SOUTH FLORIDA WADING BIRD REPORT

Volume 23 Mark I. Cook and Michael Baranski, Editors February 2018

SYSTEMWIDE SUMMARY

NESTING IN SOUTH FLORIDA

An estimated 46,248 wading bird nests (excluding Cattle Egrets [CAEG], which do not rely on wetlands) were initiated in South Florida during the 2017 breeding season (December 2016 to July 2017). This is a moderate improvement compared to 10-year average (39,065.9 nests) and the 5-year average (36,939.6 nests), and one of the highest counts since the banner breeding season of 2009 (87,564 nests).

Most wading bird species exhibited increased or average nesting effort in South Florida during 2017. Of note was the large number of nests produced by the federally threatened Wood Stork (WOST; 3,894 nests), which was almost double (1.8 times) the 10-year average (2,127.4 nests). From a historical perspective, this was the largest nesting effort for WOST in South Florida since 2009 (6,487 nests) and the third largest since the late 1960s. The White Ibis (WHIB), the most abundant wading bird species in South Florida, produced slightly above average numbers of nests (22,995 nests) during 2017, a 13% increase compared to the 10-year average. Great Egrets (GREG) had a relatively average breeding season, producing 8,151 nests, which was a 2% increase compared to the 10-year average. The smaller *Egretta* heron species have exhibited consistent and steep declines in nest numbers in recent years, such that relatively few of these birds now nest in South Florida. This year, 844 Tricolored Heron (TRHE) and 1,341 Snowy Egret (SNEG) nests were counted, representing an 18% and 54% reduction in nesting effort, respectively, for these species relative to their decadal averages, and a marked decline from the 10,000 or so pairs that historically nested in South Florida. On the other hand, Little Blue Heron (LBHE) nesting (960 nests) increased by 62% this year relative to the 10-year average, which represents a marked increase relative to the very low numbers of nests recorded in recent years (e.g., only 49 nests were recorded in 2011). A relatively large number of small heron nests (3,713 nests) could not be identified to species this year (they were either SNEG, LBHE, or CAEG nests), which suggests the estimated counts for SNEG or LBHE, or both, were relatively conservative for 2017. Nonetheless, the decrease in nesting by the three *Egretta* species remains a concern, and the causes for these sharp declines have yet to be determined. The Roseate Spoonbill (ROSP) produced 460 nests in South Florida, which is a 19% decline from last year (566 nests) but comparable to the 10-year average (461.4 nests).

Wading bird nesting is not evenly distributed in South Florida (**Figure 1**). The most important region in terms of numbers of nests is the Everglades Protection Area (hereafter Everglades), which comprises the Water Conservation Areas (WCAs) and Everglades National Park (ENP), supporting between 70% and 95% of all nests annually. Wading birds initiated an estimated 35,127 nests in the Everglades during 2017, which is 76% of all nests in South Florida. This count is almost 15% greater than the 10-year average (30,660.2 nests), and 28% greater than the 5-year average (27,391.2 nests), but fewer than half the nests produced during 2009 when a record high of 73,096 nests was recorded in the Everglades. The next most important nesting region is Lake Okeechobee, which typically supports approximately 10% of South Florida's nests. This year, the lake produced an estimated 5,635 nests, which is a 32% improvement on the 10-year average (4,265.7 nests) and more than twice the number of nests produced last year (2,453 nests). Other regionally important nesting areas in 2017 were the Kissimmee Lakes (1,195 nests) and Florida Bay (1,500 nests).

In terms of the spatial distributions of individual species in South Florida in 2017, the Everglades supported most of the nesting WHIB, GREG, WOST, and LBHE (86%, 82%, 57%, and 87**%** of their total nests, respectively), but only a small proportion of SNEG and TRHE nests (17% and 4% of their total nests, respectively). Lake Okeechobee supported most of the nesting SNEG and TRHE (71% and 54% of their total nests, respectively), while Florida Bay was also a relatively important area for TRHE (29% of nests).

A nesting area that has experienced substantially reduced nesting activity in recent years is Audubon's Corkscrew Swamp Sanctuary. This historically important nesting area, which supported up to 7,000 WOST nests per year in the 1960s and often more than 1,000 nests per year in the early 2000s, has failed to support nesting during 8 of the past 10 years. While WOST did nest at Corkscrew in 2017, the number of nests was relatively low (250 nests) given the large nesting effort recorded elsewhere in South Florida. Loss of critical WOST foraging habitat in southwestern Florida and changes to the hydrology of the swamp may be responsible for the decline in nests.

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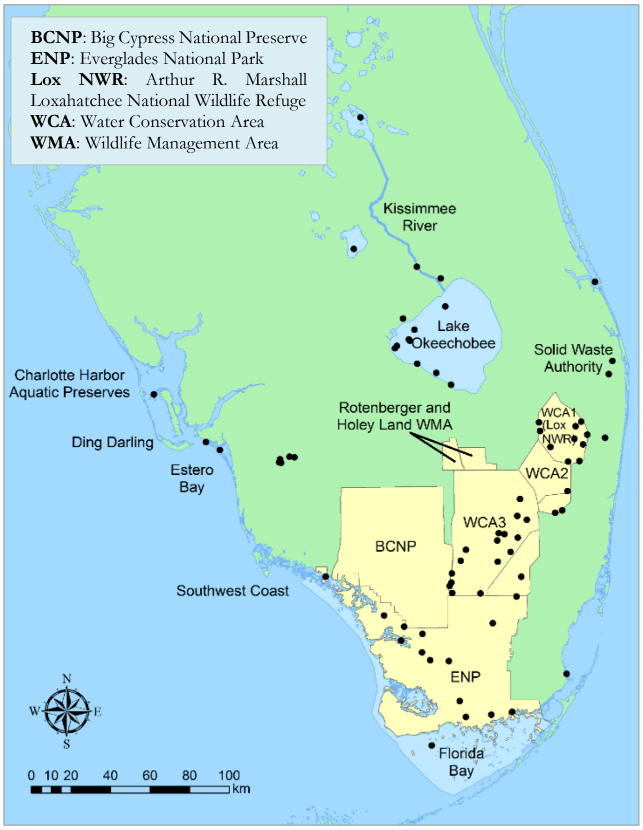

Figure 1. Locations of wading bird colonies with 50 or more nests in South Florida, 2017.

NESTING IN THE EVERGLADES

A primary goal of the Comprehensive Everglades Restoration Plan (CERP) and other restoration programs in South Florida is the return of healthy populations of breeding wading birds to the Everglades. CERP predicts that restoration of historical hydropatterns will result in the return of large, sustainable breeding wading bird populations, reset the historical timing of nesting, and encourage birds to nest again at the large colonies in the coastal region of ENP (Frederick et al. 2009). There are two sets of performance measures aimed at assessing these responses, based on historical ecological conditions and the hydrology-prey-foraging relationships that govern wading bird reproduction in South Florida. CERP's performance measures (http://www.evergladesplan.org/pm/recover) include the 3-year running average of the number of nesting pairs of key wading bird species, the timing of WOST nesting, and the proportion of the population that nests in the coastal ecotone (Ogden et al. 1997). In addition, annual Stoplight Reports have added two other measures: the ratio of visual to tactile wading bird species breeding in the Everglades, and the frequency of exceptionally large WHIB breeding events (Frederick et al. 2009).

Nest Numbers

Annual nesting effort is assessed using the average nest count from three successive breeding seasons to account for the large natural fluctuations in annual nesting effort. The primary indicator species are GREG, WHIB, WOST, and SNEG (Ogden et al. 1997) for mainland Everglades and ROSP for Florida Bay. TRHE originally was included among the mainland species but has proven difficult to monitor during aerial surveys due to its cryptic plumage and tendency to nest below the tree canopy. GREG, WHIB, and WOST exhibited relatively improved nesting effort in the Everglades during 2017 (**Figure 2**), but only GREG and WHIB met their CERP numeric restoration targets based on their 3-year running averages (**Table 1**; **Figure 3**). In terms of long-term trends, GREG and WHIB have exceeded target counts every year since 1996 and 2000, respectively, while WOST have exceeded their target seven times since 2000. SNEG and TRHE have been consistently below target since 1986 (**Table 1**; **Figure 3**).

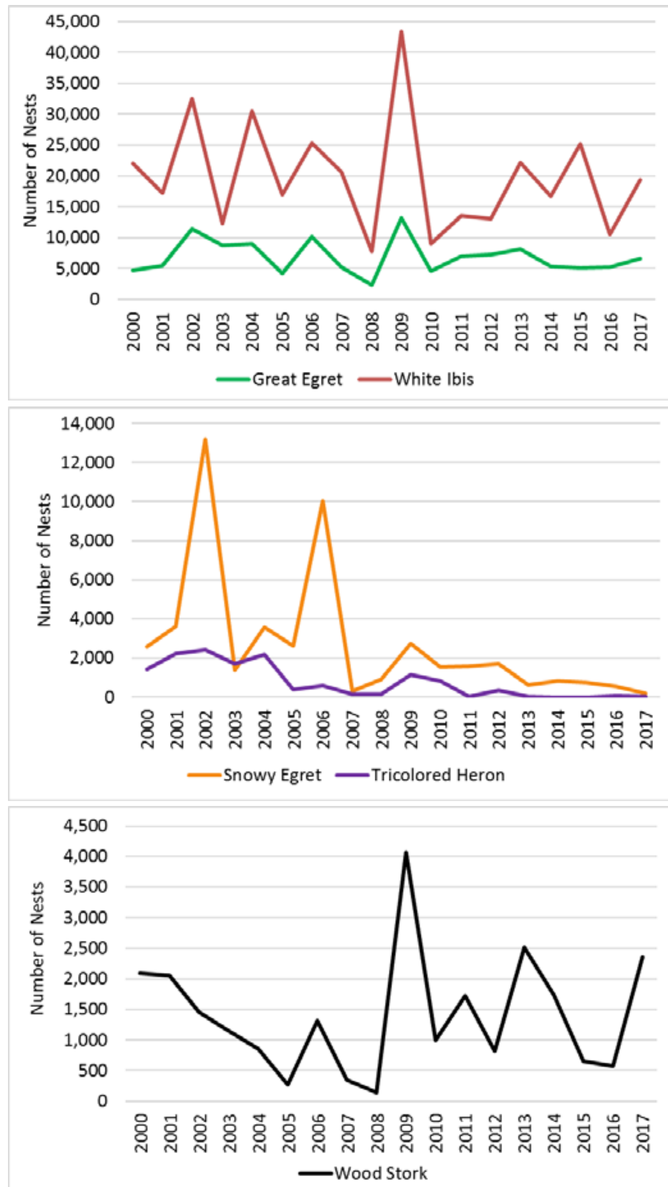

Figure 2. Wading bird nest numbers in the Everglades Protection Area (WCAs and ENP) for individual species since 2000.

Table 1. Three-year running averages of the number of nesting pairs for the four indicator species in the Everglades.

Period	GREG	SNEG	WHIB	WOST
1986-1988	1,946	1,089	2,974	175
1987-1989	1,980	810	2,676	255
1988-1990	1,640	679	3,433	276
1989-1991	1,163	521	3,066	276
1990-1992	2,112	1,124	8,020	294
1991-1993	2,924	1,391	6,162	250
1992-1994	3,667	1,233	6,511	277
1993-1995	3,843	658	2,107	130
1994-1996	**4,043**	570	2,172	343
1995-1997	**4,302**	544	2,850	283
1996-1998	**4,017**	435	2,270	228
1997-1999	**5,084**	616	5,100	279
1998-2000	**5,544**	1,354	**11,270**	863
1999-2001	**5,996**	2,483	**1,655**	**1,538**
2000-2002	**7,276**	6,455	**23,983**	**1,868**
2001-2003	**8,460**	6,131	**20,758**	**1,596**
2002-2004	**9,656**	6,118	**24,947**	1,191
2003-2005	**7,829**	2,618	**20,993**	742
2004-2006	**8,296**	5,423	**24,926**	800
2005-2007	**6,600**	4,344	**21,133**	633
2006-2008	**5,869**	3,767	**17,541**	552
2007-2009	**6,956**	1,330	**23,953**	1,468
2008-2010	**6,715**	1,723	**21,415**	**1,736**
2009-2011	**8,270**	1,947	**22,020**	**2,263**
2010-2012	**6,296**	1,599	**11,889**	1,182
2011-2013	**7,490**	1,299	**16,282**	**1,686**
2012-2014	**7,041**	1,017	**17,194**	**1,696**
2013-2015	**6,300**	710	**21,272**	**1,639**
2014-2016	**5,328**	837	**17,379**	995
2015-2016	**5,655**	639	**17,974**	1,195
Target Minima	4,000	10 - 20k	10 - 25k	1.5 - 2.5k

Note: Bold entries are those that meet minimum criteria.

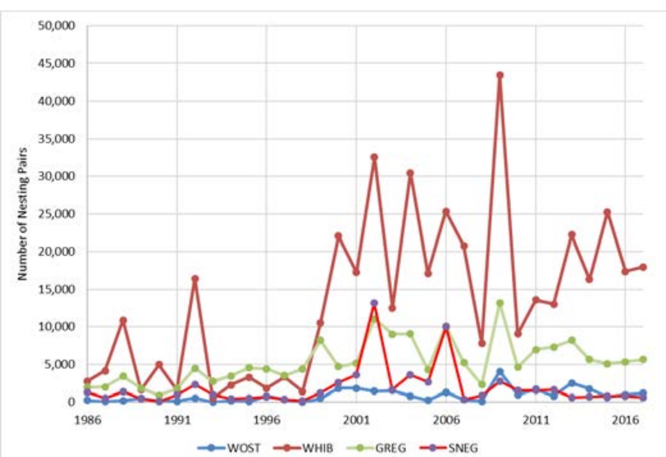

Figure 3. Trends in 3-year running average of nesting pairs of the four target species since 1986.

The regional declines of *Egretta* herons have been particularly acute in the Everglades and are cause for increasing concern (**Figure 2**). Nesting effort in 2017 was reduced 81% for the SNEG relative to the 10-year average, while TRHE nesting was down 87%. The number of SNEG nests in 2017 (228 nests) was the lowest recorded since 1990. These declines in *Egretta* herons do not appear to be due to birds moving to other nesting areas in South Florida; instead, they appear to reflect a general reduction in overall nesting effort in the Everglades. The cause of these sharp declines has yet to be determined.

In Florida Bay, ROSP produced 207 nests, which is a 31.7% reduction from the 10-year average (303.4 nests) and only 16.5% of the target 1,258 nests per year. From a historical perspective, this is 54.9% lower than the 32-year mean (459.1 nests) and far below the mid-20th century nesting effort when more than 1,000 nests per year were common.

Spatial Distribution of Nests

The estuarine region of ENP historically supported approximately 90% of all nesting wading birds in the Everglades, probably because it was the most productive region of the Everglades ecosystem. During the past 50 years, that productivity has declined due to reduced freshwater flows, and the location of nesting has shifted to inland colonies in the WCAs. An important goal of CERP is to restore the hydrologic conditions that will re-establish prey availability across the southern Everglades landscape that, in turn, will support the return of large successful wading bird colonies to the traditional estuarine rookeries. In 2017, ENP supported 22.5% of nests in the Everglades, while WCA-3A and WCA-1 supported 51.7% and 25.8%, respectively. The proportion of nests in the estuarine region has increased since the lows of the 1990s and early 2000s (2% to 10%) and seems to have stabilized around 20% to 25% (10-year average is 23.1%) but remains far short of the 50% restoration target.

The location of ROSP nesting colonies within the Florida Bay area has shifted in recent years. Whereas most nesting used to occur on small keys within the bay, many birds have moved during the past 5 years to mainland colonies adjacent to the coast (e.g., Madeira Hammock and Paurotis Pond colonies supported 150 nests during 2016, 41% of all nests in the region). However, this year relatively few birds nested at these 2 colonies (28 nests). Other individuals have deserted Florida Bay entirely. For 3 of the past 4 years, approximately 200 pairs have nested at colonies in the central freshwater Everglades such as northern WCA-3A. This pattern continued during 2017, with 170 nests found at inland colonies in the WCAs.

Timing of Nesting

WOST nesting success is highly dependent on the availability of prey (fish), which are easy to find and feed upon when concentrated at high densities in shallow water during the dry season (winter) but are not available in the wet season (summer) when water levels rise and they re-disperse into deeper marsh waters. To successfully fledge their young, WOST require a continuous supply of high-density fish throughout the reproductive period. WOST have a relatively long reproductive period (approximately 4 months), so 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 when fish availability declines. WOST nesting historically started in November or December, but in recent decades, nesting initiation has shifted to January to March (Ogden 1994). This delay is associated with reduced nesting success (Frederick et al. 2009) and is thought to occur because of a reduction in the amount and quality of the short-hydroperiod wetlands that provide foraging habitat early in the nesting season. In 2017, WOST nesting started relatively early, with the first eggs noted on January 5 and a possible first lay date sometime in late December, within the CERP target time frame. This is one of the earliest egg laying dates in recent decades and is considerably earlier than 2016 (late March) and 2015 (early February).

GREG also started nesting very early this year, with the first nest observed in early December. This is the earliest recorded nesting date for this species in the Everglades. Moreover, nesting was relatively asynchronous during 2017 with many new nests (incubating birds) observed during each monthly colony survey from January through June. Given that nest estimates are based on the peak count for each colony, the observed staggered nesting behavior in 2017 possibly resulted in a relatively conservative nest estimate compared to those of previous years.

ROSP in Florida Bay also have exhibited a recent shift toward later nesting. For at least 70 years (1936 to 2009), ROSP nest initiations consistently fell between October 1 and December 31. However, as of 2010, nesting began to start increasingly later in the season; from 2010 to 2014, nesting started between January 1 and 10; in 2015, it began on January 24; and in 2016, it began on February 5, the latest start date ever recorded. Moreover, the timing of laying appeared to be getting considerably more asynchronous both within and among colonies. Whereas nest initiations within Florida Bay historically would span a few weeks, lay dates in the past 2 years have extended from January through April. These changes in the phenology and synchrony of nesting might suggest that the timing of optimal foraging conditions for ROSP is changing temporally and spatially within Florida Bay. However, this year saw a complete reversal of that trend, with most nest initiations starting in November. The reasons for these patterns are unclear.

Nesting Success

Nest success of CERP indicator species in the Everglades is often low and highly variable in time and space, with average probabilities of fledging at least 1 offspring ranging between 35% and 49% for the 5 species (derived from 2010 to 2015 data). During 2017, nest success was relatively high and similar among the CERP indicator species, with between 60% and 80% of study nests fledging at least 1 offspring (see **Water Conservation Areas 2 and 3, and A.R.M. Loxahatchee National Wildlife Refuge** section). These results are supported by observations from weekly South Florida Water Management District surveys of nesting colonies, which noted that a large proportion of nests of all species produced fledglings. Of particular note was the high productivity of WOST, with many nests appearing to fledge two or three offspring. Nest success of WHIB was the highest recorded for this species in nearly 30 years, despite some late season, weather-related abandonments in WCA-1.

Role of Hydrology and Food Availability on Nesting Patterns

The most important process affecting wading bird nesting in the Everglades is the availability of prey (fishes and aquatic invertebrates). Prey availability is a function of prey production (the amount and size of prey animals) and by how vulnerable they are to capture by birds, with both components strongly affected by hydrologic conditions (Frederick and Ogden 2001; Herring et al. 2011). Prey production is influenced largely by the duration and frequency of wetland flooding and drying, with optimal conditions for population growth varying by species. Most fish populations grow during extended periods (multiple years) of relatively deep, flooded conditions over extensive areas of wetland (Trexler et al. 2005), while some invertebrate species (e.g., crayfish) are most numerous after periodic dry conditions (Dorn and Cook 2015). Prey vulnerability to capture is determined largely by water depths and whether water levels are rising or falling. Prey become easiest to capture during drying conditions when water levels decline to depths at which birds can forage effectively (5 to 30 centimeters) and the areal coverage of water shrinks such that prey become concentrated at relatively high densities (Gawlik 2002; Cook et al. 2014). Conversely, prey vulnerability declines when water levels rise, and prey can disperse within the marsh. Prey availability, therefore, is naturally variable among years depending on prior and current water conditions. Accordingly, wading bird nesting effort and success fluctuates considerably from year to year.

Nesting during 2017 was an improvement compared to recent years due to hydrologic conditions being relatively conducive to prey availability prior to and during the breeding season. Nesting was preceded by relatively wet conditions, and water levels remained above ground for extended periods across large areas of the Everglades (see **Everglades Protection Area Hydrology** section). The resultant increase in fish production (Trexler et al. 2005) likely accounted for the observed early nesting and increased number of nests by the piscivorous WOST and GREG in 2017. On the other hand, the extended wet conditions likely limited crayfish populations, which resulted in a moderate nesting effort for the crayfish-eating WHIB (Boyle et al. 2014). In contrast to the antecedent conditions, the 2017 winter-spring breeding season was drier than average. This led to a relatively continuous drop in water level across the Everglades landscape, producing ideal water levels and recession rates for wading bird prey availability and foraging until late in the dry season. These conditions probably played a large role in the relatively high nest success in 2017. A rain event in late April caused a water level reversal in WCA-1 and WCA-2, which may have caused the WHIB nest abandonments in WCA-1 that occurred shortly thereafter.

Long-Term Trends

To understand the status of wading bird populations and how they are responding to climatic conditions, water management, and restoration efforts, it is important to think beyond the noisiness of the annual fluctuations in nesting effort and instead consider the long-term (decadal and longer) trends in nesting responses. These long-term data reveal that several nesting responses have improved over the past 20 years, while others have shown no change or are getting worse. In short, numbers of WHIB, WOST, and GREG nests have increased over the past 20 years and appear to be frequently meeting restoration targets (**Figure 3**). Moreover, the interval between exceptional WHIB nesting years has met the restoration target (<2.5 years) for 9 of the past 11 years. There have been some recent improvements in the number of birds nesting at historical coastal colonies, but the proportion remains well below the restoration target (5-year running average of 22% compared to the 50% target.

