SOUTH FLORIDA WADING BIRD REPORT

Volume 24 Mark I. Cook and Michael Baranski, Editors May 2019

SYSTEMWIDE SUMMARY

NESTING IN SOUTH FLORIDA

An estimated 138,834 wading bird nests (excluding Cattle Egrets [CAEG], which do not rely on wetlands) were initiated in South Florida during the 2018 nesting season (December 2017 to July 2018). This is the largest annual nesting effort observed since comprehensive system-wide surveys began in South Florida in 1995 and is comparable with reports of large nesting events from the 1940s. It surpasses the previous banner nesting season of 2009 by 51,270 nests and is approximately 3.5 times the 5-year (39,965.2 nests) and 10-year (39,850.6 nests) averages.

While all species exhibited increased nesting effort in 2018 relative to the 10-year annual average, some of the greatest increases were for the tactile foraging species—White Ibis (WHIB), Wood Stork (WOST), and Roseate Spoonbill (ROSP)—three species that have exhibited considerable declines in nesting since the 1940s. The large number of nests produced by WHIB (100,784 nests) was almost five times the 10-year average (20,444.1 nests) and more than double the previous record of 47,001 nests in 2009. WHIB are the most numerous wading bird in South Florida and accounted for 72.6% of all wading bird nests in the region in 2018. The federally threatened WOST produced 5,777 nests, which is 2.4 times the 10-year average (2,448.1 nests) and the third highest count since the late 1960s. This was the second consecutive year of strong nesting effort for WOST (3,984 nests in 2017). In 2018, ROSP produced 981 nests in South Florida, which is 2.2 times the 10-year average (455.3 nests) and the largest count since monitoring began in 1984. The sight-foraging Great Egret (GREG) produced 17,960 nests in 2018, which is more than double the 10-year average (8,288.8 nests).

The smaller *Egretta* heron species have exhibited consistent and steep declines in nest numbers over recent years, such that relatively few of these birds now nest in South Florida. This year, 1,611 Tricolored Heron (TRHE) and 4,573 Snowy Egret (SNEG) nests were counted, representing a 50% and 53% increase in nesting effort, respectively, relative to their decadal annual averages. While this is a moderate improvement, it remains considerably lower than the 10,000 or so pairs of each species that historically nested in South Florida. The exception to the improved nesting effort in 2018 was the Little Blue Heron (LBHE), which produce a similar number of nests (634 nests) to the 10-year annual average (584.5 nests). A relatively large number of small heron nests (4,259 nests) could not be identified to species this year (they were either LBHE, SNEG, or CAEG nests); therefore, the estimated counts for LBHE, SNEG, or both are considered conservative.

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) and supports 70% to 90% of all nests annually. Wading birds initiated an estimated 122,571 nests in the Everglades during 2018, 88.3% of all nests in South Florida. This nesting effort is the largest observed in more than 80 years and is comparable in magnitude to the large nesting events that occurred prior to drainage of the Everglades in the 1940s. Nesting effort was approximately four times greater than the 5-year (29,578.4 nests) and 10-year (30,648.9 nests) averages, and almost double the number of nests produced during the previous banner nesting year in 2009 when 73,096 nests were 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 5,712 nests, a 20.2% improvement on the 10-year average (4,751.8 nests) and similar to the number of nests produced last year (5,635 nests). The lake accounted for 4.1% of the nests in South Florida. Other regionally important nesting areas during 2018 were the Kissimmee Lakes (2,539 nests) and Florida Bay (1,216 nests).

In terms of the spatial distribution of individual species in South Florida, the Everglades supported most of the nesting WHIB, GREG, WOST, SNEG, and LBHE (95%, 81%, 61%, 55% and 54% of their total nests, respectively), but only 20% of TRHE nests. Florida Bay and Lake Okeechobee supported most of the nesting TRHE (34% and 29%, respectively). Lake Okeechobee also was a relatively important area for SNEG (40% of nests).

INSIDE THIS ISSUE

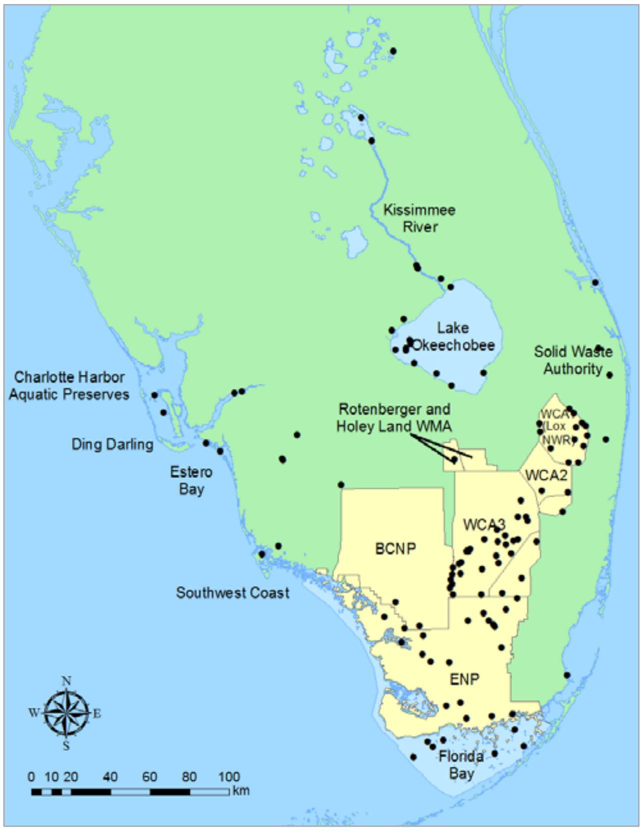

Figure 1. Locations of wading bird colonies with 50 or more nests in South Florida, 2018.

A nesting area that has experienced substantially reduced nesting activity in recent years is Audubon Florida'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 Swamp Sanctuary in 2018, the number of nests was relatively small (328 nests) given the large nesting effort recorded elsewhere in South Florida. It is possible that loss of critical WOST foraging habitat in southwestern Florida and reduced hydroperiods in the sanctuary are responsible for the decline.

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 and sustainable breeding wading bird populations, reset the historical timing of nesting, and encourage birds to nest again 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 numbers of nesting pairs of key wading bird species, the timing of WOST nesting, and the proportion of the population that nest in the coastal ecotone (Ogden et al. 1997). In addition, 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 WHIB breeding events (Frederick et al. 2009).

Nest Numbers

Annual nesting effort is assessed using the average nest count from three successive nesting seasons to account for 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, WOST, and SNEG all exhibited greatly improved nesting effort in the Everglades during 2018 (**Figure 2**), but only GREG, WHIB, and WOST met their CERP numeric restoration targets based on the 3-year running average (**Table 1**, **Figure 3**). GREG and WHIB have exceeded target counts every year since 1996 and 2000, respectively, while WOST have exceeded their target eight times since 2000. SNEG and TRHE have been consistently below target since 1986 (**Table 1**, **Figure 3**).

The regional declines of *Egretta* herons over the last decade have been particularly acute in the Everglades (**Figure 2**). This year's nesting effort was a moderate improvement compared to recent years but remained considerably lower than historic numbers (approximately 10,000 nest per year per species). The number of SNEG nests in 2018 (2,521 nests) was 2.1 times the 10-year average, and an order of magnitude more nests than in 2017 (228 nests), which was the lowest recorded since 1990. TRHE produced 315 nests, a slight improvement on the decadal average (270.9 nests) and almost 10 times the number in 2017 (35 nests). The cause of the sharp declines in *Egretta* nesting has yet to be determined, but the improved nesting in 2018 suggest hydrologically driven food limitation is at least partially responsible.

In Florida Bay, ROSP produced 278 nests, the same as the 10-year average (278.9 nests), but only 22% of the target 1,258 nests per year. From a historical perspective, this is only 61.4% of the 33-year mean (452.2 nests) and far below the mid-20th century nesting effort when more than 1,000 nests per year were common. However, overall numbers of nests in the WCAs and ENP in 2018 were the highest ever recorded (521 nests), three times the 10-year average (171.6 nests).

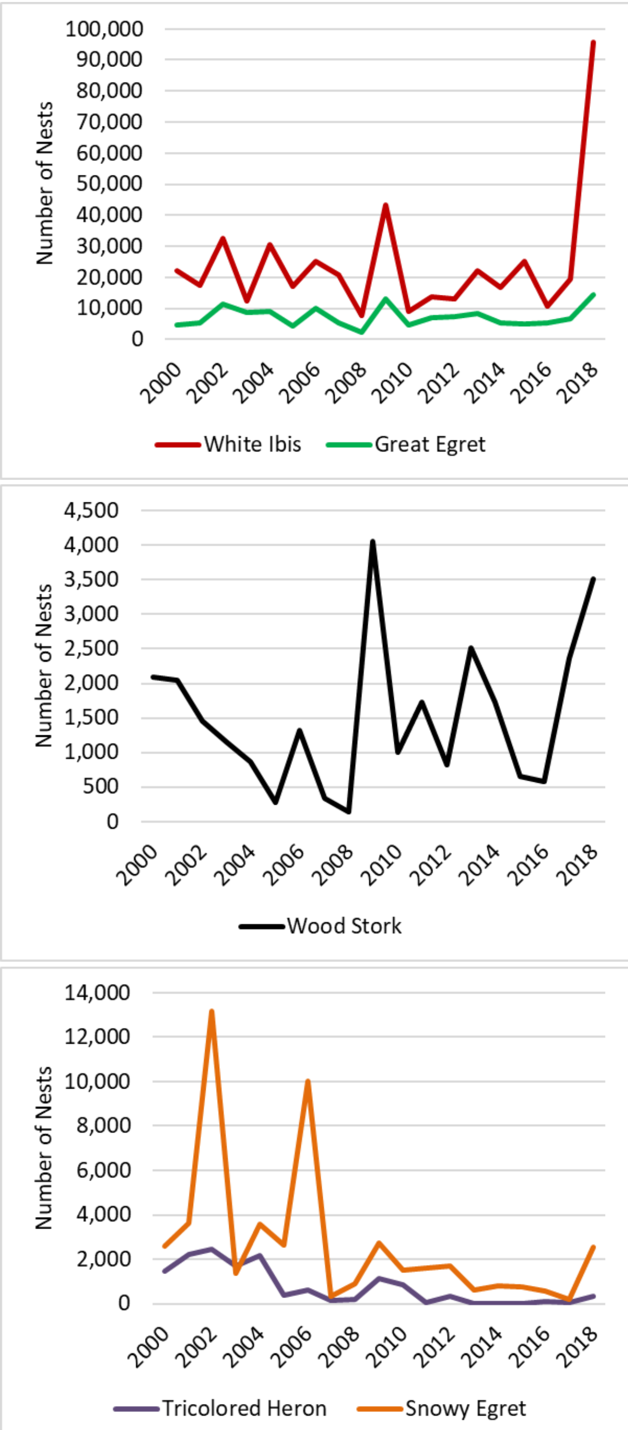

Figure 2. Wading bird nest numbers in the Everglades Protection Area (Water Conservation Areas and Everglades National Park) since 2000.

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
2015-2017	**5,655**	639	**17,974**	1,195
2016-2018	**8,803**	1,224	**41,465**	**2,152**
Target Minima	4,000	10 - 20k	10 - 25k	1.5 - 2.5k

Note: Bold entries are those that meet minimum criteria.

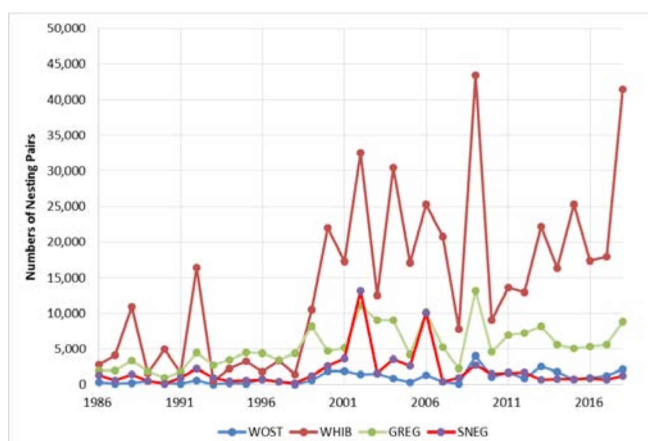

Figure 3. Trends in the 3-year running average of nesting pairs of the four target species since 1986.

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, productivity has declined due to reduced freshwater flows, and the location of nesting has shifted to inland colonies in the WCAs or elsewhere in the southeastern United States. An important goal of CERP is to restore the hydrologic conditions that will re-establish prey availability across the southern Everglades landscape, which, in turn, will support the return of large successful wading bird colonies to traditional estuarine rookeries. In 2018, ENP supported 36.5% of nests, while WCA-3A and WCA-1 supported 57.6% and 6.0%, respectively. The proportion of nests in the estuarine region in 2018 (32.8%) was one of the highest recorded in recent decades and continues a trend of increased nesting in this area compared to the lows of the 1990s and early 2000s (2% to 10%). While this proportion remains short of the 50% restoration target, the magnitude of nesting (approximately 40,000 nests) was considerably higher than it has been in recent years (15-year average: 4,040 nests). This suggests that the coastal ecotone and local marl prairies retain the capacity to support large numbers of nesting birds when hydrologic conditions are suitable.

The location of ROSP nesting colonies within Florida Bay has shifted in recent years. Whereas most nesting historically occurred on small keys within the bay itself, many birds have moved during the past decade 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, fewer birds nested at these two colonies (27% of 278 total nests) and a greater proportion nested on the keys. Other individuals have deserted Florida Bay entirely. For three of the past four years, approximately 200 ROSP pairs have nested at colonies in the central freshwater Everglades, such as northern WCA-3A and along the gulf coast of ENP. This number increased in 2018, with 521 nests found at Everglades colonies.

Timing of Nesting

WOST nesting success is highly dependent on the availability of aquatic prey (fish), which are easy to find and feed upon when concentrated at high densities in shallow water during the dry season (winter-spring) but are not available during the wet season (summer-fall) when they move into deeper waters and disperse across the landscape. To successfully fledge their young, WOST require a continuous supply of abundant and concentrated 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 between January and 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 high elevation (short-hydroperiod) wetlands that provide foraging habitat early in the nesting season. In 2018, WOST nesting started relatively early, with a possible first lay date in late December (within the CERP target time frame). This is one of the earliest egg-laying dates in recent decades and the second successive year that WOST started nesting in December. This is considerably earlier than 2016 (late March) and 2015 (early February). The likely reason for this early nesting is the extended flooding of the high-elevation marshes that occurred in 2016 and 2017.

ROSP in Florida Bay also have exhibited a recent shift towards 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 within and among colonies. Whereas nest initiations within the 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 the timing of optimal foraging conditions for ROSP is changing temporally and spatially within Florida Bay. However, 2017 was notable for a complete reversal of this trend, with most nest initiations starting in November. In 2018, nest initiations also were relatively early, ranging from early December to early January. The reasons for these patterns are unclear but likely relate to changes in where and when optimal foraging conditions become available, possibly as a result of sea level rise.

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 one offspring ranging between 35% and 49% for the four indicator species (derived from 2010 to 2015 data). During 2018, nest success was relatively high and similar among the CERP indicator species, with 48% to 78% of study nests fledging at least one 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 a large proportion of nests of all species produced fledglings. Of note was the high productivity of WHIB, with estimates of at least 27,000 fledglings from just 2 colonies in the Everglades.

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 how vulnerable they are to capture by birds, with both components strongly affected by hydrologic conditions (Frederick and Ogden 2001, Herring et al. 2011). In a hydrologically fluctuating wetland such as the Everglades, 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 peak after extended periods (multiple years) of relatively deep, flooded conditions over extensive areas of wetland (Trexler et al. 2005), while some invertebrate populations grow best during moderate hydroperiods punctuated by periodic dry conditions (Dorn and Cook 2015).

A particularly important prey group in the Everglades is crayfish, which are critical for fueling WHIB nesting colonies (Boyle et al. 2014). Crayfish populations are strongly limited by predatory sunfishes such as warmouth that eat small (young-of-the-year) juveniles. Once crayfish grow beyond a certain size threshold, they are less vulnerable to fish predation. During periodic dry conditions, predatory fish populations decline but crayfish can survive in burrows until the rains return and water levels rise again during the wet season. At this point, adult crayfish emerge and release their young into a marsh habitat that is largely free of fish predators, allowing for a temporary (1 to 2 years) boost in the crayfish population (Dorn and Cook 2015).

Prey vulnerability to capture is determined largely by water depth and whether water levels are rising or falling. Prey become easiest to capture during drying conditions when water levels decline to depths at which the birds can forage effectively (5 to 30 cm) 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 concentrated prey can disperse into the marsh. Prey availability, therefore, is naturally variable among years, depending on antecedent and current water conditions. Accordingly, wading bird nesting effort and success fluctuate considerably from year to year.

The considerable improvements in nesting during 2018 likely were a response to an unprecedented series of fortuitous hydrologic conditions that were near optimal for prey availability prior to and during the nesting season (see *Hydrologic Patterns for Water Year 2018* section). This year's nesting season was preceded by a relatively short period of dry conditions (April to May 2017) over relatively large areas of the ecosystem. This likely reduced predatory fish populations and led to a boost in juvenile crayfish survival and recruitment. The only region where extensive drying did not occur was in WCA-1, where considerably fewer birds nested or foraged in 2018 relative to previous years. The dry conditions were followed by a wet season (June to October 2017) with record-breaking rainfall driven primarily by Hurricane Irma and two tropical storms. This led to long periods of relatively wet conditions with water levels that remained above ground across large areas of the Everglades. This likely boosted prey (fish and crayfish) production over large areas of the ecosystem and was particularly relevant in the higher elevation marshes such as the marl prairies in ENP and Big Cypress Basin that are overdrained and currently have hydroperiods that are too short for optimal prey production. Following the wet summer of 2017, the 2018 winter to spring breeding season was drier than average. This led to a relatively continuous drop in water levels across the Everglades landscape and provided water levels and recession rates ideal for concentrating prey and providing optimal foraging conditions across large areas of the Everglades until late in the dry season.

During the 2018 nesting season, there was a massive concentration of nesting birds at the Alley North colony in northeastern WCA-3A. This colony supported 59,120 total nests (56,402 WHIB nests), by far the largest nesting effort at a single colony since the 1930s. Water management played an important role during the nesting season by maintaining appropriate hydrology around this colony. The area often dries out early in the nesting season, which can reduce the colony's attractiveness to nesting birds, allow mammalian predators (i.e., raccoons) to access the colony, and cause large-scale nest abandonment. The rerouting of water to this area throughout the nesting season ensured hydrological conditions remained optimal for nesting.

