, n=44), Great Egret (GREG, n=5), and Black-crowned Night Heron (BCNH, n=1). Between January (n=74) and July 2014 (n=161), 19 of the 24 islands monitored were active with a total peak nest count of 350 (Table 14). Nest counts peaked in June (n=259). Overall, nesting colonies saw an 18% decline in nesting effort from the 6-year average; however, four species exhibited increased nesting effort (Table 15).

DCCO nests were found on seven islands with nesting activity recorded January (n=17) through July (n=28) and nesting peaked in June (n=45), with a season peak of 56 active nests. DCCO peak nesting numbers were 23% below the 6-year average.

BRPE nests were documented January (n=7) through July (n=55) on three islands. Peak nest counts were recorded in June (n=74) with a season peak of 82 active nests. BRPE peak nesting was 28% below the 6-year average.

GBHE nests were found January (n=44) through July (n=8) on 13 islands. Nesting effort peaked in January with a season peak of 59 nests, 21% below the 6-year average. White morphs were documented on seven nests at five separate colonies.

Table 14. Peak nest counts documented in Estero Bay Aquatic Preserve colonies, January–July 2014.

Colony	Latitude	Longitude	DCCO	ANHI	BRPE	GBHE	GREG	SNEG	LBHE	TRHE	REEG	BCNH	YCNH	GRHE	CAEG	Total
619038c	26.36737	-81.84357	0	0	0	0	0	0	0	0	0	0	4	0	0	4
Big Bird Island	26.38286	-81.84995	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Big Carlos Pass M-43	26.43155	-81.90066	0	0	0	0	0	0	0	3	0	0	4	0	0	7
Big Carlos Pass M-50&52	26.42244	-81.89527	1	0	0	0	0	0	0	0	0	0	5	0	0	6
Big Carlos Pass W of M-46	26.42926	-81.90137	0	0	0	1	0	0	0	0	0	0	0	1	0	2
Big Carlos Pass W of M-52	26.42469	-81.89359	8	0	16	6	16	5	4	8	3	2	0	0	0	68
Big Hickory E of M-85	26.35315	-81.84164	10	0	0	9	1	2	1	0	0	0	0	0	0	23
Big Hickory M-83	26.35057	-81.84388	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Coconut Point East	26.38411	-81.84905	19	0	28	8	6	1	0	0	0	0	0	0	0	62
Denegre Key *	26.43772	-81.86728	0	0	0	5	0	0	0	0	0	0	1	3	0	9
Estero River North *	26.43653	-81.86091	0	0	0	0	0	1	0	0	0	0	8	4	0	13
Estero River South *	26.43416	-81.86211	0	0	0	0	0	0	0	0	0	0	2	1	0	3
Hogue Channel M-78	26.34988	-81.84644	1	0	0	1	0	0	0	0	0	1	4	0	0	7
Matanzas Pass	26.46092	-81.95717	15	0	38	15	5	12	15	13	4	2	0	0	0	119
New Pass M-21	26.38865	-81.85925	0	0	0	1	0	0	0	0	0	0	0	0	0	1
New Pass M-9	26.40465	-81.86816	2	0	0	3	0	0	0	0	0	0	0	0	0	5
North Coconut E of M-3	26.41131	-81.85486	0	0	0	4	3	5	0	0	0	1	0	0	0	13
North Coconut M-4	26.40737	-81.85998	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Ruth's Island	26.40783	-81.85302	0	0	0	2	0	0	0	0	0	0	0	1	0	3
Total			**56**	**0**	**82**	**59**	**31**	**26**	**20**	**24**	**7**	**6**	**29**	**10**	**0**	**350**

* Surveys conducted April to July

Note: No nests were found on Big Carlos Pass M-48, Big Carlos Pass S of M-48, Big Hickory M-49 2NW, Big Hickory M-49 3NW, or Coconut Point West.

GREG nests were documented January (n=5) through July (n=13) on five islands. Nesting peaked in March (n=23) and the annual peak was 31 nests, which represented a 48% decrease in nesting compared with the 6-year average.

Snowy Egret (SNEG) nests were documented April (n=4) through July (n=12) with peak nest counts in June (n=25). SNEG nested on six islands with an annual peak nest count of 26, which is a 14% increase over the 6-year average.

Little Blue Heron (LBHE) nested on three islands. Nesting was documented in March (n=2), May (n=5), June (n=19), and July (n=9). The annual peak of 20 nests represented a 33% increase in nesting effort over the 6-year average.

Tricolored Heron (TRHE) nests were documented on three islands between May (n=5) and July (n=16) with peak nesting effort in June (n=24). The annual peak (n=24) represented a 3% decrease in nesting effort compared with the 6-year average.

Reddish Egret (REEG) nested on two islands with an annual peak of seven nests, which is consistent with the 6-year average. Nesting was documented in February and March (n=1), May (n=6), and June and July (n=3).

BCNH nests were documented on four islands with an annual peak of six nests; a 54% decrease from the 6-year average. Nesting occurred in January and April (n=1) and May through June (n=2).

Yellow-crowned Night Heron (YCNH) nesting was documented on eight islands from March (n=3) through July (n=9) and nesting effort peaked in May (n=26). The annual peak nest count was 29 nests, which represented a 69% increase in nesting effort over the 6-year average.

Green Heron (GRHE) nests were documented on five islands between April (n=2) and July (n=6) and peak nesting effort occurred in June (n=7). The annual peak was 10 nests, which represented a 161% increase in nesting effort over the 6-year average.

Anhinga (ANHI) and Cattle Egret (CAEG) nests were not documented during 2014 surveys.

Staff and volunteers removed 631 ft of fishing line and 44 hooks from nesting islands between January and July. During this same period, 22 bird fatalities were documented due to fishing line entanglement.

Discussion

After the 2013 report was submitted, nesting continued through December 2013 (n=43) with an annual peak nest count of 416 active nests. Nesting surveys were conducted year-round in 2012 and 2013 due to the extended nesting season. Staff plans to continue monitoring year-round to document nesting efforts and shifts in nesting time. As of July 2014, 161 nests were still active.

Eight of the ten GRHE nests were documented on three islands that were not surveyed prior to this year. New islands are added as birds are documented nesting there by staff and volunteers. Due to the small, inconspicuous nature of the GRHE nests, it is possible that nesting activities were not observed in the past, although they may have been present in the area.

BRPE constituted 59% of the 2014 fishing line fatalities, consistent with counts since 2008. Pelican nesting within Estero Bay has been concentrated on three islands throughout the monitoring period: Matanzas, Coconut Point East, and Big Carlos West of 52. Management strategies need to be developed for islands with documented BRPE fecundity and Critical Wildlife Area designation, or some form of protection allowing for the islands to be marked with a buffer zone to protect nesting birds from disturbance and fishing line entanglement should be implemented.

Table 15. Mean nest count, standard error, and percent difference, by species, for annual peak nest counts.

Species	Mean (2008–2013)	Standard Error	Peak (2014)	Percent Difference
DCCO	73	7.8	56	-23
BRPE	114	19.3	82	-28
GBHE	75	9.0	59	-21
GREG	60	6.9	31	-48
SNEG	23	3.5	26	14
LBHE	15	2.7	20	33
TRHE	25	5.2	24	-3
REEG	7	1.1	7	0
CAEG	2	0.8	0	-100
BCNH	13	2.9	6	-54
YCNH	17	1.5	29	69
GRHE	4	0.5	10	161
Total	**427**	**24.6**	**350**	**-18**

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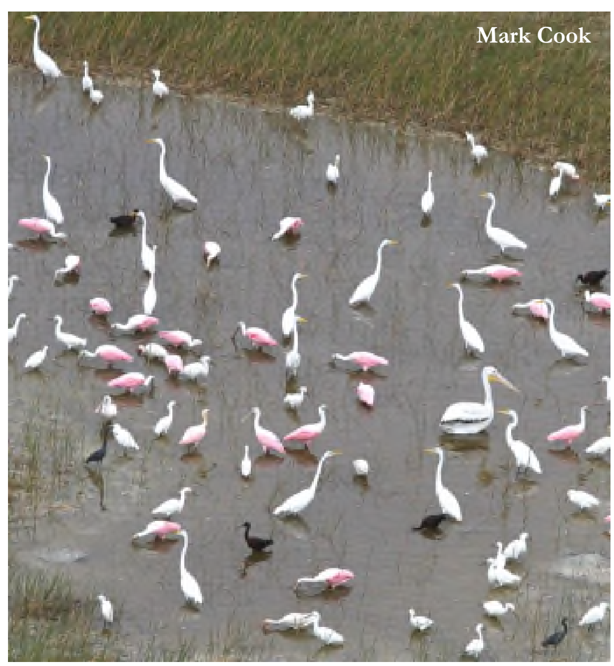

WADING BIRD NESTING AT LAKE OKEECHOBEE

In 2005, Florida Atlantic University (FAU) initiated wading bird nesting surveys on Lake Okeechobee to determine location and size of colonies as part of the Comprehensive Everglades Restoration Plan Restoration Coordination and Verification Monitoring and Assessment Plan. We reported the highest nesting effort on record in 2006 with 11,310 nests, and the lowest nesting effort on record in 2008 with 38 nests. Herein we report our findings for 2014.

METHODS

From February through June 2014, FAU conducted wading bird nesting surveys to determine timing and location of breeding populations. Detailed methods are described in previous editions of the *South Florida Wading Bird Report*.

We obtained rainfall and hydrology data from the South Florida Water Management District's DBHYDRO database. We calculated lake stage as the mean of four principle gauges in the pelagic zone of Lake Okeechobee (L001, L005, L006, and LZ40). All presented elevation data are relative to the National Geodetic Vertical Datum 1929 (NGVD29) and locations are based on the North American Datum 1983 (NAD83). Historical stage data are from 1977 to the present, which corresponds to the period of systematic aerial surveys.