Several measures are not improving and are cause for concern. The numbers of SNEG, TRHE, and LBHE are declining sharply (**Figure 2**), and the causes of the declines are unknown. Also, despite improved WOST nesting effort, the late timing of their nesting has remained relatively static, and their nesting success often is below that necessary to sustain the local population. The ratio of tactile (storks, ibises, and spoonbills) to visual (herons and egrets) foragers has improved since the mid-2000s but remains an order of magnitude below the restoration target. For more information on Everglades restoration performance measures, see the Status of Wading Bird Recovery section at the end of this report. **Figure 3** and **Table 1** were provided by Peter Frederick.

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Abbreviations

Bird Species: Anhinga (ANHI, *Anhinga anhinga*), Bald Eagle (BAEA, *Haliaeetus leucocephalus*), Black-crowned Night Heron (BCNH, *Nycticorax nycticorax*), Brown Pelican (BRPE, *Pelecanus occidentalis*), Cattle Egret (CAEG, *Bubulcus ibis*), Cape Sable Seaside Sparrow (CSSS, *Ammodramus maritimus mirabilis*), 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*), Magnificent Frigatebird (MAFR, *Fregata magnificens*), Osprey (OSPR, *Pandion haliaetus*), Reddish Egret (REEG, *Egretta rufescens*), Roseate Spoonbill (ROSP, *Platalea 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*), Unidentified Small White Herons (SMWH, either Snowy Egret or juvenile Little Blue Heron), Unidentified Small Dark Herons (SMDH, either Little Blue Heron or Tricolored Heron)

Regions, Agencies, and Miscellaneous: Arthur R. Marshall (A.R.M.), c/n = chicks per nest, Charlotte Harbor Aquatic Preserves (CHAP), Comprehensive Everglades Restoration Plan (CERP), Corkscrew Regional Ecosystem Watershed (CREW), Everglades National Park (ENP), 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), Restoration Coordination and Verification (RECOVER), South Florida/Caribbean Inventory and Monitoring Network (SFCN), South Florida Water Management District (SFWMD), standard deviation (SD), Water Conservation Area (WCA), Water Year (WY)

EVERGLADES PROTECTION AREA HYDROLOGY

Annual rainfall totals and annual mean water depths in the Everglades Protection Area (Everglades) during water year 2017 (WY2017; May 1, 2016 to April 30, 2017) were close to average historical conditions. Rainfall for the year ranged from 2.2 to 2.9 inches below historical averages (less than 6% difference) in Water Conservation Areas (WCAs) 1, 2, and 3, and 3.4 inches below average in Everglades National Park (ENP); annual average water depths were generally within an inch of historical mean depths (**Table 2**). Despite the relatively normal depths when considered over the entire water year, relatively wet antecedent conditions and lower than average rainfall during the dry season had strong impacts on WY2017 hydrology, with important consequences for the ecology of the Everglades.

Water depths across the Everglades at the start of WY2017 (June 2016) generally were above historical average water levels due to the exceptionally high rainfall during the WY2016 dry season. Average amounts of rainfall from June through October 2016 led to wet season water depths that were close to historical mean water levels across much of the system (the WCAs and ENP received 97% and 79% of historical wet season averages, respectively; **Table 2**). These rainfall patterns resulted in extended wet conditions and meant that large areas of the marsh remained flooded for long periods (since July 2015). Long hydroperiods and a large spatial extent of flooded marsh are key components of wading bird prey availability because they generally are associated with increased fish production (Trexler et al. 2005). By contrast, dry season rainfall amounts were well below average, with WCA-1 and WCA-2 at 83%, WCA-3 at 72%, and ENP at 71% of historical average. Of note was the very dry November with relatively high evapotranspiration rates and rapid declines in water level, which dropped approximately 0.5 feet below average in WCA-3A by the end of November (**Figures 4A** to **4G**). These early dry season shallow water levels and fast recession rates coupled with high prey productivity provided excellent foraging conditions for wading birds early in the breeding season but also meant that large areas of marsh dried earlier in the breeding season than they typically do, resulting in the loss of foraging and nesting habitat. High prey production and early drying led to early breeding and above average number of nests for some piscivorous species of wading birds such as Wood Storks (WOST). However, the earlier than average drying across the landscape resulted in limiting breeding opportunities for species that nest later in the breeding season. Rain-driven reversals in water level in late April also negatively impacted foraging and nesting in the northern Everglades. The dry conditions during the second half of the water year were conducive to Cape Sable Seaside Sparrow (CSSS) nesting efforts. Monitoring suggests these birds had a very active breeding season in WY2017, which was important due to the very poor nesting success in WY2016.

Figures 4A to **4G** show hydropatterns at select gauges highlight the average water level changes in each of the WCAs for the last 2.5 years. The figures relate water levels relative to historical averages, flooding tolerances for tree islands, drought tolerances for wetland peat, and recession rates and depths that support foraging and nesting needs of wading birds during the breeding season. The South Florida Water Management District (SFWMD) uses these indices as part of the ecological recommendations to water managers at weekly interagency water operations meetings. Tree island inundation tolerances are considered exceeded when depths on the islands are above 2.0 or 2.5 feet, depending on the height of the tree islands, for longer than 120 days (Wu et al. 2002). Lower islands are inundated at lower high-water levels (e.g., 2 feet versus 2.5 feet). The ground elevations in **Figures 4A** through **4G** (in feet National Geodetic Vertical Datum of 1929 [NGVD29]) are used to indicate the threshold for peat conservation. When water levels are more than 1 foot below ground for more than 30 days, the drought tolerance of peat is considered exceeded according to the criterion for the Everglades Minimum Flow and Minimum Water Level (MFL; SFWMD 2014). Peat may be harmed at shallower water levels, however.

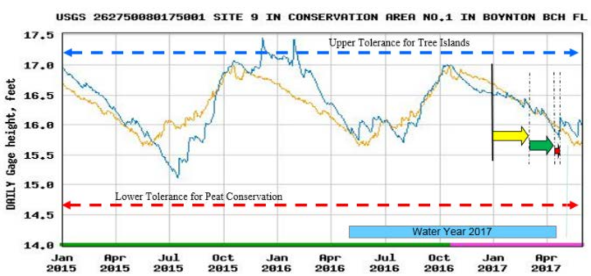
The wading bird nesting period ranges from January through May each year. Wading bird foraging habitat suitability is determined by water depths and recession rates, and is divided into three categories (poor, moderate, and good) according to recent research on foraging requirements of wading birds in the Everglades (Gawlik 2002; Beerens et al. 2011, 2015; Cook et al. 2014). A green arrow on the hydropattern figures indicates a period with good recession rates and depths for wading birds. A yellow arrow indicates water levels that are too shallow or too deep and/or recession rates that are slightly too rapid or too slow. A red arrow indicates poor conditions resulting from poor depths (high or low) and/or unsuitable recession rates (rising or falling too rapidly). For CSSS habitat suitability presented for the Marl Prairie in Everglades National Park, appropriate water depths and the maintenance of target depths are used to categorize if the nesting requirements of the sparrow are being met.

Table 2. Average, minimum, and maximum stage in feet NGVD29 and total annual rainfall in inches for WY2017 in comparison to historic water depth stages and rainfall.[a] (Average depths calculated by subtracting elevation from stage.)

Area	WY2017 Rainfall (inches)	Historic Rainfall (inches)	WY2017 Stage Mean (min.; max.)	Historic Stage Mean (min.; max.)	Elevation
WCA-1	48.99	51.96	16.34 (15.34; 17.01)	15.70 (10.00; 18.16)	15.1
WCA-2	48.99	51.96	12.24 (11.07;13.58)	12.51 (9.33; 15.64)	11.2
WCA-3	49.01	51.24	9.74 (8.58; 10.63)	9.60 (4.78; 12.79)	8.2
ENP	47.15	54.55[b]	6.57 (5.41; 7.32)	6.03 (2.01; 8.08)	5.1

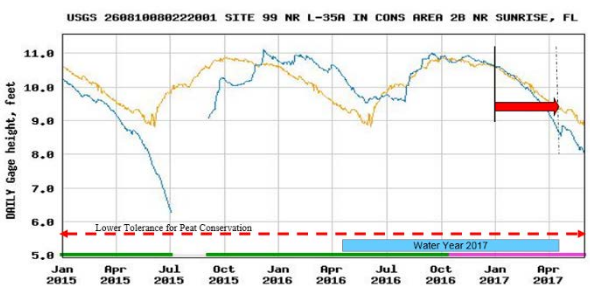
[a] Historical averages are based on varying lengths of records at gauges.
[b] 1941-2016.

A. WCA-1 – Site 9

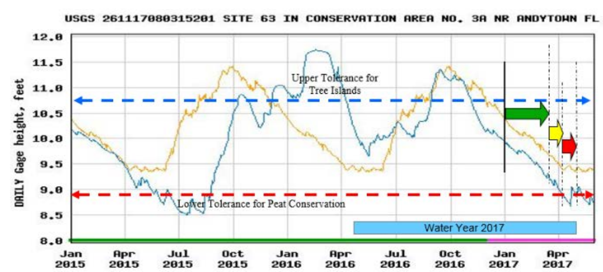


B. WCA-2A – Site 17

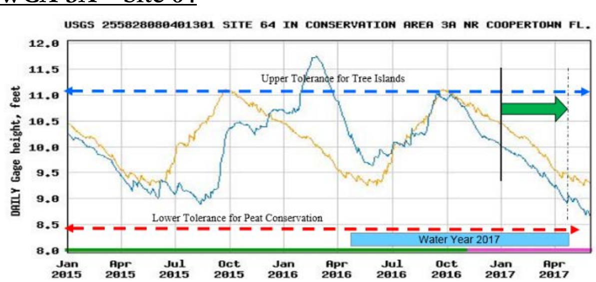
C. WCA-2B – Site 99



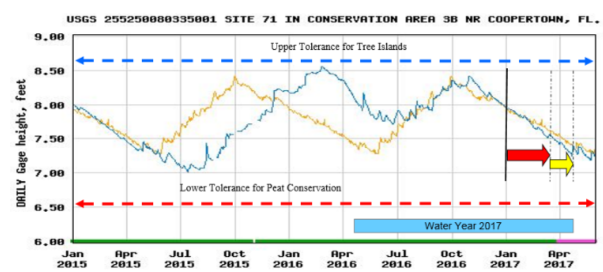
D. WCA-3A – Site 63



E. WCA-3A – Site 64



F. WCA-3B – Site 71



G. Northeast Shark River Slough

Median daily statistic
Gage height
Period of approved data
Period of provisional data
Good recession and depth
Fair recession or depth
Poor recession or depth

Figure 4. Hydrology in the WCAs and ENP in relation to average water depths (A: 21-year average, B: 21-year average, C: 21-year average, D: 22-year average, E: 22-year average, F: 22-year average, G: 32-year average), and indices for tree island flooding, peat conservation, and wading bird foraging.

Water Conservation Area 1

Water levels in WCA-1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge) at the start of WY2017 were close to their 21-year average (**Figure 4A**). Wet season depths generally followed the long-term average ascension rates to peak in mid-October. Early concerns going into the wading bird season (from January through May) were that the water levels in WCA-1 were too low to sustain an optimal recession rate throughout the entirety of the breeding season without levels dropping below ground. Recession rates during the wading bird breeding season were good to fair in the first couple months, then improved to a long-term good recession rate despite a few minor reversals where water levels suddenly increased due to local rainfall. The below average dry season rainfall resulted in water levels dropping below suitable foraging in WCA-1 before the end of the dry season, and wading birds nesting in WCA-1 either abandoned their nest or sought forage elsewhere. Rain-driven water level reversals in April and May also led to some nest abandonment. The upper tolerance for tree islands was not exceeded.

Water Conservation Areas 2A and 2B

Similar to the hydropattern in WCA-1, water levels in WCA-2A during the WY2017 wet season initially were close to the long-term average. In July, water levels began to rise to peak in October, and exceeded the upper flood tolerance for tree islands from September through November (**Figure 4B**). Recession rates were good for wading birds starting in November and throughout most of the wading bird breeding season. A large reversal event towards the end of April resulted in the loss of foraging habitat in WCA-2A for the remainder of the breeding season. WCA-2A provided good to optimal foraging during most of the breeding season, perhaps augmented by an operational shift in the location of discharge later in the dry season when flows were shifted to S-7 from the northernmost structures, the S-11s. The releases from S-7 were much closer to the areas where wading birds were observed feeding within WCA-2A.

In WY2017, the Florida Fish and Wildlife Conservation Commission closed WCA-3 and WCA-2A to public access twice. High water in summer 2016 and low water in spring 2017 forced closures in order to protect wildlife from human disturbance.

Unlike the rest of the Everglades, WCA-2B tends to be wet and deep most of the year (**Figure 4C**). During WY2017, water depths at gauge 99 generally tracked the historical average despite an above average depth to begin the water year; the red arrow in **Figure 4C** signifies water levels too deep to support wading birds. The continued rapid decline in water levels towards the end of the dry season provided excellent foraging conditions for wading birds.

Water Conservation Area 3A

Water levels in northeastern WCA-3A (gauge 63) during WY2017 generally tracked the historical average (**Figure 4D**). Water levels were above average at the beginning of May and rose quickly starting in August to peak in mid-September. Water levels exceeded the upper tolerance for tree islands during September and October. In November, water levels began to recede at a rate that generally exceeded the preferred rate for wading bird foraging (the yellow arrow in **Figure 4D** signifies a moderate recession). As a result, foraging conditions were available during the early part of the wading bird breeding season, but water depths fell too low to support feeding by the end of breeding season. Wildfires were active in northern WCA-3 during late WY2017, however no peat occurred. Gauge 63 is near one of the most productive wading bird colonies in the Everglades (Alley North), and operational attempts were made to keep the area hydrated during nesting to protect the colony.

The hydrologic pattern in central WCA-3A (gauge 64) (**Figure 4E**) was similar to that at gauge 63 except that the elevated recession rates in the beginning of the dry season did not last as long. Water levels peaked in September and did not exceed 2.5 feet deep (tree island metric). Depths during the dry season were lower than the historical average, which probably helped tree islands recover from the unseasonably high water levels in WY2016. Recession rates during the wading bird breeding season began at an elevated rate but slowed to the preferred rate and remained in the good range until some minor late season reversals.

Water Conservation Area 3B

As in other parts of the Everglades, water levels were well above the historical average at the beginning of WY2017 (**Figure 4F**). In August, water levels equaled the historical average and ascended at a typical rate to peak in late October. Water levels then began receding at a rate conducive to wading bird foraging and continued to do so for most of the wading bird breeding season. Depths at gauge 71 did not exceed the upper tolerance for tree islands in WY2017.

Northeast Shark River Slough

At the beginning of WY2017, water levels were much higher than the historical average at this site (**Figure 4G**). Water levels rose gradually to peak in early October, remaining above the historical average. Recession rates at this location generally tracked the historical average for the remainder of WY2017. Recession rates and depths were good for most of the wading bird breeding season until water depths became too low to support wading bird foraging near the end of WY2017.

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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 (A.R.M.) Loxahatchee National Wildlife Refuge (also WCA-1) in 2017. Monitoring focused primarily on counts for Great Egret (GREG), White Ibis (WHIB), Snowy Egret (SNEG), and Wood Stork (WOST), the species that serve as bioindicators for the Comprehensive Everglades Restoration Plan (CERP) and are most readily located and identified through aerial searches. Estimates for these and other species were gleaned from aerial and systematic ground surveys as well as visits to nesting colonies and more intensive studies of nest success.

METHODS

Aerial and ground surveys were performed in 2017 to locate and characterize nesting colonies. On or around the 15th of each month from January through June, aerial surveys were performed to find active colonies using observers seated on both sides of a Cessna 182. Surveys were conducted from an altitude of 800 feet above ground level along east-west oriented flight transects spaced 1.6 nautical miles apart. These techniques have been used since 1986, and they result in overlapping coverage under a variety of weather and visibility conditions. In addition to contemporaneous visual estimates of nesting birds by the two observers, digital aerial photos were taken of all colonies, and nesting birds in the photos were counted. The reported numbers of nest starts were derived from a combination of information sources, including peak estimates of nests in any colony, supplemental information from monthly South Florida Water Management District helicopter surveys staggered by 2 weeks from the University of Florida survey, ground visits, and inference from observations across the season.

Since 2005, systematic ground surveys have been performed 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 sixteen 500-meter wide belt transects (covering 336 km^2 total) are approached closely enough to flush nesting birds, and nests were counted directly if visible, or estimated from flushed birds. The totals were added to the numbers derived from aerial estimates. Because 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

An estimated 27,378 wading bird nests were initiated at colonies within WCA-1, WCA-2, and WCA-3 in 2017 (**Tables 3** and **4**). The total number of nests was 18% above the 10-year average nesting effort and 39% above the 5-year average. Nesting effort for WOST (1,046 nests) accounted for much of this difference, being 3.57 times the 10-year average and 5.21 times the 5-year average. Storks are relatively philopatric, but two new colonies were discovered this year on the west side of WCA-3 (New Colony 013) and at Cypress City. Overall, this was the second highest nesting effort for WOST in the last 18 years. GREG nesting effort was 95% of the 10-year average and 1.02 times the 5-year average. WHIB nesting effort was 1.06 times the 10-year average and 1.16 times the 5-year average.

Table 3. Number of nesting pairs found in A.R.M. Loxahatchee National Wildlife Refuge (WCA-1) during systematic surveys, February through June 2017.

Colony	Latitude	Longitude	GREG	WHIB	ROSP	SNEG	GBHE	LBHE	TRHE	CAEG	Unidentified Small White	Colony Total
UTU	26.37197	-80.31035	72									**72**
010	26.47544	-80.28161	78								3	**81**
038	26.45047	-80.24233	92				4				6	**102**
043	26.51123	-80.43767						+			132	**132**
LoxRamp	26.49446	-80.22302	74			47		+	+	+	364	**485**
Lox73	26.37433	-80.25850	133	69							49	**251**
LoxNC1	26.55370	-80.25080	44								538	**582**
LoxWest	26.55014	-80.44268	322	195	15	70		400		150	150	**1,302**
Lox99	26.43822	-80.39053	539	2,876	2			90	22		35	**3,564**
LoxNC4	26.53280	-80.27620	120	2,502								**2,622**
Colonies >50 nests			1,474	5,642	17	117	4	490	22	150	1,277	**9,193**
Colonies <50 nests			32	0	0	0	0	0	0	0	0	**32**
Total by Species			**1,506**	**5,642**	**17**	**117**	**4**	**490**	**22**	**150**	**1,277**	**9,225**

Note: WOST, GLIB, BCNH, YCNH, unidentified large white birds, unidentified small dark birds, and ANHI were not observed (count = 0).
+ Present but not counted.

Table 4. Number of nesting pairs found in WCA-2 and WCA-3 during systematic surveys, February through June 2017.

Colony	WCA	Latitude	Longitude	GREG	WHIB	WOST	ROSP	SNEG	GBHE	LBHE	TRHE	GLIB	BCNH	YCNH	Unidentified Small White	ANHI	Colony Total*
008	2	26.13853	-80.36901	51					1								**52**
Kidlow	3	26.04123	-80.59968	51					14						2		**67**
Big Mel	3	26.04602	-80.62586	66					1								**67**
Aerie	3	25.77158	-80.70872	69													**69**
Vacation	3	25.91565	-80.63022	72					2								**74**
Hidden	3	25.77353	-80.83722	77													**77**
Diana	3	25.84727	-80.52347	78					3								**81**
Henry	3	25.82077	-80.84115	94									+				**94**
Joule	3	26.01230	-80.63233	110					4								**114**
Jetport	3	25.86302	-80.83874			129											**129**
Nanse	3	26.10715	-80.49802	176					4								**180**
Vulture	3	26.02563	-80.53917	184					4						3		**191**
Horus	3	25.96052	-80.57207	162					22						26		**210**
Cypress City	3	26.12408	-80.50438	138		23	18								36	+	**215**
Rhea	2	26.23782	-80.31280	316	63				1						122		**502**
Jetport South	3	25.80510	-80.84902	63		857	5								32		**957**
Alley North	3	26.20132	-80.52873	652			40								855		**1,547**
6th Bridge	3	26.12428	-80.54148	177	9,982		88	+			+	+	+		1,105	+	**11,532**
093	3	25.91997	-80.79868	2				15		40							**57**
047	3	25.97019	-80.77479					11		67	3					1	**81**
	Colonies >50 nests			2,538	10,045	1,009	151	26	56	107	3	0	0	0	2,181	1	**16,117**
	Colonies <50 nests**			419	4	37	2	49	172	68	5	0	1,230	17	34	316	**2,353**
	Total by Species			**2,957**	**10,049**	**1,046**	**153**	**75**	**228**	**175**	**8**	**0**	**1,230**	**17**	**2,215**	**317**	**18,153**

Note: CAEG, unidentified large white birds, and unidentified small dark birds were not observed (count = 0).
+ Present but not counted.
* Excludes ANHI.
** Includes count of wading bird nesting pairs from ground surveys.

Roseate Spoonbills (ROSP) nested at LoxWest, Lox99, Cypress City, Jetport South, Alley North, and 6th Bridge colonies (170 nests total) this season. Two nests were observed in the new WOST colony in southwestern WCA-3A. Overall, this was the third highest nesting effort for ROSP in the last 18 years, with 2.09 times the 10-year average and 1.79 times the 5-year average. This follows the recent trend of increased nesting effort by ROSP in the WCAs.