The observed sequence of optimal hydrologic conditions prior to and during the 2018 nesting season would be predicted to result in a strong reproductive response, and similar hydrologic patterns have been evident in previous strong nesting seasons (e.g., 2009). Unique to 2018 was the extended flooding of high-elevation marshes in the western marl prairies and Big Cypress Basin. The wetter conditions in these areas likely allowed for early WOST nesting, extended periods of optimal foraging conditions, and formation of the exceptionally large colonies in the coastal ecotone. The nesting responses of 2018 show the Everglades ecosystem is resilient and retains the capacity to support exceptionally large populations of nesting wading birds given the appropriate hydrology. An expected outcome of CERP and other restoration programs is to extend the period of flooding in high-elevation marshes and repeat such nesting patterns on a more regular basis.

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 consider the long-term (decadal and longer) trends in nesting responses. Long-term data reveal 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 10 of the past 12 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 32.8% compared to the 50% target).

Several measures are not improving and are cause for concern. Despite slight improvements this year, the numbers of SNEG, TRHE, and LBHE have been declining sharply for unknown reasons (**Figure 2**). Also, despite improved WOST nesting effort, the late timing of nesting, with the exception of the last 2 years, has remained relatively static and nesting success often is below that necessary to sustain the local population. The ratio of tactile (WOST, WHIB, and ROSP) 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: American Flamingo (AMFL, *Phoenicopterus ruber*), 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*), Neotropic Cormorant (NECO, *Phalacrocorax brasilianus*), 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)

HYDROLOGIC PATTERNS FOR WATER YEAR 2018

WATER CONSERVATION AREAS AND NORTHEAST SHARK RIVER SLOUGH HYDROLOGY

Annual rainfall totals and annual mean water depth stages in the Everglades Protection Area (Everglades) during Water Year 2018 (WY2018) were well above average historical conditions. Rainfall for the year ranged from 15.2 to 18.9 inches above historical averages in Water Conservation Areas (WCAs) 1, 2, and 3, and 4.6 inches above average in Everglades National Park (ENP). As a result, annual average stages were significantly higher than historical means (**Table 2**). While water depths in WY2018 began and ended near the historical average, the above average wet season rainfall amounts and elevated stages throughout most of the wet and dry seasons had notable impacts on the ecology of the Everglades.

Water depths across the Everglades at the start of WY2018 (June 2017) generally were just below average historical stages. Above average rainfall (the WCAs and ENP received 124% and 108% of the historical averages, respectively; **Table 2**) led to mean water depths that were more than 1 foot above the historical mean stages in WCA-1 and WCA-3. WCA-2 and ENP mean water stages for WY2018 were 0.33 and 0.74 feet above the historical average, respectively. Much of the rainfall fell early in the wet season, with closer to average amounts falling throughout the rest of the wet season. In contrast, dry season rainfall amounts were well below average in WCA-1 and WCA-2 at 87% of the historical average, WCA-3 at 45%, and ENP at 58%. Overall, these rainfall patterns resulted in historically high peak water depths, yet optimal dry season recession rates meant water depths returned to near average by May 2018. WY2018's above-average stage conditions early in the wet season resulted in large areas of the marsh flooded for long periods. 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). Consistent recession rates for most of the dry season (November to May) were at or near the optimal rate for wading bird foraging success and, combined with an early nest initiation by most species of wading birds, led to a record year for wading bird nesting. Conditions during WY2018 also were conducive to Cape Sable Seaside Sparrow (CSSS) nesting efforts. Monitoring suggests a very active nesting season in WY2018, building on the productive nesting in WY2017.

Due to the unusually high rainfall and a subsequent rapid rise in stages early in WY2018, the U.S. Army Corp of Engineers issued a temporary deviation to address high water concerns in the Everglades that allowed for higher water levels in WCA-2A. **Figures 4A** through **4G** present hydropatterns at select gauges, highlighting the average stage changes in 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). Note, however, that peat soils may be harmed at shallower water levels than stipulated in the MFL.

The wading bird nesting period ranges from November 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 (Beerens et al. 2011, 2015, Cook 2015). 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).

Water Conservation Area 1

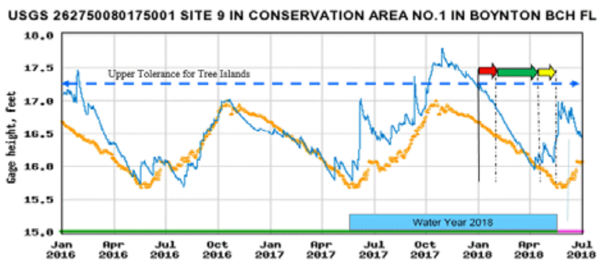
Water levels in WCA-1 (also called the Arthur R. Marshall Loxahatchee National Wildlife Refuge) at the start of WY2018 were close to their 24-year daily median (**Figure 4A**). Above-average ascension rates in June and October caused wet season depths to rise quickly, with the stage peaking on October 30. The red arrow in **Figure 4A** is an indication that depths during this time were too deep to support wading bird foraging. Recession rates during the wading bird breeding season (January through May) were near optimal, and the historical average depth was reached by March. Despite these conditions, relatively limited wading bird foraging was observed within WCA-1 during the nesting season. The upper tolerance level or depth for tree islands, above which indicates flooding stress, was exceeded for nearly 3 months. Water depths never fell below the lower tolerance band, below which is an indication of potential peat soil loss due to oxidation.

Table 2. Average, minimum, and maximum stage (in feet NGVD29), and total annual rainfall in inches for WY2018 compared to historical water depth stages and rainfall.[a] (Average depths calculated by subtracting elevation from stage.)

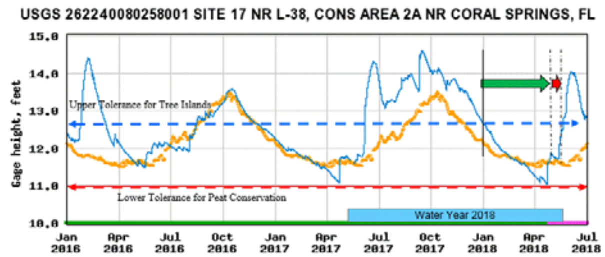
Area	WY2018 Rainfall (inches)	Historical Rainfall (inches)	WY2018 Stage Mean (min.; max.)	Historical Stage Mean (min.; max.)	Elevation
WCA-1	70.83	51.96	16.82 (15.76; 17.99)	15.70 (10.00; 18.16)	15.1
WCA-2	70.83	51.96	12.84 (11.05;14.60)	12.51 (9.33; 15.64)	11.2
WCA-3	66.46	51.24	10.60 (8.52; 12.58)	9.60 (4.78; 12.79)	8.2
ENP	59.14	54.55[b]	6.77 (5.19; 8.02)	6.03 (2.01; 8.08)	5.1

[a] Historical averages are based on varying lengths of records at gauges.
[b] 1941-2017.

A. WCA-1 – Site 9

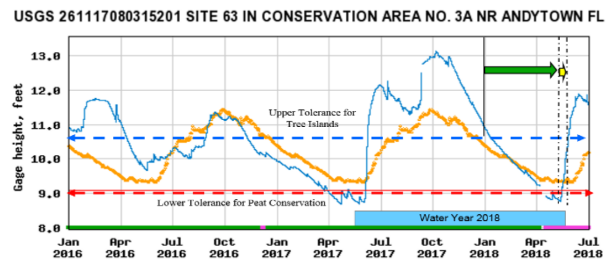


B. WCA-2A – Site 17

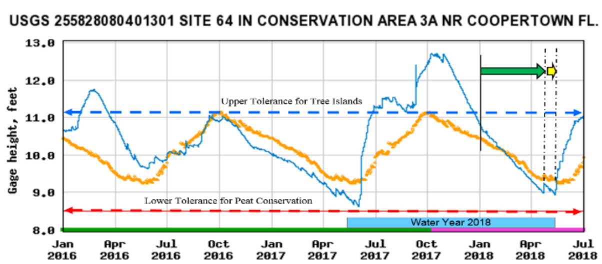


C. WCA-2B – Site 99

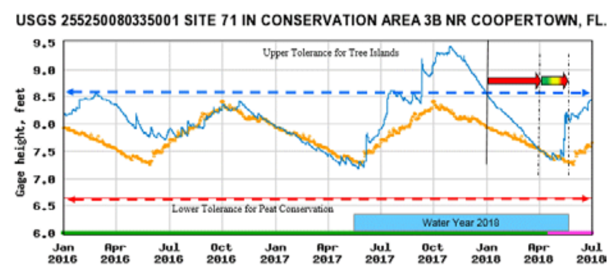
D. WCA-3A – Site 63



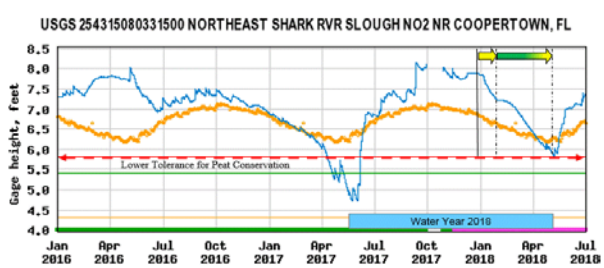
E. WCA-3A – Site 64



F. WCA-3B – Site 71



G. Northeast Shark River Slough



Median daily statistic (25 years)
Gauge 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: 24-year average, B: 24-year average, C: 23-year average, D: 24-year average, E: 22-year average, F: 24-year average, G: 34-year average), and indices for tree island flooding, peat conservation, and wading bird foraging.

Water Conservation Areas 2A and 2B

As in other parts of the Everglades, water levels in WCA-2A were near the long-term average at the beginning of WY2018 (**Figure 4B**). In June and early September, water levels rose rapidly to peak on September 15 (5 weeks before WCA-1). Stages exceeded the upper flood tolerance for tree islands from late June through December. WCA-2A stages approached the lower tolerance level during the dry season but did not drop below. Water levels then began receding at a rate conducive to wading bird foraging starting in January and lasting through most of the nesting season. Wading bird foraging activity was moderate in WCA-2 during WY2018 despite favorable hydrologic conditions. In WY2018, the Florida Fish and Wildlife Conservation Commission (FWC) closed WCA-2A to public access due to high water.

Unlike the rest of the Everglades, WCA-2B tends to be relatively deep most of the year (**Figure 4C**). During WY2018, water depths at gauge 99 began below the historical average, rising rapidly and peaking in late October. The red arrow in **Figure 4C** signifies water levels that were too deep to support wading birds. The continued steady decline in water levels toward the end of the dry season provided fair foraging conditions for wading birds at the end of the dry season.

Water Conservation Area 3A

Unlike WCA-1 and WCA-2A, water levels in northeastern WCA-3A (gauge 63) during WY2018 began well below the historical average (**Figure 4D**) and below the lower tolerance for peat conservation. Similar to the rest of the Everglades, the stage rose quickly in the early wet season and again in November, peaking on October 8 at above 13.0 feet NGVD29. Over the last 20 years, only WY1999 had a higher peak depth than WY2018. Although there are few tree islands left in northern WCA-3A, some like Alley North are critical nesting grounds for wading birds. Throughout the wading bird nesting season, the recession rate met or minimally exceeded the optimal rate for wading bird foraging (the green arrow in **Figure 4D**). The hydrologic conditions present in northeastern WCA-3A during the WY2018 wading bird nesting season were very well suited for wading bird reproduction and supported tens of thousands of foraging and nesting White Ibises (WHIB). Unique operational management at the S-7 structure was approved during the nesting season to route water into northeastern WCA-3A in order to maintain surface water surrounding the very productive wading bird colony Alley North. In WY2018, the FWC closed WCA-3 twice to public access. High water in summer 2017 and low water conditions in spring 2018 forced a closure of northern WCA-3A in order to protect wildlife from human disturbance.

The hydrologic pattern in central WCA-3A (gauge 64) (**Figure 4E**) was similar to that at gauge 63. Water levels peaked on October 13 and exceeded the 2.5-foot depth (tree island metric) from July through December. Depths and recession rates during the dry season were near optimal for wading bird foraging, and wading birds responded by feeding in large numbers along the drying front in WCA-3A throughout the nesting season. A minor late season reversal (the yellow arrow in **Figure 4E** signifies a reduction in suitability of foraging potential due to the reversal) closed out a record year for wading bird nesting.

Water Conservation Area 3B

Water levels at site 71 in WCA-3B began WY2018 near the historical average (**Figure 4F**). While stages climbed quickly, the rise was much more moderate than at WCA-3A. Water levels peaked on October 30 at nearly 1 foot above the historical average, which meant water levels remained too deep for optimal wading bird foraging until the beginning of April. Depths at gauge 71 exceeded the upper tolerance for tree islands from mid-September through December. The multi-colored arrow in **Figure 4F** indicates good foraging conditions as depths in early April become suitable but stage flux and an eventual reversal led to poorer conditions.

Northeast Shark River Slough

At the beginning of WY2018, water levels in Northeast Shark River Slough were well below the historical average (**Figure 4G**) and the lower tolerance for peat conservation. Water levels rose dramatically to peak in October at a stage above 8.0 feet NGVD29, only the third time in the last 20 years that stage at this location has exceeded that mark (WY1999 and WY2017). Depths remained above the historical average until April. The yellow arrow in **Figure 4G** at the beginning of the nesting season indicates less than desirable depth conditions. Recession rates and depths were near optimal for wading bird foraging at this location beginning in February and continuing through the remainder of WY2018. As in WCA-3A, record numbers of wading birds nested within ENP. The multi-colored arrow indicates very good conditions transitioning to poorer conditions as depths drop to near the ground surface, too low for wading birds to forage.

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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 2018. 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 2018 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) were 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.

In 2018, an unexpected super colony of nesting WHIB formed in northern WCA-3A at the Alley North colony. Due to the sheer size and density of the breeding colony, traditional standard aerial survey methods were inadequate. Therefore, an unmanned aerial vehicle (UAV) was used to supplement the original sampling method. The DJI Inspire II quadcopter fitted with a Zenmuse X7 35 mm equivalent camera lens was used to conduct an aerial survey in March 2018. Based on other aerial surveys and ground observations at the time, this appeared to be the peak of incubation for WHIB, which was surprisingly synchronous throughout the colony. GREG were in incubation and early chick periods. The entire island was surveyed with the flight plan, which took 9 hours of flight time. Images captured via UAV were from an altitude of 350 feet above ground level, were shot at an angle of 10° from nadir, and included >75% overlap in all four directions. The images were stitched together using AgiSoft on a 10-core computer and counted manually by a single observer using Photoshop to mark targets counted.

RESULTS

Nesting Effort

An estimated 77,884 wading bird nests were initiated at colonies within WCA-1, WCA-2, and WCA-3 in 2018 (**Tables 3** and **4**). This is believed to be the largest total nesting ever recorded in the WCAs (1975 to 2018). The closest record was 2009, when 57,564 nests were recorded. The 2018 record was 35% higher than in 2009.

The total number of nests was 3.4 times the 10-year average nesting effort and 3.5 times the 5-year average. While nesting effort by all species individually was above the 10-year average, nesting effort for tactile foragers (WHIB 58,893 nests; WOST 1,545 nests; Roseate Spoonbill [ROSP] 380 nests) accounted for much of this difference. A massive WHIB super colony formed in northern WCA-3A (Alley North) with more than 56,000 nesting pairs, dominated by WHIB. WHIB nesting effort was 4.1 times the 10-year average and 3.9 times the 5-year average. WOST had a second strong year in a row for nest initiations, with an effort 3.9 and 3.8 times the 10-year and 5-year averages, respectively. In addition to some historical locations, WOST continued to nest for the second year in New Colony 013 (west side of WCA-3). Overall, this was the highest nesting effort for WOST and WHIB in the last 19 years. GREG nesting effort also was high, with 2.0 times the 10-year average and 2.2 times the 5-year average.

ROSP nested at Jetport South, 6th Bridge, Alley North, Cypress City, Lox99, LoxWest, LoxRamp, and Lox73 (380 nests total) this season. Overall, this was the highest nesting effort for ROSP in the last 19 years, 4 times the 5-year and 10-year averages. This follows the recent trend of increased nesting effort by ROSP in the WCAs.

Table 3. Number of nesting pairs found in A.R.M. Loxahatchee National Wildlife Refuge (WCA-1) during systematic surveys, February through June 2018.

Colony	Latitude	Longitude	GREG	WHIB	ROSP	SNEG	GBHE	LBHE	TRHE	Unidentified Small White	Colony Total
43	26.51123	-80.43767	19					+		47	**66**
10	26.47807	-80.28207	76				2				**78**
Utu	26.37197	-80.31035	157								**157**
63/006	26.61690	-80.30672						+		166	**166**
38/185	26.44892	-80.24226	108	79		36		+			**223**
Zulu	26.59650	80.28623	57	200		15	3	+		204	**479**
Cook NC1	26.55370	-80.25080	64	300		121		+		400	**885**
Lox 99	26.43822	-80.39053	760		2	32	1	+	+	99	**894**
Cook NC4	26.53280	-80.27617	46	900			1			2	**949**
Lox West	26.55014	-80.44268	208	200	14		1	+	+	553	**976**
Lox Ramp/011	26.49511	-80.22533	287		1	224	1	+	+	586	**1,099**
Lox 73/Tyr	26.37187	-80.26597	249	600	1		2	+		375	**1,227**
Colonies >50 nests			2,031	2,279	18	428	11	0	0	2,432	**7,199**
Colonies <50 nests			105	0	0	0	2	0	0	0	**107**
Total by Species			**2,136**	**2,279**	**18**	**428**	**13**	**0**	**0**	**2,432**	**7,306**

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

Despite high overall nesting effort, this season showed a continued declining trend in *Egretta* heron nesting effort, with 233 LBHE and 31 TRHE observed during systematic ground surveys. Compared with average nesting between 1996 and 2007, the average number seen between 2007 and 2018 was reduced 77% for LBHE and 83% for TRHE. However, there was an increase in LBHE nesting effort (3.2 times the 5-year average), but still far below the overall average. *Egretta* herons 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 these species are nesting elsewhere in the system, such as in larger colonies or in coastal areas. *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 predators of *Egretta* heron nestlings. During the past 10 years, BCNH nesting has been increasing rapidly, and nest success was one of the highest of any species during 2018.

Reproductive Success

Nest success was monitored at six colonies: one in Everglades National Park (Tamiami West) and five in WCA-3 (6th Bridge, Joule, Jetport, Henry, and Vacation). Individual nests of GREG (n = 206 at six colonies), WHIB (n = 58 at Tamiami West and 6th Bridge), WOST (n = 79 at Jetport South), ROSP (n = 22 at 6th Bridge and Tamiami West), BCNH (n = 97 at Henry, Tamiami West, Vacation, and 6th Bridge), and *Egretta* herons (n = 86 at Tamiami West and 6th Bridge) were monitored through ground-based nest checks every 5 to 7 days throughout the season.