HYDROLOGY

In 2014, lake levels were slightly below average at approximately 4.3 m (14.1 ft) in January with an extended dry-down throughout the season (Figure 12). On January 30 and February 5, substantial rains caused a rise in water levels that peaked at 4.26 m (13.9 ft) on February 8. Thereafter, barring a few small reversals, water levels receded in typical fashion through May. Water levels reached their lowest point on June 11 at 3.74 m (12.3 ft).

RESULTS

Colony Location and Size

We detected 12 colonies (Figure 13), 10 on-lake and 2 off-lake (Gator Farm and Lakeport Marina), with an estimated total of 3457 nests. We derived this number by summing the peak nesting month for each species except Anhinga (ANHI) and Cattle Egret (CAEG)(Table 16). The cumulative total for Great Egret (GREG), Great Blue Heron (GBHE), White Ibis (WHIB), and Snowy Egret (SNEG) was 2997 nests, which is below the average for the 34 years monitored since 1957 (Figure 14). We also identified nests of Tricolored Heron (TRHE), Little Blue Heron (LBHE), and Glossy Ibis (GLIB) during the surveys.

Traditional willow head colonies were active this year. The largest colony, Liberty Point 2, produced 23% of the total nesting effort. In addition, the three Clewiston spoil island colonies and Little Bear Beach (also a spoil island) also produced 23% of the total nesting effort in 2014 (Table 17). This is similar to the nesting patterns seen in 2012. As drought conditions have persisted in recent years, it appears that wading birds are using spoil island colonies more frequently now even during years with average water levels (Table 18).

Timing and Success

The first species to initiate nesting was GREG, with a median initiation date of February 12 (Table 16). The next species was SNEG, with a median initiation date of February 19. TRHE had a median initiation date of March 12. Nesting was asynchronous across colonies; by the end of April, some nests were still initiating while others had already fledged chicks. Nest success was moderate, with many nests fledging at least one young.

Wood Storks and Roseate Spoonbills

Wood Storks (WOST) have nested in a mixed-species colony at an alligator farm about 4 km north of Harney Pond along County Road 721 from 2007–2010. Although the colony has developed each successive year since, storks did not initiate nesting in 2011–2014. This year, we consistently observed flocks of about 50 Roseate Spoonbills (ROSP) roosting near the Eagle Bay East and Liberty Point 2 colonies. Scattered individuals were also observed foraging near the Moore Haven East 4 and Indian Prairie 1 colonies. However, no ROSP nests were observed.

ACKNOWLEDGMENTS

Funding for the nest monitoring was provided by the U.S. Army Engineer Research and Development Center. We appreciate the support from our field technician Nicole Hengst.

Figure 12. Hydrograph of 2014 Lake Okeechobee stage (m) and daily precipitation (cm) with the mean daily lake stage from 1977 to the present.

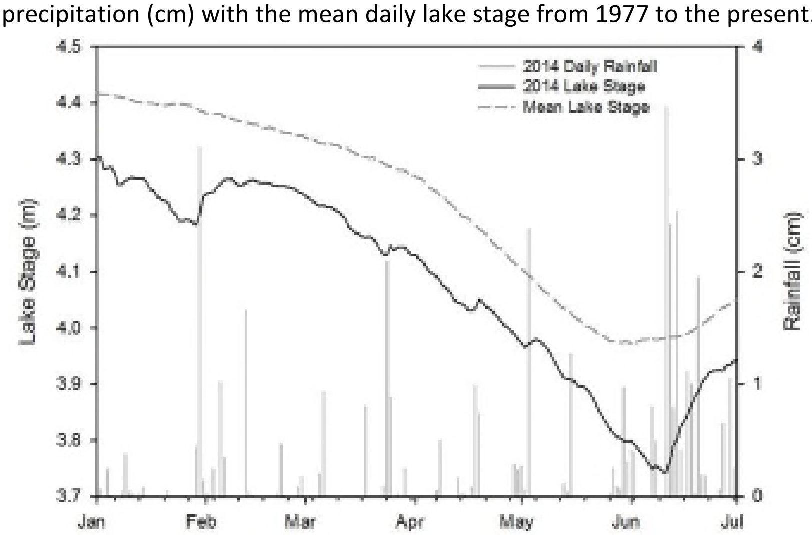

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Figure 13. Wading bird colonies observed at Lake Okeechobee, February–June 2014.

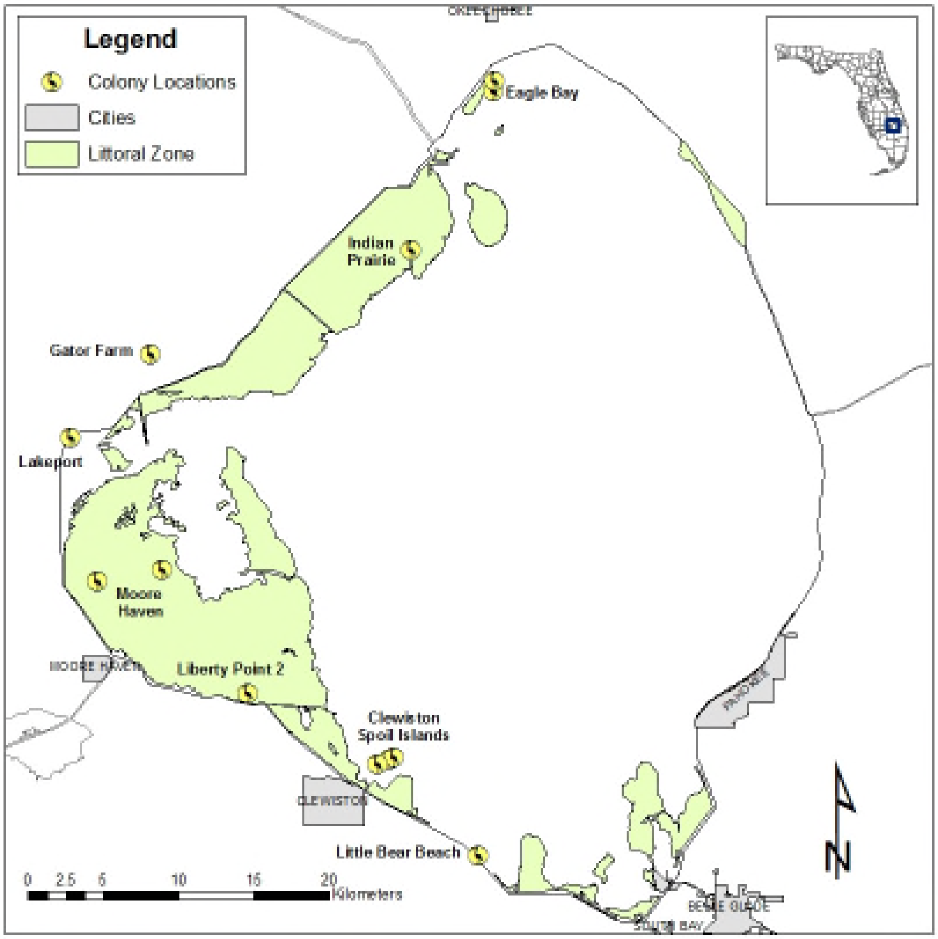


Figure 14. Historic record of wading bird nesting on Lake Okeechobee (four species include GBHE, GREG, SNEG, and WHIB). The thick horizontal line represents the mean and the thin horizontal line represents one standard deviation above the mean. Data for 1961–1970, 1973, 1976, and 1993–2004 are not available.

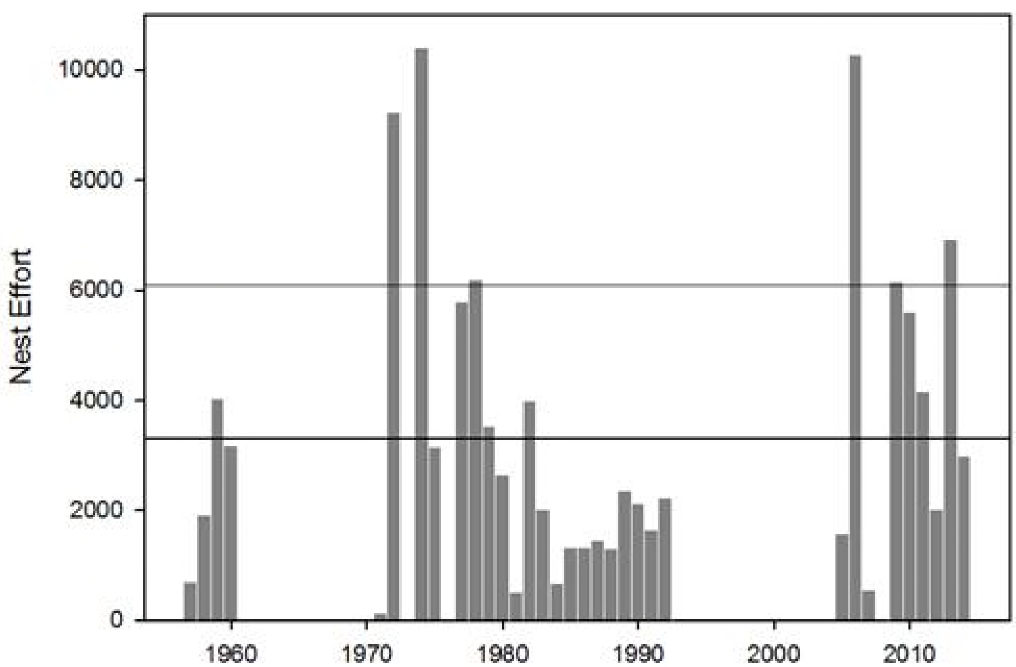


Table 16. Timing and nest effort for species breeding in wading bird colonies during 2014 at Lake Okeechobee. Bold denotes peak nest effort for species included in grand total.