There has been a clear trend of many fewer TRHE and LBHE nests in the study area over the past decade. This season showed a continued declining trend, with 8 TRHE and 175 LBHE observed during systematic ground surveys. Compared with the average nesting numbers between 1996 and 2007, the average number seen between 2007 and 2017 was reduced by 77% for LBHE and 81% for TRHE. Furthermore, compared with the 2007 to 2017 average, 2017 showed a 97.1% reduction of nesting effort for TRHE. *Egretta* herons clearly are not nesting in their former locations within 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 these species are nesting elsewhere in the system, such as in larger colonies or in coastal areas. For logistical reasons, *Egretta* herons are difficult to count in large colonies. Competing predictions about the declines are being addressed, such as a decline or shift in composition of the prey base, displacement by Black-crowned Night Herons (BCNH), or movement to coastal colonies. BCNH are likely to be a predator on nestlings of *Egretta* herons, have been rapidly increasing as nesters during the past 10 years, and have one of the highest nest success rates of any species during 2017.

Reproductive Success

Nest success was monitored at eight colonies; three in Everglades National Park (Tamiami West, Rookery Branch, and Cuthbert) and five in WCA-3 (6th Bridge, Jerrod, Joule, Henry, and Vacation). Individual nests of GREG (n = 271 at all eight colonies), WHIB (n = 155 at Tamiami West and 6th Bridge), WOST (n = 17 at Tamiami West), ROSP (n = 2 at 6th Bridge), BCNH (n = 30 at Henry, Tamiami West, and 6th Bridge), and *Egretta* herons (n = 81 at Tamiami West, Rookery Branch, Cuthbert, Vacation, Jerrod, and 6th Bridge) were monitored via nest checks every 5 to 7 days throughout the season.

Systemwide nest success (P; probability of fledging at least one young, Mayfield method) showed considerable variation by species; GREG (P = 0.603; standard deviation [SD] = 0.0374), unidentified small white *Egretta* herons (SNEG and LBHE) (P = 0.559; SD = 0.061), TRHE (P = 0.572; SD = 0.076), SNEG (P = 0.652; SD = 0.061), WHIB (P = 0.675; SD = 0.045), WOST (P = 0.845; SD = 0.106), BCNH (P = 0.932; SD = 0.046), and ROSP (P = 1.00; SD = 0.00). Nestling success (83% to 100%) generally was higher than incubation success (65% to 100%) across species and colonies, suggesting foraging conditions remained favorable throughout the season. Notably, WOST success was high; young fledged early and before rains began, in part because nest initiation was much earlier than usual. WHIB nest success was one of the highest metrics recorded for this species in nearly 30 years, despite some apparent abandonments in WCA-1 and WCA-3. Large numbers of WHIB young were seen in all colonies studied. All the *Egretta* herons appeared to do well in terms of fledging young. Over time, the reproductive pattern for wading bird species in the Everglades appears to be one of highly variable nest success with occasional year classes that are successful enough to be demographically dominant. These year classes of offspring, including 2017, may be extremely important and carry the population through many years in which recruitment is lower than mortality.

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EVERGLADES NATIONAL PARK

MAINLAND

This summary report addresses colony monitoring within the slough and estuarine areas of Everglades National Park (ENP) using data collected during the 2017 wading bird breeding season.

Wading bird nesting colonies in ENP are surveyed as part of a regional monitoring program to track wading bird 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 monitoring objectives for wading bird nesting colonies in ENP are as follows:

- Collect data on wading bird nesting effort, locations, number of colonies, and timing of colony nesting; and
- 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 Everglades.

Methods

Airplane or helicopter surveys of known colony locations were conducted monthly from December through July (December 28 and 29; January 3, 20, and 21; February 21 through 24; March 31; April 13 and 14; May 12; June 15; and July 28). Mainland colony flights were often combined with Florida Bay wading bird and seabird surveys. Flight altitude was maintained at 600 to 800 feet above ground level during the surveys. During each flight, visual estimates of nest numbers by species were made, and photos were taken 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. Reconnaissance flights to scout for new colony locations were not flown this season.

Species monitored include Great Egret (GREG*)*, White Ibis (WHIB), Wood Stork (WOST), Snowy Egret (SNEG*)*, Roseate Spoonbill (ROSP), Tricolored Heron (TRHE), and Little Blue Heron (LBHE). Other birds found nesting in colonies such as the Great Blue Heron (GBHE*)*, Anhinga (ANHI), Cattle Egret (CAEG), and Black-Crowned Night Heron (BCNH) were noted as well.

Results

Nesting effort in ENP was up by 65% compared to the 2016 breeding season. The total pooled species nest estimate was 7,899 (**Table 5**). WOST had a peak of 1,313 nests, an increase of 126% compared to the 2016 season. GREG nest counts (n = 2,144) were up by 26%. WHIB (n = 3,986) were up by 156%. SNEG nest counts (n = 236) were down by 57%. Seventeen wading bird colonies were monitored (**Figure 5**).

Initial flights to check mainland colony sites were conducted on December 28, 2016 (Madeira Hammock and Diamond Key) and January 3, 2017 (all other mainland colony sites). WOST initiated nesting much earlier this year; many were paired up and building nests at Broad River in early January (approximately 150 birds were seen). Other WOST colony sites were empty or contained GREG, which were also setting up nests.

Table 5. Peak numbers of wading bird nests found in ENP colonies through July 28, 2017.

Colony	Latitude	Longitude	GREG	WOST	WHIB	SNEG	SWHE	ROSP	TRHE	LBHE	Total
Alligator Bay	25.67099	-81.14714	35		130						**165**
Broad River	25.50292	-80.97440	193	545				19			**757**
Cabbage Bay	25.62000	-81.05612	154	224	350	+		7		+	**735**
Chokoloskee Bay (new site)	25.84808	-81.41297	145								**145**
Cuthbert Lake	25.20933	-80.77500	55								**55**
East River	25.26860	-80.86785	12								**12**
Grossman Ridge West	25.63627	-80.65275	73	55							**128**
Joe Bay, Diamond Key[1]	25.23205	-80.56455	120		1	36				172	**329**
Lostmans Creek	25.58723	-80.97204	35		400						**435**
Madeira Hammock[1]	25.21932	-80.65945	9		280			+	5		**294**
Otter Creek	25.46780	-80.93772	347		325	+		7			**679**
Paurotis Pond	25.28150	-80.80300	125	326		+		10	+	+	**461**
Rodgers River Bay Large Island	25.55667	-81.06984	140	25							**165**
Rookery Branch	25.46356	-80.85256	331		+	+			+	+	**331**
GREG Colony 1 (2016 Colony 5)	25.31100	-80.85630	40								**40**
GREG Colony 2 (2016 Colony 6)	25.34570	-80.61298	30								**30**
Tamiami West[2]	25.75745	-80.54502	300	138	2,500		200				**3,138**
Total			**2,144**	**1,313**	**3,986**	**36**	**200**	**43**	**5**	**172**	**7,899**

SWHE = Unidentified small white herons.
+ Species present and nesting, but unable to determine number of nests.
[1] Data from Audubon of Florida.
[2] Data from the University of Florida.

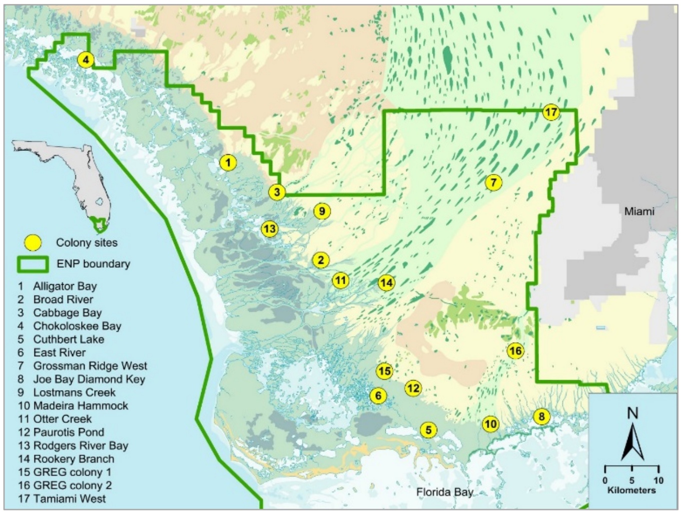

Figure 5. Active wading bird nesting colonies in ENP and south Big Cypress National Preserve, 2017.

The next set of survey flights was flown in late February when all mainland colonies were active. Many WOST nests contained small young, but some nests were still empty. GREG had reached peak nest numbers by late February. During the March 31 aerial survey, WOST colonies were at peak nest numbers, with two to three chicks per nest. Many GREG nests were empty, and newly fledged young were roosting on the tops of trees.

WHIB were first observed nesting in several colonies during the March and April flights. Most were either roosting within the nesting areas or incubating on nests. Peak WHIB numbers were recorded in May. In June, approximately 130 additional pairs of WHIB were observed nesting at Alligator Bay (previously had none) and approximately 150 additional pairs were nesting at Otter Creek. However, when these sites were checked on July 28, the colonies were empty. No adult or young WHIB were seen within or outside the colony sites, thus these nests may have been abandoned.

WOST and other nesting birds appeared to have a successful breeding season in ENP. WOST initiated nesting at the beginning of January, more than 2 months earlier than the previous season's start on March 22. The weather was conducive to nesting, with no major rain events or reversals in water levels. After the May 15 survey, young WOST fledged and left the area. When colonies were checked again on June 15, all WOST nests were empty, and no adults or young were seen along the flight path.

Florida Bay

Methods

Aerial surveys were conducted in ENP across Florida Bay on November 21, December 28-29, January 3 and 20, February 24, April 13 and 14, and May 11 and 15 using a National Park Service Cessna 206 high-wing float aircraft. The surveys targeted nesting Bald Eagles (BAEA) and Ospreys (OSPR); nesting Great White Heron (GWHE), GREG, WHIB, ROSP, SNEG, Reddish Egret (REEG), Brown Pelican (BRPE), Double-crested Cormorant (DCCO), and Magnificent Frigatebird (MAFR) were recorded as well. Nest counts for wading birds and BRPE were recorded by island or island group. Nesting DCCO were noted, but nest numbers were not estimated. The survey area included most islands and island groups within Florida Bay. Islands were checked at least twice during the season, and most were checked monthly. Only islands that had nesting wading birds, BRPE, and DCCO are included in this report.

Results

Wading bird and BRPE nesting activity was observed on 44 islands (**Table 6**; **Figure 6**). REEG were not observed during the flights (or perhaps were not distinguished from LBHE). They are difficult to see from aircraft unless they are foraging on banks, flying, or photographed on trees. When final surveys were conducted in May, most wading bird and BRPE nests contained large young. Fledged young were also seen in the nesting areas.

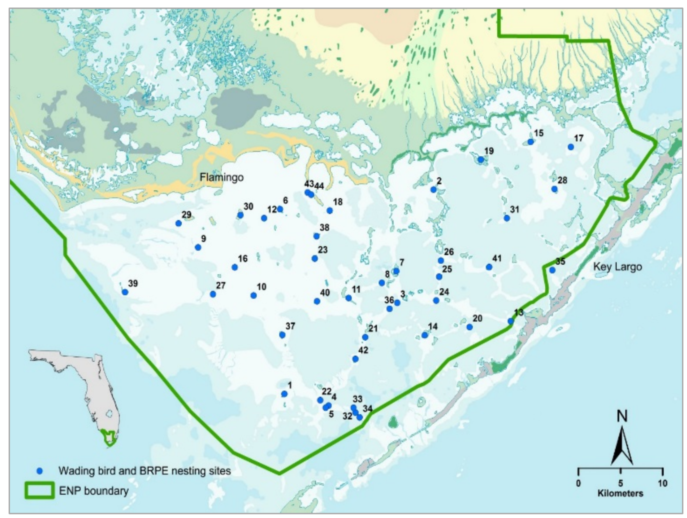

Figure 6. Active nesting colony sites in Florida Bay, 2017. See **Table 6** for the colony names and details.

Hurricane Irma Update

On September 10, 2017, Hurricane Irma passed over ENP. Several reconnaissance flights were flown on September 25 through 27 to check the status of wildlife resources, including the mainland and Florida Bay wading bird nesting sites. Numerous flocks of wading birds were seen foraging in the western coastal mangroves, and pairs of BAEA and OSPR were seen perched on their nesting islands in Florida Bay. The most visible impact was to wading bird colony nesting sites on the western side of ENP that contain taller trees. Many of the taller nesting trees at Cuthbert Lake, Paurotis Pond, Broad River, and Cabbage Bay were bent over or downed and broken. However, the colony sites appeared to contain enough structure for nesting birds. Islands in Florida Bay appeared to sustain less tree damage than mainland colony sites. Despite the damage to trees, most birds likely will return to nest at the same sites during the 2018 breeding season.

Table 6. Nesting activity in Florida Bay, 2017.

Map ID	Island	Latitude	Longitude	GWHE	GREG	BRPE	GBHE	ROSP	LBHE	TRHE	DCCO
1	Arsnicker Key, Upper	24.9317950	-80.8270700	4							
2	Black Betsy Keys	25.1376501	-80.6511778								+
3	Bob Allen Keys, West, Small	25.0235340	-80.6941310	2							
4	Buchanan Keys, East	24.9199580	-80.7752150	2		32					+
5	Buchanan Keys, West	24.9179080	-80.7785730	2							
6	Buoy Key, Big, N	25.1181450	-80.8320750	2							
7	Calusa Keys, Big	25.0554230	-80.6951190	3							
8	Calusa Keys, West (a.k.a. Bruce Key)	25.0437130	-80.7122470	3		2					
9	Clive Key	25.0797127	-80.9284920	1	30	95	5				+
10	Cluett Key	25.0311902	-80.8632897	3		2					
11	Corinne Keys, NW and SE	25.0284550	-80.7514720	2							
12	Cormorant Key	25.1091510	-80.8508650	1							
13	Cowpens Key*	25.0046770	-80.5608370		7						+
14	Crab Keys	24.9908050	-80.6619360	3							
15	Deer Key	25.1855730	-80.5366480	1							
16	Dildo Key	25.0596010	-80.8854230	5			8				
17	Duck Key	25.1801089	-80.4893057	2	13			+	+	+	+
18	Dump Keys, North	25.1167830	-80.7734240	2							
19	Eagle Key	25.1677864	-80.5952700	6	5			+			
20	East Key (Crane Keys)	24.9988789	-80.6091774	8							
21	Gopher Keys, North and South	24.9889340	-80.7319180	3							
22	Green Mangrove Key (Buchanans)	24.9254890	-80.7849580	1							
23	Jim Foot Key	25.0683373	-80.7911160	1							
24	Jimmie Channel Keys, South (East of Captain)	25.0257510	-80.6483160								+
25	Jimmy Channel Keys, Big Central	25.0497770	-80.6449260	3							
26	Jimmy Channel Keys, North	25.0659560	-80.6427150	4							
27	Man-of-War Key	25.0325026	-80.9111069	1			3				
28	Nest Key, South	25.1378340	-80.5087090	3	15						
29	Oyster West	25.1039196	-80.9515561	4		75		3			+
30	Palm Key	25.1122632	-80.8786116	6			2	+	+		+
31	Park Key, South	25.1085353	-80.5648183			20					
32	Peterson Key, Middle	24.9128595	-80.7436809	3							
33	Peterson Key, North	24.9177330	-80.7459430	3							
34	Peterson Key, South	24.9080554	-80.7387305	6							
35	Pigeon Key*	25.0560035	-80.5115010	6				+			+
36	Pollock Keys	25.0175030	-80.7033330	2							
37	Rabbit Keys, Big	24.9913300	-80.8294160	2							
38	Roscoe Key	25.0908550	-80.7890300	1							
39	Sandy Key	25.0345075	-81.0144826	32		5	2	+	+		+
40	Sid Key	25.0252100	-80.7886260	1							
41	Stake Key	25.0593640	-80.5858250	4							
42	Twin Keys, North and South	24.9669968	-80.7435746	3							+
43	Umbrella Key, Big	25.1349830	-80.7994370	3							
44	Umbrella Key, Little	25.1328690	-80.7953050	1							
	Total			**145**	**70**	**231**	**20**	**+**	**+**	**+**	**+**

+ Species present and appear to be nesting, but unable to determine numbers.
* Islands that are not within the ENP boundary but included in survey.

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BISCAYNE NATIONAL PARK

Nesting colonies of wading birds and seabirds are important indicators of ecosystem health as they respond to changes in food abundance, food 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 will suffer and may indicate a problem in the ecosystem. The South Florida/Caribbean Inventory and Monitoring Network (SFCN) of the National Park Service monitors colonial nesting birds in Biscayne National Park, and this report summarizes the results for the year July 2016 through June 2017 (hereafter "nesting year").

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 Ibises (WHIB), and Roseate Spoonbills (ROSP) (referred to as focal species).
- The annual peak active nest counts of colonial nesting birds in Biscayne National Park for the focal species.
- Changes in an annual nesting index (sum of monthly nest counts) for the focal species.
- Changes in the timing of peak nest counts for the focal species.

METHODS

The monitoring process in 2016-2017 consisted of an annual park-wide survey via helicopter to locate new nesting colonies of wading birds and seabirds within Biscayne National Park. This was coupled with monthly surveys of located colonies that were detected during the annual survey. Two SFCN technicians, a photographer and an observer, participate in each survey. As the helicopter circles each island colony, the colonies are photographed, and the observer records the number of nesting and non-nesting birds. Approximately 400 photographs are taken during each survey. The photographs are downloaded for processing and analyzed to identify active nests. Nests are circled on the photographs and then counted from the processed photographs.

Peak nest counts are identified for each colony and then summed across colonies to calculate the peak nesting year total across the park for each species. In addition, an annual nesting index is calculated, which is the sum of monthly nest counts for the entire nesting year. The nesting estimates for months with no sampling are calculated as the average of the months before and after the missing month. The SFCN uses the annual nesting index in addition to peak nest counts because some species, such as DCCO, nest in all months, and peak nest counts alone were considered insufficient to describe the nesting effort. Trying to estimate the true number of nest starts is not feasible at this time. This year's peak nest counts and nesting index are compared to the six previous nesting years' mean, maximum, and minimum. Complete methods are described in Muxo et al. (2015).

Colony surveys were conducted from July to December 2016, from January to April 2017, and in June 2017. Due to helicopter availability, the flight scheduled for March occurred on April 1 and a flight was not conducted in May 2017. The eight islands surveyed during the routine monthly flights were: Kings Road Island (25.49250, -80.33861), Mangrove Key (25.39444, -80.31583), West Arsenicker (25.40528, -80.31722), Arsenicker Key (25.39667, -80.28611), Jones Lagoon (25.37194, -80.24111), Ragged Key 5 (25.52722, -80.18972), Soldier Key (25.59027, -80.16139), and Kings Bay (25.6286, -80.30667) (**Figure 7**).

Figure 7. Eight island colonies monitored within Biscayne National Park. The two yellow stars indicate the locations of the new Kings Bay and Kings Road colonies.

Results and Discussion

In the 2016-2017 nesting year, the SFCN completed its seventh year of monitoring colonial nesting birds in Biscayne National Park. This year, two new colonies were surveyed: Kings Bay is approximately 2 km north of the Biscayne National Park boundary, and Kings Road Island is approximately 3 km north of the park headquarters (**Figures 7** and **8**). Only DCCO have been recorded nesting at the Kings Bay and Kings Road Island colonies.

In the 2016-2017 nesting season, DCCO nested at every colony except West Arsenicker (**Table 7**). The entire park peak nest count for DCCO was 1,245 nests, 24% above the mean of previous years (**Table 7**; **Figure 9**). This peak nest count is within the previous data range of 792 to 1,336 nests. The annual nesting index of 7,552.5 is above the previous maximum of 6,914, recorded in 2015-2016 (**Figure 10**). DCCO continue to nest year-round and account for 95% of recorded nests. Three (Arsenicker Key, Jones Lagoon, and Ragged Key 5) of the six previously monitored colonies showed lower peak nest counts than the previous year, while two colonies (Mangrove Key and Soldier Key) showed increases in peak nest counts. West Arsenicker, for the fifth season in a row, had no DCCO nests.

Figure 8. The two newest colonies monitored: Kings Road Island (top) and Kings Bay (bottom).

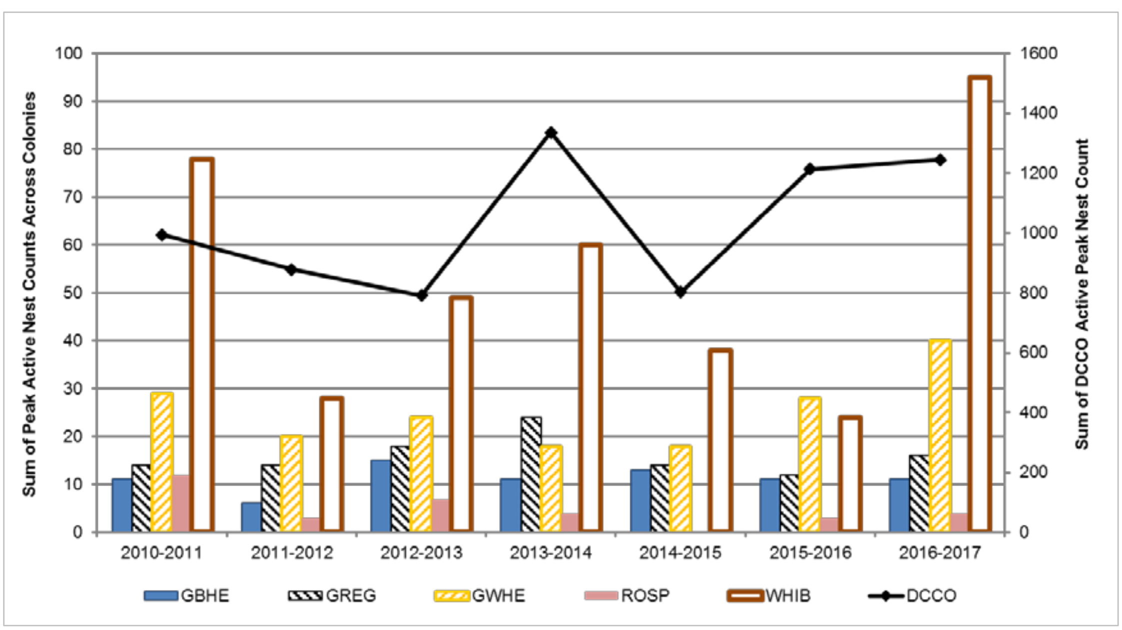

Figure 9. Total of peak active nest counts from all colonies.