Systemwide nest success (P; probability of fledging at least one young, Mayfield method) varied considerable by species; GREG (P = 0.769; standard deviation [SD] = 0.0357), small heron (P = 0.563; SD = 0.0564), WHIB (P = 0.475; SD = 0.0662), WOST (P = 0.570; SD = 0.0604), BCNH (P = 0.768; SD = 0.0525), and ROSP (P = 0.480; SD = 0.1273). Nestling success (73% to 93%) was slightly higher than incubation success (65% to 83%) across species and colonies, suggesting foraging conditions remained favorable throughout the latter part of the nesting season. Notably, GREG and BCNH success was high, and most young of all species fledged before rains began. The high nest success and exceptional nesting effort combine to have made this one of the strongest production years in the history of monitoring the WCAs. The 2018 nesting season generated a huge cohort of young birds. For example, at least 27,000 WHIB were estimated to have been fledged this year from only two colonies in the Everglades.

Table 4. Number of nesting pairs found in WCA-2 and WCA-3 during systematic surveys, February through June 2018.

Colony	WCA	Latitude	Longitude	GREG	WHIB	WOST	ROSP	SNEG	GBHE	LBHE	TRHE	GLIB	BCNH	CAEG	YCNH	Unidentified Small White	ANHI	Colony Total*
Shamash	2		-80.43317	53														**53**
Rhea	2	26.23782	-80.31280	259					10	+	+							**269**
387	3	25.97397	-80.77251							52								**52**
388	3	25.97029	-80.77474							59								**59**
430	3	25.96867	-80.76341		5			1		30	20		3					**59**
438	3	25.98024	-80.75647					25		50	7		6					**88**
Forsetti	3	25.88681	80.70217	5					6									**61**
Jupiter	3	26.01557	-80.56272	62					3									**65**
71	3	26.54026	-80.23328							+						66		**66**
Kidlow	3	26.04123	-80.59968	67					5									**72**
70/134	3	26.06944	-80.63514													75		**75**
Austere	3	25.77982	-80.61312	75														**75**
Aerie	3	25.77158	-80.70872	82														**82**
67/001C	3	25.91318	-80.80832							+						83		**83**
60	3	26.02514	-80.69306					7		+						77		**84**
Vacation	3	25.91565	-80.63022	102					5									**107**
Juno	3	26.01430	-80.45685	107					2									**109**
Diana	3	25.84727	-80.52347	124												1		**125**
Mel	3	25.94812	80.63816	130														**130**
Jerrod	3	26.00012	-80.59513	140					7									**147**
66	3	25.91959	-80.79877							+						167		**167**
13	3	25.89387	-80.83727	98		72												**170**
Joule	3	26.01230	-80.63233	203					6									**209**
Cypress City	3	26.12410	-80.50440	197			21		11									**229**
Vulture	3	26.02765	-80.54106	200					33									**233**
65	3	25.86667	-80.80083							+						253		**253**
Nanse	3	26.10715	-80.49802	244					4							7		**255**
Henry	3	25.81913	-80.83983	317					4									**321**
Horus	3	25.96052	-80.57207	477					31									**508**
Jetport	3	25.86302	-80.83874			520	3		3									**526**
64	3	25.84139	-80.84643					478		100	100					50		**528**
Hidden	3	25.77353	-80.83722	654					3									**657**
Jetport South	3	25.80510	-80.84902	488		953	15											**1,456**
6th Bridge	3	26.12428	-80.54148	780	200		88	1,423	7			+						**2,498**
Alley North	3	26.20132	-80.52873	1,973	56,402		235		10							500		**59,120**
Colonies >50 nests				6,887	56,607	1,545	362	1,934	150	291	127	0	9	0	0	1,279	0	**69,191**
Colonies <50 nests**				359	7	0	0	8	231	42	4	12	622	1	3	98	304	**1,691**
Total by Species				**7,246**	**56,614**	**1,545**	**362**	**1,942**	**381**	**333**	**131**	**12**	**631**	**1**	**3**	**1,377**	**304**	**70,578**

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.

Python Occurrence and Predation in Wading Bird Colonies

Invasive Burmese pythons (*Python bivittatus*) have been established and spreading in southern Florida since the 1980s. As novel super-predators with a wide trophic niche, Burmese pythons are restructuring food webs and likely initiating complex cascades throughout the Everglades. Burmese python occurrence and predation in wading bird colonies were quantified from data collected in 2016-2017 via environmental DNA and camera traps. Overall occupancy rates in all Everglades habitats combined were 0.93 (0.79 to 0.99, 95% credible interval) in 2016 and 0.88 (0.67to 0.99, 95% credible interval) in 2017, suggesting pythons are widely distributed across the central Everglades near tree islands when wading birds are breeding. A comparison of environmental DNA concentrations in 2017 revealed Burmese pythons may use colony islands more than control islands. Using trail cameras, multiple pythons were documented depredating WHIB and GREG nests at Tamiami West colony in 2017. The overall python predation rate (4%, 5/125 nests) was five times higher than the predation rate by native predators (0.8%, 1/125 nests). The widespread distribution of pythons and the observed nest predation rates warrant future monitoring to assess whether python impacts on wading bird reproduction may increase over time.

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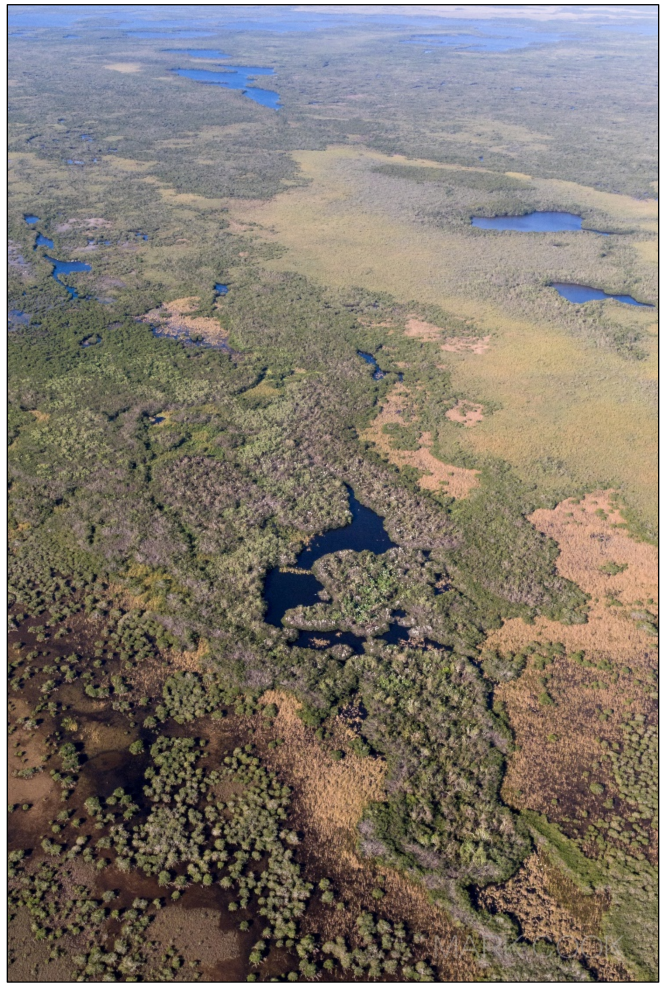


EVERGLADES NATIONAL PARK

MAINLAND

This summary report addresses colony monitoring within the slough and estuarine areas of Everglades National Park (ENP) using data collected during the 2018 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, numbers 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 from January through September. Flight dates were January 13; March 2, 5, and 6; April 7, 17, 18, 19, and 23; May 5, 18, and 29; June 12; July 23; August 6 and 28; and September 14. The airplane was unavailable for the scheduled February surveys this season. 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 100-400 mm lens. Photos were compared to visual estimates to assist with determining nest numbers, nesting stage, and species composition.

A systematic reconnaissance colony survey was conducted on April 18 and 19 across slough and estuarine habitat within the park to locate new colonies. Two observers, with one observer sitting on each side of a Cessna 206 high-wing float aircraft, searched for colonies along 20 established transects oriented east to west and spaced 1.6 nautical miles apart. Flight altitude was maintained at 800 feet above ground level throughout the survey. Coordinates of colony locations were recorded, and photos were taken of colony sites.

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

RESULTS

Nesting effort in ENP was up 466% compared to the 2017 breeding season. The total nest estimate for all species was 44,688 nests (**Table 5**). WOST had a peak number of 1,973 nests, an increase of 50% compared to the 2017 season. GREG nest counts (n = 5,130) were up 139%. WHIB (n = 36,835) were up 824%. SNEG nest counts (n = 151) were down 36%. Thirty-seven wading bird colonies were surveyed (**Figure 5**).

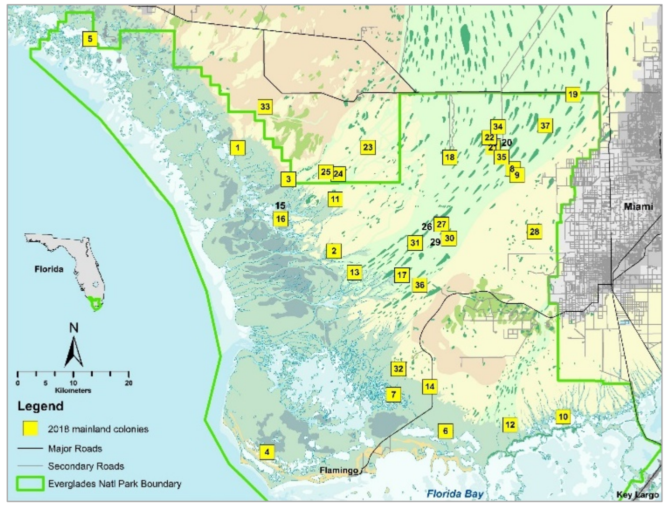


Figure 5. Active wading bird nesting colonies in ENP and southern Big Cypress National Preserve, 2018. Details for each colony are provided in **Table 5**.

The first flight to check on the mainland colony sites was conducted on January 12. WOST started nesting early again this year as some were already incubating on nests. WOST at the Broad River, Paurotis Pond, and Rodgers River Bay colony sites were either standing on completed nests or incubating. They were paired and standing on new nests at the Cabbage Bay colony, and a few birds were roosting together in tree tops at the Tamiami West colony site.

The next set of survey flights was flown on March 2. All colonies were found to be active, and two colony sites—Broad River and Cabbage Bay—had many thousands of WHIB paired up at nest sites. Most of the WHIB nests at the Broad River colony were constructed within the grassy areas just west of the trees where the egrets, herons, and WOST were nesting. Most WOST nests contained small young while others had medium-sized young. GREG nesting status varied widely between and within the colonies, ranging from incubating adults to small, medium, and large young. The Grossman Ridge West WOST colony had a later start than the other sites, with adult birds paired at nests or incubating. WOST that were roosting at the Tamiami West colony in January were not seen during subsequent surveys.

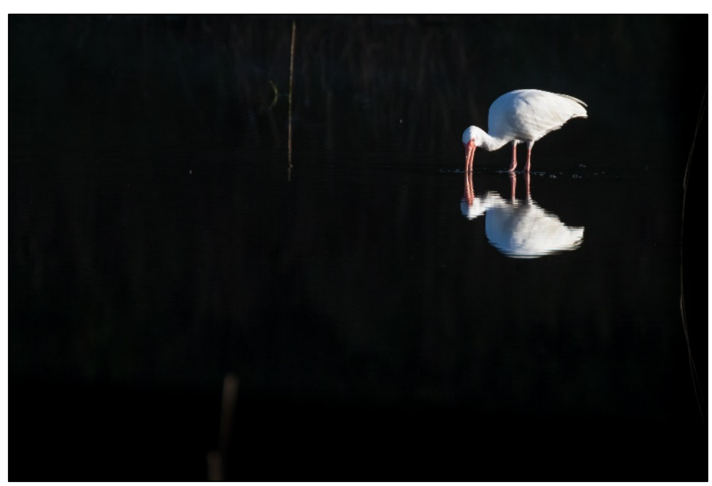
On April 7, WOST at most colonies had medium to large young and most nests contained two, three, or four young per nest. WHIB at Broad River and Cabbage Bay were brooding mostly medium young. On April 18 and 19, a reconnaissance flight was flown across Shark River Slough, Taylor Slough, and west of both sloughs to look for new colonies and transient colonies that nest on tree islands. No new large mixed-species colonies were found, but 18 GREG colonies and a small mostly SNEG colony were seen.

Table 5. Peak numbers of wading bird nests found in ENP colonies through September 2018.

Map ID	Island	Latitude	Longitude	GREG	WOST	WHIB	SNEG	ROSP	TRHE	LBHE	BCNH	GBHE	SWHE	Total
1	Alligator Bay	25.67099	-81.14714	200		3,000	75		+	+				**3,275**
2	Broad River	25.50292	-80.97440	550	746	11,000	+	50	+	+	+			**12,346**
3	Cabbage Bay	25.62000	-81.05612	388	430	19,320	+	30	+	+				**20,168**
4	Cape Sable[1]	25.17965	-81.08711					1						**1**
5	Chokoloskee Bay Lane Cove	25.84808	-81.41297	35										**35**
6	Cuthbert Lake	25.20933	-80.77500	115										**115**
7	East River	25.26860	-80.86785	50										**50**
8	Grossman Ridge West	25.63627	-80.65275	223	105							1		**329**
9	Grossman Ridge Willowhead	25.62613	-80.64582	150										**150**
10	Diamond Key, Joe Bay[2]	25.23205	-80.56455	181			23	7	134					**345**
11	Lostmans Creek	25.58723	-80.97204	182			+							**182**
12	Madeira Hammock[2]	25.21932	-80.65945	110				4						**114**
13	Otter Creek	25.46780	-80.93772	600		100	+	+				3		**703**
14	Paurotis Pond[2]	25.28150	-80.80300	400	682	1,000	13	50	50	9				**2,204**
15	Rodgers River Bay Large Island	25.55667	-81.06984	326	10									**336**
16	Rodgers River Bay Small Island	25.55522	-81.06998	30										**30**
17	Rookery Branch	25.46356	-80.85256	300										**300**
18	Shark Valley Tower	25.65538	-80.76652	130		700	+		+	+	+			**830**
19	Tamiami West[3]	25.75745	-80.54502	500		1,715		2	+	+	+		256	**2,473**
20	2018 Colony 1a	25.67358	-80.68823	45										**45**
21	2018 Colony 1b	25.67136	-80.68881	40										**40**
22	2018 Colony 2	25.68742	-80.69522	50										**50**
23	2018 Colony 3	25.67185	-80.91335	30										**30**
24	2018 Colony 4	25.62842	-80.96675	40										**40**
25	2018 Colony 5	25.63180	-80.98904	75										**75**
26	2018 Colony 6a	25.54693	-80.78242	25										**25**
27	2018 Colony 6b	25.54626	-80.78134	45										**45**
28	2018 Colony 7	25.53374	-80.61482	60										**60**
29	2018 Colony 8a	25.52306	-80.76891	5										**5**
30	2018 Colony 8b	25.52352	-80.76713	8										**8**
31	2018 Colony 9	25.51588	-80.82878	25										**25**
32	2018 Colony 10	25.31081	-80.85908	15										**15**
33	2018 Colony 11	25.73808	-81.09794	55										**55**
34	2018 Colony 12	25.70518	-80.67991	6								2		**8**
35	2018 Colony 13	25.65562	-80.67360	10			40							**50**
36	2018 Colony 14	25.44726	-80.82063	6										**6**
37	2018 NE Shark Slough Willowhead	25.70662	-80.59487	120										**120**
	Total			**5,130**	**1,973**	**36,835**	**151**	**144**	**184**	**9**	**0**	**6**	**256**	**44,688**

SWHE = Unidentified small white herons.
\+ Species present and nesting, but unable to determine number of nests.
[1] LBHE, ROSP, SNEG, and TRHE data from Audubon of Florida.
[2] ROSP, SNEG, and WHIB data from the University of Florida.

On May 2, video footage was captured from a helicopter of the Cabbage Bay and Broad River WHIB colonies. Both colony sites had many thousands of WHIB fledglings with adults coming and going. When all colony sites were re-checked on May 15, WOST chicks were standing in nests, and on May 29, fledged WOST were seen in trees and/or outside the colonies (Cabbage Bay). At the other colony sites, no WOST were seen and were presumed to have fledged.



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COLONIAL NESTING BIRDS IN 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 South Florida/Caribbean Inventory and Monitoring Network (SFCN) of the National Park Service (NPS) monitors colonial nesting birds in Biscayne National Park. This report summarizes the results for July 2017 through June 2018 (hereafter referred to as 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) (hereafter 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 2017-2018 consisted of an annual park-wide survey in January (via helicopter) to locate new nesting colonies and monthly surveys of known colonies. Two SFCN technicians, a photographer and an observer, participated in each survey. As the helicopter circled each island colony, the colonies were photographed, and the observer recorded the number of nesting and non-nesting birds. Approximately 450 photographs were taken during each survey. The photographs were downloaded for processing and analyzed to identify occupied active nests. Nests were circled on the photographs and then counted from the processed photographs.

Peak nest counts were identified for each colony and summed across colonies to calculate the peak nesting year total across the park for each species. In addition, an annual nesting index, the sum of monthly nest counts for the entire nesting year, was calculated. The nesting estimates for months with no sampling were calculated as the average of the months before and after the missing month. SFCN used the annual nesting index as well as peak nest counts because some species (e.g., 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 were compared to the seven previous nesting years' mean, maximum, and minimum. Complete methods are described in "Colonial Nesting Bird Monitoring Protocol in Biscayne National Park" (Muxo et al. 2015).

Colony surveys were conducted from July to December 2017 and January, February, and April to June 2018). A flight was not conducted in March 2018 because of helicopter availability. The August 2017 flight took place over 2 days (August 25 and 31) due to weather conditions. 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 6**).

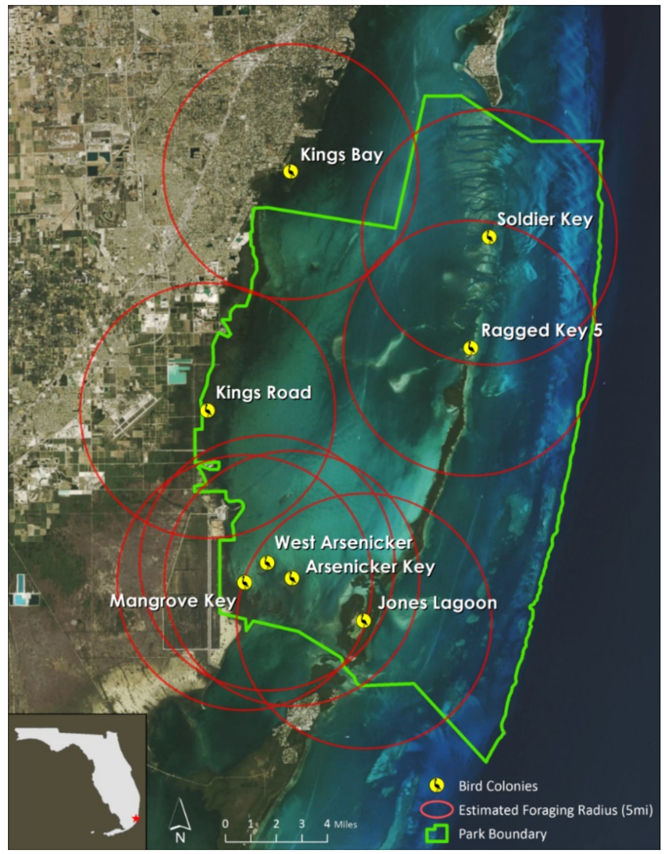

Figure 6. Eight island colonies monitored within Biscayne National Park and the estimated foraging areas.