Month	GREG	GBHE	WHIB	SNEG	LBHE	TRHE	WOST	GLIB	ROSP	CAEG	ANHI	Peak nest effort[1]
January	---	---	---	---	---	---	---	---	---	---	---	---
February	800	4	---	55	---	---	---	---	---	---	---	859
March	925	**54**	115	360	---	230	---	50	---[2]	---	---	1734
April	**1420**	54	**575**	**948**	**50**	**285**	---[2]	**125**	---[2]	---	---[2]	3457
May	250	---	75	170	---	30	---	---	---	200	---[2]	525
June	---	---	---	---	---	---	---	---	---[2]	900	---	---

[1] Does not include CAEG or ANHI.
[2] Species detected during monthly survey effort but never seen nesting.

Table 17. Geographic coordinates (NAD 83) and species-specific peak nest efforts in detected colonies during the 2014 breeding season at Lake Okeechobee.

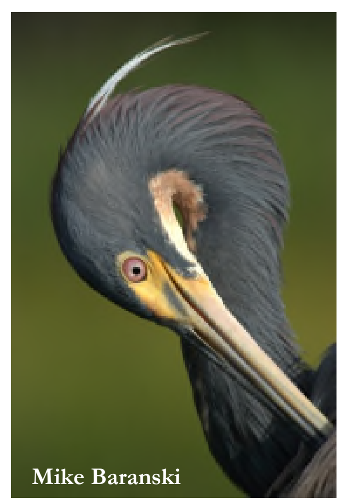
Colony	Peak Month[1]	Latitude	Longitude	GREG	GBHE	WHIB	SNEG	LBHE	TRHE	WOST	GLIB	ROSP	CAEG	ANHI	Total[1]
Clewiston Mid	APR	26.77965	-80.90157	---	---	---	75	---	75	---	---[2]	---	---	---	150
Clewiston Out	MAR	26.78091	-80.89850	50	---[2]	---	30	---	---	---	---	---	---	---	80
Clewiston Spit	APR	26.77658	-80.90914	200	---[2]	---	118	---	---	---	---[2]	---	---	---	318
Eagle Bay East	APR	27.17987	-80.83080	---	2	200	250	50	50	---[2]	100	---[2]	200	---	652
Eagle Bay Trail	APR	27.18659	-80.83056	---	2	200	75	---	50	---	---	---	---	---	327
Gator Farm	APR	27.02278	-81.06084	300	---	---	---	---	---	---	---	---	400	---	300
Indian Prairie 1	FEB	27.08526	-80.88613	20	---	---	---	---	---	---	---	---[2]	---	---	20
Lakeport Marina	MAR	26.97260	-81.11440	100	---	---	---	---	---	---	---	---	300	---[2]	100
Liberty Point 2	APR	26.81906	-80.99579	550	25	100	100	---	25	---[2]	---	---[2]	---	---	800
Little Bear Beach	APR	26.72139	-80.84222	50	---	---	150	---	35	---	---	---	---	---	235
Moore Haven	FEB	26.88641	-81.09644	50	---	25	50	---	---	---	---	---	---	---	125
Moore Haven East 4	MAR	26.89336	-81.05337	100	25	50	100	---	50	---	25	---[2]	---	---	350

[1] Does not include CAEG or ANHI
[2] Species detected during monthly survey effort but never seen nesting

Table 18. Annual percent nest effort between marsh and spoil island colonies. Water level classification was based on a comparison with the mean January lake stage of 4.4 m (14.5 ft; within 3 SD) from 1977 to the present.

Year	Marsh % Nest Effort	Spoil % Nest Effort	No. Colonies[1]	No. Spoil Colonies	January Stage (m)	January Stage (ft)	Water Level Classification
2006	96	4	27	6	4.8	15.7	High
2007	0	100	4	4	3.7	12.1	Low
2008	100	0	1	0	3.1	10.2	Very Low
2009	96	4	16	3	4.3	14	Average
2010	98	2	10	2	4.1	13.6	Low
2011	89	11	9	5	3.8	12.4	Low
2012	74	26	13	6	4.2	13.6	Low
2013	93	7	10	4	4.6	14.9	High
2014	74	26	10	4	4.3	14.1	Average

[1] Does not include off-lake colonies



KISSIMMEE BASIN

The South Florida Water Management District (SFWMD) surveys wading bird nesting colonies and foraging wading bird abundance along the Kissimmee River as part of the Kissimmee River Restoration Evaluation Program (KRREP)(Williams and Melvin 2005a, 2005b). To date, approximately 7710 acres of wetland habitat (about half of the project total) has been restored and the interim response of foraging wading birds has exceeded restoration expectations (Cheek et al. 2014). While there is no formal expectation for wading bird nesting effort, the number and size of colonies that have formed along the river since restoration began in 2001 has been below historic levels (Williams and Melvin 2005a).

While foraging conditions on the floodplain can become optimal for wading birds during parts of the year (see *Foraging Abundance*), the current timing and magnitude of floodplain inundation and recession is not optimal for rookery formation due to constraints and other demands on water control operations that may limit prey availability. All restoration construction is scheduled for completion by January 2017, when implementation of the Headwaters Revitalization Schedule will allow water managers to more closely mimic the historical stage and discharge characteristics of the river, presumably leading to suitable hydrologic conditions for wading bird nesting colonies. Wading bird responses to the river restoration project will be monitored through 2022.

METHODS

As part of KRREP, the SFWMD performed five aerial surveys (February 18 and 25, March 21, April 22, and May 13, 2014) and one ground survey (April 8, 2014) to visit known wading bird nesting colonies and search for others in the Kissimmee Basin and Lake Istokpoga (Figure 15 and Figure 16). The survey area was expanded this season to include the entire Kissimmee Basin where wading bird colonies were likely to occur, with the exception of non-Central & South Florida Flood Control Project water bodies near Orlando and Disney World. Nesting colonies were also monitored, when encountered, during separate aerial surveys of foraging wading birds on November 13 and December 17, 2013, and January 14, February 11, March 11, April 17, and May 20, 2014. Known colonies in Lakes Mary Jane, Kissimmee (Rabbit Island), and Istokpoga (Bumblebee Island) were surveyed at least once, and two surveys were conducted throughout the Kissimmee Basin to search for previously undocumented colonies.

Observers sat on both sides of a helicopter flying at an altitude of 244 m along east-west transects spaced 2 km apart. Once a colony was located, the principal observer recorded nesting species and the number of active nests while another observer took photographs. Nest counts were also obtained from the digital photos to improve the accuracy of initial counts made from the air. The numbers of nests reported here represent the maximum number of observed nests for each species. It is likely that nests for a small number of dark-colored wading birds, such as Little Blue Heron (LBHE), Glossy Ibis (GLIB), Tricolored Heron (TRHE), Yellow-crowned Night Heron (YCNH) and Black-crowned Night Heron (BCNH), were undercounted because of their lower visibility from above (Frederick et al., 1996). Thus, the colony totals presented in Table 19 are considered conservative. Nest fate and nesting success were not monitored, but one ground survey was conducted at the Lake Mary Jane colony on April 8, 2014, to obtain a more accurate nest count and determine the presence of less visible dark-colored species.

RESULTS

Twenty-one colonies were located during the 2014 surveys (Table 19). None of the colonies were within 3 km of the restored portions of the Kissimmee River, but several were in unrestored portions of the river both north and south of the restoration area (Table 19; Figure 15 and Figure 16). As a result of the expanded survey area this season, 10 previously undocumented wading bird colonies were located.

The number of wading bird nests documented this season (3671) was slightly higher than the long-term average of 3123 (±160 SE); however, part of the increase is due to the previously undocumented colonies, which included 234 nests. The remaining additional nests this season were largely the result of increased White Ibis (WHIB) nesting on Lake Mary Jane. All other species, except the terrestrial Cattle Egret (CAEG), were similar to the long-term average. There was a decrease in the number of CAEG nesting on the Kissimmee River and Lakes Mary Jane, Istokpoga, and Kissimmee compared to last season; although in past years the peak number of CAEG nests occurred in late May and June, after the final survey in May. The S-65C Boat Ramp Colony, typically the largest colony within the 100-year floodline of the Kissimmee River and dominated by CAEG, did not form this season. One likely reason is a decline in suitable nesting substrate. The colony had previously formed in invasive or non-native shrubs that had established on floating mats of vegetation; these stands were treated with herbicide in 2011 and have now completely decomposed.

All colonies this season were dominated by aquatic species as of late May, with the exception of Bumblebee Island on Lake Istokpoga, which was dominated by CAEG. As was the case last year, the largest colony to form in the Kissimmee Basin was on Lake Mary Jane (1792 nests), which was dominated by WHIB, Great Egret (GREG), and Wood Stork (WOST)(Table 19).

Most nesting of aquatic wading birds and cattle egrets continues to occur outside of the Kissimmee River Restoration Project area on islands in the Upper Kissimmee Basin and Lake Istokpoga. To date, only one colony of aquatic bird species (S-65C Boat Ramp Colony) has formed within 3 km of the partially restored portion of the Kissimmee River, and during most years it contains less than 50 nests of aquatic species. The continued small numbers of aquatic species nesting along the restored area suggests that prey availability on the floodplain is not sufficient to support the completion of breeding for these wetland-dependent birds.

Figure 15. Observed nesting colony sites within the Upper Kissimmee Basin, February–May 2014.