Table 7. Peak nest and nesting index for Biscayne National Park, by species and colony, for the 2016-2017 nesting year, plus the mean, percent change, maximum, and minimum of the six previous nesting years (July through June).

Species	Peak Nest					Nesting Index				
	2016-2017	Mean	% Change	Max.	Min.	2016-2017	Mean	% Change	Max.	Min.
Biscayne National Park										
DCCO	1,245	1,002.7	24%	1,336	792	7,552.5	5,764.6	31%	6,914	4,957.5
GBHE	11	11.2	-1%	15	6	37.5	29.5	27%	44	12
GREG	16	16	0%	24	12	42	48.8	-14%	75.5	22
GWHE	40	22.8	75%	29	18	140.5	92.4	52%	122	68.5
ROSP	4	4.8	-17%	12	0	7	11.7	-40%	25	0
WHIB	95	46.2	106%	78	24	206	66.8	208%	110	27
Arsenicker Key										
DCCO	141	169.5	-17%	257	107	779.5	760.3	3%	983.5	521
GBHE	0	0.3	-100%	2	0	0	0.8	-100%	5	0
GREG	1	0.7	50%	2	0	1	1.8	-43%	5	0
GWHE	13	3.5	271%	6	2	36	15.5	132%	26	11.5
ROSP	0	0	0	60	22	0	0	0	0	0
WHIB	0	42	-100%	60	22	0	62.3	-100%	87	23
Jones Lagoon										
DCCO	102	119.2	-14%	135	100	463	621.2	-25%	905	476
GBHE	5	6	-17%	10	2	23	17.7	30%	29	6.5
GREG	0	0.7	-100%	2	0	0	0.8	-100%	2	0
GWHE	8	8.5	-6%	13	6	38	35.6	7%	64	23
ROSP	4	4.8	-17%	12	0	7	11.7	-40%	25	0
WHIB	0	0	0	0	0	0	0	0	0	0
Mangrove Key										
DCCO	38	32.2	18%	115	0	148	102.6	44%	309	0
GBHE	4	0	0	0	0	12	0	0	0	0
GREG	1	0	0	0	0	2	0	0	0	0
GWHE	4	0.2	2,300%	1	0	12.5	0.3	3,650%	2	0
ROSP	0	0	0	0	0	0	0	0	0	0
WHIB	0	0	0	0	0	0	0	0	0	0
Ragged Key 5										
DCCO	367	438	-16%	706	294	2,772.5	2,903.8	-5%	3,568	2,163
GBHE	0	0.3	-100%	1	0	0	0.3	-100%	1	0
GREG	0	0.3	-100%	1	0	0	0.3	-100%	1	0
GWHE	5	4.2	20%	7	2	13.5	16.3	-17%	23	10
ROSP	0	0	0	0	0	0	0	0	0	0
WHIB	0	0	0	0	0	0	0	0	0	0
Solider										
DCCO	284	206.7	37%	342	140	1,575.5	1,303.7	21%	1,552	1,003
GBHE	1	1.2	-14%	2	1	1	3.3	-70%	9	1
GREG	1	0.3	200%	1	0	1.5	0.3	350%	1	0
GWHE	9	3	200%	5	2	36.5	9.4	288%	18	5
ROSP	0	0	0	0	0	0	0	0	0	0
WHIB	0	0	0	0	0	0	0	0	0	0
West Arsenicker										
DCCO	0	1.8	-100%	10	0	0	2.4	-100%	13	0
GBHE	1	3.3	-70%	5	2	1.5	7.3	-80%	15	3
GREG	13	14	-7%	20	11	37.5	45.5	-18%	73	19
GWHE	1	3.5	-71%	6	1	4	15.3	-74%	29.5	5
ROSP	0	0	0	0	0	0	0	0	0	0
WHIB	95	4.2	2,180%	23	0	206	4.5	4,478%	23	0
Kings Bay										
DCCO	250	-	-	-	-	1,598.5	-	-	-	-
Kings Road Island										
DCCO	63	-	-	-	-	215.5	-	-	-	-

Note: The Biscayne National Park 2016-2017 DCCO count includes the two new colonies.

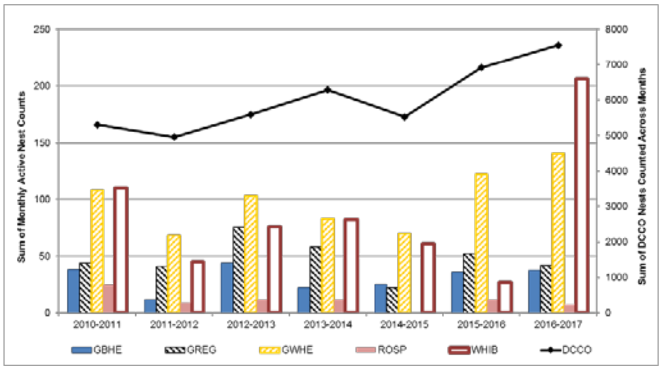

Figure 10. Annual nesting index across colonies, by focal species. The number of nests counted at each colony during each month was summed to create an annual nesting index across all colonies for the six focal species. This number exceeds the actual number of nest starts as a single nest could be counted during two or more monthly visits.

GBHE were observed nesting on four of the eight colonies (**Table 7**). The peak nest count for the 2016-2017 nesting season was 11 nests (**Figure 9**), compared to a mean of 11.2 nests of previous years and within the previous data range of 6 to 15 nests.

The park-wide peak nest count for GREG was 16 nests, which equaled the mean from previous years (**Table 7**; **Figure 9**). During the 2016-2017 breeding season, GREG nested at four colonies across Biscayne National Park.

The GWHE peak nest count (40 nests) was 75% above the mean of previously monitored seasons (22.8 nests) and above the previous maximum peak nest count of 29 nests recorded in the 2010-2011 nesting season (**Table 7**; **Figure 9**). GWHE nested on six of the eight colonies monitored.

ROSP were observed nesting only in Jones Lagoon, which is consistent with previous breeding season data. The peak nest count for the 2016-2017 nesting season was 4 nests (**Table 7**; **Figure 9**), which is 17% below the previous years' mean of 4.8 nests, but within the previous data range of 0 to 12 nests.

The WHIB peak nest count of 95 nests was 106% above the mean of the previous 6 years (46.2 nests) (**Table 7**; **Figure 9**). The maximum peak nest count of 95 nests exceeded the maximum peak nest count of 92 nests recorded during pilot sampling on April 30, 2010.

West Arsenicker had the highest nesting species richness (seven species). Jones Lagoon and Arsenicker Key both had six species nesting. Only DCCO have been observed at the Kings Bay and Kings Road Island colonies thus far (**Figure 9**). The Kings Bay and Kings Road Island colonies add a substantial number of DCCO nests (1,814) to the peak abundance.

Overall, the number of nests was slightly higher compared with the average of the past six nesting years for four of the focal species. Peak nest counts and nesting indices fell within the range of variation seen in the past 6 years (**Figures 9** and **10**). The exceptions were GWHE and WHIB, which have new maximum peak nest counts, and DCCO, which has a new maximum nesting index.

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ROSEATE SPOONBILL NESTING IN FLORIDA BAY

METHODS

Roseate Spoonbills (ROSP) have used 61 keys in Florida Bay and 3 mainland colony sites adjacent to Florida Bay (**Table 8**). These colonies were divided into five distinct nesting regions based on the primary foraging locations used by the birds (**Figure 11**; Lorenz et al. 2002). During the 2016-2017 breeding season (December 2016 to April 2017), complete nest counts were performed in all five regions of the bay by entering the colonies and thoroughly searching for nests. Mark and revisit surveys were performed at active colonies within each region to estimate nest success. The 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 1 chick to 21 days per nesting attempt. Mean laying and hatching dates refer to the first egg laid and hatched in each clutch. Results are presented in the context of the target metrics found in the stoplight report for the northeast and northwest regions (Lorenz et al. 2009). The Southeast, Southwest, and Central regions were compared using 1984 as a baseline; 1984 was the year the South Dade Conveyance System was completed, which has direct water management implications on Florida Bay (Lorenz et al. 2002; Lorenz 2014).

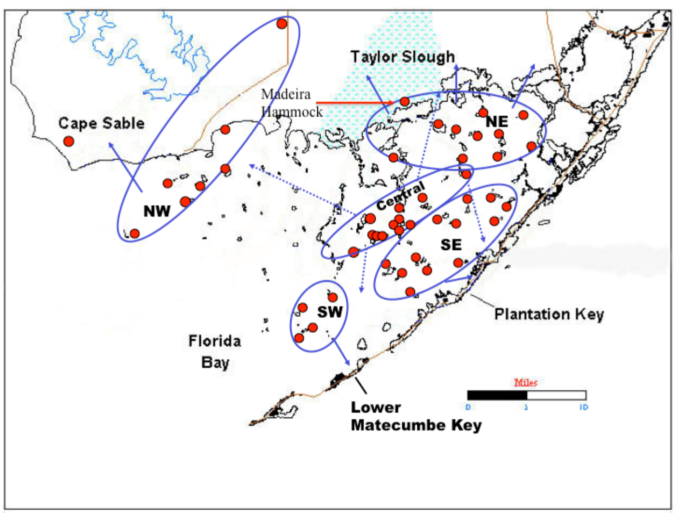

Figure 11. Map of Florida Bay indicating ROSP colony locations (red dots) and nesting regions (blue circles). Arrows indicate the primary foraging area for each region. The dashed lines from the Central region are speculative.

RESULTS

Northwest Region

There were 4 active colonies in the Northwest region, producing a total of 103 nests. This is a decline from last year's 141 nests and is below the target of 210 nests. Sixty nests with known fate produced chicks to at least 21 days of age (75% success rate), with a mean production of 1.29 chicks per nest (c/n) (**Table 9**). This is slightly below the target of 1.38 c/n and above what is considered successful. Total production for the Northwest region was estimated at 156 chicks to 21 days of age (**Table 9**). The mean lay date was December 21, and the mean hatch date was January 11 (**Table 9**). Sandy Key produced 20 nests this season, an increase from the 2015-2016 breeding season (6 nests), but below the 5-year mean for the island (35 nests).

Northeast Region

There were 4 active colonies in the Northeast region this year, including Madeira Hammock, producing an estimated 56 nests total; less than 10% of the target of 688 nests. Madeira Hammock produced only eight nests, an all-time low since monitoring of the colony began. An estimated 1.77 c/n were produced, for a total of 99 chicks in the Northeast region (**Table 9**). Despite the low nesting numbers, the production rate is considered highly successful and well above the target of 1.38 c/n. The mean lay date was January 11, and the mean hatch date was February 2 (**Table 9**).

Southeast Region

Three colonies in the Southeast region produced approximately 34 nests, below the mean of 57 nests since 1984-1985 (**Table 8**). There were approximately 30 nests on Pigeon Key, well above the colony mean of 9 nests. The region produced 68 chicks to branch status with 2 c/n (**Table 9**). The estimated mean lay date was January 2 (**Table 9**), and the mean hatch date was January 23.

Central Region

The Central region yielded 11 nests from 4 colonies, which is lower than the average 43 nests for this region since 1984-1985 (**Table 8**). Estimated total production was very low; only seven chicks fledged in the region. Of the 10 nests with known fate, only 40% successfully raised chicks to 21 days of age (**Table 9**), well below the mean since 1984 (**Table 10**). The mean lay date was January 4, and the mean hatch date was January 25 (**Table 9**).

Southwest Region

Ten colonies in the Southwest region were surveyed in 2016-2017. Only Twin Key was active, producing three nests (**Table 8**) with an estimated production of 2.33 c/n. Seven chicks were observed to 21 days of age, giving the region a success rate of 100% (**Table 8**). The mean lay date and hatch date could not be established.

Table 8. Number of ROSP nests in Florida Bay, November 2016 through May 2017, with minima, mean, and maxima summary data since 1984-1985.

Region	Colony	Number of Nests	Minimum	Mean	Maximum	Number of Years with Nesting since 1984-1985	Number of Years Monitored
Southeast	M. Butternut	0	0	14.37	66	24	27
	Bottle	2	0	8.23	40	17	26
	Stake	2	0	4.56	19	14	25
	Cowpens	0	0	3.76	15	10	25
	Cotton	0	0	0.00	0	0	24
	West	0	0	1.91	9	9	23
	Low	0	0	0.48	9	3	25
	Pigeon	30	0	8.68	56	16	25
	Crab	0	0	1.33	8	6	24
	Crane	0	0	8.24	27	17	25
	East	0	0	2.61	13	11	26
	East Butternut	0	0	4.13	27	14	24
	Southeast Region Subtotal	**34**	**4**	**56.28**	**117**	--	--
Central	Central Bob Allen	5	2	8.00	18	6	6
	Jimmie Channel	3	0	14.81	47	24	27
	First Mate	1	0	2.45	15	8	11
	Bruce	0	7	7.00	7	2	2
	West Bob Allen	2	0	3.16	9	4	6
	East Bob Allen	0	0	9.33	35	17	27
	Manatee	0	0	0.12	3	1	25
	Calusa	0	0	7.47	21	13	17
	Pollock	0	0	1.22	13	3	18
	S. Park	0	0	7.88	39	19	27
	Lil Jimmy	0	0	1.09	12	1	11
	North Jimmie	0	0	0.33	2	2	9
	Captain	0	0	2.72	13	5	11
	Junk	0	0	0.00	0	0	1
	Central Region Subtotal	**11**	**3**	**42.84**	**96**	--	--
Northeast	Tern	0	0	75.15	184	22	32
	N. Nest	0	0	0.56	8	5	25
	S. Nest	27	0	16.32	59	22	25
	Porjoe	0	0	19.89	118	14	29
	N Park	0	0	12.00	50	15	27
	Duck	20	0	12.13	100	16	29
	Pass	0	0	0.60	7	4	25
	Deer	0	0	2.58	15	6	12
	Lil Betsy	0	0	2.50	21	2	10
	Madeira	8	0	25.84	164	6	25
	Eagle	1	1	3.60	8	4	5
	Diamond	0	0	0.50	1	1	3
	Lake	0	0	0.00	0	0	3
	Russell	0	0	0.00	0	0	2
	Northeast Region Subtotal	**56**	**3**	**154.11**	**333**	--	--
Southwest	E. Buchanan	0	0	3.92	27	8	25
	W. Buchanan	0	0	2.12	9	7	24
	Barnes	0	0	0.16	3	2	24
	Twin	3	0	1.87	8	14	24
	Petersons	0	0	0.00	0	0	3
	Shell	0	0	0.00	0	0	2
	Hobo	0	0	0.00	0	0	2
	Panhandle	0	0	0.00	0	0	2
	Southwest Region Subtotal	**3**	**0**	**7.16**	**35**	--	--
Northwest	Sandy	20	6	123.56	250	32	32
	Frank	0	0	34.73	125	15	26
	Clive	9	2	19.43	52	16	16
	Oyster	0	0	4.00	45	12	26
	Palm	54	0	33.92	100	13	14
	Han Van	0	0	4.71	18	2	7
	Paurotis	20	2	40.66	128	12	12
	Cape Sable	0	1	2.50	8	3	4
	Catfish	0	0	0.00	0	0	2
	Northwest Region Subtotal	**103**	**67**	**198.46**	**325**	--	--
	Florida Bay Total	**207**	**115**	**459.12**	**880**	--	--

Table 9. Breakdown of colonies, by region, of all monitoring data collected.

Region	Colony	Number of Nests Observed	Number of Marked (Monitored) Nests	Number of Nests with Known Fate	Number of Chicks to Branchling	Estimated Production per Nest	Estimated Number of Chicks Fledged	Number of Nests with at Least One Branchling	% Success	Mean Lay Date	Mean Hatch Date
Northeast	Duck	20	5	0	23*	1.15	23	U/K	U/K	2/3/17	2/24/17
	Eagle	1	1	1	2	2	2	1	1	1/15/17	2/5/17
	South Nest	27	18	0	51*	1.88	50.76	U/K	U/K	12/17/16	1/8/17
	Madeira Hammock	8	0	8	8	1.75	14	8	1	U/K	U/K
	Region Subtotal	**56**	**24**	**9**	**10**	**1.77**	**99.12**	**9**	**1**	**1/11/17**	**2/2/17**
Northwest	Clive	9	9	7	9	1.29	11.57	5	0.71	12/28/16	1/18/17
	Palm	54	42	28	56	2	108	24	0.86	12/17/16	1/7/17
	Sandy	20	16	7	10	1.43	28.57	6	0.86	12/20/16	1/10/17
	Paurotis	20	0	18	16	0.89	17.78	16	0.89	U/K	U/K
	Region Subtotal	**103**	**67**	**60**	**91**	**1.52**	**156.22**	**45**	**0.75**	**12/21/16**	**1/11/17**
Southeast	Pigeon	30	9	0	49*	1.63	49	U/K	U/K	U/K	U/K
	Bottle	2	2	2	4	2	4	2	1	1/6/17	1/27/17
	Stake	2	2	2	4	2	4	2	1	12/31/16	1/21/17
	Region Subtotal	**34**	**13**	**4**	**8**	**2**	**68**	**4**	**1**	**1/3/17**	**1/24/17**
Central	First Mate	1	1	1	1	1	1	1	1	1/24/17	2/15/17
	Central Jimmie	3	3	2	3	1.5	4.5	2	1	1/4/17	1/25/17
	West Bob Allen	2	2	2	2	1	2	1	0.5	12/19/16	1/9/17
	Central Bob Allen	5	5	5	0	0	0	0	0	12/31/16	1/21/17
	Region Subtotal	**11**	**11**	**10**	**6**	**0.6**	**6.6**	**4**	**0.4**	**1/4/17**	**1/25/17**
Southwest	S. Twin	3	0	3	7	2.33	7	3	1	U/K	U/K
	Region Subtotal	**3**	**0**	**3**	**7**	**2.33**	**7**	**3**	**1**	**U/K**	**U/K**
	Total	**207**	**115**	**86**	**122**	**1.42**	**293.65**	**65**	**0.83**	**1/2/17**	**1/23/17**

U/K = unknown.
* Data field is observed but not recorded.

Table 10. Mean number of chicks to 21 days per nesting attempt, and the percentage of nests that were successful. Summary data indicate the overall minimum, mean, and maximum production rates (chicks per nest) to 21 days of age as well as the percentage of years that the region has been successful since 1984-1985. Success is defined as a mean of at least 1 chick to 21 days per nesting attempt. Summary figures refer to the focal colony or colonies surveyed in each year.

Region	2016-2017 Nesting Season		Summary Since 1984-1985			
	Mean Production per Nest	% Successful Nests	Minimum	Mean	Maximum	% Years Successful
Northeast	1.77	1.00	0	0.92	2.20	0.54
Northwest	1.42	0.78	0	1.25	2.50	0.66
Southeast	2	1.00	0	0.95	3.25	0.39
Central	0.6	0.40	0	0.80	1.86	0.35
Southwest	2.33	1.00	0.89	1.56	2.33	1.00

Baywide Synthesis

ROSP nest numbers in 2016-2017 (207 nests) were considerably lower than last year's 367 nests and only 16.5% of the target 1,258 nests per year (**Figure 12**; note that counts in 2009-2010 and 2010-2011 were underestimated because ROSP nests observed at Madeira Hammock were not counted). This year's nesting effort continues a trend of declining nesting effort from the early 1990s, with current counts remaining much lower than historical nesting patterns of the 1970s to 1990s (**Figure 12**). The 2016-2017 nesting numbers in the Northeastern region of Florida Bay were much lower than in previous years due to low nesting at Madeira Hammock (**Figure 12**).

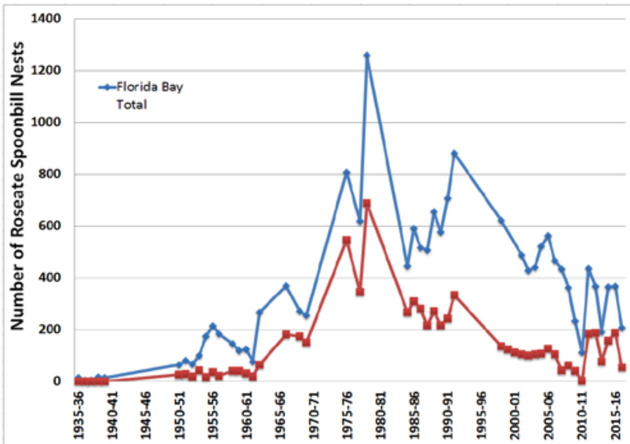

Figure 12. Total ROSP nests in Florida Bay (blue) and in the northeastern subregion of Florida Bay (red). Note: nests were undercounted in 2009-2010 and 2010-2011 because the Madeira Hammock colony was active both years but nests were not counted. ROSP did not nest at Madeira Hammock prior to 2009-2010.

Throughout Florida Bay, the average nest production was 1.42 c/n, with 83% of nests successfully raising at least 1 chick to 21 days of age (**Table 9**). This is well above the mean of 1.09 c/n since 1984. The mean lay date of January 2 occurred much closer to the traditional historical nesting range, which is an improvement from recent years. Lay dates were synchronous throughout the colonies, except at Paurotis Pond and Madeira Hammock, where a mean lay and hatch date could not be determined. The largest colony was at Palm (54 nests).