RESULTS AND DISCUSSION

In the 2017-2018 nesting year, the SFCN completed its eighth year of monitoring colonial nesting birds in Biscayne National Park. The Kings Bay colony is located approximately 2 km north of the Biscayne National Park boundary; however, the colony results are included because of its proximity to the park (**Figure 6**) and the high likelihood DCCO at this colony are feeding in the park.

The peak nest count (893 nests) for DCCO occurred in May 2018 (**Figure 7**). The park-wide peak nest count (based on peak nest count by month by colony) for DCCO was 1,135, 8% above the mean of previous years (**Table 6**, **Figure 8**) but within the previous range of 792 to 1,336 nests. The annual nesting index of 5,127 was below the maximum of 6,285 recorded last season and 5% lower than the 8-year average, but higher than the minimum of 4,927 (**Figure 9**). DCCO continue to nest year-round and account for 87% of the nests counted. Three (Mangrove Key, Kings Bay, and Kings Road Island) of the eight previously monitored colonies showed higher peak nest counts than the previous year, while the other five colonies showed decreases in peak nest counts. It is interesting to see the recovery in DCCO nesting after Hurricane Irma (**Figure 7**).

GBHE were observed nesting in five of the eight colonies (**Table 6**). The peak nest count for the 2017-2018 nesting season was 16 nests (**Figure 8**), compared to a mean of 11.8 nests in previous years. This was a new maximum peak nest count for GBHE (**Table 6**). The majority of GBHE nesting occurred at Jones Lagoon.

Park-wide peak nest count for GREG was 29 nests (**Figure 8**), which exceeded the mean from previous years (**Table 6**) and is a new maximum. During the 2017-2018 nesting season, GREG nested at two colonies in the park (**Table 6**, **Figure 8**).

The GWHE peak nest count of 45 nests (**Figure 8**) was 62% above the mean of previously monitored seasons (27.8 nests). This is the highest observed count to date (**Table 6**). GWHE nested on six of the eight colonies monitored. The majority of GWHE nesting occurred at Arsenicker Key and Jones Lagoon.

Jones Lagoon was the only colony with ROSP nesting, which is consistent with previous nesting seasons. The peak nest count for the 2017-2018 nesting season was 9 nests (**Figure 8**), which is above the mean of 5.3 nests but within the previous data range of 0 to 12 nests (**Table 6**, **Figure 8**).

The WHIB peak nest count was 66 nests (**Table 6**), 20% above the mean of the previous 7 years (54.8 nests; **Table 6**). This year's peak count was between the minimum and maximum count of 24 to 95 nests. WHIB were only observed nesting on West Arsenicker (**Table 6**, **Figure 8**).

In terms of species richness, West Arsenicker and Jones Lagoon had seven nesting species and Mangrove Key had five nesting species. Only DCCO have nested at the Kings Bay and Kings Road colonies thus far (**Figure 8**). The two Kings colonies add a substantial number of DCCO nests (423) to the peak abundance.

Overall, the number of peak nests was higher compared with the average of the past 7 nesting years for all the focal species. GBHE, GREG, and GWHE set new maximum peak nest counts (**Figure 9**) in the park since monitoring began in 2010.

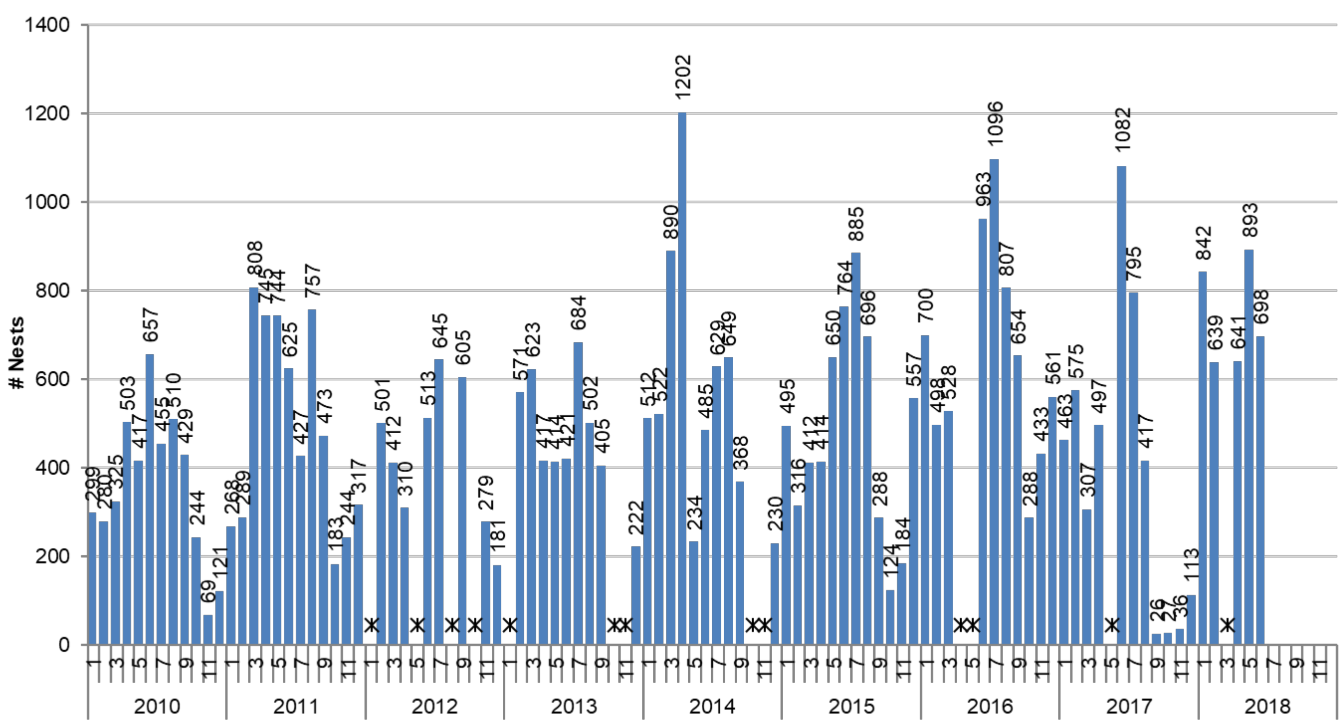

Figure 7. Number of DCCO nests per month and peak nesting periods. (*Months not sampled.)

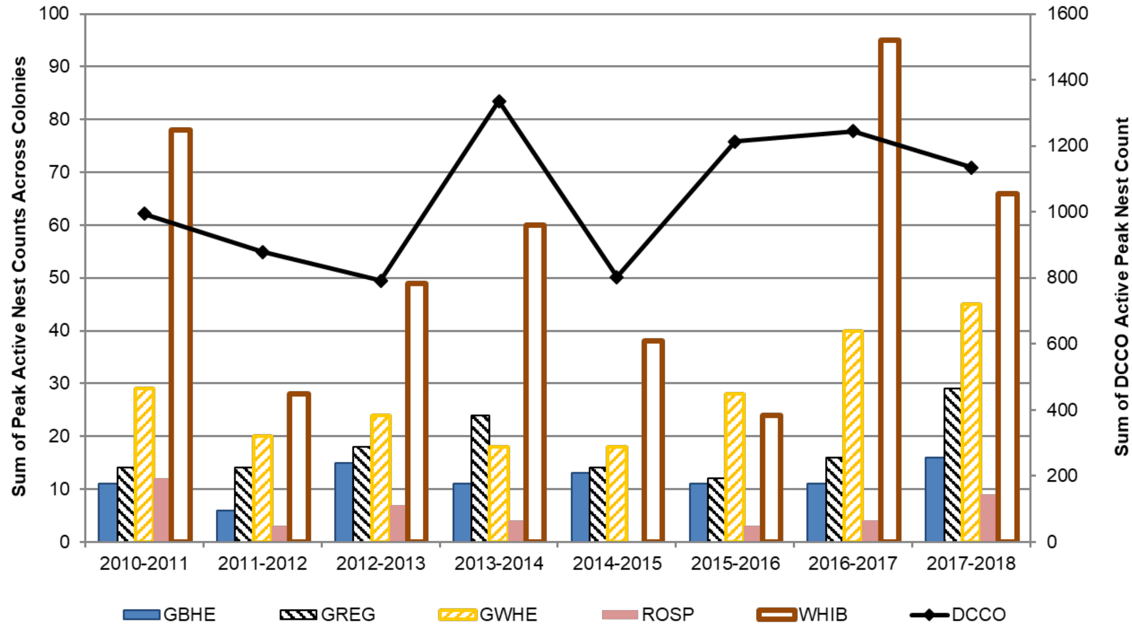

Figure 8. Total of peak active nest counts from all colonies, including Kings Bay and Kings Road Island.

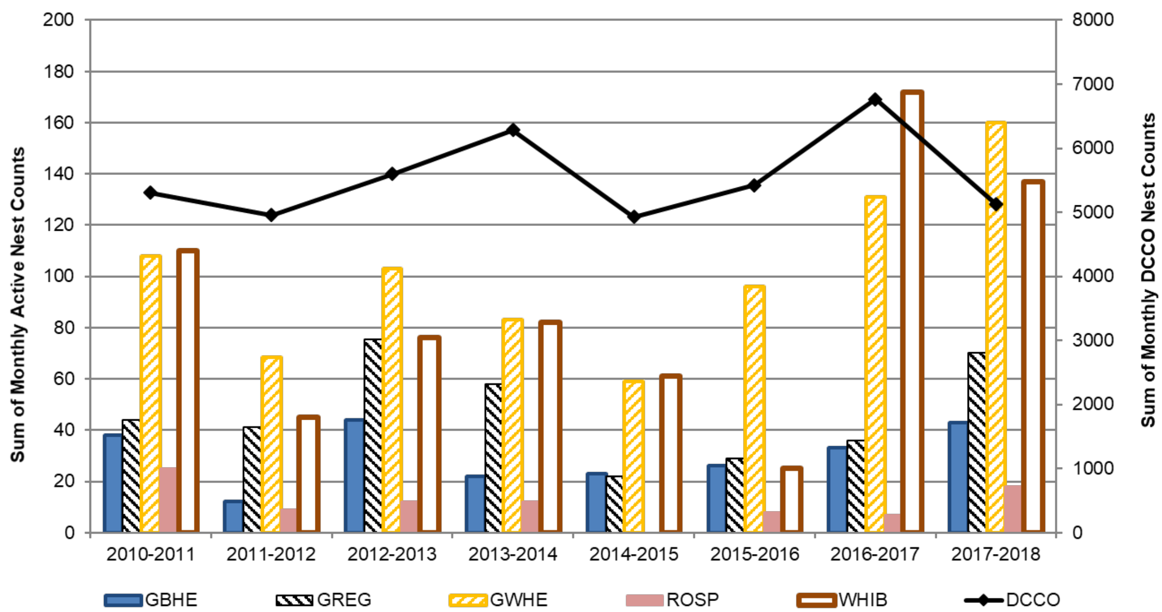

Figure 9. Annual nesting index across colonies, including Kings Bay and Kings Road Island, by focal species. The number of nests counted at each colony during each month was summed to create an annual nesting index across all colonies for the six focal species. This number exceeds the actual number of nest starts as a single nest could be counted during two or more monthly visits.

Table 6. Peak nest and nesting index for Biscayne National Park, by species and colony, for the 2017-2018 nesting year, plus the mean, percent change, maximum, and minimum of the seven previous nesting years (July through June).

Species	Peak Nest					Nesting Index				
	2017-2018	Mean	% Change	Max.	Min.	2017-2018	Mean	% Change	Max.	Min.
Biscayne National Park										
DCCO	1,135	1,049.5	8%	1,336	792	5,127	5,415.1	-5%	6,285	4,927
GBHE	16	11.8	36%	16	6	43	27.8	55%	44	12
GREG	29	17.6	65%	29	12	70	48.1	46%	75.5	22
GWHE	45	27.8	62%	45	18	160	84.3	90%	108	59
ROSP	9	5.3	70%	12	0	18	11.6	55%	25	0
WHIB	66	54.8	20%	95	24	137	74.8	83%	110	45
Arsenicker Key										
DCCO	106	158	-33%	257	106	426	752.1	-43%	983.5	489
GBHE	1	0.4	150%	2	0	1	1	0%	5	0
GREG	0	0.7	-100%	2	0	0	2.1	-100%	5	0
GWHE	11	5.6	96%	13	2	46	15.2	203%	26	11
ROSP	0	0	N/A	0	0	0	0	N/A	0	0
WHIB	0	36	-100%	60	0	0	70.2	-100%	87	45
Jones Lagoon										
DCCO	55	109	-50%	135	55	287	627.2	-54%	905	433
GBHE	9	6.3	43%	10	2	30	15	100%	25.5	6.5
GREG	2	1	100%	2	0	2	1.3	54%	2	0
GWHE	14	9.1	54%	14	6	44	28.9	52%	36	18
ROSP	9	5.3	70%	12	0	18	11.6	55%	25	0
WHIB	0	0	N/A	0	0	0	0	N/A	0	0
Mangrove Key										
DCCO	35	33.3	5%	115	0	85	104.7	-19%	309	0
GBHE	2	1.5	33%	4	0	7	0	N/A	0	0
GREG	0	0.3	-100%	1	0	0	0	N/A	0	0
GWHE	4	1.1	264%	4	0	13	0	N/A	0	0
ROSP	0	0	N/A	0	0	0	0	N/A	0	0
WHIB	0	0	N/A	0	0	0	0	N/A	0	0
Ragged Key 5										
DCCO	351	418.3	-16%	706	294	1,774	2,713.6	-35%	3,568	2,163
GBHE	0	0.3	-100%	1	0	0	0.4	-100%	1	0
GREG	0	0.3	-100%	1	0	0	0.4	-100%	1	0
GWHE	8	4.8	67%	8	2	29	15.3	90%	23	9
ROSP	0	0	N/A	0	0	0	0	N/A	0	0
WHIB	0	0	N/A	0	0	0	0	N/A	0	0
Solider Key										
DCCO	165	211.1	-22%	342	140	752	1214.6	-38%	1531	1003
GBHE	1	1.1	-9%	2	1	2	3.6	-44%	9	1
GREG	0	0.6	-100%	1	0	0	0.5	-100%	1	0
GWHE	6	4.1	46%	9	2	19	8.5	124%	16	5
ROSP	0	0	N/A	0	0	0	0	N/A	0	0
WHIB	0	0	N/A	0	0	0	0	N/A	0	0
West Arsenicker										
DCCO	0	1.4	-100%	10	0	0	2.9	-100%	13	0
GBHE	3	3	0%	5	1	3	7.8	-62%	15	3
GREG	27	15.5	74%	27	11	68	44.2	54%	73	19
GWHE	2	3	-33%	6	1	7	16.4	-57%	29.5	5
ROSP	0	0	N/A	0	0	0	0	N/A	0	0
WHIB	66	23.3	183%	95	0	137	4.6	2878%	23	0
Kings Bay										
DCCO	357	273	31%	357	212	1578	1076.3	47%	1578	212
Kings Road Island										
DCCO	66	64.5	2%	66	63	209	203	3%	209	197

Note: Kings Bay only has 3 years of data for comparison, and Kings Road only has 2 years of data for comparison.

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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 for nesting (**Table 7**). These colonies are divided into five distinct nesting regions based on the primary foraging locations used by the birds (**Figure 10**; **Table 7**; Lorenz et al. 2002). During the 2017-2018 nesting season (November 2017 through June 2018), complete nest counts were performed in all five regions of the bay by entering the colonies and thoroughly searching for nests. Twelve former colony sites were not surveyed for logistical regions; however, these colonies had not been active for at least 20 years (**Table 7**). Fifteen colonies were found to have ROSP nesting activity.

Nest production was estimated using two methods. The preferred method was to perform mark-and-revisit surveys at active colonies within each region to estimate nest success. These surveys involved marking as many nests as possible shortly after full clutches had been laid, and then revisiting the colonies on a 10- to 21-day cycle. Nests were monitored until failure or until all surviving chicks reached at least 21 days of age, which is when chicks begin branching and can no longer be assigned to a nest. A colony was considered successful if it averaged at least one chick to 21 days per nesting attempt (c/n). If revisits placed chicks (ROSP or other species) in danger or could not be performed because of logistical reasons (e.g., water levels were too low to access the colony), flighted young of the year (they conspicuously roost in the colony tree tops) prior to fledging from the island were counted and the maximum observed number was used. 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 are compared using 1984 as a baseline; the year that the South Dade Conveyance System was completed, which has direct water management implications on Florida Bay and impacted ROSP nesting activity within the bay (Lorenz et al. 2002; Lorenz 2014).

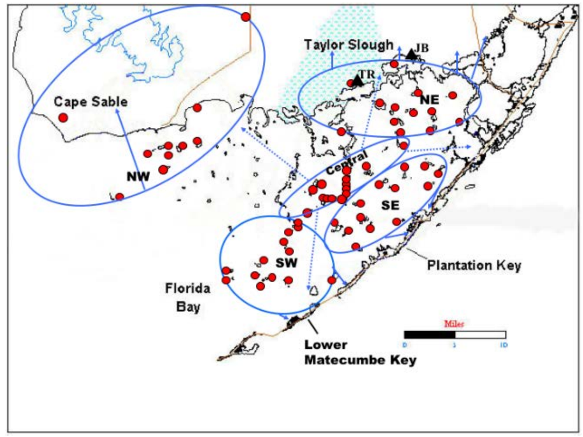

Figure 10. Map of Florida Bay, indicating ROSP colony locations (red dots) and nesting regions (blue circles). Arrows indicate the primary foraging area for each region. The dashed lines from the Central region are speculative. Black triangles are the locations of two hydrostations located at historical ROSP foraging locations.