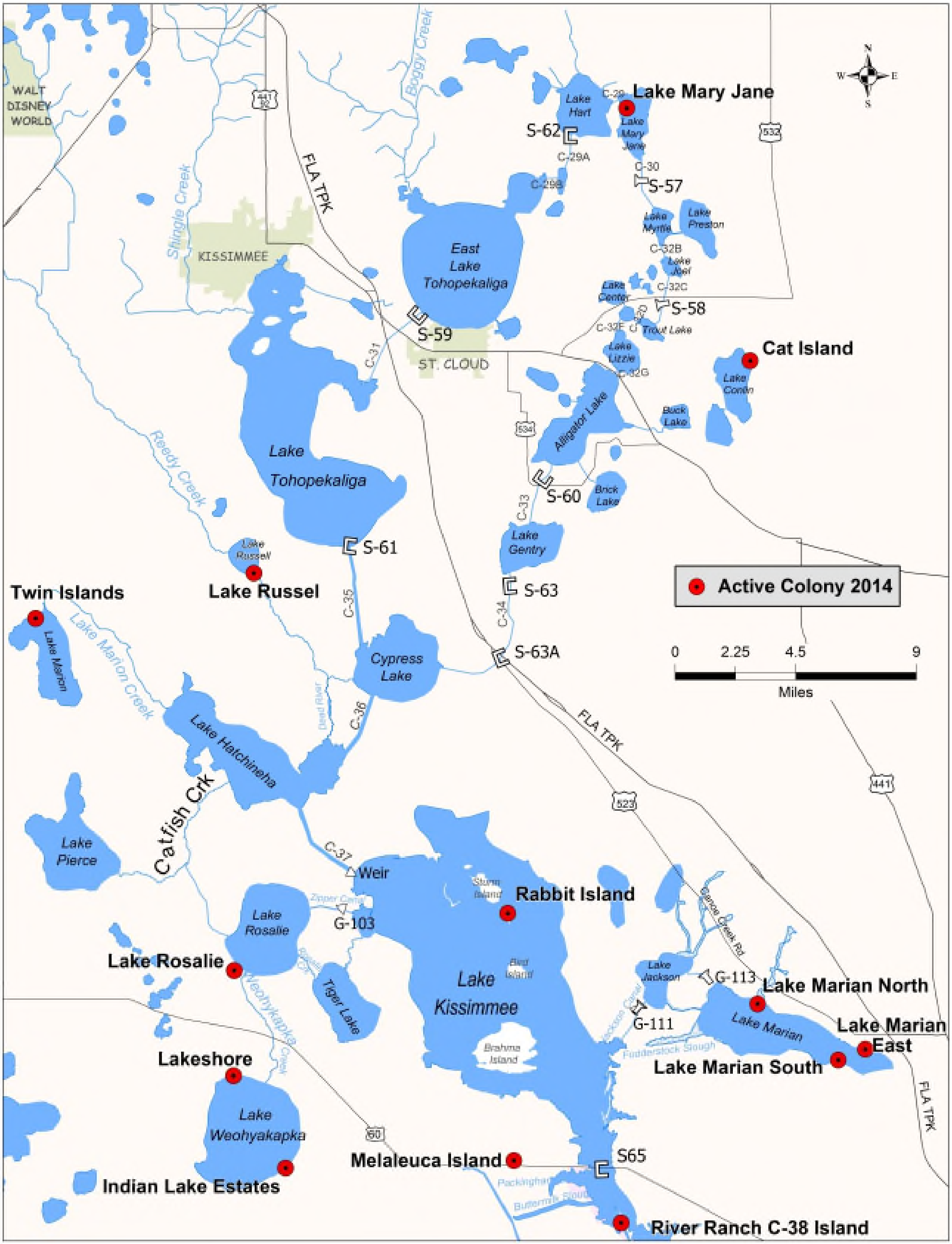


Figure 16. Aerial wading bird colony survey transect routes and nesting colony sites within the Lower Kissimmee Basin, February–May 2014.

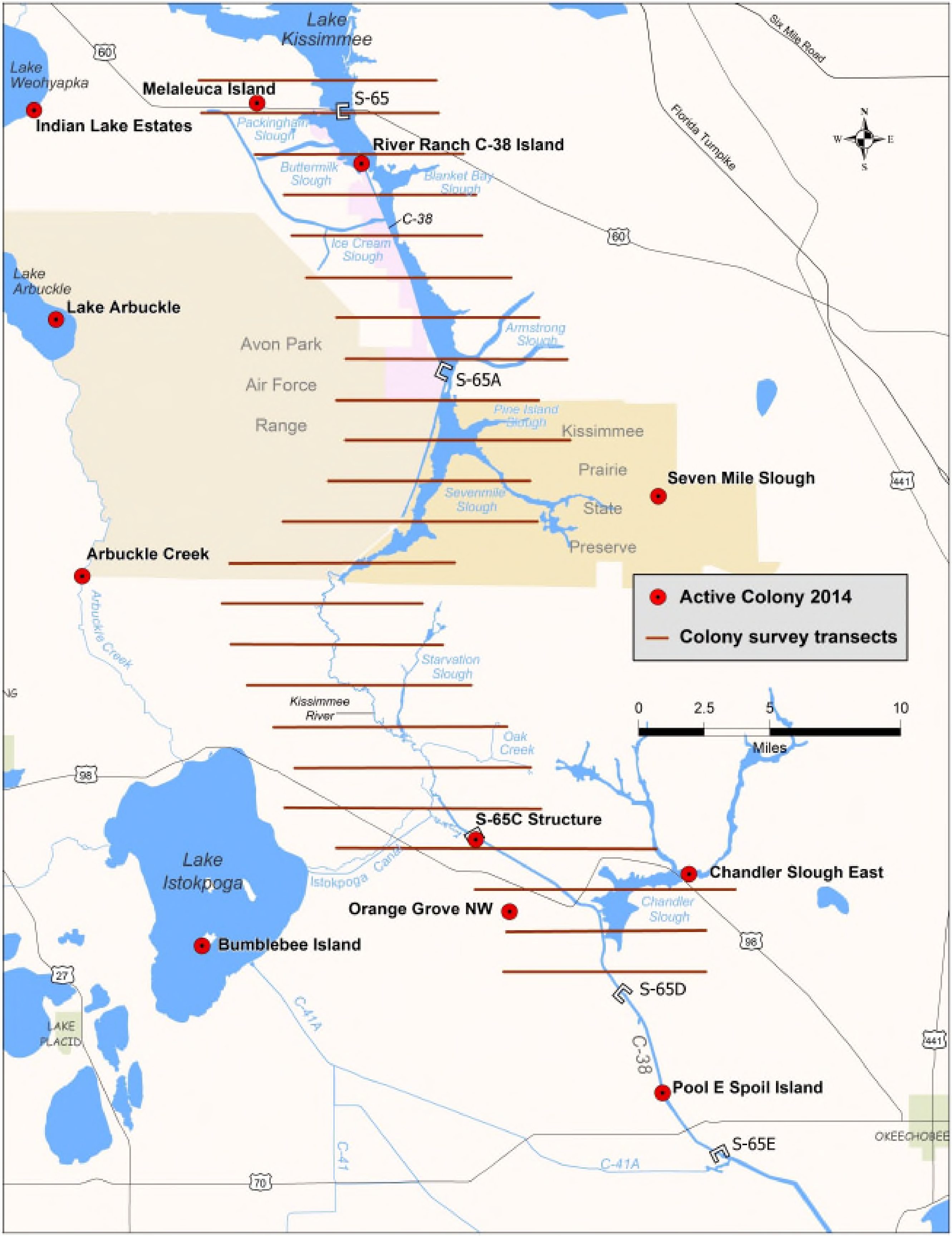


Table 19. Peak (maximum) numbers of wading bird nests within the Kissimmee Basin, February–May 2014.

Colony Name (Location)	Lat, Long	CAEG	GREG	WHIB	GBHE	Small Dark	Small White	GLIB	BCNH	WOST	Total Nests
Arbuckle Creek*	27.5448, -81.3592	-	18	-	5	-	-	-	-	-	23
Bumblebee Island (Lake Istokpoga)	27.3993, -81.1136	658	210	75	55	-	-	-	-	-	998
Cat Island (Lake Conlin)	28.2412, -81.1075	-	-	-	-	-	-	-	-	40	40
Chandler Slough East	27.3803, -80.9811	-	5	-	3	-	-	-	-	-	8
Indian Lake Estates*	27.8034, -81.3901	-	-	-	2	-	-	-	-	-	2
Lake Arbuckle*	27.6874, -81.3760	-	-	-	8	-	-	-	-	-	8
Lake Marian East*	27.8681, -81.0370	-	-	-	3	-	-	-	-	-	3
Lake Marian North*	27.8925, -81.1028	-	-	-	28	-	-	-	-	-	28
Lake Marian South*	27.8622, -81.0536	-	-	-	2	-	-	-	-	-	2
Lake Mary Jane	28.3789, -81.1843	-	245	1254	-	53	35	2	15	188	1792
Lake Rosalie	27.9100, -81.4219	-	44	-	-	-	-	-	-	9	53
Lake Russel*	28.1251, -81.4108	-	2	-	-	-	-	-	-	45	47
Lakeshore (Fedhaven)*	27.8531, -81.4222	-	-	-	9	-	-	-	-	-	9
Melaleuca Island	27.8077, -81.2511	-	-	-	4	-	-	-	-	-	4
Orange Grove NW	27.3595, -81.0930	-	1	-	15	-	-	-	-	-	16
Pool E Spoil Island*	27.7157, -81.2203	5	8	-	6	1	-	-	-	-	20
Rabbit Island (Lake Kissimmee)	27.9387, -81.2541	85	186	157	75	-	15	-	-	-	518
River Ranch C-38 Island	27.7749, -81.1858	-	25	-	3	-	-	-	-	-	28
S-65C Structure	27.3993, -81.1136	-	2	-	-	-	-	-	-	-	2
Seven Mile Slough	27.5898, -81.0011	-	7	-	4	-	-	-	-	-	11
Twin Islands* (Lake Marion)	28.1002, -81.5440	-	52	-	7	-	-	-	-	-	59
Total		748	805	1486	229	54	50	2	15	282	3671

***** = Previously undocumented colony, newly observed in 2014

FORAGING ABUNDANCE

As part of KRREP, the following restoration expectation was developed for the abundance of foraging wading birds on the floodplain post-construction:

> Mean annual dry season density of long-legged wading birds (excluding cattle egrets) on the restored floodplain will be ≥ 30.6 birds per square kilometer (birds/km^2) (Williams and Melvin, 2005a).