Mean sea level in the Gulf of Mexico has a profound impact on water levels in ROSP 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 coastal wetlands, lowering water levels and concentrating fish in the remaining wetted habitat. This makes fish easily available to ROSP, which time their nesting cycle with the low water and high fish concentration period. In recent years, higher mean sea level in the Gulf of Mexico (**Figure 13**) has resulted in higher water levels in foraging grounds, causing reduced and delayed nesting in Florida Bay's ROSP population. This may change the way ROSP will be used as an indicator for Everglades restoration going forward. However, the 2016-2017 water levels were closer to traditional levels than in recent years, hopefully indicating a slowing or reversal in the differential sea level affecting Florida Bay (**Figure 14**).

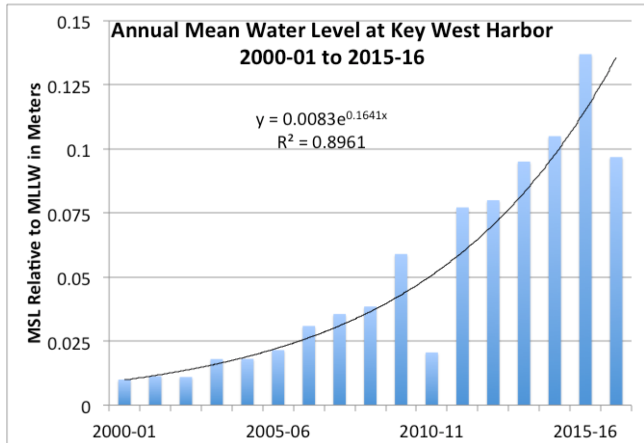

Figure 13. Mean annual sea level at Key West Harbor from 2000-2001 to 2016-2017.

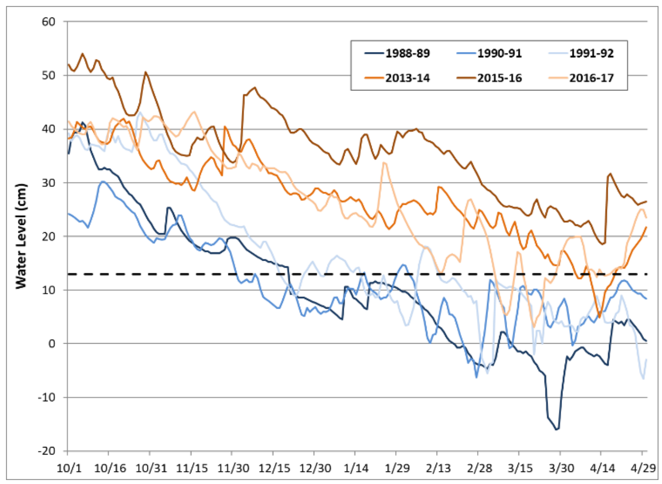

Figure 14. Water levels relative to the 13-centimeter prey concentration threshold (dotted line) from Taylor River hydrostation during 3 years of peak ROSP nest numbers (1988-1989: 654 nests; 1990-1991: 880 nests; 1991-1992: 707 nests) and the 3 lowest years of ROSP nest numbers (2015-2016: 367 nests, 2013-2014: 191 nests; 2016-2017: 207 nests). The 3 years with the highest nesting show considerable amounts of time below the prey concentration threshold while the 3 lowest years only briefly had water levels below threshold, if at all.

There is a sizable difference in the time water levels went below the prey concentration threshold level of 13 centimeters during the peak 3 years of nesting versus the lowest 3 years of nesting (**Figure 14**). Sea level rise increased exponentially after 2000 (**Figure 13**), when the lowest nesting numbers became more frequent. This has a detrimental impact on a breeding ROSP's ability to successfully support its high caloric dietary needs for itself and its offspring during and after the breeding season when the mean water level is consistently above the prey concentration threshold. Over time, this affects the fecundity of the bird; if it cannot forage for itself, then it will not have the energy needed to support itself and its offspring. Therefore, ROSP may abandon nesting areas with high waters or abandon reproduction for that season. Even in successful years such as this one, fledglings need favorable conditions to learn how to successfully forage. With higher mean water levels, prey may not be sufficiently concentrated long enough for fledglings to learn proper foraging behavior, which may result in reduced fledgling survival after leaving the care of their parents.

In recent nesting years, Madeira Hammock and Paurotis Pond have supported large numbers of nesting ROSP (combined 268 nests in 2014-2015 and 150 nests in 2015-2016). This breeding season, 28 nests were detected between the 2 colonies. The birds nesting in these two colonies may be younger birds that have not experienced traditional environmental cues, which have been distorted or absent because of the masking effects of sea level rise. Because these young birds reached reproductive age after sea level rise altered the hydropatterns on the traditional foraging grounds, they probably are inexperienced regarding the sustained drawdown in water levels during the time frame when ROSP historically should be initiating courtship. In 2016-2017, hydropatterns were closer to those pre-sea level rise (**Figures 13** and 1**4**), so the habitats these young birds have been using to gain cues regarding nest timing may have been too dry by the time they staged courtship and mating behaviors. Therefore, they failed to nest in these colonies successfully or abandoned the area altogether. Sandy Key and Pigeon Key saw an increase in nesting (20 and 30 nests, respectively) over previous years nesting. South Nest also has seen an increase in nesting, with 27 nests this season, where the 5-year mean was 14 nests. This could be because older ROSP (hatched pre-2010) nest at Sandy, Pigeon, and South Nest, and responded more positively to the more traditional environmental cues that occurred this breeding season. This may explain the high success rate on the bay keys and the lack of nesting on the two mainland colonies.

The results suggest that environmental cues that traditionally promoted breeding activity occurred this season. For example, water levels dropped to 13 centimeters, at which prey begin to concentrate (Lorenz 2014), and this has not happened in the past 7 years. Despite the ideal lay and hatch dates, ROSP nest numbers were considerably below sustainable numbers. Many variables could lead to these low numbers. From the end of 2014 to the beginning of 2016, Florida Bay experienced multiple abnormal conditions, including El Niño weather events, a drought during the 2015 rainy season, and exceptionally high rainfall during the 2016 dry (breeding) season. Florida Bay became hypersaline, which triggered a historic seagrass die off. This breeding season was a year following a drought, when ROSP typically have good nesting success. However, this is one of the lowest breeding seasons since the beginning of data collection.

These data suggest that conditions within Florida Bay have deteriorated for nesting ROSP. ROSP nesting is one of many environmental indicators suggesting the health of Florida Bay is declining and exhibiting dramatic and rapid changes in its ecology.

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NESTING ACTIVITY OF WATER BIRDS ON ROSEATE SPOONBILL COLONY KEYS IN FLORIDA BAY

While surveying known Roseate Spoonbill (ROSP) colonies throughout Florida Bay, other water bird nesting activity on the keys was investigated (including other species of wading bird, Osprey [OSPR], Brown Pelican [BRPE], Double-crested Cormorant [DCCO], and Anhinga [ANHI]). Nineteen species of water bird, 13 of which were nesting on these islands, were encountered and enumerated to the extent possible (**Table 11**). These findings should not be treated as a thorough or exhaustive survey of water birds in Florida Bay. Many keys were not surveyed because ROSP did not nest on them. Also, searches did not extend beyond areas where ROSP nested on a given key.

That stated, great efforts were taken to thoroughly find all Reddish Egret (REEG) nests. REEG recently have become a species of interest at the state and local level, and are now being treated the same as ROSP (i.e., attempts are made to find all nests and document productivity). REEG estimates likely are an accurate representation of effort for this species in Florida Bay.

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Table 11. Number of water bird nests in Florida Bay, November 2016 through May 2017.

Region	Colony*	OSPR	GBHE	GWHE	GREG	GRHE	BRPE	DCCO	SNEG	TRHE	WHIB	ANHI	WOST	REEG
	Sandy	1		20				55		1				2
	Clive	2	80	50	35		60	50	12					1
Northwest	Palm							55						7
	Paurotis											12	60	
	Oyster						200	50						
	Tern									30				
	S. Nest	1		3										
	Duck		1	4	7			10	1	30				5
Northeast	Madeira Hammock				9					5	280	15		
	Diamond				120				36	172	1	7		2
	Eagle			4										2
	Lil Betsy	1	2			1		20						
	Stake			4	1									4
	East													1
	Pigeon		1	10		2		250		8				2
Southeast	Crane	1												
	Cowpens				7			19						3
	Cotton	1												
	West	1		1										
	WBA	1												1
	CBA	2												2
	C. Jim	4		3										7
	Calusa			1										1
Central	S. Park						20							
	1st Mate							7						2
	Captain	2												
	Polluck	1												
	N. Jim	4												
	Bruce		2											8
	S. Twin							50						1
Southwest	Buchanan				2	35	25							
	Peterson				1									
	Shell	1												
Nest Totals		**23**	**86**	**100**	**182**	**38**	**305**	**566**	**49**	**246**	**281**	**34**	**60**	**51**

Note: LBHE, BAEA, YCNH, GLIB, MAFR, and BCNH nests were not observed (count = 0).
* The following colonies (by region) had no recorded nests: Northwest Region – Han Van, Frank, Cape Sable, Murray, Catfish, and Dildo; Northeast Region – Porjoe, Deer, N. Nest, N. Park, Pass, and Lake; Southeast Region – M. Nut, B. Nut, Low, Dowitcher Key, Bottle, and Crab; Central Region – EBA, Manatee, Ogden #12, Lil Jim, and Russell; Southwest Region – Arsnickers, Barnes, N. Twin, and Green Mangrove.

SOUTHWEST FLORIDA

In 2017, Audubon Florida monitored five wading bird colonies in Lee and Collier counties. In addition to the colony at Corkscrew Swamp Sanctuary, each of the sites has been used as a Wood Stork (WOST) colony site at some point in the past decade. These colonies are targeted due to the marked decline of WOST in Southwest Florida, including and most importantly, the historic Corkscrew colony. The decline in WOST in this region is concurrent with wetland loss and reduced hydroperiod of many remaining wetlands. While the primary focus of this investigation was WOST, all wading birds were monitored.

METHODS

Monthly aerial surveys were conducted from a fixed-wing aircraft (January 9, February 1, March 1, April 3, May 4, and June 17). At each colony location, a digital SLR camera with a 70-300 mm lens was used to take a series of overlapping photos of the colony at an altitude of 500 to 1,000 feet above ground level. Visual estimates of nesting WOST also were made while in flight. Numbers included in this report reflect only the in-flight estimates as the analysis of aerial imagery is not yet complete.

HYDROLOGY

Water levels at Corkscrew Swamp Sanctuary climbed quickly in June, remaining within the normal to high range throughout the wet season. Rainfall recorded at the Blair Audubon Center from June through September was 45.97 inches, 7.76 inches above the average for the period of record. A La Niña cycle brought very dry conditions from October through April, when only 10.28 inches of rain was recorded compared to the period of record of 18.08 inches. Water table recession at Corkscrew Swamp Sanctuary during this time exceeded the average for the period of record. The water table dropped below ground surface at the Corkscrew Swamp Sanctuary B-staff gauge by March 16, 2017.

RESULTS

The 2017 breeding season represented the 60th consecutive year monitoring the historic Corkscrew WOST colony and the 12th consecutive year monitoring four additional WOST colony sites in Lee and Collier counties. Despite the rapid water table recession, the largest subcolony at Corkscrew Swamp Sanctuary appeared to be unaffected. Some subcolonies did fail, reducing the colony size by more than half. This is believed to be related to the loss of water under the nest trees, exposing the nests to raccoon predation.

Wading birds in Southwest colonies formed and initiated nesting in early January, slightly outside of the historical initiation window. No wading bird nesting was recorded at the Sunniland or Collier Hendry Line colonies during the 2016-2017 breeding season.

Barron Collier 29

WOST and Great Egrets (GREG) nested successfully at the Barron Collier 29 colony. The colony initiated in early January and produced 280 successful WOST nests. GREG nest numbers are not known at this time.

Corkscrew Swamp Sanctuary

Information from an aerial survey conducted by the Florida Fish and Wildlife Conservation Commission places nest initiation at or before January 5. Audubon's January 9 aerial survey revealed incubating WOST, platform construction, and a few nests containing at least two eggs with attending adults. The colony continued to grow through the February 1 flight when a conservative in-flight count of 250 WOST nests were observed. They occupied five subcolonies within Corkscrew Swamp Sanctuary's old-growth bald cypress forest. The colony contained at least one visible Roseate Spoonbill (ROSP) nest and several GREG nests. The March 1 flight recorded three failed subcolonies, and a fourth colony had lost many of the nests. Predation is thought to be the primary cause of the nest failure. No heavy winds, rains, or cold weather were experienced in the region during the breeding season that could account for the failure. Water levels are thought to have fallen too low beneath the three failed colonies, resulting in a departure of the alligators beneath the nest trees, leaving the nests vulnerable to raccoon predation. Approximately 120 nests from the 2 remaining subcolonies successfully fledged chicks.

Lenore Island

The 2017 colony at Lenore Island had 300 successful WOST nests. Great Blue Herons (GBHE), Brown Pelicans (BRPE), GREG, and Double-crested Cormorants (DCCO) also were present and nesting, but no numbers are available at this time.

Caloosahatchee East

GBHE and BRPE were observed nesting on this mangrove island. No WOST nests were identified.

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CORKSCREW REGIONAL ECOSYSTEM WATERSHED MANAGEMENT AREA

The Florida Fish and Wildlife Conservation Commission monitored nine wading bird nesting colonies in Corkscrew Regional Ecosystem Watershed (CREW) Management Area and National Audubon Society's Corkscrew Swamp Sanctuary in Lee and Collier counties. Foraging and roosting aggregations were also identified with the goal of monitoring long-term trends in activity.

METHODS

Monthly systematic aerial surveys of CREW Management Area and Corkscrew Swamp Sanctuary were performed in a Cessna 182, covering 170 km² (41,910 acres) from November 2016 through July 2017. Transects spaced 1.48 km (0.8 nautical miles) apart and oriented northeast to southwest (**Figure 15**) were flown at an altitude of 244 meters (800 feet). Once a colony was located, altitude was reduced to 152 meters (500 feet), the GPS coordinates were recorded, and digital photos were taken using a Canon EOS 7D with a 70-300 mm lens and image stabilization. Photos were used to count individuals and nests, and each photo was digitally marked using Adobe® Photoshop Elements 9 to avoid double-counting. Peak nest numbers (the highest nest count for the season) were reported within each colony.

HYDROLOGY

Southwest Florida experienced lower than average rainfall from November 2016 through April 2017. Stage data indicated that the peak fall water level occurred on September 30, 2016 followed by drier than normal conditions which persisted until late May (Corkscrew Swamp Sanctuary Lettuce Lake staff gauge; 26.375582, -81.603836). Fall water recession rates began in early October and continued through May until significant rain events occurred in late May and early June. Rainfall for June was significantly higher than normal, 22.96 centimeters (9.04 inches) (CREW office rainfall gauge; 26.433446, -81.569398).

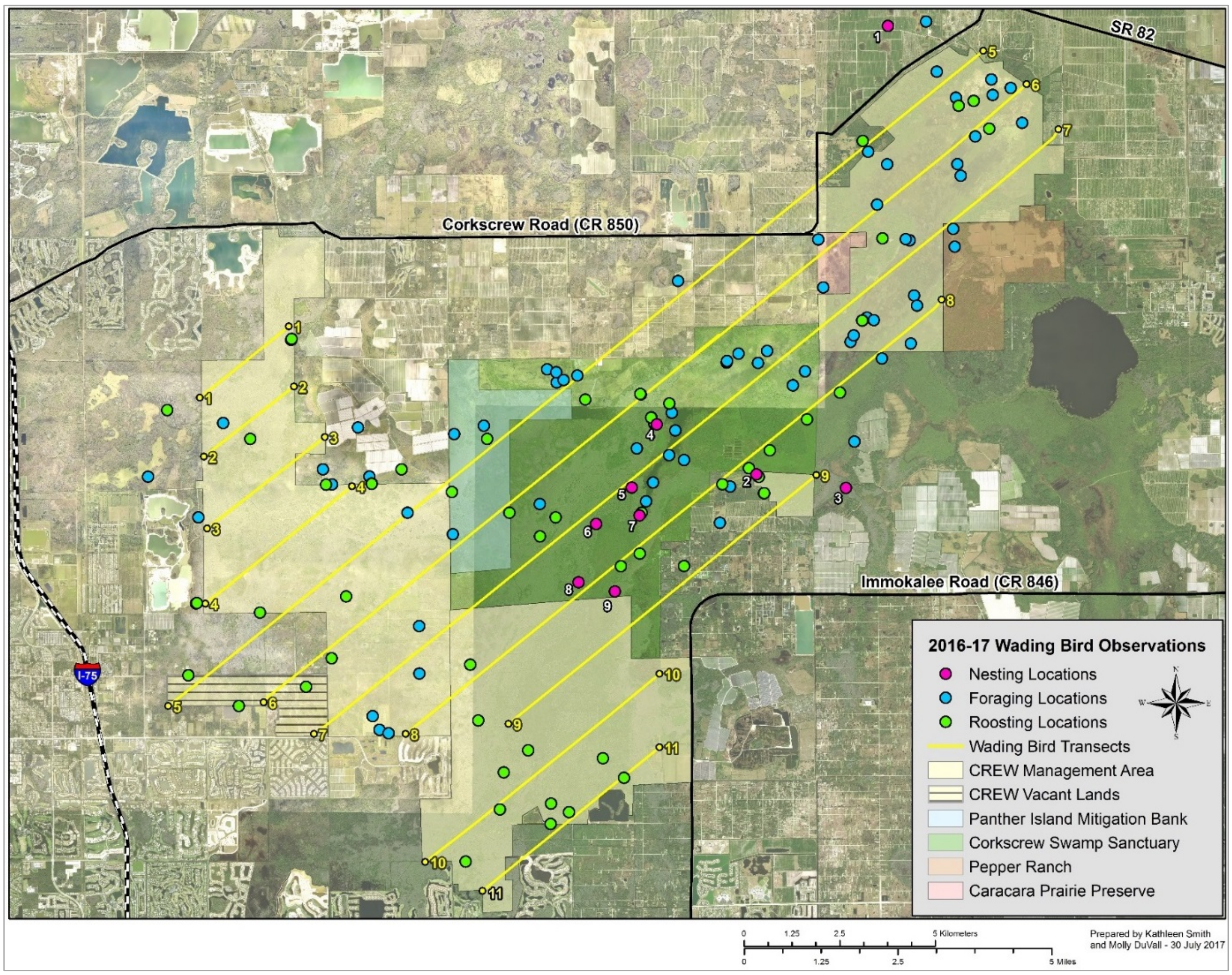

Figure 15. Locations of nesting, foraging, and roosting wading birds in and around CREW Management Area and Corkscrew Swamp Sanctuary, November 2016 through July 2017. Colony 1 is Orange Grove, Colony 2 is Sod Farms, Colony 3 is Cypress East, Colony 4 is Corkscrew Swamp Sanctuary GREG, Colony 5 is Corkscrew Swamp Sanctuary Small White, Colony 6 is WOST Subcolony 1, Colony 7 is WOST Subcolony 3, Colony 8 is WOST Subcolony 4, and Colony 9 is BRS WOST Subcolony.

Results and Discussion

Nine nesting colonies were monitored for a combined peak nest number of 895 nests, which was a 46% increase from 2016. The increase in peak nest number was due to the return of nesting Wood Stork (WOST) to the Corkscrew Swamp Sanctuary. WOST nested in large numbers in four subcolonies, while WOST nesting in the regularly monitored colonies declined relative to recent years.

WOST Subcolonies

WOST nested in Corkscrew Swamp Sanctuary for only the second time in the last 8 years. WOST nesting areas were identified as subcolonies to locate priority nesting habitat and assist with photographic analysis. All subcolonies were dominated by old-growth bald cypress. Nesting was estimated to have started between mid-December and early January for all WOST subcolonies. The combined WOST peak nest number totaled 467 nests, and 53 branchlings were recorded.

There appeared to be a shift in WOST nesting effort from the BRS WOST Subcolony to WOST Subcolony 4 between February and March. No nesting was observed after March in the BRS WOST Subcolony, yet nesting effort in nearby WOST Subcolony 4 increased that month (0.99 km [0.61 miles] apart). It is unclear why WOST may have abandoned the BRS WOST Subcolony.

Orange Grove

The peak nest number for the Orange Grove colony was 36 nests, a 44% decrease from 2016 (**Table 12**). Overall, the trend in peak nest number for Great Egrets (GREG) has declined over the last 5 years. A delay in nest initiation was observed in the Orange Grove colony in 2017 (nesting was not observed until April). In 2017, fewer species (two species compared to six species) were observed nesting in the Orange Grove colony, and it is the first year that fewer than four nesting species have been observed in this colony (**Table 12**).

The Orange Grove colony is located on a vegetated island in a retention pond at the Alico-owned orange grove. Power lines (15 meters [50 feet] high) pass over the island. Birds nested in Brazilian pepper trees surrounded by Peruvian primrose willow.

Sod Farms

The peak nest number for the Sod Farms colony was 96 nests, an 8% decrease from 2016 due to a continued reduction in the number of nesting Cattle Egrets (CAEG). There was an increase in nesting Little Blue Herons (LBHE) and Snowy Egrets (SNEG) (**Table 12**) in 2017. Seven species were present in this colony, and five of the seven species were nesting (SNEG, LBHE, Anhinga [ANHI], CAEG, and Black-crowned Night Herons [BCNH]). Birds were first observed nesting in April, which is a month earlier than last year. Birds nested in Carolina willow that was surrounded by Brazilian pepper. The willow was in a shallow marsh bordered by bald cypress trees.