Table 7. Number of ROSP nests in Florida Bay, November 2017 through June 2018, 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
Northeast	South Nest	22	0	16.5	59	23	26
	Porjoe	2	0	19.3	118	15	30
	Duck	15	0	12.2	100	17	30
	Madeira	9	0	25.2	164	7	26
	Diamond	10	0	2.8	10	2	4
	Northeast Region Subtotal	**58**	**3**	**150.7**	**333**	--	--
Northwest	Sandy	22	6	120.5	250	33	33
	Oyster	27	0	4.9	45	13	27
	Palm	25	0	33.3	100	14	15
	Paurotis	65	2	42.5	128	13	13
	Cape Sable	1	0	2.2	8	4	5
	Northwest Region Subtotal	**140**	**65**	**196.2**	**325**	--	--
Central	Central Bob Allen	13	0	4.6	13	5	7
	West Bob Allen	2	2	7.1	18	7	7
	Calusa	2	0	7.2	21	14	18
	South Park	1	0	7.6	39	20	28
	North Jimmie	12	0	1.5	12	3	10
	Captain	25	0	4.6	25	6	12
	Central Region Subtotal	**55**	**3**	**43.3**	**96**	--	--
Southeast	Middle Butternut	5	0	14.0	66	25	28
	Stake	3	0	4.5	19	16	26
	Pigeon	15	0	8.9	56	17	26
	Southeast Region Subtotal	**23**	**4**	**55.0**	**117**	--	--
Southwest	Twin	2	0	1.9	8	15	25
	Southwest Region Subtotal	**2**	**0**	**7.0**	**35**	--	--
	Florida Bay Total	**278**	**112**	**452.2**	**880**	--	--

Results

Northeast Region

There were 5 active colonies in the Northeast region this year, including Madeira Hammock, producing an estimated 58 nests total; less than 10% of the target of 688 nests. Madeira Hammock produced only nine nests, just one nest more than last year's all-time low since monitoring of the colony began in 2011-2012. An estimated 1.32 c/n were produced for an estimated total of 76 chicks in the Northeast region (**Table 8**). Despite the low nesting numbers, the production rate is considered successful and was just under the target of 1.38 c/n. The mean lay date was December 30, and the mean hatch date was January 20 (**Table 8**).

Northwest Region

There were 5 active colonies in the Northwest region, producing a total of 140 nests. This is an increase from last year's 103 nests, although still below the target of 210 nests. There were 22 nests with known fate that produced chicks to at least 21 days (80% success rate), with a mean production rate of 1.95 c/n (**Table 8**). This exceeded the target of 1.38 c/n (Lorenz et al. 2009). Total production for the Northwest region was estimated at 274 chicks to 21 days (**Table 8**). The mean lay date was December 11, and the mean hatch date was January 1 (**Table 8**). Sandy Key produced 22 nests this season, a slight increase from the 2016-2017 nesting season of 20 nests.

Central Region

The Central region yielded 55 nests from 6 colonies, above the regional average of 43.3 nests since 1984-1985 (**Table 7**). The production rate was unusually high (1.76 c/n), and estimated total production greatly increased from last year's 7 chicks to this year's 97 chicks fledged. Of the 21 nests with known fate, approximately 80% successfully raised chicks to 21 days (**Table 8**), more than double last year's 40%. The mean lay date was January 4, and the mean hatch date was January 25 (**Table 8**).

Southeast Region

Three colonies in the Southeast region produced 23 nests, below the mean of 55 nests since 1984-1985 (**Table 7**). Approximately 15 nests were on Pigeon Key, well above the colony mean of 8.92 nests. The region produced 37 chicks to branch status, with 1.59 c/n (**Table 8**). The estimated mean lay and hatch dates were January 4 and January 25, respectively (**Table 8**).

Southwest Region

Five colonies were surveyed in the Southwest region in 2017-2018. Only South Twin Key was active, producing two nests (**Table 7**). Logistical problems prevented tracking these nests to 21 days post-hatch; however, one chick capable of short sustained flights was observed at the colony approximately 6 weeks post-hatch. Based on surveys conducted before the chicks reached the branchling phase, the mean lay and hatch date were estimated to be February 15 and March 8, respectively.

Baywide Synthesis

This nesting season's 278 nests was higher than last year's 207 nests but was little more than 20% of the target 1,258 nests per year. (**Figure 11**; note that counts in 2009-2010 and 2010-2011 may have been underestimated because ROSP nests at Madeira Hammock were not counted those years). There was a fairly rapid decline in nesting effort from the early 1990s through 2008-2009, and although recent counts have stabilized between 200 and 400 nests, ROSP numbers are much lower than historical nesting patterns of the 1970s to 1990s (**Figure 11**) and remain a concern. Similarly, nest numbers in northeastern Florida Bay are much lower, and there appears to be declining numbers of nests in the Northwestern region beginning in 2008-2009 (**Figure 11**). Throughout the regions, the average nest production was 1.48 c/n, with 80% of nests successfully raising at least 1 chick to 21 days (**Table 8**). This is well above the mean of 1.09 c/n since 1984. The mean lay date was January 6; the sixth time in 7 years that mean nesting occurred outside of the historical nesting period (November 1 to December 31; Alvear-Rodriguez 2000).

As reported in previous wading bird reports, ROSP nesting in Florida Bay appears to be responding negatively to differential sea level rise in the Florida Keys, which has caused water levels in the primary foraging areas to have increased by as much as 13 centimeters since 2000. ROSP nesting has been shown to depend on high prey concentrations that result from low water conditions in the dwarf mangrove wetlands located on the northern coast of Florida Bay (Lorenz 2014). The number of times that water levels in the foraging areas reach the point at which prey concentrate (approximately 13 centimeters; Lorenz 2014) has greatly diminished in recent years (**Figure 12**), possibly explaining the declines in nest numbers in both the Northeast and Northwest regions (**Figure 11**).

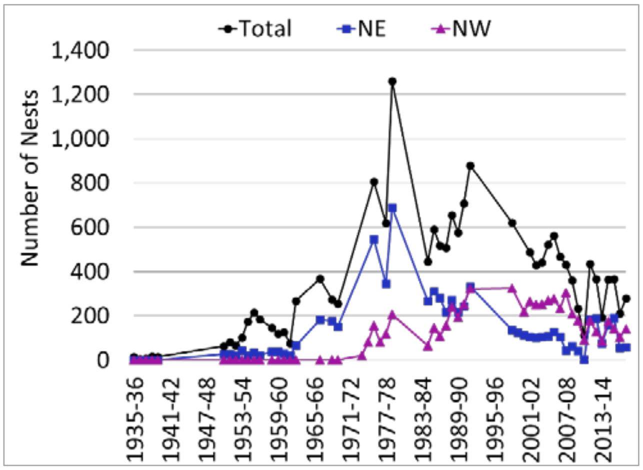

Figure 11. Total ROSP nests in Florida Bay and in the Northeast and Northwest regions of Florida Bay.

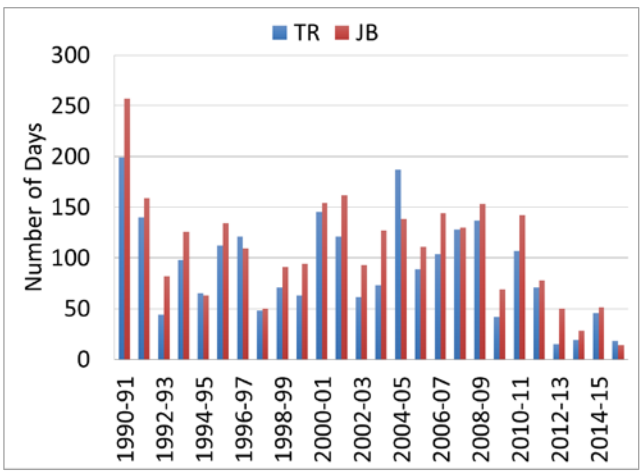

Figure 12. Number of days that water levels were below the prey concentration threshold of 13.4 centimeters in seasonally ephemeral wetlands (Lorenz 2014) at two historical ROSP foraging locations (**Figure 10**) from 1990 to 2016. More recent data were not available.

Although the unprecedented numbers of nesting wading birds observed in the rest of the Everglades watershed was not observed in Florida Bay, the nesting success rate for ROSP was relatively very high throughout the bay. Anecdotal observation of other water bird nests indicated a very high success rate throughout the bay as well. Similar to the greater Everglades, water levels in historical wading bird foraging grounds in the mangrove transition zone north of the bay had a near-textbook drawdown pattern with no major reversals, although the water level was consistently higher than the mean (**Figure 13**). The higher-than-mean water levels likely are the result of locally high rates of sea level rise, indicating the water may have been too deep to concentrate fish at the hydrostation location. The picture-perfect recession pattern, however, suggests that elsewhere on the foraging grounds, there was a predictable drying front moving across the landscape that concentrated prey such that prey was reliably and readily available to nesting wading birds, thereby explaining the high wading bird success rates in Florida Bay this year.

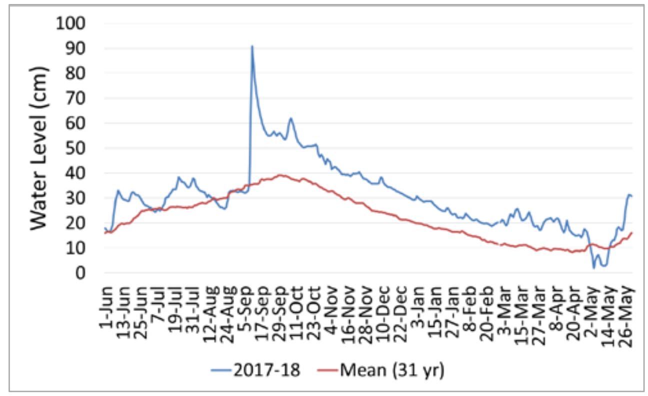

Figure 13. 2017-2018 water levels with 31-year mean at Taylor River.

In stark contrast to this decline in nest numbers, nesting success over the last decade has been relatively high compared to production rates reported by Lorenz et al. (2002) for 1982-1983 to 1998-1999. Mean production for the Northeast and Northwest regions since 2008-2009 was 1.20 c/n and 1.36 c/n, respectively; while mean production for 1982-1983 to 1998-1999 was 0.67 c/n and 1.24 c/n, respectively. Furthermore, the percentage of years that averaged ≥1 c/n in the Northeast region was only 36% from 1982-1983 to 1998-1999 but was 80% for the last decade. It appears the chicks produced in Florida Bay are not recruiting into Florida Bay's adult nesting population, otherwise nest numbers would be increasing (i.e., it appears Florida Bay is acting as a source population for other nesting areas). This is unusual because ROSP have been shown to have some affinity for natal site fidelity when it comes selecting a nesting location. This may explain the observed increase in nesting in other areas of the Everglades such as the colonies on the southwestern coast associated with Shark River Slough and Lostman's Slough. This idea is supported by the relatively high number of ROSP nesting in the greater Everglades this year: 492 compared to an average of 210 for the last 5 years and 172 for the last 10 years. (This estimate is likely very conservative because ROSP were largely observed during aerial surveys, which have been shown to greatly underestimate ROSP nests.) Furthermore, ROSP throughout the state are rapidly expanding their nesting range northward and, in recent years, have been observed nesting in southern Georgia. Given that prey concentration events are becoming less predictable in historical foraging grounds, birds nesting in Florida Bay likely are traveling farther inland or to more remote locations to forage. Perhaps when young birds fledge from the colony, they follow the parents to these locations where they learn to forage, and when they return as adults, they nest closer to those foraging grounds rather than the more distant sites in Florida Bay.

Table 8. Breakdown of colonies, by region, of all monitoring data collected.

Region	Colony	Number of Nests Observed	Number of Marked (Monitored) Nests	Number of Nests Successfully Monitored	Number of Chicks to 21 Days	Maximum Number of Fledglings	Number of Nests Used to Estimate Production	Estimated Production per Nest	Estimated Number of Chicks Fledged	Number of Nests Successful	% Success	Mean Lay Date	Mean Hatch Date
Northeast	South Nest	22	22	11	13	0	11	1.18	26	6	55%	12/20/17	1/10/18
	Porjoe	2	2	2	4	0	2	2.00	4	2	100%	1/5/18	1/26/18
	Duck	15	11	0	0	27	15	1.80	27	U/K	U/K	1/4/18	1/25/18
	Madeira Hammock	9	0	0	0	5	9	0.56	5	U/K	U/K	U/K	U/K
	Diamond	10	1	1	1	0	1	1.00	10	1	U/K	U/K	U/K
	Region Subtotal	**58**	**36**	**14**	**18**	**32**	**38**	**1.32**	**76**	**9**	**64%**	**12/30/17**	**1/20/18**
Northwest	Sandy	22	22	9	20	0	9	2.22	49	8	89%	11/27/17	12/18/17
	Oyster	27	27	7	11	0	7	1.57	42	5	71%	1/13/18	2/3/18
	Palm	25	25	5	10	0	5	2.00	50	4	80%	11/22/17	12/13/17
	Paurotis*	65	0	0	0	>75	0	U/K	U/K	U/K	U/K	U/K	U/K
	Cape Sable	1	0	1	0	2	1	2.00	2	U/K	U/K	U/K	U/K
	Region Subtotal	**140**	**74**	**22**	**41**	**>77**	**22**	**1.95**	**274**	**17**	**77%**	**12/11/17**	**1/1/18**
Central	West Bob Allen	13	13	8	11	0	8	1.38	18	5	63%	12/14/17	1/4/18
	Central Bob Allen	2	2	1	1	0	1	1.00	2	1	100%	1/6/18	1/27/18
	Calusa	2	2	2	6	0	2	3.00	6	2	100%	12/29/17	1/19/18
	South Park	1	1	1	1	0	1	1.00	1	1	100%	2/8/18	3/1/18
	North Jimmie	12	12	0	0	18	12	1.50	18	U/K	U/K	1/6/18	1/27/18
	Captain	25	25	9	21	0	9	2.33	58	8	89%	12/28/17	1/18/18
	Region Subtotal	**55**	**55**	**21**	**40**	**18**	**33**	**1.76**	**97**	**17**	**81%**	**1/4/18**	**1/25/18**
Southeast	Middle Butternut	5	5	5	9	0	5	1.80	9	4	80%	2/14/18	3/7/18
	Stake	3	3	3	5	0	3	1.67	5	2	67%	12/13/17	1/3/18
	Pigeon	15	15	14	21	0	14	1.50	23	10	71%	12/17/17	1/7/18
	Region Subtotal	**23**	**23**	**22**	**35**	**0**	**22**	**1.59**	**37**	**16**	**73%**	**1/4/18**	**1/25/18**
Southwest	South Twin**	2	2	0	0	0	0	U/K	U/K	U/K	U/K	2/15/18	3/8/18
	Region Subtotal	**2**	**2**	**0**	**0**	**0**	**0**	**U/K**	**U/K**	**U/K**	**U/K**	**2/15/18**	**3/8/18**
	Total	**278**	**190**	**79**	**134**	**127**	**115**	**1.62**	**450**	**59**	**75%**	**1/6/18**	**1/27/18**

U/K = unknown.
* The maximum count of young for the year was 75; however, it is believed this is a severe underestimate of the actual number of fledges. The size and convoluted nature of the colony made it impossible to observe all pre-fledge birds at one time.
** One chick capable of short flights was observed at the colony, but the island had not been monitored since April 10, 2018, so other chicks may have already fledged the island.

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NESTING ACTIVITY OF WATER BIRDS ON ROSEATE SPOONBILL COLONY KEYS IN FLORIDA BAY AND BAYWIDE AERIAL SURVEY RESULTS

Audubon Florida and Everglades National Park performed surveys of nesting water birds in Florida Bay and adjacent habitats. The results of those surveys are combined here by selecting the largest nest count for each species for each nesting site regardless of who performed the survey, the survey method, or the time of the survey.

METHODS

Audubon Florida

While surveying known Roseate Spoonbill (ROSP) colonies in Florida Bay, other water bird nesting activity on the keys was investigated. Of the 20 species of water birds observed, 14 were nesting on the keys and nests were counted as accurately as possible (**Table 9**, **Figure 14**). 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, there were no surveys beyond areas where ROSP nested on a given key.

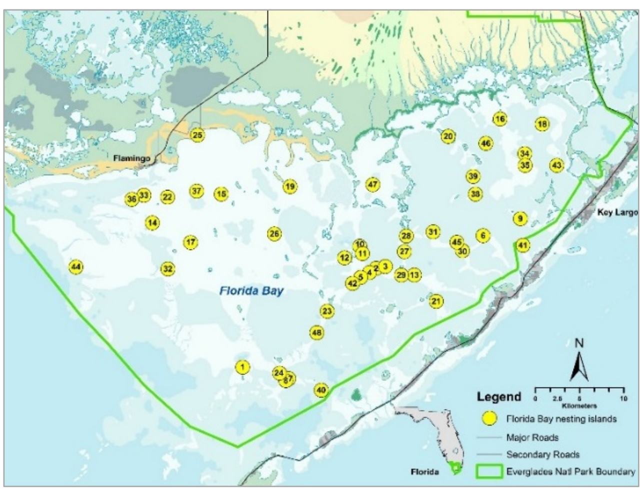

Figure 14. Active nesting colony sites in Florida Bay, 2018. **Table 9** contains the colony names and details.

That stated, every attempt was made to find all ROSP and Reddish Egret (REEG) nests and to use total counts rather than the maximum observed during any given survey. 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.

Everglades National Park

Aerial surveys were conducted in Everglades National Park on January 12, March 5 and 6, April 17, and May 18 using a National Park Service Cessna 206 high-wing float aircraft and a U.S. Fish and Wildlife Service Quest Kodiak float aircraft. Peak nest counts for wading birds and Brown Pelicans (BRPE) were recorded by island or island group. Nesting Double-crested Cormorants (DCCO) were noted, but nest numbers were not estimated. The survey area included most islands and island groups within Florida Bay (**Table 9**, **Figure 14**). The goal was to fly monthly surveys from November to when birds have completed nesting. Due to aircraft unavailability, surveys did not start until January.

RESULTS

This is the fifth year Audubon Florida has been reporting numbers of other nesting water birds observed while performing surveys for ROSP. There were two notable findings this year.

- Two Neotropic Cormorant (NECO) nests were observed at Duck Key. One nest was attended by a mated pair of NECO and fledged four chicks; only one NECO was observed at the second nest and it did not produce any chicks. Photographs were taken during each survey of Duck Key. This is believed to be the first record of a mated pair of NECO nesting in Florida. There is a record of a NECO nesting at the Wakodahatchee Wetlands (Delray Beach, Florida) in 2012; however, it was reported to have mated with a DCCO.
- Although Audubon Florida has only been quantifying nesting of species other than ROSP and REEG for the past 5 years, ROSP surveys have been performed in all but a few years since 1983. Tricolored Heron (TRHE) nesting activity in Florida Bay has increased in recent years. Including counts at Paurotis Pond and Diamond Key, there were a total of 734 nests this year. An estimated 184 TRHE were nesting on West Arsenicker Key in Biscayne National Park. The nest counts in Florida Bay from 2014 to 2017 were 268, 718, 793, and 248 nests. These counts are thought to be much lower than the actual numbers of nesting TRHE because ROSP complete nesting just as TRHE are starting; therefore, many TRHE that nest later in the season likely are missed. Conversely, as previously reported, ROSP are nesting later than they did 7 years ago, so Audubon Florida is extending ROSP surveys later each year. It is possible that for the last three decades, ROSP surveys simply were being completed before TRHE began nesting, and the impression of increased nesting activity is the result of doing surveys later in the year. Regardless of whether the nests counts are showing an increase in TRHE nesting activity in Florida Bay, there appears to be more TRHE (nesting or otherwise) in Florida Bay and southern Biscayne Bay than there were prior to 2000.