Detailed information regarding the interim response of wading birds and waterfowl to Phase I restoration can be found in a recent research article by Cheek et al. (2014).

Methods

East-west aerial transects (n=218) were established at 200 m intervals beginning at the S-65 structure and ending at the S-65D structure (see Figure 16 for structure locations). Each month, a minimum of 20% of the 100-year floodplain was surveyed in the restored and unrestored portions of the river/floodplain. Surveys were conducted via helicopter at an altitude of 30.5 m and a speed of 80 km/hr. A single observer counted all wading birds and waterfowl within 200 m of one side of the transect line. Because it is not always possible to distinguish TRHE from adult LBHE during aerial surveys, the two are lumped together as Small Dark Herons. Likewise, Snowy Egret (SNEG) and immature LBHE were classified as Small White Herons (Bancroft et al. 1990).

Results

Prior to the restoration project, dry season abundance of long-legged wading birds in the Phase I restoration area averaged (±SE) 3.6±0.9 birds/km² in 1997 and 14.3±3.4 birds/km² in 1998. Since completion of Phases I, IVa, and IVb of restoration construction in 2001, 2007, and 2009, respectively, abundance has exceeded the restoration expectation of 30.6 birds/km² (evaluated as a 3-year running average), except during 2007–2009 and 2009–2011 (Figure 17).

The mean monthly wading bird abundance within restored parts of the river during the 2013–2014 season (24.6±8.0 birds/km²) was less than last year's estimate (28.8±6.6 birds/km²). This brought the 3-year running average to 32.6±6.0 birds/km² (Figure 18). Wading bird numbers were above average in November as water levels on the floodplain receded relatively quickly and began to concentrate prey items. December numbers were below the long-term monthly average before rebounding to above average during January. In February, numbers dropped substantially after a reversal during which water levels rose approximately 0.34 ft on the floodplain and presumably dispersed potential prey. Water levels receded again on the floodplain through mid-March, when survey numbers showed an uptick in bird use. A second, smaller reversal (≈0.16 ft) occurred in mid-April prior to the survey flight that showed a slight decrease in bird use. Floodplain water levels receded a third time prior to another reversal (≈0.31 ft) in early May when bird numbers were extremely low (≈5.8 birds/km²).

WHIB dominated numerically, followed in order of abundance by GREG, GLIB, Small White Herons (SNEG and juvenile LBHE), WOST, Great Blue Heron (GBHE), CAEG, Small Dark Herons (TRHE and adult LBHE), Roseate Spoonbill (ROSP), and Black-crowned Night Heron (BCNH).

Figure 17. Post-restoration abundance (3-year running averages [±S.E.]) of long-legged wading birds (excluding CAEG) during the dry season (December–May) within the Phase I, IVA, and IVB restoration areas of the Kissimmee River.

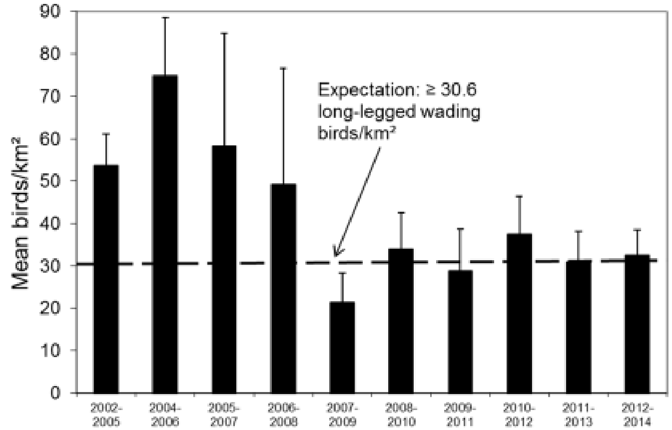
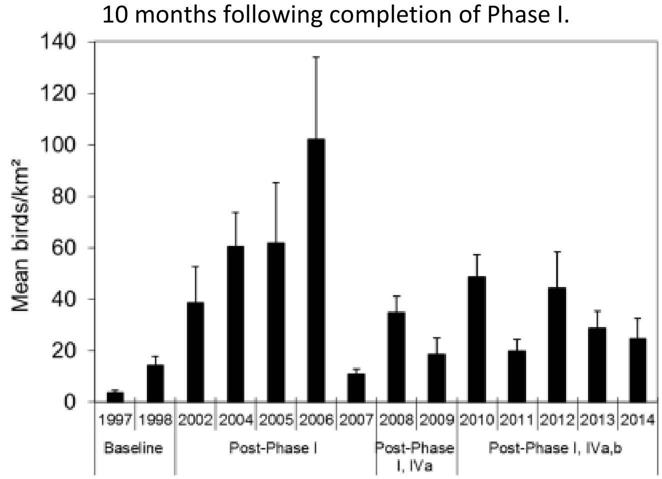


Figure 18. Baseline and post-Phases I, IVa, and IVb mean abundance (± E) of long-legged wading birds (excluding CAEG) per square kilometer (birds/km^2) during the dry season (December–May) within the 100-year flood line of the Kissimmee River. Baseline abundance was measured in the Phase I area prior to restoration. Post-restoration abundance was measured beginning approximately 10 months following completion of Phase I.



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STATUS OF WADING BIRD RECOVERY

The sustainability of healthy wading bird populations is a primary goal of the Comprehensive Everglades Restoration Plan (CERP) and other Everglades restoration programs in south Florida. A central prediction of CERP is that a return to natural flows and hydropatterns will result in the recovery of large and sustainable breeding wading bird populations, a return to natural timing of nesting, and restoration of large nesting colonies in the coastal zone (Frederick et al. 2009). There are at least two overlapping sets of measures of attaining these conditions, all based on historical conditions and thought to represent key ecological features of the bird-prey-hydrology relationship. RECOVER (Restoration Coordination and Verification) established Performance Measures[b] that include the 3-year running average of the numbers of nesting pairs of key avian species in the mainland Everglades, the timing of Wood Stork (WOST) nesting, and the proportion of the population that nests in the coastal ecotone (Ogden et al. 1997). In addition to these three, the *System-Wide Ecological Indicators for Everglades Restoration* reports[c] have two other measures: the ratio of visual to tactile wading bird species breeding in the Everglades and the frequency of exceptionally large White Ibis (WHIB) breeding events. These measures were added to further capture key ecological relationships found in the historical ecosystem (Frederick et al. 2009). In this section, I report on the long-term trends and current status of these measures. When thinking about progress towards these restoration measures, it should be remembered that the hydrological system is not yet restored to provide anything like the ecological functions expected in a completed CERP. Based on the current status of the hydrological system, we would not have predicted restored or even partially restored wading bird population indicators.

[b] http://www.evergladesplan.org/pm/recover
[c] http://www.evergladesrestoration.gov/documents.html

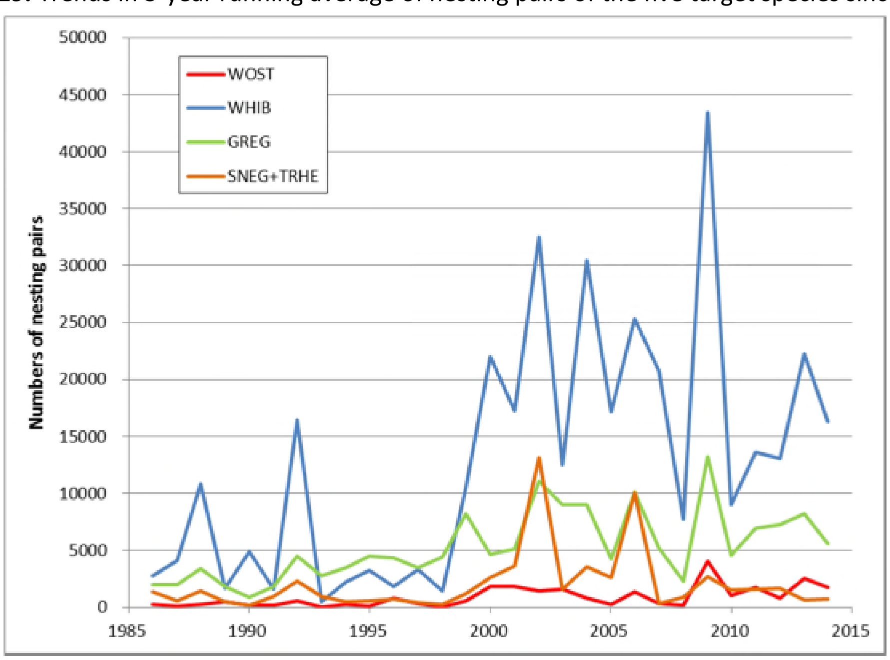
The main indicator species are Great Egret (GREG), Snowy Egret (SNEG), WHIB, and WOST. The Tricolored Heron (TRHE) was originally included in these species (Ogden et al. 1997), but this species has proven extremely difficult to consistently monitor during aerial surveys due to their dark plumage. Ogden et al. (1997) lumped TRHE and SNEG population targets (e.g., 10,000 breeding pairs) because it is difficult to derive an expected number for SNEG alone (Ogden 1994). Based on relative abundances in coastal colonies (Ogden 1994), roughly equal support can be derived for 1:1 ratios as for 2:1 ratios (SNEG:TRHE). In practice, the distinction is unimportant since both species appear to be declining and are nowhere near the population restoration targets. Here, I summarize data for the three Water Conservation Areas (WCAs) and mainland Everglades National Park (ENP).