Cypress East

The peak nest number for the Cypress East colony was 92 nests, a 15% increase from last year and slightly above average for the last 4 years (**Table 12**). This colony consisted only of nesting GREG in 2017, and nesting was first observed in February. No nesting ANHI were observed. Birds in this colony nested in approximately 12-meter (40-foot) high bald cypress trees surrounded by depression marsh.

Corkscrew Swamp Sanctuary GREG

The peak nest number at the Corkscrew Swamp Sanctuary GREG colony was 40 nests, a 35% decline from last year. Nesting birds were observed in March and April and included GREG and ANHI (**Table 12**). Because of the small window of nesting observed at this colony, the fate of the nestlings is not optimistic. This colony is located on the perimeter of a cypress dome in bald cypress trees.

Corkscrew Swamp Sanctuary Small White

The peak nest number at the Corkscrew Swamp Small White colony was 142 nests, an 18% decline from last year. Beginning in May, only five species nested at the Corkscrew Swamp Small White colony, down from seven species last year. Nesting birds included BCNH and LBHE (**Table 12**). The primary nesting substrate is Carolina willow interspersed Brazilian pepper and red maple trees.

Foraging and Roosting Effort

In addition to nesting colonies, 99 foraging aggregations and 53 roosting colonies were located (**Figure 15**). White Ibis (WHIB) (n = 3,475), GREG (n = 1,498), SNEG (n = 1,367), WOST (n = 1,021), LBHE (n = 269), and GBHE (n = 194) were the most abundant species observed in foraging aggregations, with WHIB and GREG being present in 73% and 84% of the foraging aggregations, respectively. WHIB and GREG also were the most common species in roosting colonies, with 74% and 66% presence, respectively. Other species of interest foraging or roosting in the CREW Management Area included LBHE, BCNH, Tri-colored Heron (TRHE), and Roseate Spoonbill (ROSP).

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Table 12. Peak number of wading bird nests at the CREW Management Area and Corkscrew Swamp Sanctuary, 2013 to 2017.

Colony	Latitude	Longitude	Year	WOST	GREG	SNEG	CAEG	ROSP	WHIB	BCNH	GRHE	TRHE	LBHE	ANHI	LGWH	LGDA	SMWH	SMDA	Total
1	26.50040	-81.54440	2013		56	1	12							2			7		**78**
			2014		49	1	1				1			6			5		**63**
			2015		18	4	2					2	2	5	2		1		**36**
			2016		39	2	9					3	1	5	2	1	2		**64**
			2017		30	4											2		**36**
2	26.39442	-81.57710	2013				198					3	10	1			116	2	**330**
			2014			1	251					1	18				33		**304**
			2015		2	16	319					7	66	2			1	1	**414**
			2016			2	70					3	22				7		**104**
			2017		2	17	36			4			30				6	1	**96**
3	26.39132	-81.55490	2013		8														**8**
			2014	8	90			7											**97**
			2015		53	1								2	1				**57**
			2016		77									3					**80**
			2017*		91													1	**92**
4	26.40473	-81.59860	2014		2														**2**
	26.40913	-81.60583	2016**		61									1					**62**
	26.40611	-81.60460	2017*		30									10					**40**
5	26.38971	-81.61227	2014				1												**1**
			2016	1	1	4	126	1		13	4	2	12	8			2		**173**
			2017			3	116			5			7	3			8		**142**
6	26.38156	-81.61930	2014	37					13										**50**
	26.38254	-81.62037	2017*	57															**57**
7	26.38161	-81.60862	2014	73	5														**78**
	26.38462	-81.60901	2017*	20															**20**
8	26.36877	-81.62493	2017	162	10			4							1		1		**178**
9	26.36510	-81.61393	2014	59															**59**
	26.36664	-81.61535	2017*	228	3			2						1					**234**

Colony 1 = Orange Grove, owned by Alico; Colony 2 = Sod Farms, owned by CREW Management Area; Colony 3 = Cypress East, privately owned; Colony 4 = Corkscrew Swamp Sanctuary GREG, owned by Corkscrew Swamp Sanctuary; Colony 5 = Corkscrew Swamp Sanctuary Small White, owned by Corkscrew Swamp Sanctuary; Colony 6 = WOST Subcolony 1, owned by Corkscrew Swamp Sanctuary; Colony 7 = WOST Subcolony 3, owned by Corkscrew Swamp Sanctuary; Colony 8 = WOST Subcolony 4, owned by Corkscrew Swamp Sanctuary; Colony 9 = BRS WOST Subcolony, owned by Corkscrew Swamp Sanctuary.

* In 2017, GPS coordinates were modified from previous reports. Aerial imagery, flight paths, and aerial GPS coordinates were used to improve the accuracy of colony locations.

** The 2016 Corkscrew Swamp Sanctuary GREG colony nested approximately 0.86 km (0.54 miles) northwest of the 2014 location.

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

Introduction/Background

For 10 consecutive years, the Florida Department of Environmental Protection (FDEP) and U.S. Fish and Wildlife Service have collaborated to collect wading and diving bird nesting data. Staff at Charlotte Harbor Aquatic Preserves (CHAP), a field site of FDEP's Florida Coastal Office, 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 16**). Colonial wading and diving bird nest monitoring began in 2008 with 9 islands and expanded to 34 islands in 2011. This year, 38 islands were monitored, and 28 were identified as active wading and diving bird nesting sites within the study area. Goals of this continuous study include documenting population trends to better understand avian biodiversity on the islands and producing a long-term data set for better analysis of nesting efforts by species throughout the greater Charlotte Harbor estuarine system. This year, two islands in the study area (Hemp Key and Broken Islands, both located in Pine Island Sound) were designated by the Florida Fish and Wildlife Conservation Commission as Critical Wildlife Areas. The islands will be posted sometime in spring 2018.

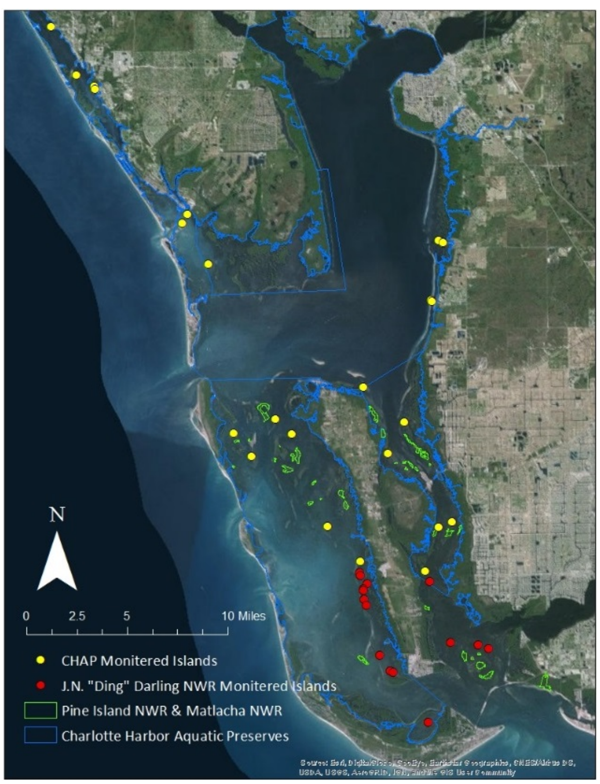

Figure 16. Locations of monitored bird colonies in the CHAP and J.N. "Ding" Darling NWR Complex.

Photo courtesy of Melynda Brown

Methods

The study area was divided between the two agencies based on location. J.N. "Ding" Darling 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 employ 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*, *chicks*, or *unknown* if the nesting stage could not be determined. Nests were documented as *incubating* when an adult was sitting on the nest in a crouched position, shading the nest. The *chicks* category was used when juvenile birds were visible in or near the nest. This category was counted as a nesting stage, *chicks in the nest,* and was not used as a measure of productivity. Data collected from February through July 2017 were analyzed for this report. Peak numbers reflect the highest number per species throughout the survey period. The total number of peak nests were calculated for each island as well.

Results

The peak estimate for 14 species of colonial nesting birds from all 38 islands combined was 1,349 nests (**Table 13**). Diving birds constituted approximately 75% of the documented nests, and the remaining 25% were wading bird nests. The largest nesting effort in 2017 occurred on Hemp Key (254 nests), Broken Islands (212 nests), and Useppa Oyster Bar (119 nests). Broken Islands also supported the greatest species diversity, with 11 species nesting in 2017. The 2017 total peak nest count was 1,412 nests, down 4.46% from 2016.

Table 13. Colonial nesting bird peak counts for the CHAP and J.N. "Ding" Darling NWR Complex, February through July 2017.

Colony (Island)	Lat.	Long.	GBHE	TRHE	LBHE	SNEG	GREG	REEG	CAEG	YCNH	BCNH	GRHE	WHIB	BRPE	DCCO	ANHI	Total
Bodifer Key	26.4977	-82.1125												1	2		**3**
Broken Islands	26.6777	-82.1940	5	11		4	1	4	3	1			28	85	69	1	**212**
Burnt Store Marina N	26.7625	-82.0669	7		2		1				1				1		**12**
Burnt Store Marina S	26.7611	-82.0660	1							1	1	1					**4**
Clam Key	26.5063	-82.1128	4								1			9	37		**51**
Darling Keys	26.6669	-82.1811	1														**1**
Dog Island	26.8205	-82.2671	1														**1**
E of Chadwick Cove	26.9289	-82.3511	7			8	14								7	1	**37**
Fish Hut Island	26.5467	-82.1245	2	1		1	1		2					1	25		**33**
Gasparilla Marina S	26.8269	-82.2625	3	9	1	2		1	4			1		31	27		**79**
Hemp Key	26.5999	-82.1532	9				14					1		66	164		**254**
Little Oyster Creek	26.9203	-82.3363	5														**5**
Masters Landing	26.5666	-82.0749	4														**4**
N of York Island	26.4945	-82.1043	1		2	2			1					62	5	7	**80**
NE of York Island	26.4940	-82.1021	2		1	1					1			17			**22**
NW of Mason Island	26.5543	-82.1251												3	5	2	**10**
NW of Pumpkin Key	26.5660	-82.1279	2					1							2		**5**
Oyster Creek W	26.8181	-82.3359	4											10	19		**33**
Pirate Harbor N	26.8052	-82.0597	6	3		5	9		10					39	17	4	**93**
Pirate Harbor SE	26.8037	-82.0565	2	10		3			15		1			5	36	2	**74**
Royal Palm Marina	26.9640	-82.3708	10														**10**
Skimmer Island	26.5104	-82.0250	1	11	1	3	2			1			2	20	22	1	**64**
SW of Mason Island	26.5534	-82.1250		1												1	**2**
SW of Pumpkin Key	26.5640	-82.1275	2	1										1	12		**16**
Tarpon Bay Keys	26.4577	-82.0744	10	1		1	5							14	16		**47**
Upper Bird Island	26.5592	-82.0714	2											10	11		**23**
Useppa Oyster Bar	26.6513	-82.2134	2							1				46	70		**119**
White Pelican Island	26.7905	-82.2463	9			6	6	3			1				30		**55**
Total			**102**	**48**	**7**	**36**	**53**	**9**	**35**	**4**	**6**	**3**	**30**	**420**	**577**	**19**	**1,349**

Note: Nesting birds were not observed at the following colonies (islands): Bird Keys, Bird Rookery Keys, Cork Island, Crescent Island, Givney Key, Lumpkin Island, Lower Bird Island, N of Mason Island, N Regla, and N of Big Smokehouse.

Species Summaries – Diving Birds

Double-crested Cormorant (DCCO)

DCCO nesting peaked at 577 nests, making up approximately 43% of nests in the 2017 season. Nesting was documented on 20 islands, with the highest nest count (164 nests) occurring on Hemp Key.


Photo courtesy of Melynda Brown

Brown Pelican (BRPE)

BRPE nesting peaked at 420 nests and was documented on 17 islands. This accounted for approximately 31% of the total nesting effort documented this season. The highest peak nest count (85 nests) occurred in May at Broken Islands. This year's BRPE nesting effort was comparable to that of 2016 (436 nests).

Anhinga (ANHI)

ANHI nested on 8 islands, with a peak count of 19 nests. The highest nest count was seven, which occurred on N of York Island.

Species Summaries – Wading Birds

Great Blue Heron (GBHE)

GBHE nested on 25 islands, 66% of the islands monitored this year. The peak nest count for GBHE was 102 nests. Royal Palm Marina West and Tarpon Bay Keys had the largest number of peak nests (10 nests each). A white morph GBHE chick was documented in a nest on Hemp Key.

Tricolored Heron (TRHE)

TRHE nested on 9 islands with a peak nest count of 48 nests. The highest peak nesting effort occurred on Broken Islands and Skimmer Island, each with a peak count of 11 nests.


Photo courtesy of Melynda Brown

Little Blue Heron (LBHE)

LBHE nesting peaked at 7 nests, documented on 5 of the 38 islands. Burnt Store Marina North and N of York Island had the greatest number of nests (2 nests each).

Snowy Egret (SNEG)

SNEG nesting occurred on 11 islands, with a peak nest count of 36 nests. The highest counts were on E of Chadwick Cove (8 nests) followed by White Pelican Island (6 nests). SNEG nesting effort was down 26.5% from 2016 (49 nests).

Great Egret (GREG)

GREG nesting peaked at 53 nests, a 48% decrease from 2016 (102 nests). E of Chadwick Cove and Hemp Key had the most nests (14 nests each).

Reddish Egret (REEG)

REEG were documented nesting on four islands. The peak count was 9 nests, a decrease of 47% from 2016 (17 nests). The highest nest count occurred on Broken Islands (4 nests) followed by White Pelican Island (3 nests). REEG nesting effort in the study area is reported to Audubon Florida and the Florida Fish and Wildlife Conservation Commission to support the statewide survey efforts.


Photo courtesy of Melynda Brown

Yellow-crowned Night Heron (YCNH)

Four YCNH nests were recorded during 2017, one nest each on four separate islands.

Black-crowned Night Heron (BCNH)

BCNH nesting was documented on six islands and peaked at six nests.

Green Heron (GRHE)

GRHE produced three nests, one each at Burnt Store Marina South, Gasparilla Marina South, and Hemp Key. Peak nesting was down 80% from 2016 (15 nests).

White Ibis (WHIB)

WHIB nesting occurred on 2 islands with a peak count of 30 nests. Broken Islands accounted for approximately 93% of the nesting effort (28 nests).

Cattle Egret (CAEG)

CAEG nesting peaked at 35 nests, with 15 of the nests (71%) documented on Pirate Harbor SE and 10 nests on Pirate Harbor North.

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

Estero Bay Aquatic Preserve was designated in 1966 as Florida's first aquatic preserve. 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, 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 support extensive seagrass beds, oyster reefs, and hundreds of islands dominated by mangroves. The islands provide roosting and nesting habitat for wading and diving birds, and nesting has been documented on 25 islands.

METHODS

Surveys between 2008 and 2017 were conducted once a month throughout the breeding 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 Florida (2004). Islands were surveyed at a distance of 30 to 45 meters by two observers; nests were documented by species and nesting stage. The primary observer, an Estero Bay Aquatic Preserve staff member, was consistent throughout the study period from 2008 to 2016 but transitioned to another staff member in September 2016. Trained volunteers conducted secondary observer counts. The average of the two observers' counts was reported. Monthly counts from 2017 are compared with monthly counts from 2008 through 2016. Mean peak nest counts for surveys conducted from 2008 to 2016 represent the 9-year average for Estero Bay.

In 2017, surveys were conducted January 9, 11, and 25; February 8 and 21; March 8, 13, and 21; April 11, 12, and 18; May 8, 10, and 16; June 12, 13, and 19; July 10, 11, and 18; and August 9, 15, 21, and 22.

RESULTS

In January, 12 islands were active with Double-crested Cormorants (DCCO; n = 12), Brown Pelicans (BRPE; n = 6), Great Blue Herons (GBHE; n = 43), and Great Egrets (GREG; n = 2). Between January (n = 63) and August 2017 (n = 205), 16 of the 25 islands monitored were active with an annual peak nest count of 423 nests (**Table 14**). Nest counts peaked in June (n = 232). The Matanzas Pass colony had the most nests in Estero Bay, with an annual peak count of 149 active nests. Overall, nesting increased 2% in 2017 compared to the 9-year average; however, nesting effort decreased for DCCO, GBHE, GREG, Little Blue Herons (LBHE), Reddish Egrets (REEG), Black-crowned Night Herons (BCNH), Yellow-crowned Night Herons (YCNH), and Green Herons (GRHE) (**Table 15**).

DCCO nests were documented on five islands, with nesting activity recorded from January (n = 12) through August (n = 29); nesting activity peaked in April (n = 37). DCCO peak count for 2017 (n = 52) was 25% below the 9-year average.

BRPE nests were documented from January (n = 6) through August (n = 17) on three islands. Peak nest count was recorded in April (n = 104), with a season peak of 118 active nests. BRPE peak nesting was 7% above the 9-year average.

GBHE nests were documented from January (n = 43) through July (n = 4) on 13 islands. Nesting effort peaked in February (n = 48), with a season peak of 64 nests; 7% below the 9-year average. White morphs were documented on four nests at four separate nesting colonies.

Michael Baranski

GREG nests were documented from January (n = 2) through August (n = 37) on five islands. Nesting peaked in August (n = 37), and the annual peak was 46 nests, a 10% decrease in nesting compared to the 9-year average.

Snowy Egret (SNEG) nests were documented from March (n = 5) through August (n = 41), with peak nest counts in August. SNEG nests were documented on six islands, with an annual peak nest count of 43 active nests, a 72% increase over the 9-year average.

LBHE nests were documented from June (n = 1) through August (n = 10), with peak nest counts in August. LBHE peak nest counts for 2017 (n = 10) represented a 29% decrease in nesting effort from the 9-year average.

Tricolored Heron (TRHE) nests were documented on six islands between April (n = 1) and August (n = 58), with peak nesting effort in August. The annual peak (n = 59) represented a 111% increase in nesting effort compared with the 9-year average.

REEG nests were documented from April (n = 1) through August (n = 3) on four islands, with peak nesting effort in May and August (n = 3). The annual peak nest count (n = 5) represents a 29% decrease compared to the 9-year average.

BCNH nests were documented on four islands, with an annual peak of 10 nests, a 23% decrease from the 9-year average. Nesting was documented from May (n = 2) through August (n = 7), peaking in July with eight nests.

YCNH nesting was documented on six islands from February (n = 1) through July (n = 2), with a peak in May and June (n = 7). The annual peak nest count was 10 nests, a 50% decrease in nesting effort compared to the 9-year average.

GRHE nests were documented on two islands from July (n = 3) through August (n = 1), with peak nesting effort in July. The annual peak was three nests, a 50% decrease in nesting effort from the 9-year average.

Cattle Egret (CAEG) nesting was documented on one island from April (n = 1) through August (n = 2), with peak nest counts in August. The annual peak of two nests represents a 100% increase in CAEG nesting efforts over the 9-year average.

Roseate Spoonbill (ROSP) nesting was documented on one island in May (n = 1). This is the first recorded ROSP nest in Estero Bay.

Anhinga (ANHI) and White Ibis (WHIB) nests were not observed during 2017 surveys.

Between January and August 2017, volunteers contributed 278 hours of service to monitoring and protecting wading and diving bird colonies in Estero Bay. Staff and volunteers removed 464 feet of fishing line and 12 hooks from nesting islands during this time. Six bird fatalities were documented due to fishing line entanglement.

Table 14. Peak nest counts documented in Estero Bay Aquatic Preserve colonies, January through August 2017.

Colony	Latitude	Longitude	DCCO	BRPE	GBHE	GREG	SNEG	LBHE	TRHE	REEG	BCNH	YCNH	GRHE	CAEG	ROSP	Total
Big Bird Island	26.38286	-81.84995			1				1							**2**
Big Carlos Pass M-43	26.43155	-81.90066	3		3							2				**8**
Big Carlos Pass M-48	26.42771	-81.90050							1			1				**2**
Big Carlos Pass W of M-52	26.42469	-81.89359	8	18	6	25	6		12	2	2	1				**80**
Big Hickory E of M-85	26.35315	-81.84164	7		11	2	1	1		1						**23**
Coconut Point East	26.38411	-81.84905	20	47	8	12	11	1	1	1	3				1	**105**
Coconut Point West	26.38111	-81.84976			2											**2**
Denegre Key	26.43772	-81.86728			7		1		2		2	1	2			**15**
Estero River M-30	26.43029	-81.86113											1			**1**
Estero River North	26.43653	-81.86091			3							1				**4**
Hogue Channel M-78	26.34988	-81.84644										4				**4**
Matanzas Pass	26.46092	-81.95717	14	53	11	4	15	8	38	1	3			2		**149**
New Pass M-9	26.40465	-81.86816			5											**5**
North Coconut E of M-3	26.41131	-81.85486			4	3	9		4							**20**
North Coconut M-4	26.40737	-81.85998			2											**2**
Ruth's Island	26.40783	-81.85302			1											**1**
Total			**52**	**118**	**64**	**46**	**43**	**10**	**59**	**5**	**10**	**10**	**3**	**2**	**1**	**423**

Note: Nests were not observed (count = 0) in the following colonies: 619038c, Big Carlos Pass M-50&52, Big Carlos Pass S of M-48, Big Carlos Pass W of M-46, Big Hickory M-83, Big Hickory M-49 2NW, Big Hickory M-49 3NW, Estero River South, and New Pass M-21.
ANHI were not observed (count = 0).

Table 15. Mean nest count, standard error, standard deviation, and percent mean differences by species for mean peak nest counts (2008 to 2016) and current (2017).