Table 9. Peak nest numbers found in Florida Bay wading and water bird colonies through July 2018. Underlined numbers were estimates collected by Audubon Florida using ground surveys, while plain text numbers are estimates collected by Everglades National Park from aerial surveys.

Map ID	Colony	Latitude	Longitude	GBHE	GWHE	GREG	REEG	LBHE	SNEG	TRHE	BCNH	ROSP	WHIB	BRPE	DCCO	NECO	ANHI	Total
1	Arsenicker Keys, upper and lower	24.93180	-80.82707															**0**
2	Bob Allen Keys, central	25.03279	-80.67685									2						**2**
3	Bob Allen Keys, east	25.03469	-80.66637															**0**
4	Bob Allen Keys, west	25.02845	-80.68426	1	3		2			7		13						**26**
5	Bob Allen Keys, west, small	25.02353	-80.69413		1													**1**
6	Bottle Key	25.06602	-80.55628															**0**
7	Buchanan Keys, east	24.91996	-80.77522											30	+			**30**
8	Buchanan Keys, west	24.91791	-80.77857		3													**3**
9	Butternut Keys, middle	25.08322	-80.51419							150		5	25					**180**
10	Calusa Keys, big	25.05542	-80.69512	1	5					9		2						**17**
11	Calusa Keys, small island SE of Big Calusa	25.04801	-80.69211											24				**24**
12	Calusa Keys, west (Bruce Key)	25.04371	-80.71225	1	2		15											**18**
13	Captain Key	25.02583	-80.63380	1	8	3	2					25						**39**
14	Clive Key	25.07971	-80.92849	4	5	40	2				28							**79**
15	Cormorant Key	25.10915	-80.85087		4													**4**
16	Deer Key	25.18557	-80.53665		1													**1**
17	Dildo Key	25.05960	-80.88542	5	10	5												**20**
18	Duck Key	25.18011	-80.48931		4	6	12		10			15			25	2		**74**
19	Dump Keys, north and south	25.11678	-80.77342		4													**4**
20	Eagle Key	25.16779	-80.59527	1	10		1											**12**
21	East Key	24.99888	-80.60918		13													**13**
22	Frank Key	25.10609	-80.91138															**0**
23	Gopher Keys, north and south	24.98893	-80.73192		2													**2**
24	Green Mangrove Key	24.92559	-80.78548				1											**1**
25	HanVan, Gibby Point	25.16966	-80.87754															**0**
26	Jim Foot Key	25.06834	-80.79112		2													**2**
27	Jimmie Keys, central	25.04978	-80.64493				6			80								**86**
28	Jimmie Keys, north	25.06596	-80.64272		10	5	2					12						**29**
29	Jimmie Keys, south including First Mate	25.02575	-80.64832		1		1				1				7			**10**
30	Low Key	25.05064	-80.57963	5	5													**10**
31	Manatee Keys	25.06999	-80.61251															**0**
32	Man of War Key	25.03250	-80.91111	15	1													**16**
33	Murray Key	25.10806	-80.93806		4													**4**
34	Nest Keys, north	25.14988	-80.50914															**0**
35	Nest Keys, south	25.13783	-80.50871		1	1	1					22						**25**
36	Oyster Keys	25.10392	-80.95156	1	20	10	2	1	1	6		27		43				**111**
37	Palm Key	25.11226	-80.87861		6	25	5					25						**61**
38	Park Keys, south	25.10854	-80.56482				2					1		17				**20**
39	Park Keys, north	25.12677	-80.56724															**0**
40	Peterson Keys, south	24.90806	-80.73873		6													**6**
41	Pigeon Key	25.05600	-80.51150		10		6			9		15			150			**190**
42	Pollock Keys	25.01750	-80.70333		1													**1**
43	Porjoe Key	25.13777	-80.47305							1		2						**3**
44	Sandy Key	25.03451	-81.01448	1	28	23	1			178		22						**253**
45	Stake Key	25.05936	-80.58583									3						**3**
46	Tern Keys	25.16056	-80.55278							110			15					**125**
47	Triplet Key	25.11862	-80.68025		4													**4**
48	Twin Keys, south	24.96700	-80.74357		1	1	1					2			100			**105**
	Total			**36**	**175**	**119**	**62**	**1**	**11**	**550**	**29**	**193**	**40**	**114**	**282**	**2**	**0**	**1,614**

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SOUTHWEST FLORIDA

The 2018 nesting season represented the 61st consecutive year monitoring the Corkscrew Wood Stork (WOST) colony. In 2018, Audubon Florida monitored five wading bird colonies in Lee and Collier counties. In addition to the colony at Audubon's Corkscrew Swamp Sanctuary (CSS), each of the sites has been used as a WOST colony site at some point in the past decade. The decline in WOST in this region is concurrent with foraging habitat loss (i.e., freshwater wetlands) and deleterious hydrologic impacts across many of the remaining wetlands. Ongoing wetland restoration projects like those in Picayune Strand and the southern Corkscrew Regional Ecosystem Watershed (CREW) provide promise for improving foraging conditions within this region, although understanding and alleviating regional hydrologic stress from changes in land use, increased human population, and water management activities are critical for long-term recovery of southwest Florida's wading birds.

METHODS

Monthly aerial surveys from a fixed-wing aircraft were conducted from December 2017 to June 2018. At each colony location, a digital SLR camera with 70-300 mm lens was used to take a series of overlapping photographs of the colony at an altitude of 500 to 1,000 feet. While WOST were the primary target for these surveys, all light-colored wading birds were counted. For each colony, peak nest counts were reported from the monthly survey with the highest number of nests but few to no branchlings. Reported peak nest counts are conservative as new nests were observed throughout the season.

HYDROLOGY

CSS experienced a record high 76.8 inches of rainfall from June to September 2017 (12.6 inches attributed to Hurricane Irma [September 9 to 11]). This was 41% higher than the wet season rainfall record of 54.4 inches set in 2013 and twice the average wet season rainfall received since 1959 (38.6 inches). Following Hurricane Irma, water levels at the CSS "B" staff gauge peaked at 4.17 feet above ground level (19.26 feet National Geodetic Vertical Datum of 1929 [NGVD29]), the third highest annual peak in CSS 63-year record (record high peaks followed Hurricane Opal in 1995 and Hurricane Donna in 1960). Water Year 2018 (WY2018) monthly dry season rainfall was normal, but bi-weekly recession rates were quite high (5 to 12.2 millimeters per day) from early February until water levels receded below ground at the "B" staff gauge in mid-April.

A visual comparison of hydrologic conditions following Hurricane Donna (September 10, 1960) and Hurricane Irma (September 10, 2017), with both storms making landfall south of Naples and taking similar paths within miles of CSS, provides perspective on how dry season hydrologic conditions have changed in recent decades. Peak water levels and recession rates following the storms were similar (**Figure 15**). Beginning in late December, however, differences became apparent as recession rates were notably higher and annual minimum water levels were notably lower than those seen in WY1961. These observations are consistent with the dramatic reduction in hydroperiods at CSS beginning in 2000 (Clem and Duever 2018), which likely have significant implications for aquatic prey production and may increase the vulnerability of wading bird nests to mammalian predators. The geographic extent of this altered hydrology is unknown as long-term water level data in inland natural areas of southwest Florida are scarce. Record high rainfall in May 2018 (11.7 inches) returned surface water to cypress forest levels by June 1.

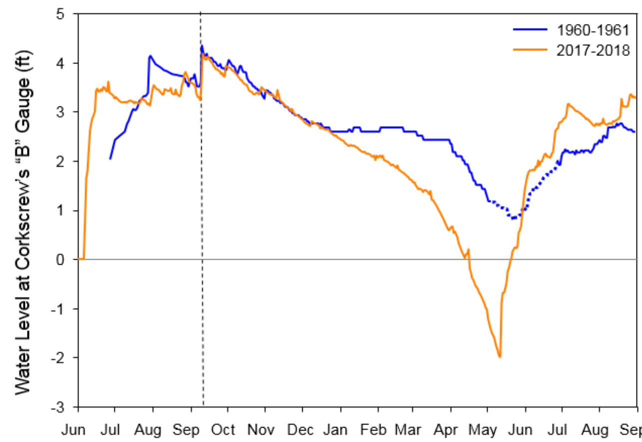

Figure 15. Daily water level at CSS "B" staff gauge in WY1961 (blue) and WY2018 (orange). Zero water level represents ground level at gauge (belowground depths were estimated using a co-located well). Vertical dashed line represents the arrival dates of Hurricanes Donna (September 10, 1960) and Irma (September 10, 2017) in Naples, Florida.

RESULTS

Wading birds in southwest Florida initiated nesting relatively early in the dry season (December to early January), similar to the average date of nest initiation at CSS from 1959 to 1980 (December 16). A total of 1,562 were observed in 2018 (**Table 10**).

Table 10. Peak numbers of wading bird nests at southwest Florida colonies in 2018.

Colony	WOST	GREG	SMWH	SNEG	GBHE	Total
CSS	328	71	117			**516**
Baron Collier 29	299	61	30	11		**401**
Collier Hendry Line						**0**
Lenore Island	473	63	31		21	**588**
Caloosahatchee East		50	3		4	**57**
Total	**1,100**	**245**	**181**	**11**	**25**	**1,562**

Corkscrew Swamp Sanctuary

This was the second consecutive year of WOST nesting at CSS and the fourth successful nesting season in the last 12 years. The last time this colony saw two successive years of nesting was 2005-2006. Nesting initiated in early December 2017, peaked in February, and most WOST fledged by early June. Peak nest effort at CSS included 328 WOST, 71 Great Egret (GREG), and 117 unidentified small white heron (SMWH) nests. Peak WOST nest counts were the highest since 2009 but were only 22% of the annual average from 1957 to 2006 (1,504 nests). The 5-year running average of WOST nesting clearly reflects the precipitous decline in this historically productive colony since the mid-1970s (**Figure 16**). GREG nest counts were higher than any recorded at CSS, although data for this species have only been collected in the past few years.

While hurricanes Donna and Irma were remarkably similar in their timing and immediate impact on southwest Florida water levels, the subsequent nesting seasons were starkly different and illustrate how the region's WOST population has changed during that time. During the nesting season following Hurricane Donna, wading bird nesting initiated in early December and produced 6,000 WOST nests (17,000 chicks fledged). Since then, southwest Florida wetlands have seen substantial changes, including reduction in the extent of short-hydroperiod wetlands, loss of foraging habitat due to development of ranches and agricultural areas, increased vegetation and forestation of wetlands due to wildfire suppression, and increased water management activities. In addition to the loss of foraging area, hydrologic changes in remaining CSS wetlands have caused high recession rates and reduced hydroperiods, which likely affect aquatic fauna productivity and prey accessibility during the nesting season.

Figure 16. Five-year running average of peak WOST nesting effort at CSS colony (1958-2018).

Concurrent with the decline in WOST nesting at CSS since 1960, there has been a shift in the average date of nest initiation and in the frequency of successful nesting (**Figure 17**). From the 1960s to 1990s, WOST nested at CSS nearly every year, but the average date of nest initiation gradually moved from mid-December in the 1960s to early February in the 1990s. Beginning in the 2000s (concurrent with the dramatic change in hydroperiod at CSS), WOST successfully nested less frequently, but the average date of nest initiation was noticeably earlier. Further investigation of these observed trends may shed light on how WOST are responding to regional changes in the landscape and how conservation efforts may aid their recovery.

Barron Collier 29

Nesting initiated at Barron Collier 29 in December 2017. Peak nest effort on March 5 included 299 WOST, 61 GREG, 11 Snowy Egret (SNEG), and 30 SMWH nests. Peak WOST nest counts were 2.7 times the previous 9-year average and 1.7 times the 5-year average. This was the second highest WOST nesting effort recorded at Barron Collier 29 since surveys began in 2009 (13% lower than the peak WOST nest count in 2016). Nearly all wading birds had fledged from the colony by early June, with most WOST fledged by mid-May.

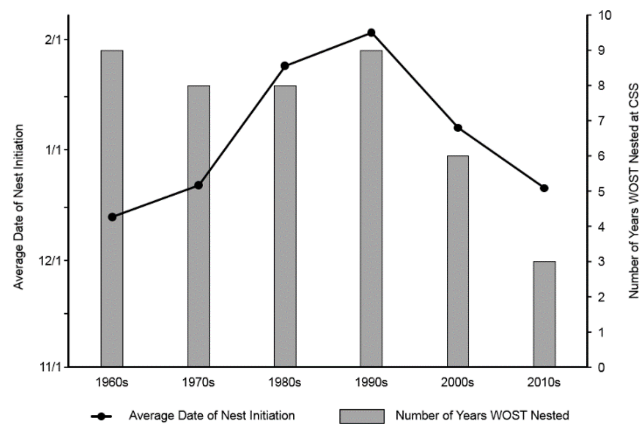

Figure 17. Decadal average of the date of WOST nest initiation (dots) and the number of years per decade that WOST nested (bars) at the CSS colony (1960-2018).

Collier-Hendry Line

Collier-Hendry Line was only surveyed once (on December 10), and no wading bird activity was observed. This colony has only had successful nesting once (2006); a small nesting effort was initiated but failed in 2012.

Lenore Island

WOST nesting initiated at Lenore Island in early January 2018. Peak nest effort at on March 5 included 473 WOST, 63 GREG, 21 Great Blue Heron (GBHE), and 31 SMWH nests. Peak WOST nest counts were 2.4 times the previous 5-year average and 2.8 times the 10-year average. This was the second highest WOST nesting effort recorded at Lenore Island since surveys began in 2006 (5% lower than the peak WOST nest count in 2009). This colony persisted longer than any other southwest Florida colony, with WOST branchlings still present in early June.

Caloosahatchee East

A small nesting effort occurred at Caloosahatchee East in 2018. Peak nest effort on March 5 included 50 GREG, 4 GBHE, and 3 SMWH nests. Nesting initiated in late January, and most chicks had fledged from the colony by late May.

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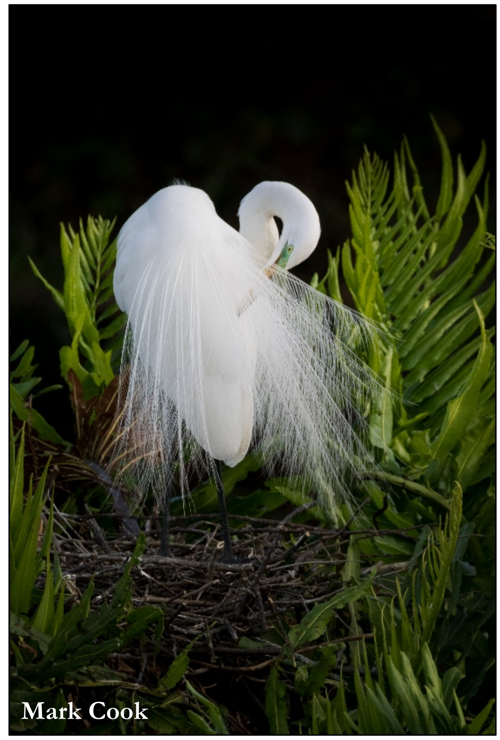
HOLEY LAND AND ROTENBERGER WILDLIFE MANAGEMENT AREAS


Mark Cook

Holey Land Wildlife Management Area supported two small nesting colonies (26.36441, -80.68503; 26.36353, -80.59873). Each colony contained approximately 15 Tricolored Heron (TRHE) and 10 Little Blue Heron (LBHE) nests.

During a rare plant survey in Rotenberger Wildlife Management Area, one wading bird nesting colony (26.388415, -80.828720) was observed. It contained approximately 20 Anhinga (ANHI) nests, 150 Black-crowned Night Heron (BCNH) nests, and 30 Great Egret (GREG) nests.

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

INTRODUCTION

For 11 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 the FDEP's Florida Coastal Office, and J.N. "Ding" Darling National Wildlife Refuge (NWR) have conducted colonial nesting bird surveys within the J.N. "Ding" Darling NWR Complex as well as the Matlacha Pass, Pine Island Sound, Gasparilla Sound-Charlotte Harbor, Cape Haze, and Lemon Bay Aquatic Preserves (**Figure 18**).

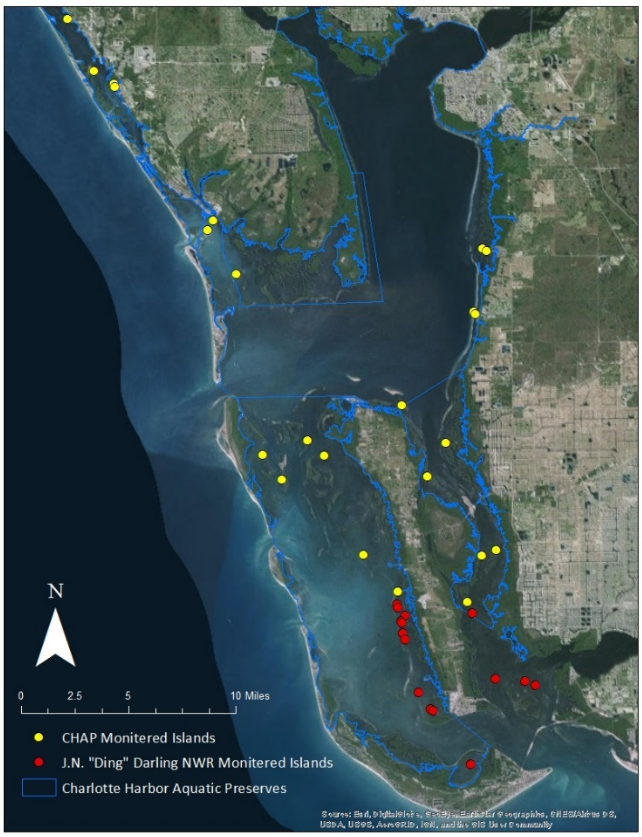

Figure 18. Locations of monitored bird colonies in the Charlotte Harbor Aquatic Preserves and J.N. "Ding" Darling NWR Complex.

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 27 were identified as active wading and diving bird nesting sites. Goals of this continuous study include establishing a long-term data set to assess nesting effort, seasonality, and activity status of known rookeries and new rookeries in the greater Charlotte Harbor area. In 2017, two islands in the study area (Hemp Key and Broken Islands) were designated by the Florida Fish and Wildlife Conservation Commission as Critical Wildlife Areas. The islands were posted as such in September 2018. Hemp Key is closed year-round while Broken Islands is seasonally closed from March 1 through August 31. Both islands are located in Pine Island Sound.