RESULTS

Numbers of nesting pairs

The 3-year running averages for nesting pairs (2012–2014) are 7040 for GREG, 1017 for SNEG, 17,194 for WHIB, and 1696 for WOST. Trends for GREG (Figure 19) for this measure increased markedly from 1988–2004, and have been stable or slightly declining since, with the 3-year running average meeting or exceeding restoration criteria for 19 consecutive sampling periods since 1996 (Table 20). SNEG also increased markedly from 1986 to 2004, but dropped since 2005. The 2014 season showed continued declines compared with the previous 3 years. The 3-year running averages of breeding SNEG have been consistently well below the target restoration goal in the time they have been monitored since 1986. The 3-year running average increased markedly for WHIB during 1986–2001 (2.7 X) and then remained variable but arguably stable during 2002–2011. From 2011–2014, substantial decreases in ibis nesting (approximate 50% reduction in three of the years), with three of the four years being well below the average of the previous decade. WHIB nesting populations met or exceeded the breeding population criterion during each of the past 13 years. WOST

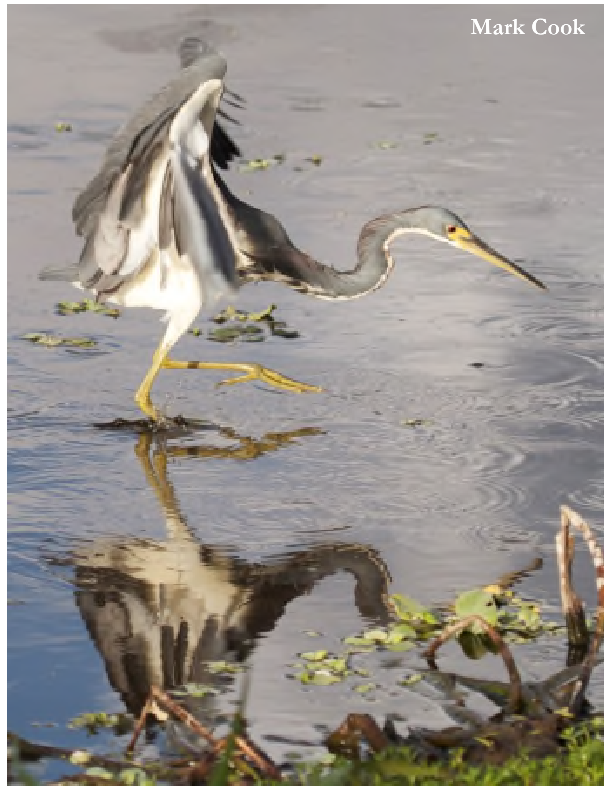
Figure 19. Trends in 3-year running average of nesting pairs of the five target species since 1986.



showed a marked increase from an average of 200–300 pairs (1986–1992) to more than 1000 after 1999. WOST have equaled or exceeded the restoration population criterion during 7 of the last 12 years. Together, these statistics illustrate that there has been a very substantial increase in numbers of GREG, WOST, and WHIB since 1986, followed by a period of relative stability during which each species has met restoration targets most years. SNEG, however, continue to nest in declining numbers and have never met restoration targets. In addition, there is evidence from systematic ground surveys in WCA-3 (see *Regional Nesting Reports – Water Conservation Areas 2 and 3, and A.R.M. Loxahatchee National Wildlife Refuge*) that breeding populations of Tricolored and Little Blue Herons are also declining sharply in the Everglades.

Table 20. 3-year running averages of the number of nesting pairs for the five indicator species in the Everglades. Bold numbers are years in which the target minima were met.

3-Year Period	Year	GREG	SNEG	WHIB	WOST
Target Minima:		4000	10,000–20,000	10,000–25,000	1,500–2,500
1986-88	1988	1,946	1,089	2,974	175
1987-89	1989	1,980	810	2,676	255
1988-90	1990	1,640	679	3,433	276
1989-91	1991	1,163	521	3,066	276
1990-92	1992	2,112	1,124	8,020	294
1991-93	1993	2,924	1,391	6,162	250
1992-94	1994	3,667	1,233	6,511	277
1993-95	1995	3,843	658	2,107	130
1994-96	1996	**4,043**	570	2,172	343
1995-97	1997	**4,302**	544	2,850	283
1996-98	1998	**4,017**	435	2,270	228
1997-99	1999	**5,084**	616	5,100	279
1998-00	2000	**5,544**	1,354	**11,270**	863
1999-01	2001	**5,996**	2,483	1,655	**1,538**
2000-02	2002	**7,276**	6,455	**23,983**	**1,868**
2001-03	2003	**8,460**	6,131	**20,758**	**1,596**
2002-04	2004	**9,656**	6,118	**24,947**	**1,191**
2003-05	2005	**7,829**	2,618	**20,993**	742
2004-06	2006	**8,296**	5,423	**24,926**	800
2005-07	2007	**6,600**	4,344	**21,133**	633
2006-08	2008	**5,869**	3,767	**17,541**	552
2007-09	2009	**6,956**	1,330	**23,953**	**1,468**
2008-10	2010	**6,715**	1,723	**21,415**	**1,736**
2009-11	2011	**8,270**	1,947	**22,020**	**2,263**
2010-12	2012	**6,296**	1,599	**11,889**	1,182
2011-13	2013	**7,490**	1,299	**16,282**	**1,686**
2012-14	2014	**7,040**	1,017	**17,194**	**1,696**


Mark Cook

Colony Location

It is estimated that more than 90% of nesting indicator species occurred in the southern ecotone region during the 1930s and early 1940s, in all likelihood because this was the most productive area. A major restoration hypothesis holds that the reduction of freshwater flows to this region reduced secondary productivity and resulted in the abandonment of the area by nesting wading birds. The proportion of the entire mainland Everglades nesting population that nests in the coastal zone is one of the restoration indicators, with at least 50% of nesting as the restoration target (Ogden et al. 1997). This measure has shown considerable improvement since the lows of the mid-1990s and early 2000s (2–10%, Figure 20), and during the last several years has ranged between 15 and 46%. In 2014 the proportion was 17%.

Timing of Nesting

This parameter applies only to the initiation of nesting for WOST, which has shifted from November–December (1930s through 1960s) to January–March (1980s–present). Later nesting increases the risk of mortality of nestlings that have not fledged prior to the onset of the wet season and can make the difference between the south Florida stork population being a source or sink population. This measure has shown a consistent trend towards later nesting from the 1930s to the 1980s (Figure 21), with variation around a February mean initiation date since the 1980s. Although some years in the mid-2000s had earlier nesting, there has been no lasting improvement. The 2014 season was early (late-January) by comparison with recent years but later than the November–December benchmark.

Figure 20. Proportion of all mainland Everglades nesting in the coastal estuarine zone, 1986–2014.