Species	Mean (2008-2016)	Standard Error	Standard Deviation	Peak (2017)	Percent Change
DCC0	69	236	625	52	-25
BRPE	110	373	988	118	7
GBHE	69	233	617	64	-7
GREG	51	172	455	46	-10
SNEG	25	85	225	43	72
LBHE	14	49	129	10	-29
TRHE	28	94	250	59	111
REEG	7	25	66	5	-29
CAEG	1	3	9	2	100
BCNH	13	45	120	10	-23
YCNH	20	69	182	10	-50
GRHE	6	20	54	3	-50
ROSP	0	0	0	1	N/A
Total	**413**	**1,406**	**3,720**	**423**	**2**

Note: Percent change cannot be calculated for ROSP as nesting data have not previously been recorded for this species.

Discussion

Estero Bay nesting activity exhibits annual variation. The annual peak nest count this season was slightly above the 9-year average; however, the overall trend is a decrease in peak nest counts (**Figure 17**). While three of the four canopy-nesting species (DCCO, GBHE, GREG) showed a decline in nesting activity in 2017 compared to the 9-year average, BRPE showed an increase in nesting activity. Out of eight interior-nesting species, LBHE, REEG, YCNH, BCNH, and GRHE showed a decline in nesting activity for 2017. ROSP nesting activity was recorded for the first time in Estero Bay Aquatic Preserve, and the pair successfully produced two chicks.

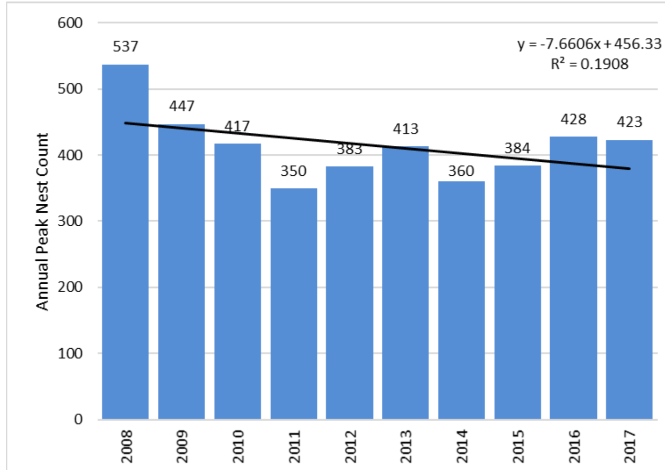

Figure 17. Annual peak nest counts in Estero Bay from 2008 to 2017.

The highest concentration of wading and diving bird nesting activity was observed on three islands: Matanzas, Coconut Point East, and Big Carlos West of 52. These islands have been approved to be designated as Critical Wildlife Areas and are expected to be marked before the 2018 nesting season.

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WADING BIRD NESTING AT LAKE OKEECHOBEE

Since 2005, Florida Atlantic University has conducted systematic wading bird nesting surveys at Lake Okeechobee as part of the Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment Plan. In 2017, three indicator species, Great Egret (GREG), Snowy Egret (SNEG), and White Ibis (WHIB), initiated an estimated 3,569 nests, which is 19% lower than average since 2006. Moonshine Bay 2 (1,430 nests) and 3 (625 nests) supported the largest number of nests from the focal species, as well as large numbers of Glossy Ibis (GLIB) and small herons. WHIB was the only species with above-average nest numbers in 2017 (24% above average).

METHODS

In February and April to June 2017, Florida Atlantic University personnel monitored the location, timing, and number of clutch initiations of wading bird nesting colonies on the lake. Ground surveys were performed by airboat to verify colony counts and species composition estimates. Two dedicated observers surveyed aerial transects for nests of five focal species: SNEG, GREG, WHIB, Wood Stork (WOST), and Roseate Spoonbill (ROSP). Estimates of nest initiation date were based on nest monitoring by boat at three colonies on spoil islands and one colony on a willow island. The hatch date of each chick was directly observed (e.g., chicks pipping) or estimated based on the estimated age of the oldest chick in each clutch. Clutch initiation date was calculated by subtracting number of days in an average incubation period (26 days for GREG, and 21 days for small herons) from the estimated hatch date. Median clutch initiation dates were calculated for each species. More detailed methods are described in previous editions of the *South Florida Wading Bird Report*.

Rainfall and lake stage data were obtained from the South Florida Water Management District DBHYDRO database. The lake stage is calculated as the mean of four gauges in the pelagic zone of Lake Okeechobee (L001, L005, L006, and LZ40). All elevation data are presented in National Geodetic Vertical Datum of 1929 (NGVD29), and locations are in North American Datum of 1983 (NAD83). Stage data from 2008 to the present correspond to the implementation of the 2008 Lake Okeechobee Regulation Schedule, while historical stage data from 1977 to the present correspond to the time period when systematic aerial wading bird nesting surveys were conducted.

RESULTS

Hydrology

There were two distinct hydrologic periods during the 2017 breeding season, distinguished by an increase in recession rate on March 3 (**Figure 18**). From January 1 to March 3, mean recession rate was 1.2 inches per week; from March 4 to June 2, mean recession rate was 2.1 inches per week. On June 2, the lake stage was at its lowest level of the season (10.96 feet), which was the lowest lake stage since 2011. There were five small 1- or 2-day reversals (<0.06-inch rise in stage per day), but no major reversals preceding the onset of the seasonal rise in water levels, which began on June 2.

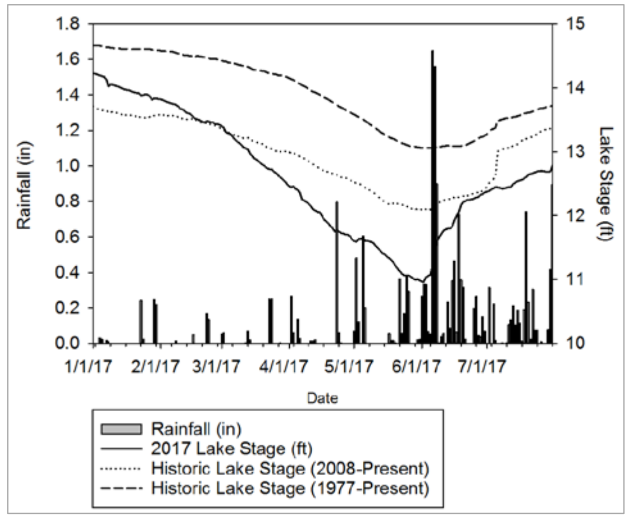

Figure 18. Hydrologic patterns on Lake Okeechobee from January to July 2017. Mean lake stage from 1977 to present, and from 2008 to present (i.e., since the 2008 Lake Okeechobee Regulation Schedule has been implemented).

Colony Location and Size

Twelve colonies (**Figure 19**) were detected, supporting a total of 3,569 nests of GREG, SNEG, and WHIB (**Table 16**). Colonies were detected at seven traditional willow colonies in the marsh (Liberty Point 2, Moore Haven, Moonshine Bay 2 and 3, Indian Prairie, Eagle Bay East, and King's Bar), three manmade spoil islands (Little Bear Beach, Clewiston Spit, and Bird Island), and two off-lake manmade islands (Lakeport Marina and the Gator Farm). Moonshine Bay 2 and 3 accounted for 58% of GREG, SNEG, and WHIB nests (1,430 and 625, respectively; **Tables 16** and **17**). Other traditional willow (*Salix caroliniana*) colonies, including Liberty Point 2 and Moore Haven, were active but supported fewer nests than in wetter years, probably because they were surrounded by little or no water, making them more susceptible to mammalian predators.

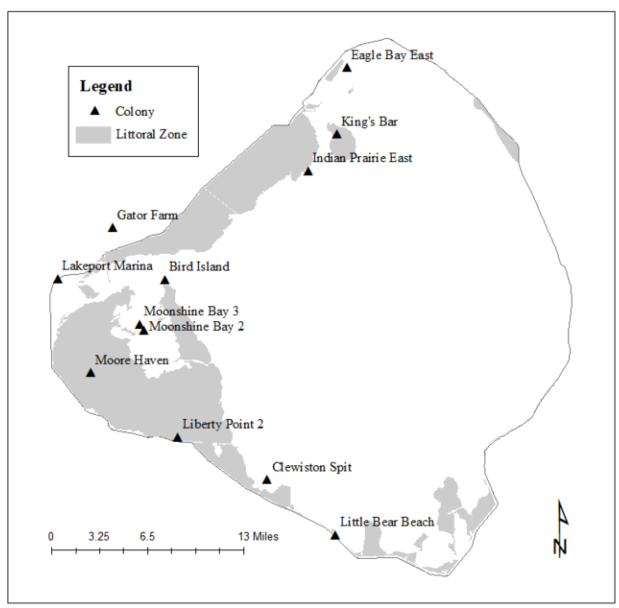

Figure 19. Map of wading bird colonies observed at Lake Okeechobee from February to June 2017.

Table 16. Geographic coordinates (NAD83) and species-specific peak nest efforts in observed colonies during the 2017 breeding season at Lake Okeechobee.

Colony	Peak Month[1,2]	Latitude	Longitude	GREG	GBHE	WHIB	SNEG	LBHE	TRHE	WOST	GLIB	ROSP	CAEG	ANHI	Total[1]
Bird Island	April	26.97199	-81.00917		1		39		63						**103**
Clewiston Spit	April	26.77573	-80.90938	55	6	4	200	5	150		57	1			**478**
Eagle Bay East	April	26.928044	-81.034227	10		75	50		30		150		650		**315**
Gator Farm	April	27.02278	-81.06084	70				15		12		7	450		**104**
Indian Prairie East	April	27.07852	-80.86883	80			10							3	**90**
King's Bar	May	26.89829	-81.08854	10		90	50							10	**150**
Lakeport Marina	March	26.97260	-81.11440	42									400		**42**
Liberty Point 2	April	26.81752	-80.99675	75		300									**375**
Little Bear Beach	April	26.72139	-80.84222	57			182	1	61						**301**
Moore Haven	April	26.887547	-81.09752	45			70						50		**115**
Moonshine Bay 2	April	26.92227	-81.02969	150	1	1,030	250		100		950	5			**2,486**
Moonshine Bay 3	April	26.92804	-81.03423	75	1	450	100		50		400			15	**1,076**
Total				**669**	**9**	**1,949**	**951**	**21**	**454**	**12**	**1,557**	**13**	**1,550**	**28**	**5,635**

[1] Does not include CAEG or ANHI.
[2] Peak month refers to the month during which combined nest effort peaked and does not refer to species-specific peak nest efforts.

Table 17. Timing and nest numbers for species breeding in wading bird colonies at Lake Okeechobee in 2017.

Month	GREG	GBHE	WHIB	SNEG	LBHE	TRHE	WOST	GLIB	ROSP	CAEG	ANHI	Peak Nest Effort[1]
February	144						10					154
March[2]	180	**9**		232	5	113	*	*	*			539
April	**589**		**1,584**	951	6	171	**12**	1,407	5	400	+	4,725
May	487		1,445	**981**	**21**	**403**	**12**	**1,535**	**12**	550	+	**4,896**
June[3]	115		880	1,161		+	5	+	3	**1,530**	+	3,694

[1] Does not include CAEG or ANHI.
[2] Nest numbers for this month are minimum estimates as they are based on ground surveys.
[3] Nest numbers for this month are likely overestimated due to the presence of fledglings, except for CAEG, as they started nesting late.
* Species status unknown as nesting colonies inaccessible by ground.
+ Species present and nesting but unable to determine number of nests.
Note: Bold values denote peak nest effort for species.

During aerial surveys, 669 GREG, 951 SNEG, and 1,949 WHIB nests were detected. The cumulative total was 19% lower than the average since 2006 (3,964 ± 2,866 nests). GREG, SNEG, and WHIB nest effort was 15% lower, 41% lower, and 24% higher than average since 2006, respectively. The average annual number of GREG, SNEG, and WHIB nests on the lake was higher in recent years (3,964 ± 2,866 nests from 2006 to 2017) than in the first survey period (2,319 ± 1,627 from 1977 to 1992), a pattern that held for all species except GREG.

Timing and Success

Median estimated clutch initiation date was March 2, March 21, and March 23 for GREG, SNEG, and Tricolored Heron (TRHE), respectively. These clutch initiation dates were 15 to 17 days earlier than average (2011 to 2013, 2015 to 2016) for all three species. This pattern of early nesting was also seen in the Everglades during 2017. Apparent nest survival (proportion of monitored nests that fledged at least one chick) was 0.79 for GREG (0.18 above average [0.61 ± 0.17]), and 0.79 for small herons (0.16 above average [0.63 ± 0.17]).

Wood Storks and Roseate Spoonbills

Twelve WOST nests and five ROSP nests were detected at the Gator Farm, an off-lake colony located north of the Moonshine Bay area, and seven ROSP nests were detected at Moonshine Bay 3. All WOST and ROSP nests at the Gator Farm appeared to fledge at least one chick, but the ROSP nests at Moonshine Bay were only observed on April 13, so they likely failed. WOST have nested at the Gator Farm colony in 6 of the last 11 years (2007 to 2010 and 2016 to 2017), successfully fledging chicks every year nesting occurred. Although nest numbers are small, it appears that WOST are part of the lake's avian community most years.

Acknowledgments

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KISSIMMEE BASIN

WADING BIRD NESTING

Birds are integral to the Kissimmee River floodplain ecosystem and highly valued by the public. 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 et al. 2005a,b). While quantitative pre-channelization data are sparse, available data and anecdotal accounts indicate that the system supported an abundant and diverse bird assemblage with several recurring breeding colonies of more than 1,000 nests (National Audubon Society 1936-1959; Florida Game and Fresh Water Fish Commission 1957). The Kissimmee River Restoration Project is expected to reproduce the necessary conditions to once again support such an assemblage.

To date, approximately 7,710 acres of wetland habitat (about half of the project total area) has been partially restored, and the interim response of foraging wading birds has exceeded restoration expectations when averaged over the interim period (2001 to 2017) (Cheek et al. 2014; SFWMD 2017a). 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 historical levels (Williams et al. 2005a; SFWMD 2017b).

While foraging conditions on the floodplain can become optimal for wading birds during parts of the year (see the Wading Bird Foraging Abundance section), 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 2019, 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 at the appropriate spatial and temporal scales for wading bird nesting colonies. The Headwaters Revitalization Schedule will allow Kissimmee River headwater stage at Lakes Kissimmee, Hatchineha, and Cypress to rise 1.5 feet higher than the current maximum under the Interim Regulation Schedule. This will allow for an additional 100,000 acre-feet of water storage in those lakes during the wet season that can be gradually released throughout the dry season to the Kissimmee River via the S65 water control structure at the south end of Lake Kissimmee (**Figure 20**). This will allow water managers to better mimic the historical recession rates and water depths on the Kissimmee River floodplain during the typical wading bird breeding season. Wading bird responses to the river restoration project will be monitored for 5 years after construction is completed.

Detailed information regarding the breadth of the avian evaluation program and the initial response of avian communities to Phase I restoration can be found in Williams et al. (2005b) and Cheek et al. (2014).

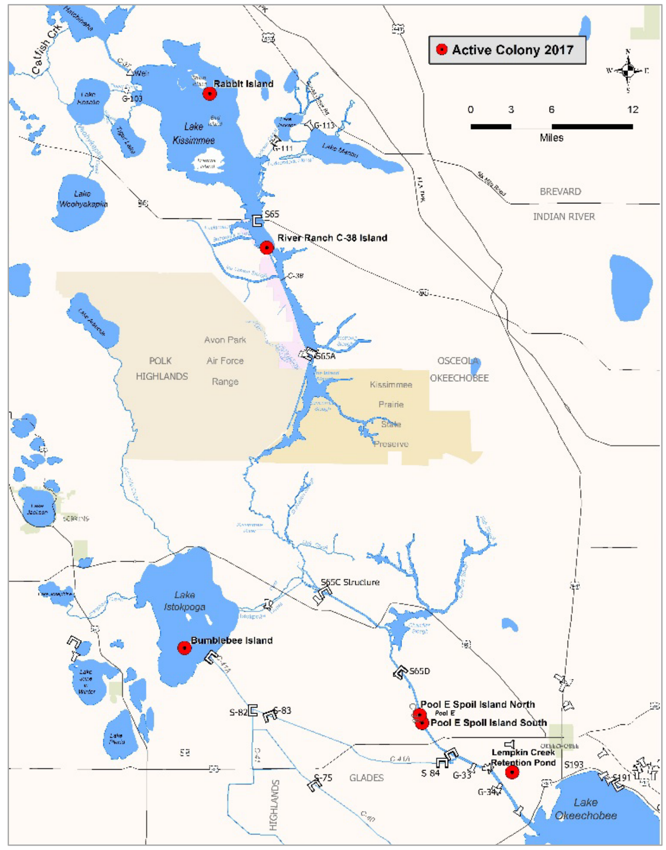

Figure 20. Nesting colony locations in Lake Kissimmee, Lake Istokpoga, and within the Kissimmee River Restoration Project area (i.e., within approximately 10 km of the C-38 canal backfill) during 2017.

Methods

As part of the KRREP, the SFWMD performed three surveys (February 14, April 21, and May 19, 2017) to visit known wading bird nesting colonies on Lake Kissimmee, along the Kissimmee River, and on Lake Istokpoga. Observers sat on both sides of a helicopter flying at an altitude of 244 meters between known colonies within the Kissimmee River Restoration Project area, which includes Lakes Kissimmee, Cypress, Hatchineha, and Istokpoga. Once a colony was located, the principal observer recorded nesting species and the number of active nests, while the second observer switched sides of the helicopter to take photographs. Nest counts were obtained from the digital photos to improve the accuracy of initial counts made from the air. Detectability of nests during aerial surveys typically is less than 100%, so the numbers of nests reported here represent the maximum number of observed nests for each species. This is particularly pertinent for the small, 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) (Frederick et al. 1996). Thus, the colony totals presented in **Tables 18** and **19** are considered conservative. Nest fate and nesting success were not monitored.

Table 18. Peak (maximum) number of wading bird nests within the Kissimmee River Restoration Project area[a] (2003 to 2017; sites were surveyed during February, April, and May 2017).

Year	CAEG	GREG	WHIB	GBHE	SMDH	SMWH	ROSP	Total Nests	Total Colonies	Nests of Aquatic Species
2003	20							**20**	1	0
2004								**0**	0	0
2005		81						**81**	2	81
2006	500	133		9				**642**	4	142
2007	226				1			**227**	1	1
2008		2		4				**6**	1	6
2009	240	126		27	14			**407**	3	167
2010	891	35		31	37			**994**	2	103
2011	751	14		35	35	8		**843**	2	92
2012	1,202			18	108	18		**1,346**	2	144
2013	599	33		37				**669**	5	70
2014[b]	5	23		28	1			**57**	5	52
2015		94		31				**125**	4	125
2016[c]	291	316		20				**627**	4	336
2017	540	143	50	13			1	**747**	5	207

Note: GLIB, BCNH, and WOST nests were not observed (count = 0).
[a] Kissimmee River Restoration Project area sites include Lakes Kissimmee, Cypress, and Hatchineha, and colonies within approximately 10 km of the C-38 Canal/backfill, including: multiple Kissimmee Prairie sites, Bluff Hammock, Cypress West, Oak Creek Marsh, C-38 Caracara Run, Chandler Slough East, Chandler Slough New, Chandler Slough, Cypress West, Orange Grove, Orange Grove NW, Orange Grove SW, Pine Island Slough, S65C Boat Ramp, S65C Structure, S65D Boat Ramp, and Seven Mile Slough, Pool E Spoil Island, S65E colony.
[b] Expanded survey effort in 2014.
[c] Reduced survey effort in 2016, but results from the Rabbit Island colony in Lake Kissimmee were added to the table this year.

Table 19. Peak (maximum) number of wading bird nests within Lake Istokpoga (Bumblebee Island) (2010 to 2017; sites surveyed during April and May 2017).

Year	CAEG	GREG	WHIB	GBHE	SMDH	GLIB	SMWH	Total Nests	Total Colonies	Nests of Aquatic Species
2010	103	325	110	75				**613**	1	510
2011	381	200	50	45				**676**	1	295
2012	75	175		75				**325**	1	250
2013	250	343		55				**648**	1	398
2014	658	210	75	55				**998**	1	340
2015	434	180	829					**1,443**	1	1,009
2016	355	171	1,296	25				**1,847**	1	1,492
2017	10	124	818	35	1	6	4	**998**	1	988

Note: BCNH and WOST nests were not observed (count = 0).

Results

Six colonies were active during the 2017 season within the KRREP area, Kissimmee River Pool E, and Lakes Istokpoga and Kissimmee (**Tables 18** and **19**; **Figure 20**). All colonies were dominated by White Ibis (WHIB) nests (868), followed by smaller numbers of Cattle Egret (CAEG; 550), Great Egret (GREG; 267), Great Blue Heron (GBHE; 48), GLIB (6), small white heron (SMWH; 4), small dark heron (SMDH; 1), and Roseate Spoonbill (ROSP; 1). The largest of these colonies was Bumblebee Island in Lake Istokpoga (998 nests), followed by Pool E Spoil Island South (330 nests), Lempkin Creek Retention Pond (271 nests), Rabbit Island (136 nests), Pool E Spoil Island North (5 nests), and River Ranch C-38 (5 nests) (**Figure 20**).

Similar to last season, none of the colonies occurred within 10 km of the partially restored portions of the Kissimmee River, but several occurred in unrestored portions of the river, including north, east, and south of the restoration area (**Figure 20**). The Kissimmee River Restoration area is within the potential foraging range of nesting waders at the S65C Structure colony (4.3 km) and the Chandler Slough East colony (13.3 km), while the Bumblebee Island colony is approaching the farthest limits of regular foraging for most species at approximately 15 km away. The Kissimmee River Restoration area likely was not used by any nesting wading birds for foraging this breeding season due to the extreme drought conditions within the Lower Kissimmee Basin (51% of average dry season rainfall) that left the floodplain mostly dry from February to May. The Rabbit Island and River Ranch Island colonies (40.6 km and 23 km, respectively) are too far to the north of the restoration area for regular foraging by nesting species.