METHODS

The study area was divided between the 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 2018 were analyzed for this report. Peak numbers reflect the highest number per species throughout the survey period. The total number of peak nests also were calculated for each island.

RESULTS

The peak estimate for 15 species of colonial nesting birds from all 38 islands combined was 1,563 nests (**Table 11**). Diving birds constituted 71% of the documented nests, while the remaining 29% were wading bird nests. The largest nesting effort in 2018 occurred on Broken Islands (261 nests), Hemp Key (259 nests), and Pirate Harbor North (131 nests). Broken Islands also supported the greatest species diversity, with 12 species nesting in 2018. The 2018 total peak nest count increased 15.8% from 2017 and was the highest nesting effort in 5 years (**Figure 19**).

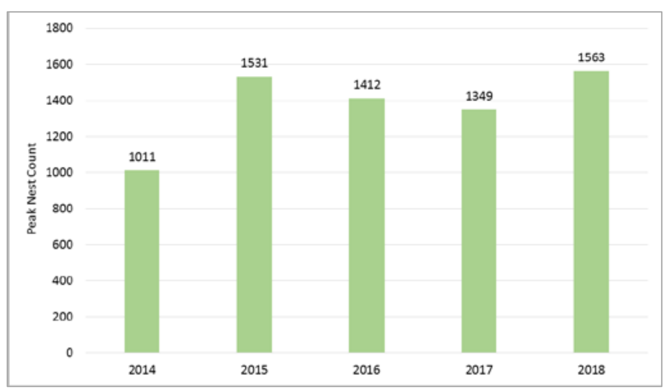

Figure 19. Annual peak nest counts in the study area from 2014 to 2018.

Table 11. Colonial nesting bird peak counts for the CHAP and J.N. "Ding" Darling NWR Complex, February through July 2018.

Colony (Island)	Lat.	Long.	GBHE	TRHE	LBHE	SNEG	GREG	REEG	CAEG	YCNH	BCNH	GRHE	WHIB	BRPE	DCCO	ANHI	ROSP	Total
Bodifer Key	26.4977	-82.1125		1														**1**
Broken Islands	26.6777	-82.1940	2	16	1	2		2	3			2	27	91	110	3	2	**261**
Burnt Store Marina N	26.7625	-82.0669	5	1	5	2	5											**18**
Burnt Store Marina S	26.7611	-82.0660	1							3		2						**6**
Clam Key	26.5063	-82.1128	2	1				1			2	1		17	34	6		**64**
E of Chadwick Cove	26.9289	-82.3511	8			7	13								1			**29**
Fish Hut Island	26.5467	-82.1245		3	1	4	2	2	3	1		1			13	3		**33**
Gasparilla Marina S	26.8269	-82.2625	5	5		12	4		1			1		22	46	1		**97**
Hemp Key	26.5999	-82.1532	12	1			18			1	1			94	132			**259**
N of Mason Island	26.5666	-82.0749	2	1								1			11	3		**18**
N of York Island	26.4945	-82.1043	1	3	4	1	3							31	2	5		**50**
N Regla	26.5422	-82.1227	1															**1**
N of Big Smokehouse	26.0000	-82.1225										2			3			**5**
NE of York Island	26.4940	-82.1021	1	3	1	2								16		3		**26**
NW of Mason Island	26.5543	-82.1251	1												12	1		**14**
NW of Pumpkin Key	26.5660	-82.1279	1							1					2	1		**5**
Oyster Creek W	26.8181	-82.3359	12				2							44	22		1	**81**
Pirate Harbor N	26.8052	-82.0597	6	1		7	15	1	7		1			68	20	5		**131**
Pirate Harbor SE	26.8037	-82.0565	4	7		3	1		20		1			5	22			**63**
Royal Palm Marina	26.9640	-82.3708	12															**12**
Skimmer Island	26.5104	-82.0250	3	8	3	9	4	1	1		3	1	14	40	23			**110**
SW of Mason Island	26.5534	-82.1250													2			**2**
SW of Pumpkin Key	26.5640	-82.1275	1				1		2		1			9	12	1		**27**
Tarpon Bay Keys	26.4577	-82.0744	10	4	2	2	15				3			17	20	2		**75**
Upper Bird Island	26.5592	-82.0714	4								1			5	11			**21**
Useppa Oyster Bar	26.6513	-82.2134	2											53	51			**106**
White Pelican Island	26.7905	-82.2463	7			17	6	4	1	1	4				8			**48**
Total			**103**	**55**	**17**	**68**	**89**	**11**	**38**	**7**	**17**	**11**	**41**	**512**	**557**	**34**	**3**	**1,563**

Note: Nesting birds were not observed at the following colonies (islands): Bird Keys, Bird Rookery Keys, Cork Island, Crescent Island, Darling Keys, Dog Island, Givney Key, Little Oyster Creek, Lumpkin Island, Lower Bird Island, and Masters Landing.

Species Summaries – Diving Birds

Double-crested Cormorant (DCCO)

The peak nest count for DCCO was 557 nests, which is approximately 36% of the total peak nest count for all species in 2018. This is a 3.5% decrease from the peak count in 2017. DCCO nesting was documented on 21 islands, with the highest nest count (132 nests) occurring at Hemp Key in June.

Brown Pelican (BRPE)

BRPE nesting peaked at 512 nests and was documented on 14 islands. This accounted for approximately 33% of the nesting effort for all species this season. The BRPE peak nest count increased approximately 22% compared to the 2017 season. The highest peak count (94 nests) occurred at Hemp Key in April.

Anhinga (ANHI)

ANHI nested on 12 islands in 2018, with a peak nest count of 34 nests. This was a 79% increase from the 2017 season. The highest count was six nests on Clam Key.

Species Summaries – Wading Birds

Great Blue Heron (GBHE)

The peak nest count for GBHE was 103 nests, with nesting occurring on 23 islands. Hemp Key, Royal Palm Marina West, and Oyster Creek West had the highest peak counts (12 nests each).

Tricolored Heron (TRHE)

TRHE nests were documented on 14 islands, with a peak count of 55 nests. The highest peak nesting effort (16 nests) occurred at Broken Islands.

Little Blue Heron (LBHE)

LBHE nesting peaked at 17 nests for the 2018 season. Nests were documented on 7 of the 38 islands surveyed. The highest nest count was five nests at Burnt Store Marina North.

Snowy Egret (SNEG)

SNEG nesting occurred on 12 islands, with a peak count of 68 nests. This was an 89% increase compared to the 2017 season, which had a peak count of 36 nests.

Great Egret (GREG)

GREG nesting peaked at 89 nests. This was a 68% increase from the peak count of 53 nests during the 2017 season. The highest GREG nesting effort was documented at Hemp Key (18 nests) followed by Pirate Harbor North and Tarpon Bay Keys (15 nests each).

Reddish Egret (REEG)

REEG nested on 6 islands, with a peak nest count of 11 nests. REEG nesting effort in the study area was reported to Florida Audubon to support statewide survey efforts.

Yellow-crowned Night Heron (YCNH)

A peak of seven YCNH nests were recorded during the 2018 season. Three of the nests were observed at Burnt Store Marina South.

Black-crowned Night Heron (BCNH)

BCNH nesting was documented on 9 islands and peaked at 17 nests. This was a significant increase from the peak nest count of 6 nests in 2017.

Green Heron (GRHE)

GRHE nesting peaked at 11 nests and occurred on 8 islands. This was an 83% increase from the peak nest count of 6 nests in 2017.

White Ibis (WHIB)

WHIB nesting occurred on 2 islands and peaked at 41 nests. Broken Islands accounted for 27 nests, while the remaining 14 nests were documented on Skimmer Island.

Cattle Egret (CAEG)

CAEG nesting peaked at 38 nests, with 20 nests documented at Pirate Harbor SE in May.

Roseate Spoonbill (ROSP)

Three ROSP nests were documented this season. Two nests were at Broken Islands and one nest was at Oyster Creek West. This was the first documentation of ROSP nesting in the study area.

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

Designated in 1966, Estero Bay Aquatic Preserve (EBAP) was Florida's first aquatic preserve. EBAP is a field site of the Florida Department of Environmental Protection managed by the Florida Coastal Office. The colonial nesting, wading, and diving bird monitoring and protection program began in 2008 at 15 islands and since has expanded to 32 islands, 25 of which are active nesting sites. Three islands (Hurricane Pass/Rebecca's Island, Little Davis Key, and Taryn's Key) were added before the 2017-2018 nesting season, and four islands (Big Carlos Pass between M-46 and M-48, Chain of Islands, Kelsey's Island, and North Coconut M-2) were added as they were discovered during the 2017-2018 breeding season

Historically, the highest concentration of wading and diving bird nesting activity has been observed on three islands: Matanzas, Coconut Point East, and Big Carlos Pass West of M-52. These islands are now designated as Critical Wildlife Areas (CWAs) and were marked in February 2018.

The objectives of this program are as follows:

- Provide peak estimates of nesting effort for each species of colonial nesting bird;
- Monitor population trends;
- Record movement of colonies, human disturbance, and bird fatalities due to fishing line entanglement;
- Reduce the number of entanglements and fatalities due to fishing line and trash within the bay; and
- Provide recommendations for the management of nesting wading and diving bird colonies in the EBAP.

METHODS

Between 2008 and 2018, surveys were conducted monthly throughout the nesting season. Since 2012, surveys have been conducted year-round due to the extended period of nesting. Employing a direct count method, two observers surveyed each island by boat from a distance of 30 to 45 meters, with a third person recording the data for each nest's species and stage (Audubon of Florida 2004). The primary observer—an EBAP staff member—was consistent throughout the study period between 2008 and 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. Peak nest counts from 2018 were compared with mean peak nest counts from 2008 through 2017, which represent the 10-year average for nesting effort in EBAP.

RESULTS

The peak nesting effort for wading and diving birds was 686 nests (**Table 12**). April marked the height of nesting season in EBAP with an estimated 423 active nests. The Matanzas Pass colony, with an annual peak of 209 nests, supported the greatest number of nests in the bay. Overall, nesting effort increased 66% compared to the 10-year average (**Table 13**). All species-specific increases or decreases in nesting effort are compared to the 10-year average.

Double-crested Cormorant (DCCO) nests were documented on seven islands; nesting activity peaked in May (n = 66 nests). DCCO peak nesting numbers for 2018 (n = 96 nests) increased 42% relative to the 10-year average.

Brown Pelican (BRPE) nests were documented on four islands. Nesting peaked in April (n = 168 nests), with a season peak of 178 active nests, a 61% increase relative to the 10-year average.

Great Blue Heron (GBHE) nests were documented on 17 islands. Nesting effort peaked in January (n = 62 nests), with a season peak of 80 nests, an 18% increase relative to the 10-year average. White morphs were documented on three nests at two nesting colonies.

Great Egret (GREG) nests were documented on eight islands. Nesting peaked in April (n = 87 nests), and the annual peak was 117 nests, a 134% increase in nesting effort relative to the 10-year average.

Snowy Egret (SNEG) nests were documented on six islands, with peak nest counts in June (n = 35 nests). SNEG had an annual peak nest count of 48 nests, a 78% increase relative to the 10-year average.

Little Blue Heron (LBHE) nests were documented on five islands, with peak nest counts in August (n = 20 nests). LBHE had a peak estimate of 20 nests, a 43% increase in nesting effort relative to the 10-year average.

Tricolored Heron (TRHE) nests were documented on six islands. Peak nesting effort occurred in August (n = 57 nests). The annual peak (n = 63 nests) represented a 103% increase in nesting effort relative to the 10-year average.

Reddish Egret (REEG) nests were documented on four islands, with peak nesting effort in February (n = 5 nests). The annual peak nest count (n = 9 nests) represents a 29% increase relative to the 10-year average.

Table 12. Peak nest counts documented in Estero Bay Aquatic Preserve colonies, January through August 2018.

Colony	Latitude	Longitude	DCCO	ANHI	BRPE	GBHE	GREG	SNEG	LBHE	TRHE	REEG	CAEG	BCNH	YCNH	GRHE	ROSP	WHIB	Total
619038c	26.36737	-81.84357				1								1				**2**
Big Bird Island	26.38286	-81.84995				2												**2**
Big Carlos Pass between M-50 and M-52	26.43155	-81.90066	11			7	1							6				**25**
Big Carlos Pass M-43	26.42771	-81.90050													3			**3**
Big Carlos Pass M-48	26.42672	-81.89852													1			**1**
Big Carlos Pass between M-46 and M-48	26.42926	-81.90137											1					**1**
Big Carlos Pass W of M-52	26.42469	-81.89359	11		52	2	51	6	2	18	2	1	10					**155**
Big Hickory E of M-85	26.35315	-81.84164	19	1		17	4	1		2	2		4					**50**
Coconut Point East	26.38411	-81.84905	23	1	16	3	21	5	1	2	1		3					**76**
Coconut Point West	26.38111	-81.84976				6												**6**
Chain of Islands	26.43803	-81.86937													1			**1**
Denegre Key	26.43772	-81.86728	2			8	1	1	1	4			8	1				**26**
Estero River M-30	26.43029	-81.86113													1			**1**
Estero River North	26.43653	-81.86091												4				**4**
Estero River South	26.43416	-81.86211												1				**1**
Hogue Channel M-78	26.34988	-81.84644												3				**3**
Hurricane Pass/ Rebecca's Island	26.46812	-81.95352				3								1		1		**5**
Matanzas Pass	26.46092	-81.95717	21		77	11	19	21	14	30	4	3	7				2	**209**
Little Davis Key	26.39682	-81.86441				1												**1**
Kelsey's Island	26.40498	-81.86449				3												**3**
North Coconut M-2	26.40572	-81.86338				8												**8**
North Coconut E of M-3	26.41131	-81.85486				1	5	14	2	7			9					**38**
North Coconut M-4	26.40737	-81.85998	9		33	5	15											**62**
Ruth's Island	26.40783	-81.85302				1							1					**2**
Taryn's Key	26.41069	-81.85412				1												**1**
Total			**96**	**2**	**178**	**80**	**117**	**48**	**20**	**63**	**9**	**4**	**43**	**17**	**6**	**1**	**2**	**686**

Note: Nests were not observed (count = 0) in the following colonies: Big Carlos Pass S of M-48, Big Carlos Pass W of M-46, Big Hickory M-83 Seagrass Island, Big Hickory M-49 2NW, Big Hickory M-49 3NW, New Pass M-21, and New Pass M-9.

Table 13. Mean peak nest count (2008 to 2017), standard error, current (2018) peak nest count, and percent mean difference by species.

Species	Mean (2008-2017)	Standard Error	Peak (2018)	Percent Change
DCCO	68	6	96	42
ANHI*	0	0	2	N/A
BRPE	111	14	178	61
GBHE	68	6	80	18
GREG	50	7	117	134
SNEG	27	4	48	78
LBHE	14	2	20	43
TRHE	31	5	63	103
REEG	7	1	9	29
CAEG	1	1	4	300
BCNH	13	2	43	231
YCNH	19	3	17	-11
GRHE	6	1	6	0
ROSP**	1	N/A	1	0
WHIB*	0	N/A	2	N/A
Total	**414**	**20**	**686**	**66**

* Percent change could not be calculated for ANHI and WHIB as nesting data were not previously recorded for these species.
** ROSP data were compared to 2017 data, not against the 10-year average.

Black-crowned Night Heron (BCNH) nests were documented on eight islands, with peak nesting effort occurring in July (n = 29 nests) and an annual peak of 43 nests, a 231% increase relative to the 10-year average.

Yellow-crowned Night Heron (YCNH) nesting was documented on seven islands, with peak nesting in April (n = 13 nests). The annual peak nest count was 17 nests, an 11% decrease in nesting effort relative to the 10-year average.

Green Heron (GRHE) nests were documented on four islands, with peak nesting effort in June (n = 4 nests). The annual peak was six nests. GRHE nesting activity was the same as the 10-year average.

Cattle Egret (CAEG) nesting was documented on two islands, with peak nest counts in April and July (n = 3 nests). The annual peak of four nests represents a 300% increase in CAEG nesting relative to the 10-year average.

A single Roseate Spoonbill (ROSP) nest was documented on one island in May. This is the second recorded ROSP nest in EBAP.

Anhinga (ANHI) nesting was documented on two islands, with a peak nesting effort of two nests. These are the first recorded ANHI nests in EBAP.

White Ibis (WHIB) nesting was documented on one island, with a peak nesting effort of two nests. These are the first recorded WHIB nests in EBAP.

Between January and August 2018, volunteers contributed 409 hours of service to monitoring and protecting wading and diving bird colonies in EBAP. Staff and volunteers removed 100 feet of fishing line and 7 hooks from nesting islands during this time period. (Large-scale cleanups of the islands are conducted after nesting season to minimize disturbance to colonies.) Seventeen bird fatalities (1 SNEG, 1 TRHE, 1 ROSP, 1 ANHI, 10 BRPE, and 3 unknown species) due to fishing line entanglement were documented.

Discussion

Many mangrove islands in EBAP were negatively impacted by Hurricane Irma. Nesting effort at several rookeries, including Coconut East, Estero River M-30, and New Pass M-9, declined from last year, possibly due to reduced vegetation or canopy loss. In December, four GBHE pairs and one ROSP pair began nesting on Coconut East. In January, three GBHE nests were still active but the ROSP nest was empty. By February, the remaining GBHE nests had been abandoned. Neither species re-nested on Coconut East for the 2018 season.

EBAP nesting activity exhibits annual variation. Despite the hurricane damage, the annual peak nest count this season was greater than the 10-year average and maximum. The overall trend expresses, for the first time, an increase in peak nest counts (**Figure 20**). Four out of five canopy-nesting species (DCCO, GBHE, GREG, and BRPE) showed improvement in nesting activity in 2018 compared to the 10-year average. For the first time on record, two pairs of ANHI nested on two islands in EBAP.

Six out of 10 interior-nesting species (SNEG, TRHE, LBHE, REEG, BCNH, and CAEG) showed a rise in nesting activity for 2018. However, YCNH exhibited a slight decline in nesting activity, and GRHE displayed no change in nesting activity compared to the 10-year average. For the first time on record, two pairs of WHIB nested on one island in EBAP. ROSP nesting activity was recorded for the second successive year in EBAP, but nesting occurred on a different island than last year. The pair successfully produced three chicks.