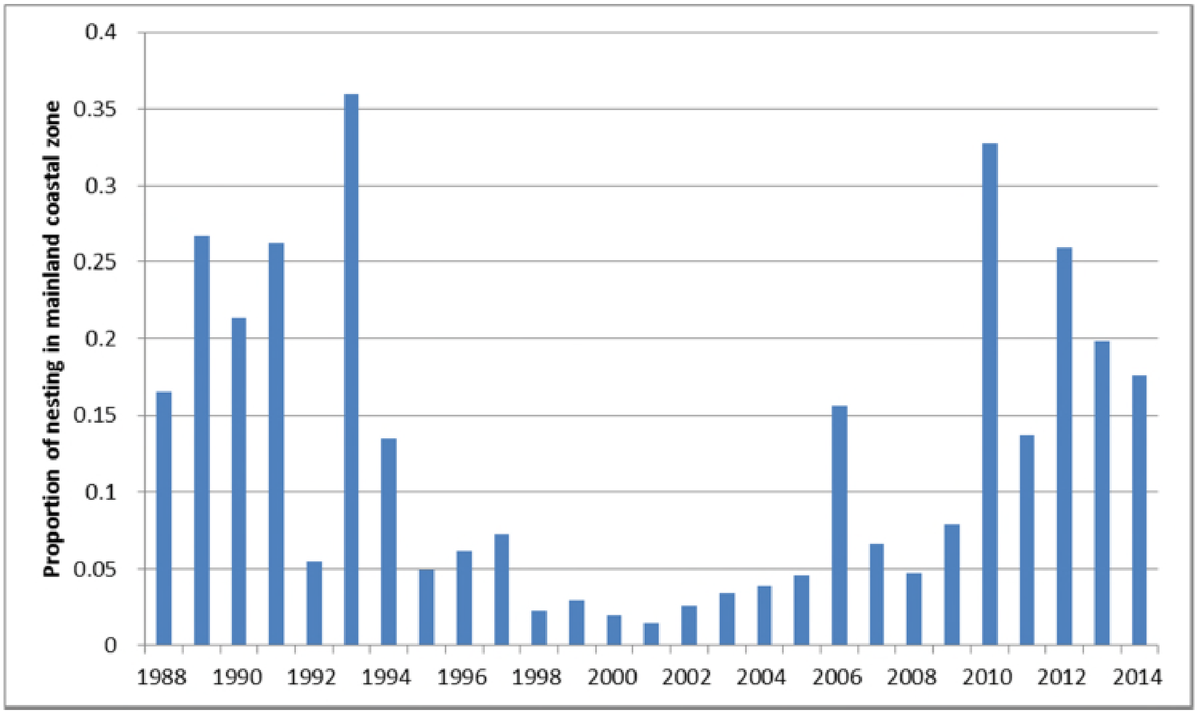
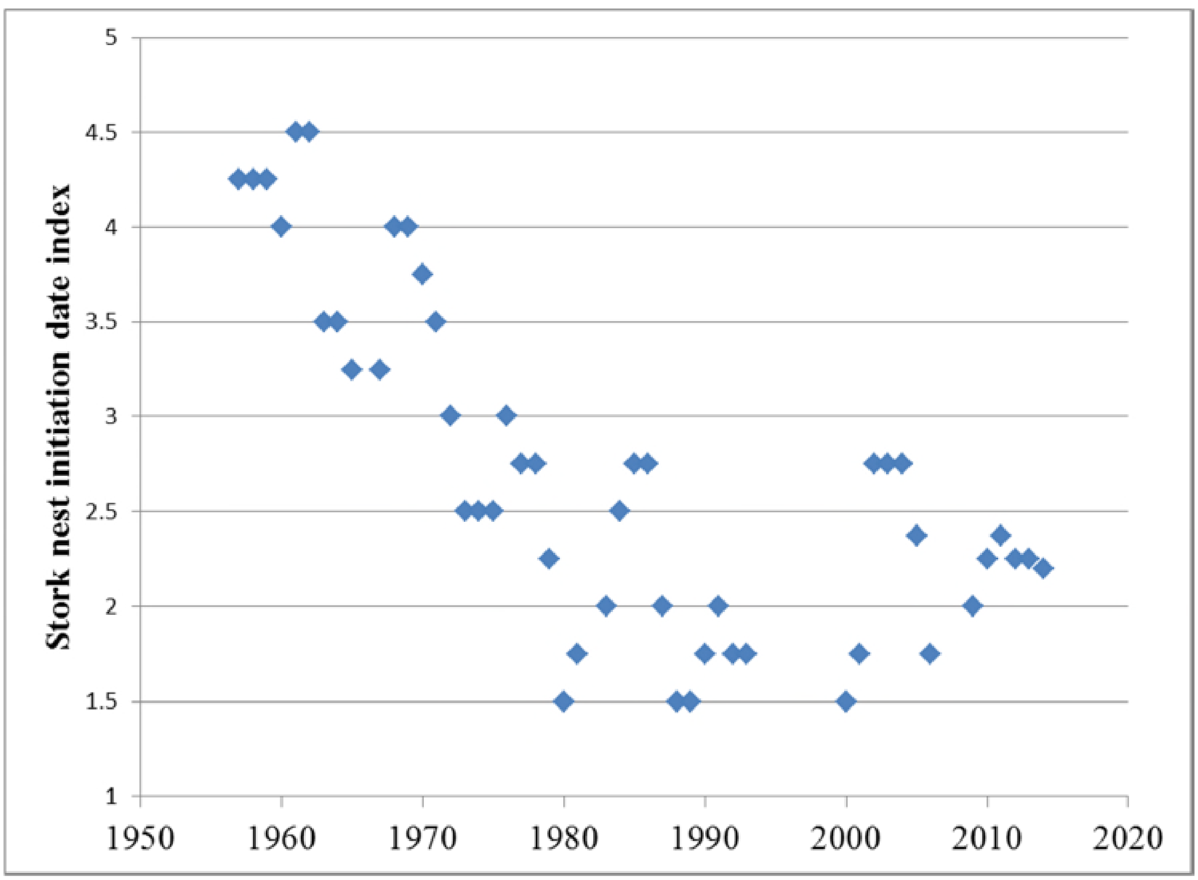


Figure 21. 4-year running average Wood Stork nest initiation date, 1960–2014 (1 = March, 5 = November). Target nest dates for restored conditions are November–December.



Ratio of Visual to Tactile Foragers

This measure recognizes that the breeding wading bird community has shifted from being numerically dominated by tactile foragers (storks and ibises) during the predrainage period to visual foragers such as GREG. This shift is thought to have occurred as a result of impounded, stabilized, or overdrained marsh, which leads to the declining availability of larger forage fishes for WOST and crayfishes for ibises. These conditions also seem to favor species like GREG that are less reliant on the entrapment of prey and can forage in groups or solitarily under various circumstances. The restoration target is 32 breeding tactile foragers to each breeding visual forager, characteristic of the 1930s breeding assemblages. While this measure has improved since the mid-1990s (from 0.66 to 3.5), the ratio is still an order of magnitude less than the restoration target. The 5-year running average for this measure in 2013 was 2.49.

Exceptionally Large Ibis Aggregations

Exceptionally large breeding aggregations of ibises were characteristic of the predrainage system and are thought to be indicators of the ability of the wetland system to produce very large pulses of prey resulting in part from typical cycles of drought and flood. Large breeding aggregations during the recent period are defined as being above 16,977 nests each year, defined as the 70th percentile of the period of record of annual nestings. The interval between large ibis nestings in the predrainage period was 1.6 years and this serves as the target for restoration. This measure has improved markedly since the 1970s, with the target achieved in 8 of the last 10 years (Figure 22). The 2014 ibis nesting did reach the criterion, and the interval averaged over the last 5 years is 1.4 years, slightly less than in the 1930s.

DISCUSSION

Taken together, these measures of wading bird nesting suggest that while there have been real improvements, several key measures are stalled and not showing further improvement. Two measures are genuinely hopeful – numbers of nesting pairs of ibises, storks, and GREG in the system seem to be achieving the restoration targets, and the interval between exceptional ibis nesting years has consistently met the restoration target for 8 of the past 10 years. There has been real progress in the location of nesting, but the proportion nesting in the coastal zone remains low (5-year running average of 22% compared to 50% target), and there is much room for improvement.

Several measures are not improving. The numbers of SNEG are declining and remain far from restoration targets. There is little evidence that the timing of nesting for WOST is improving and it may be getting worse. The ratio of tactile to visual foragers has improved since the mid-2000s, but remains an order of magnitude below the restoration target.

These results illustrate clearly that the birds probably have responded in the last two decades to a combination of altered water management regimes, good weather, and improved hydropatterns by nesting more consistently in the coastal zone, and by increasing populations of ibises and storks. While some population increases may be attributable to forces outside the Everglades, the fact that these species have been attracted to nest in the Everglades in larger numbers remains a solid indicator. The lack of movement of the other measures suggests that the current management regimes are not powerful enough to further nudge the timing of nesting, ratio of tactile foragers, or numbers of nesting SNEG. While this illustrates an apparent stasis, it should be remembered that full restoration of wading bird populations is predicted only as a result of full restoration of key historical hydropatterns, which has not yet occurred.

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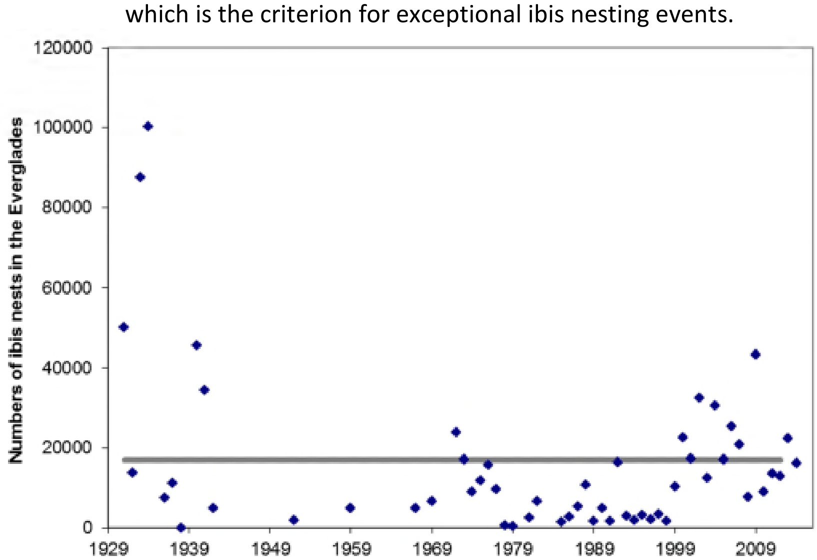
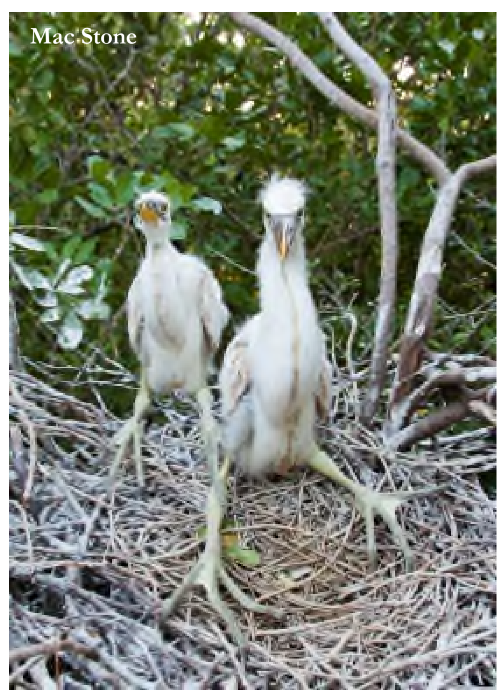
Figure 22. White Ibis nests in the mainland Everglades, 1930–2014. Gray line illustrates the 70th percentile of the period of record, which is the criterion for exceptional ibis nesting events.