Most nesting by aquatic wading bird species and CAEG continues to occur outside of the KRREP area on islands in the Upper Kissimmee Basin and Lake Istokpoga. To date, only one colony of aquatic bird species (S65C Structure colony) has formed within 5 km of the partially restored portion of the Kissimmee River, and during most years, it has contained fewer than 50 nests of aquatic species. The continued small numbers of aquatic species nesting along the restored portion of the river suggests that prey availability on the floodplain is not yet sufficient to support successful breeding for these wetland-dependent birds. Another possible factor preventing breeding colony site formation within the restoration area is lack of suitable habitat conditions during the January to June breeding season (e.g., woody substrate surrounded by water, nesting materials, nearby foraging areas) (White et al. 2005).

Wading Bird Foraging Abundance

As part of the 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 CAEG) on the restored floodplain will be ≥30.6 birds/km² (Williams et al. 2005a).

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

Methods

East-west aerial transects (n = 218) were established at 200-meter intervals beginning at the S65 structure and ending at the S65D structure (**Figure 20**). During weekly flights from November to May, 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 flying at an altitude of 30.5 meters and a speed of 80 km/hr. A single observer counted all wading birds and waterfowl within 200 meters of one side of the transect line. Because it is not always possible to distinguish TRHE from adult LBHE during aerial surveys, the two species are lumped together as "small dark herons". Likewise, Snowy Egrets (SNEG) and immature LBHE were classified as "small white herons".

Results

Prior to the restoration project, dry season abundance of long-legged wading birds in the Phase I restoration area averaged (± standard error) 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, annual abundance has ranged from 102.3 ± 31.7 birds/km² to 11.0 ± 1.9 birds/km² (mean [2002 to 2017] = 40.6 ± 6.1 birds/km²) (**Figures 21** and **22**). The annual 3-year running mean (2002 to 2017) is 41.4 ± 4.0 birds/km², significantly greater than the restoration expectation of 30.6 birds/km² (t-test, $p = 0.009$; SAS Institute 2016; Williams et al. 2005a). However, only the 3-year running means for the periods 2002 to 2005 and 2004 to 2006 were significantly different from the restoration target of 30.6 birds/km² when examined on an annual basis (t-test; SAS Institute, Inc. 2016). Mean monthly wading bird abundance within the restored portions of the river during the 2016-2017 season was 16.7 ± 3.7 birds/km², bringing the 3-year (2015 to 2017) running average down slightly to 38.3 ± 11.9 birds/km².

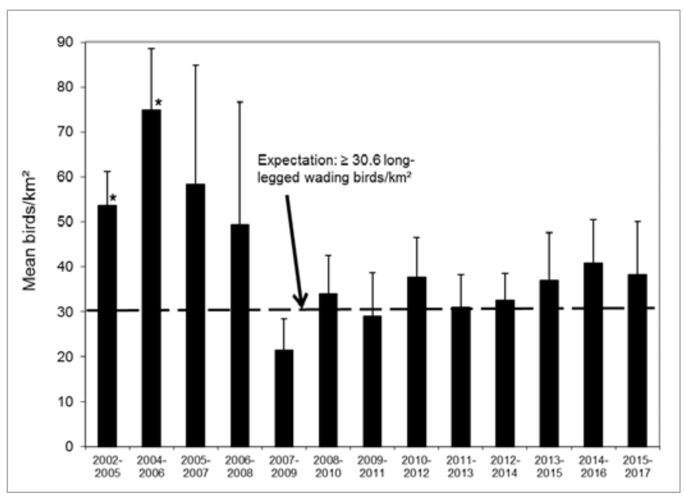

Figure 21. Post-restoration abundance as 3-year running averages ± standard error of long-legged wading birds per square kilometer (birds/km²), excluding CAEG, during the dry season (December to May) within the Phase I, IVA, and IVB restoration areas of the Kissimmee River. Each 3-year running mean was not significantly different from the restoration target of 30.6 birds/km² when examined on an annual basis (t-test; SAS Institute, Inc. 2016).

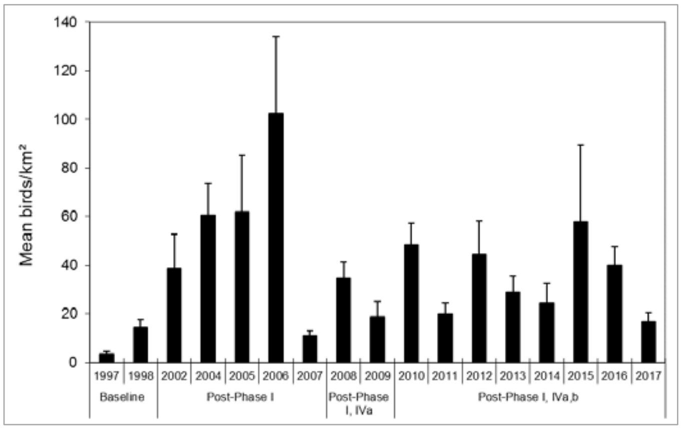

Figure 22. Baseline and post-Phases I, IVA, and IVB mean abundance ± standard error of long-legged wading birds/km² (excluding CAEG) during the dry season (December to May) within the 100-year floodplain of the Kissimmee River.

Rainfall during the 2016-2017 dry season was well below average in the Upper and Lower Kissimmee Basins (46% and 51% of average, respectively), resulting in dry floodplain conditions during most of the January to May wading bird breeding season. Mean floodplain depth declined to less than 1 inch by the first week of January 2017 and was almost completely dry by February.

Wading bird abundance was high during the initial fall recession in November and early December, with 211 birds/km² observed during the November 15 survey (**Figure 23**). Abundance estimates stayed close to the restoration target through early February, until numbers dropped to 14.5 birds/km² (during the February 14 survey), at which point the floodplain was almost completely dry. Numbers continued to stay low for the remainder of the survey period (through the end of May).

WHIB dominated numerically (32.7%), followed by GBHE (17.6%), SMWH (14.6%), GREG (10.9%), GLIB (9.9%), Wood Storks (WOST; 8.7%), SMDH (2.8%), ROSP (1.5%), and BCNH and YCNH (each 0.65%).

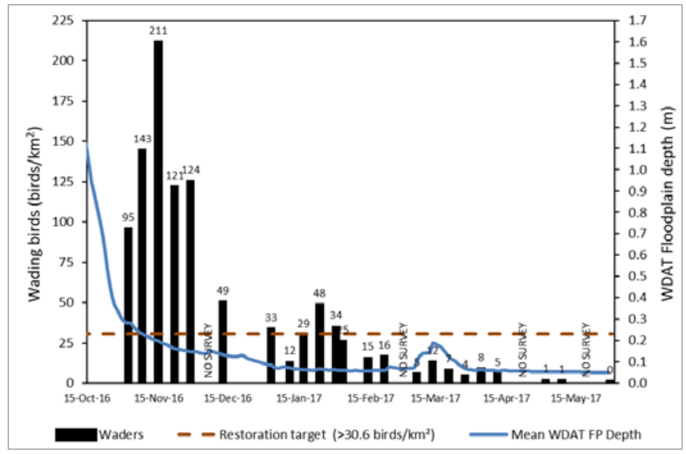

Figure 23. Wading bird abundance and mean floodplain depth in the Kissimmee River Restoration area (Phases I, IVA, and IVB) during the 2017 dry season (December to May). Floodplain depth was obtained from the South Florida Water Depth Assessment Tool (2017).

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SOUTHEAST FLORIDA (VARIOUS LOCATIONS)

METHODS

The Florida Fish and Wildlife Conservation Commission conducted nest counts at five colonies in 2017.

Bird Island (27.190281, -80.187908) is a spoil island in the Indian River Lagoon. It is cooperatively managed and monitored monthly throughout the year with Martin County. Counts are conducted from a boat circling the island, and it is certain that some interior nests are not counted.

Ballen Isles (26.830148, -80.109158) is a small island located on a lake within the Ballen Isles Country Club golf course. Counts are conducted on foot from vantage points on the north and south sides of the golf course.

Sawgrass Ford (26.149837, -80.337621) is a spoil island behind the Sawgrass Ford dealership. The counts are conducted by circling the island on a kayak. One count was conducted on April 2017.

Wakodahatchee Wetlands (26.479889, -80.142326) is a created wetland where many wading bird species breed. Florida Fish and Wildlife Conservation Commission staff counted Wood Stork (WOST) nests on a visit in April 2017. Counts are conducted from the boardwalk.

Solid Waste Authority of Palm Beach County (26.770188, -80.125313) has multiple spoil islands in abandoned shell pits that were mined in the early 1960s. One site visit was conducted in April 2017. Counts were done from four towers built for conducting bird counts.

RESULTS

Peak nest counts for each species in each colony are provided in **Table 20**.

Table 20. Peak numbers of nests at various locations from January to July 2017.

Colony	ANHI	BRPE	CAEG	DCCO	GBHE	GREG	LBHE	ROSP	SNEG	TRHE	WOST
Bird Island		38	2	20		21		3	1		44
Ballen Isles	9		8	8		1			9		36
Sawgrass Ford	4		1			33					83
Wakodahatchee*											98
Solid Waste Authority								13		1	155

*WOST were the only species counted at Wakodahatchee Wetland.

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J.W. CORBETT WILDLIFE MANAGEMENT AREA AND SAVANNAS PRESERVE STATE PARK

Due to local drought conditions at J.W. Corbett Wildlife Management Area and Savannas Preserve State Park, wading bird nesting was either not observed or access to nesting sites was not available at these locations.

PALM BEACH COUNTY NATURAL AREAS

Staff at Palm Beach County Environmental Resources Management surveyed wading bird colonies at Natural Areas between January and August 2017 to assess nesting effort (**Table 21**). This included two previously known wading bird colonies (Pine Glades and Cypress Creek) and one new colony (2017 Central Loxahatchee Slough).

METHODS

Between January and August, staff conducted monthly surveys of the Cypress Creek and Pine Glades colonies from the ground by truck (airboats could not be used due to low water levels), recording numbers of adults and nests and presence of chicks. During each visit, counts were made from multiple vantage points encircling the colonies to ensure full coverage. Please refer to the *2016 South Florida Wading Bird Report* for a detailed description of the habitat at the Cypress Creek and Pine Glades colonies.

In mid-April, staff identified a previously unknown colony in a stand of pond apples near a pump station in the Loxahatchee Slough Natural Area (the Central Loxahatchee Slough colony). Florida Atlantic University researchers monitored the colony from April 26 to July 2, 2017, as part of a small heron diet study. The colony was estimated to contain 48 Little Blue Heron (LBHE) nests and 1 Tricolored Heron (TRHE) nest; fledging success was not monitored.

RESULTS

There was no breeding at the Cypress Creek colony this year. Roosting birds were present early in the breeding season but abandoned the colony as water levels fell. Pine Glades saw a peak of only four Great Egret (GREG) nests (on March 27, 2017). Only two nests were successful, fledging a total of three chicks (last seen on April 19, 2017).

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Table 21. Peak wading bird nest counts by species observed on Palm Beach County colonies between February and August 2017.

Colony	Latitude	Longitude	GREG	LBHE	TRHE	ANHI	Total
Pine Glades	26.93611	-80.25591	4			6	**4**
2017 Central Loxahatchee Slough*	26.86861	-80.17780		48	1		**49**

Note: No birds nested at Cypress Creek in 2017.
* This colony was monitored from April 26 to July 2, 2017.

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, 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 be representative of key ecological features of the bird-prey-hydrology relationship. The Restoration Coordination & Verification program (RECOVER) established performance measures (http://www.evergladesplan.org/pm/recover), 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 performance measures, the annual Stoplight Reports have added 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 additional measures were added to further capture key ecological relationships found in the historical ecosystem (Frederick et al. 2009). This section reports on the long-term trends and current status of all five performance measures. When thinking about progress towards these restoration measures, it should be remembered that the hydrologic system is not yet restored to provide anything like the ecological functions expected in a completed CERP. Based on the current status of the hydrologic system, restored or even partially restored wading bird population indicators would not have been predicted.

The main indicator species are Great Egret (GREG), Snowy Egret (SNEG), WHIB, and WOST. Although the Tricolored Heron (TRHE) originally was included in this list (Ogden et al. 1997), the species has proven extremely difficult to consistently monitor due to the inability to see their dark plumage in colonies during aerial surveys. Ogden et al. (1997) lumped TRHE and SNEG population targets (e.g., 10,000 breeding pairs), and 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:TREG). In practice, the distinction is unimportant because both species appear to be declining and are nowhere near any of the population restoration targets. This section summarizes data for the three Water Conservation Areas (WCAs) and mainland Everglades National Park (ENP).

RESULTS

Numbers of Nesting Pairs

The 3-year (2015 to 2017) running average for nesting pairs are 5,655 pairs for GREG, 639 pairs for SNEG, 17,974 pairs for WHIB, and 1,195 pairs for WOST. Trends for GREG over time (**Figure 24**; **Table 22**) for this measure increased markedly from 1988 to 2004, and have been stable or slightly declining since, with the 3-year running average meeting or exceeding restoration criteria for 20 consecutive sampling periods (since 1996). Trends for SNEG also increased markedly between 1986 and 2004, but have dropped dramatically since 2005, with the 2017 season showing continued declines compared with the previous 5 years. Three-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 between 1986 and 2001 (2.7 times), and remained variable but arguably stable for nearly a decade (2002 to 2011). The final period in this record (2011 to 2017) showed substantial fluctuation in WHIB nesting, with 50% reduction in three of the years, and three of the five years in that period being well below the average of the previous decade. The 2017 season showed nest numbers in the middle of this recent range. WHIB nesting populations have met or exceeded the breeding population criterion for the past 16 years. WOST showed a marked increase from averages in the 2 to 300 pair range (1986 to 1992) to averages above 1,000 pairs after 1999. WOST have equaled or exceeded the restoration population criterion during 5 of the last 14 years but did not do so in 2017. 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 of these species has met restoration targets in many or 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 the **Water Conservation Areas 2 and 3, and**

A.R.M. Loxahatchee National Wildlife Refuge section) that breeding populations of the other two small herons in the genus *Egretta* (TRHE and Little Blue Herons [LBHE]) are declining sharply in the Everglades also.

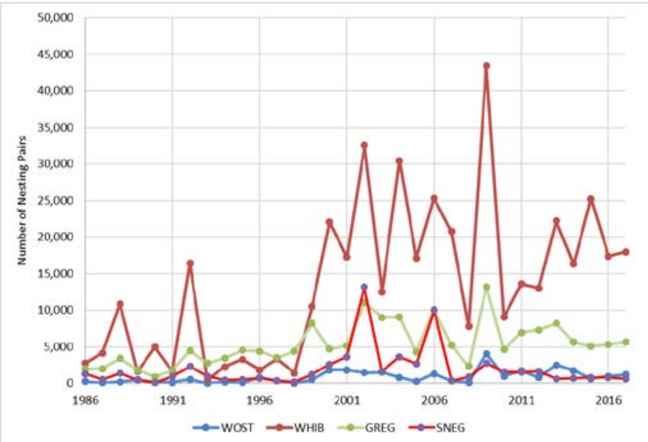

Figure 24. Trends in the 3-year running average of nesting pairs of the four target species since 1986.

Table 22. Three-year running averages of the number of nesting pairs for the four indicator species in the Everglades.

Period	GREG	SNEG	WHIB	WOST
1986-1988	1,946	1,089	2,974	175
1987-1989	1,980	810	2,676	255
1988-1990	1,640	679	3,433	276
1989-1991	1,163	521	3,066	276
1990-1992	2,112	1,124	8,020	294
1991-1993	2,924	1,391	6,162	250
1992-1994	3,667	1,233	6,511	277
1993-1995	3,843	658	2,107	130
1994-1996	**4,043**	570	2,172	343
1995-1997	**4,302**	544	2,850	283
1996-1998	**4,017**	435	2,270	228
1997-1999	**5,084**	616	5,100	279
1998-2000	**5,544**	1,354	**11,270**	863
1999-2001	**5,996**	2,483	**1,655**	**1,538**
2000-2002	**7,276**	6,455	**23,983**	**1,868**
2001-2003	**8,460**	6,131	**20,758**	**1,596**
2002-2004	**9,656**	6,118	**24,947**	1,191
2003-2005	**7,829**	2,618	**20,993**	742
2004-2006	**8,296**	5,423	**24,926**	800
2005-2007	**6,600**	4,344	**21,133**	633
2006-2008	**5,869**	3,767	**17,541**	552
2007-2009	**6,956**	1,330	**23,953**	1,468
2008-2010	**6,715**	1,723	**21,415**	**1,736**
2009-2011	**8,270**	1,947	**22,020**	**2,263**
2010-2012	**6,296**	1,599	**11,889**	1,182
2011-2013	**7,490**	1,299	**16,282**	**1,686**
2012-2014	**7,041**	1,017	**17,194**	**1,696**
2013-2015	**6,300**	710	**21,272**	**1,639**
2014-2016	**5,328**	837	**17,379**	995
2015-2017	**5,655**	639	**17,974**	1,195
Target Minima	4,000	10 - 20k	10 - 25k	1.5 - 2.5k

Note: Bold entries are those that meet minimum criteria.

Colony Location

More than 90% of the indicator species nesting is estimated to have occurred in the southern ecotone region during the 1930s and early 1940s, likely because this was the most productive area. A major restoration hypothesis holds that it is the reduction of freshwater flows to this coastal region that has reduced secondary productivity and resulted in 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% to 10%) (**Figure 25**), and during the last several years has ranged between 15% and 46%. In 2017, the proportion was 13.7%.

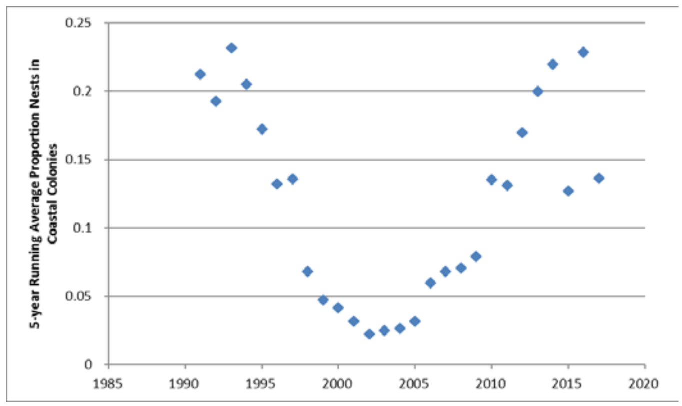

Figure 25. Proportion of all mainland Everglades nesting in the coastal estuarine zone, 1986 to 2017.

Ratio of Visual to Tactile Foragers

This performance measure recognizes that the breeding wading bird community has shifted from being numerically dominated by tactile foragers (storks and ibises) during the pre-drainage period to one in which visual foragers such as GREG are numerically dominant. This shift is thought to have occurred as a result of impounded, stabilized, or over-drained 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 and alone under a variety of circumstances. Restoration targets are set at 32 breeding tactile foragers to each breeding visual forager, characteristic of the 1930s breeding assemblages. While this performance measure has shown some improvement since the mid-1990s (movement 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 2017 was 3.31.

Timing of Nesting

This performance measure applies only to the initiation of nesting for WOST, which has shifted from November-December (1930s through 1960s) to January-March (1980s to 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 WOST population being a source or sink population. This measure has shown a consistent trend towards later nesting between the 1930s and 1980s, with variation around a February mean initiation date since the 1980s. Although some years in the mid-2000s stimulated earlier nesting, there has been no lasting improvement. The 2017 season start (late December) was quite early compared to recent years and only 1 of 2 years in the last 30 years in which WOST have nested by the end of December.

Exceptionally Large Ibis Aggregations

Exceptionally large breeding aggregations of ibises were characteristic of the pre-drainage 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 more than 16,977 nests each year, or the 70th percentile of the entire period of record of annual nesting. The interval between large ibis nesting events in the pre-drainage period was 1.6 years, and this serves as the target for restoration. This performance measure has improved markedly since the 1970s, with the target achieved in 10 of the last 11 years. The 2017 ibis nesting reached the restoration criterion, and the interval averaged over the last 5 years is 2.225 years, slightly less frequent than in the 1930s.

Discussion

Taken together, these measures of wading bird nesting suggest that while there have been real improvements in several of the performance measures during the past one or two decades, several key measures are stalled and not showing further improvement. Two measures are genuinely hopeful: numbers of nesting pairs of WHIB, WOST, and GREG in the system seem to be regularly achieving the restoration targets, and the interval between exceptional ibis nesting years has met the restoration target for 10 of the past 11 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 20% compared to 50% target), and there is much room for improvement. Several performance measures are not improving. The numbers of SNEG are declining and remain far from restoration targets. There is little evidence that the timing of WOST nesting is improving on average, and despite the early nesting in 2017, this performance measure 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.

This picture clearly illustrates that the birds probably have responded in the last two decades to a combination of altered water management regimes, good weather, and hydropattern by nesting more consistently in the coastal zone, and by increasing populations of WHIB and WOST. While some of the population increases may be attributable to forces outside the Everglades system, 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 performance measures suggests the current management regimes are not powerful enough to nudge the timing of nesting, ratio of tactile foragers, or numbers of nesting SNEG further. 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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This document is the result of continued cooperation among a diverse group of ecologists. It is not a peer-reviewed scientific publication; narratives reflect the views of individual authors rather than the collective participants. Photos provided by Mark Cook, Michael Baranski, Melynda Brown, and Chuck Hanlon. The *South Florida Wading Bird Report* is available online at www.sfwmd.gov/documents-by-tag/wadingbirdreport.

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