SPECIAL TOPIC

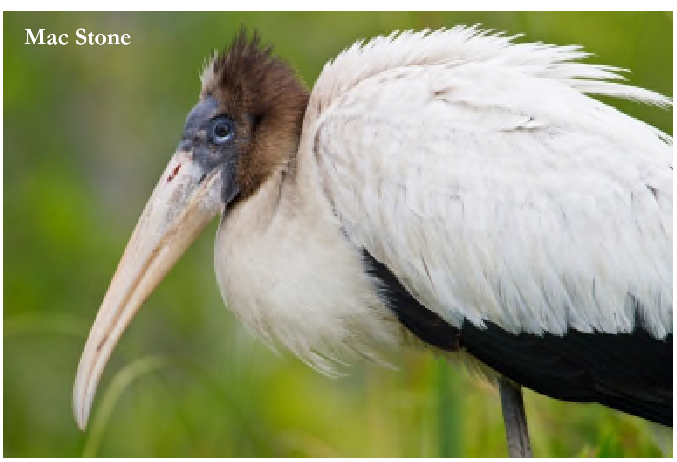
WOOD STORK PREY COMPOSITION AT A COASTAL AND INTERIOR COLONY IN EVERGLADES NATIONAL PARK

Wood Storks (WOST) are sensitive to changes in Everglades ecosystem conditions due to their reliance on the abundance and availability of aquatic prey to initiate and sustain reproductive activities (Gawlik 2002). As a food-limited species (Kushlan 1986, Gawlik 2002), WOST diets can give insights into fish community assemblages and highlight key prey species for nesting colonies. This is of particular interest since the most recent study on WOST diets was in 1976 (Ogden et al. 1976), just as stork colonies on the coast were collapsing. We present preliminary data regarding WOST prey composition from a coastal and interior colony in Everglades National Park (ENP) during the 2014 nesting season.

METHODS

We collected boluses from nestling WOST within Paurotis Pond (25.28150, -80.80300) and Tamiami West (25.75784, -80.54484) colonies in ENP from March 3 through May 20, 2014. Paurotis Pond is near the southern tip of Florida in a coastal brackish water wetland, whereas Tamiami West is further north in the freshwater interior of the Everglades. Nestlings often regurgitate in the presence of humans, making bolus contents readily available. If a targeted nestling did not voluntarily regurgitate, we gently massaged its trachea to encourage regurgitation. To compensate for loss of bolus contents, we fed nestlings a comparable amount of baitfish before leaving the nest site. Bolus contents were placed in a Ziploc bag on ice for the duration of the sampling trip and later stored in a freezer for preservation.

To determine consumed prey species, we poured thawed bolus contents through a 0.6-micrometer mesh net, rinsed with water, and sorted remains under a magnifying lens. We identified, weighed, and measured each prey item found within each bolus, noting whether each piece represented a part or whole prey species.



RESULTS AND DISCUSSION

We collected 110 boluses: 54 from Paurotis Pond and 56 from Tamiami West. Bolus contents included 648 prey items from 26 taxonomic groups (Table 21). Prey items ranged in length from 1.0 to 35.5 cm with a mean length of 5.5±2.8 cm.

Prey Differences 1976 to 2014

The primary change in diets since the Ogden et al. (1976) study was the prominence of exotic fishes. Bolus contents from the 1976 study contained only native species whereas exotic fishes accounted for 13% of prey species and 8% of prey biomass within boluses collected in 2014. We also noted a shift in dominant prey species. Odgen et al. (1976) noted that flagfish (*Jordanella floridae*), sailfin molly (*Poecilia latipinna*), and marsh killifish (*Fundulus confluentus*) accounted for 70% of all prey items. However, we found spotted sunfish (*Lepomis punctatus*), dollar sunfish (*Lepomis marginatus*), and African jewelfish (*Hemichromis letourneauxi*) to be the most common prey, accounting for 75% of all prey items within both colonies. One commonality between both studies was the fish species contributing the most biomass: sunfish (*Lepomis* spp.) and bullhead (*Ameriurus* spp.) species comprised 56% of the biomass in the Ogden et al. (1976) study and 84% of the biomass in our 2014 study. We also found a slight shift towards larger prey (Figure 23) with the most common prey length approximately 1 cm larger in 2014 when compared to Ogden et al. (1976). Considering the average fish size available in the landscape was smaller in 2014 (1.5 cm, unpublished data) compared to 2.5 cm for Ogden et al. (1976), this shift may indicate an increased selectivity by WOST for larger prey.

Colony Differences in Exotic Fish Composition

Paurotis Pond and Tamiami West differed greatly in the number of consumed exotic fishes. Boluses from Paurotis Pond contained only 7 exotic prey individuals, whereas boluses from Tamiami West contained 74 exotic prey individuals accounting for 18% of all prey consumed at that colony. This high number of exotic individuals at Tamiami West was primarily composed of African jewelfish (n = 57). More importantly in terms of caloric provisions, exotic species accounted for 11% of the biomass in Tamiami West boluses, but only 2% of the biomass of Paurotis Pond boluses. This difference in exotic species consumption is most likely due to the proximity of the Tamiami West colony along the L-29 canal, a known source of exotic fish populations. As exotic fish continue to proliferate throughout the Everglades, they may become a more dominant prey source for WOST and an important source of calories during the nesting season.

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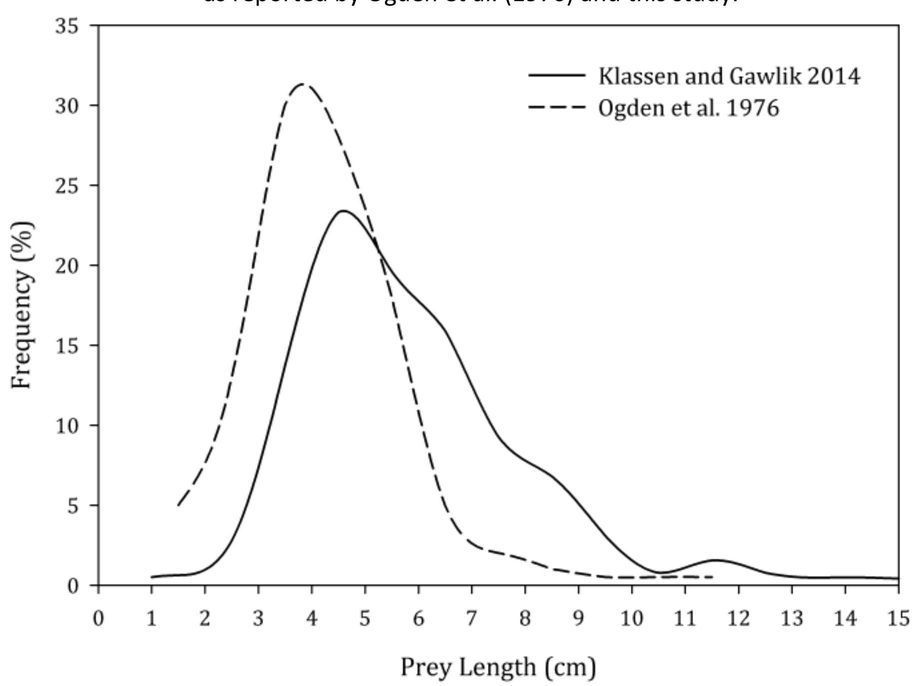
Table 21. Prey species found within Wood Stork boluses nesting at Paurotis Pond and Tamiami West colonies in 2014. N is the number of individuals within each taxonomic group.

		Paurotis Pond		Tamiami West	
Common Name*	**Scientific Name**	**N**	**Biomass (g)**	**N**	**Biomass (g)**
African jewelfish	*Hemichromis letourneauxi*	5	26.0	57	130.2
Bluefin killifish	*Lucania goodei*	2	0.5	4	0.7
Black acara	*Cichlasoma bimaculatum*	0	0.0	9	46.0
Black sea bass	*Centropristis striata*	0	0.0	1	75.4
Bluegill	*Lepomis macrochirus*	0	0.0	1	33.0
Brown bullhead	*Ameiurus nebulosus*	13	278.8	12	224.8
Bluespotted sunfish	*Enneacanthus gloriosus*	2	3.6	0	0.0
Crayfish	*Procambarus* species	6	6.5	1	0.9
Dollar sunfish	*Lepomis marginatus*	28	90.9	62	201.7
Flagfish	*Jordanella floridae*	1	1.6	6	1.8
Golden topminnow	*Fundulus chrysotus*	5	9.9	8	15.4
Grass carp	*Ctenopharyngodon idella*	0	0.0	1	101.5
Grass shrimp	*Palaemonetes paludosus*	1	0.3	2	0.5
Largemouth bass	*Micropterus salmoides*	4	135.3	0	0.0
Mayan cichlid	*Cichlasoma urophthalmus*	1	2.9	5	31.6
Marsh killifish	*Fundulus confluentus*	1	1.1	1	1.8
Mosquito fish	*Gambusia holbrooki*	1	0.3	7	2.1
Pike killifish	*Belonesox belizanus*	1	5.9	2	24.5
Sailfin molly	*Poecilia latipinna*	4	7.0	19	30.0
Siren	*Sirenidae* species	2	100.2	0	0.0
Spotted sunfish	*Lepomis punctatus*	123	919.8	205	2005.6
Tadpole madtom	*Nocturus gyrinus*	9	11.5	0	0.0
Unknown bullhead	*Ameriurus* species	1	1.7	1	1.3
Unknown sunfish	*Lepomis* species	12	52.9	12	62.4
Warmouth	*Lepomis gulosus*	0	0.0	1	4.3
Yellow bullhead	*Ameiurus natalis*	6	131.7	3	94.3

* Species with common names in bold are exotic.

Figure 23. Comparison of prey lengths within Wood Stork boluses in the Everglades as reported by Ogden et al. (1976) and this study.



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