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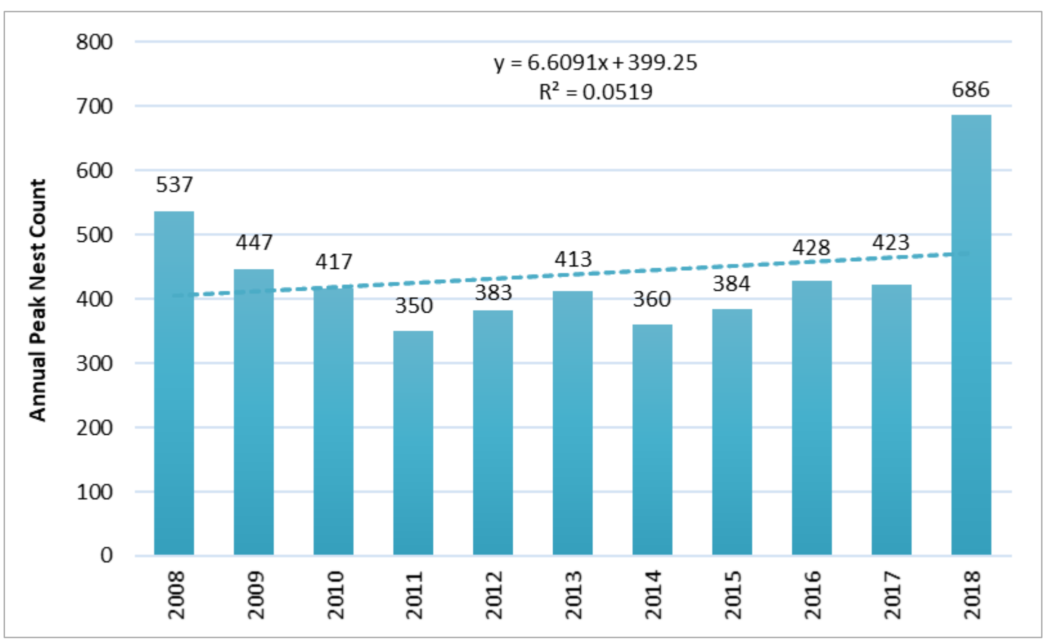

Figure 20. Annual peak nest counts in Estero Bay Aquatic Preserve from 2008 to 2018.

CORKSCREW REGIONAL ECOSYSTEM WATERSHED MANAGEMENT AREA

In 2018, the Florida Fish and Wildlife Conservation Commission monitored seven wading bird nesting colonies in and around 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 identified with the goal of monitoring long-term trends in activity.

METHODS

Monthly systematic aerial surveys of CREW and Corkscrew Swamp Sanctuary covering 170 km² (41,910 acres), were conducted in a Robinson R66 helicopter from January through July 2018. Transects spaced 1.48 kilometers (0.8 nautical miles) apart and oriented northeast to southwest (**Figure 21**) were flown at an altitude of 244 meters (800 feet). Once a colony was located, flight altitude was reduced to 152 meters (500 feet) for non-Wood Stork (WOST) nests or 305 meters (1,000 feet) for WOST nests, GPS coordinates were recorded, and digital photographs were taken using a Canon EOS 7D with a 70-300 mm lens with image stabilization. Photographs were used to count individuals and nests, and each photograph was digitally marked using Adobe® Photoshop Elements 15 to avoid double-counting. Peak nest numbers (the highest nest count for the season) were reported within each colony.

HYDROLOGY

Southwest Florida experienced higher than average rainfall from May through October 2017 due to record rainfall in June, a tropical storm in late August, and Hurricane Irma (Category 3) on September 10, 2017. Stage data indicated the rainy season water level peaked on September 11, 2017 after Hurricane Irma impacted southwest Florida. Water then receded through April 17, 2018. CREW experienced lower than average rainfall from November 2017 through April 2018 (-1.09 inches below normal). Drier than normal conditions persisted until May 20, 2018 (Corkscrew Swamp Sanctuary Lettuce Lake staff gauge; 26.375582, -81.603836) when the rainy season began.

RESULTS AND DISCUSSION

Seven nesting colonies were monitored, including two WOST subcolonies. The combined peak nest number of 939 nests was a 5% increase from 2017. Overall, there was a declining trend in peak nest numbers for the three consistently monitored colonies (Orange Groves, Sod Farms, and Cypress East).

WOST Subcolonies

In 2018, WOST nested in two sub-colonies in the Corkscrew Swamp Sanctuary with a combined peak nest number of 264 nests. WOST nest initiation was estimated to have occurred between early and mid-December for both subcolonies, and nestlings were observed in both subcolonies during the first flight on January 12. Few birds nested in WOST Subcolony 1 (5 nests). WOST Subcolony 3 supported a peak of 259 WOST nests and 400 Great Egret (GREG) nests, the largest total peak counts within the last 6 years. It is unclear why such large numbers of GREG nested in this subcolony; it may be related to altered nesting habitat elsewhere due to Hurricane Irma. Unlike 2017, the WOST subcolonies did not show a marked decline in nesting effort throughout the 2018 nesting season.

Orange Grove

The peak nest number for the Orange Grove colony was 71 nests, a 49% increase from 2017 (**Table 14**). GREG nesting effort rebounded in 2018 to its highest level since surveys began 6 years ago. Nesting was first observed on February 7, which is early compared to last year when birds did not nest until April. Five species nested in the colony this year, an increase from two species in 2017.

The Orange Grove colony is located on an island in a retention pond at the Alico-owned orange grove. Birds nested in Brazilian pepper trees surrounded by Peruvian primrose willow.

Sod Farms

The peak count for the Sod Farms colony was 46 nests, a 52% reduction from 2017 and an 89% reduction from its peak in 2015 (**Table 14**). The nesting substrate at this colony was heavily impacted by Hurricane Irma. Much of the Carolina willow and Brazilian pepper were flattened because of the hurricane. Only small herons such as Tricolored Herons (TRHE) nested at this colony in 2018. Birds began nesting in April and continued through June.

Cypress East

No wading birds were recorded nesting in the Cypress East colony in 2018. This is the first time in 6 years that no birds have nested in the colony. It is unclear why wading birds did not nest in Cypress East this year.

Corkscrew Swamp Sanctuary GREG

The peak count for the Corkscrew Swamp Sanctuary GREG colony in 2018 was four nests, a 90% decline from last year. While the colony also experienced low species richness, Great Blue Heron (GBHE) and Anhinga (ANHI) nests were recorded here for the first time (**Table 14**). This colony is located on the perimeter of a cypress dome in bald cypress trees.

Corkscrew Swamp Sanctuary Small White

The Corkscrew Swamp Sanctuary Small White colony had a peak count of 94 nests, a 33% decline from last year. Nesting began in April and primarily consisted of Cattle Egrets (CAEG), along with ANHI, GREG, and Little Blue Herons (LBHE) (**Table 14**). The number of nesting species (four species) has declined since its peak in 2016 (seven species). The primary nesting substrate at this colony is Carolina willow, interspersed Brazilian pepper and red maple trees.

Foraging and Roosting Effort

In addition to nesting colonies, 112 foraging aggregations and 51 roosting colonies were located (**Figure 21**). White Ibis (WHIB; n = 5,846), GREG (n = 2,070), Snowy Egret (SNEG; n = 921), WOST (n = 543), Glossy Ibis (GLIB; n = 529), and Roseate Spoonbill (ROSP; n = 139) were the most abundant species observed in foraging aggregations. WHIB and GREG were present in 71% and 75% of the foraging aggregations, respectively. WHIB (observed in 55% of all roosting colonies) and GREG (observed in 23% of all roosting colonies) were the most common species present in roosting colonies. Other species foraging or roosting in CREW included WOST, ROSP, LBHE, BCNH, TRHE, and Yellow-crowned Night Heron (YCNH).

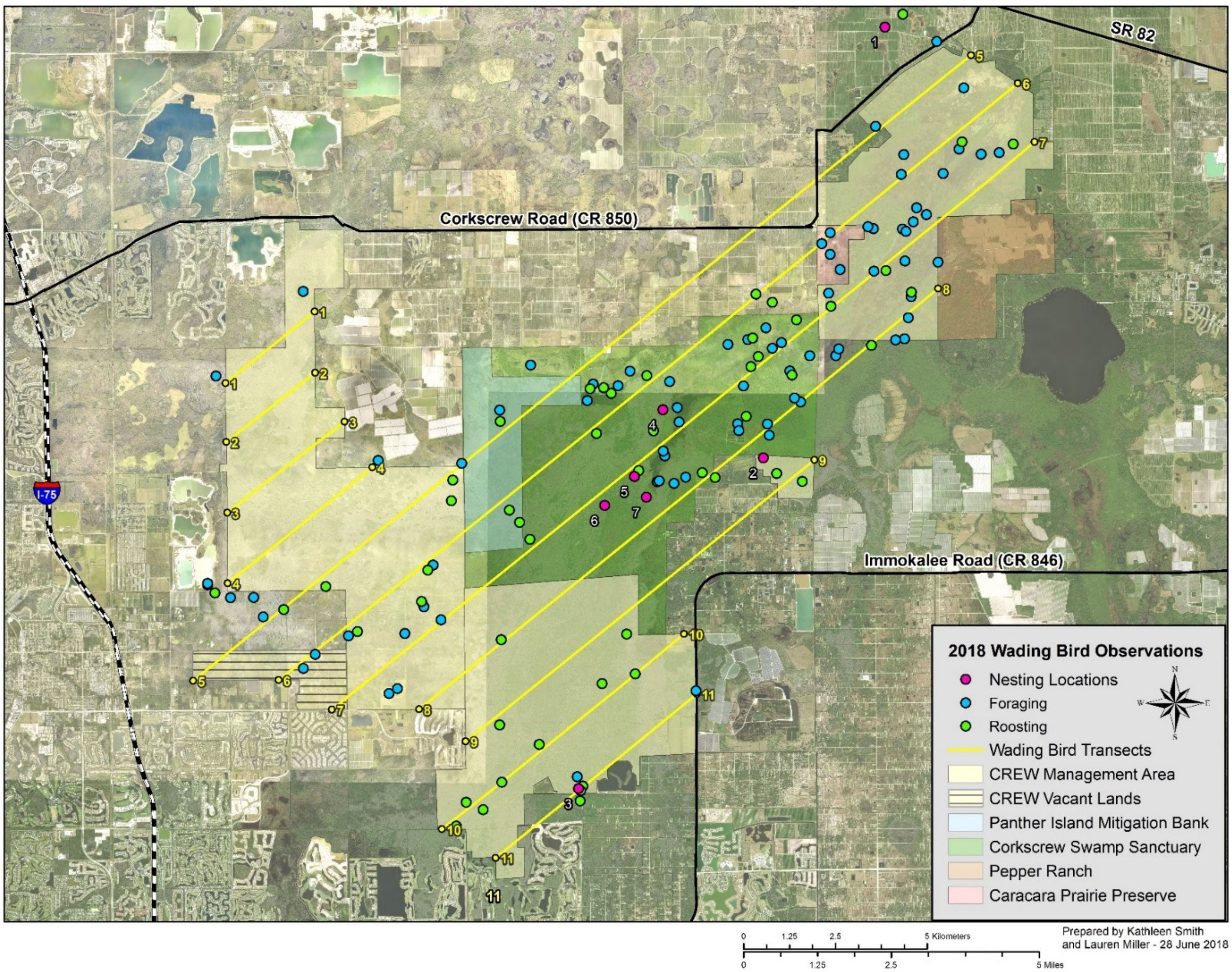

Figure 21. Locations of nesting, foraging, and roosting wading birds in and around CREW Management Area and Corkscrew Swamp Sanctuary, January 2018 through July 2018. Colony 1 is Orange Grove, Colony 2 is Sod Farms, Colony 3 is BRS ANHI, Colony 4 is Corkscrew Swamp Sanctuary GREG, Colony 5 is Corkscrew Swamp Sanctuary Small White, Colony 6 is WOST Subcolony 1, Colony 7 is WOST Subcolony 3.

Table 14. Peak number of wading bird nests at the CREW Management Area and Corkscrew Swamp Sanctuary, 2013 to 2018.

Colony	Latitude	Longitude	Year	WOST	GREG	SNEG	CAEG	ROSP	WHIB	BCNH	GBHE	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**
			2018		57	6							1	2	5					**71**
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**
			2018			7	8						5	17				3	6	**46**
3	26.31293	-81.62713	2018												7					**7**
4	26.40473	-81.59860	2014		2															**2**
	26.40913	-81.60583	2016		61										1					**62**
	26.40611	-81.60460	2017*		30										10					**40**
			2018								3				1					**4**
5	26.38971	-81.61227	2014				1													**1**
			2016	1	1	4	126	1		13		4	2	12	8			2		**174**
			2017			3	116			5				7	3			8		**142**
	26.40611	-81.60460	2018		2		77							1	5			5	4	**94**
6	26.38156	-81.61930	2014	37					13											**50**
	26.38254	-81.62037	2017*	57																**57**
			2018	5																**5**
7	26.38161	-81.60862	2014	73	5															**78**
	26.38462	-81.60901	2017*	20																**20**
			2018	259	400			1							2	50				**712**

Colony 1 = Orange Grove, owned by Alico; Colony 2 = Sod Farms, owned by CREW Management Area; Colony 3 = BRS ANHI, owned by CREW Management Area; 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.
* 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.

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ROOKERY BAY NATIONAL ESTUARINE RESEARCH RESERVE

Staff at the Rookery Bay National Estuarine Research Reserve surveyed three wading bird colonies within the ABC Islands Critical Wildlife Area (CWA; surveyed in collaboration with Florida Fish and Wildlife Conservation Commission) and one colony at Curcie Lake. Counts were conducted by circling each island by boat.

The Rookery Islands CWA is located in Rookery Bay, north of Marco Island. Three islands support nesting in the CWA (Island 2: 26.028584, -81.742763; Island 1: 26.031425, -81.745141; Island 0: 26.034497, -81.754245). The islands are primarily composed of red mangrove (*Rhizophora mangle*) and are closed to public access year-round to protect nesting, migratory, and wintering birds.

Curcie Lake is a manmade lake that contains numerous mangrove islands. This colony was first discovered by Rookery Bay National Estuarine Research Reserve staff late in the 2018 nesting season.

RESULTS

The only active nesting island in Rookery Islands CWA was Island 1, with a total of four Great Egret (GREG) nests.

Curcie Lake monitoring began relatively late in the breeding season (June 2018) due to its recent discovery, and only limited data are available (**Table 15**). The surveys in 2018 were primarily used to develop an appropriate monitoring technique for the colony.

Table 15. Total nesting effort for Rookery Islands CWA and Curcie Lake, with peak number of nests observed.

Colony	Latitude	Longitude	ANHI	BCNH	CAEG	DCCO	GLIB	GRHE	GREG	LBHE	SNEG	TRHE	WHIB
Rookery Islands CWA	26.03143	-81.7451							4				
Curcie Lake	25.99495	-81.6288	74	39	100	1	31	15	11	19	35	74	359
	Total		**74**	**39**	**100**	**1**	**31**	**15**	**15**	**19**	**35**	**74**	**359**

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WADING BIRD NESTING AT LAKE OKEECHOBEE

Since 2005, Florida Atlantic University (FAU) has been monitoring the timing, size, and location of wading bird colonies at Lake Okeechobee as part of the Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment Plan (MAP). In 2018, three focal species: Great Egret (GREG), Snowy Egret (SNEG), and White Ibis (WHIB), initiated an estimated 4,149 nests; this is 13% higher than the average since 2008 when the current Lake Okeechobee Regulation Schedule went into effect (**Table 16**). The increase in nesting was driven by WHIB and GREG (34% and 33% above the peak monthly nesting effort average since 2008, respectively). In contrast, SNEG nest abundance was 14% lower than average. The Moore Haven (2,400 nests) and Eagle Bay Island (500 nests) colonies supported the largest number of nests of these species.

METHODS

FAU personnel monitored the location, timing, and number of clutch initiations of wading bird nesting colonies on the lake from February to June 2018. Systematic aerial surveys were conducted monthly along transects covering the lake's littoral zone, with two dedicated observers surveying for nests of the five focal species: SNEG, GREG, WHIB, Wood Stork (WOST), and Roseate Spoonbill (ROSP). Counts and species composition of large colonies were verified by airboat. Estimates of nest initiation dates were based on nest monitoring by boat at two colonies on spoil islands and two naturally occurring willow colonies. 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 (SFWMD) 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 represent the lake levels under the current Lake Okeechobee Regulation Schedule.

RESULTS

Hydrology

During the 2018 nesting season, Lake Okeechobee was characterized by moderate stage levels and a recession rate that was relatively fast and virtually uninterrupted. There were two distinct hydrologic periods, distinguished by an increase in recession rate on March 3 (**Figure 22**). From January 1 to March 2, the mean recession rate was 0.93 inches per week and from March 3 to May 12, the mean recession rate was 2.3 inches per week. On May 12, the lake stage receded to 12.83 feet, the lowest depth of the season. This was 5.5 inches higher than the average lake stage since 2008 and 15.6 inches lower than the average from 1977 to 2007. There was a 2-day reversal in the drying pattern (0.24-inch rise in stage per day) from April 23 to 24, but otherwise no major disruption of the drying pattern.

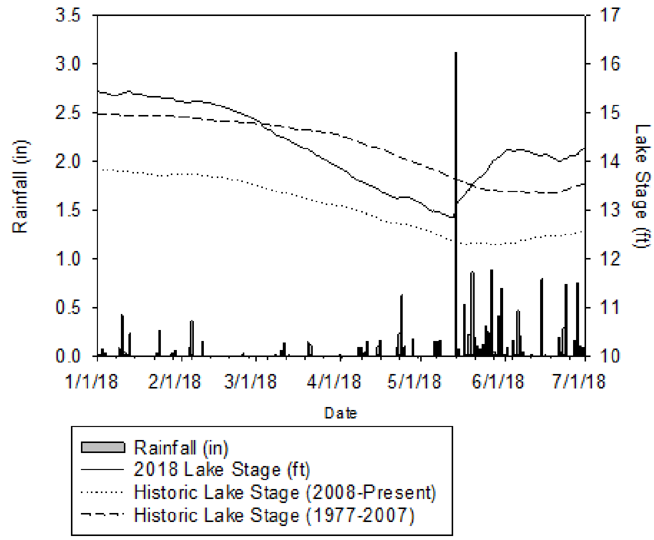

Figure 22. Hydrologic patterns in Lake Okeechobee from January to July 2018, and mean lake stages from 1977 to 2007 and from 2008 to present (i.e., since the 2008 Lake Okeechobee Regulation Schedule has been implemented).

Colony Location and Size

Sixteen colonies (**Figure 23**) supported a total of 4,995 nests of GREG, SNEG, and WHIB. This is 13% higher than the average since 2008 (3,666 ± 1,920 nests; all averages use standard deviation [SD]; **Table 16**). Colonies were located at 10 natural willow colonies in the marsh (Liberty Point; Liberty Point 2; Moore Haven; Moore Haven East 2, 3, and 4; Moonshine Bay 1, 2 and 3; and Eagle Bay Island), four created spoil islands (Little Bear Beach, Clewiston Spit, Bird Island, and Pahokee Airport), and two off-lake created islands (Lakeport Marina and the Gator Farm). Moore Haven was the largest colony, supporting 450 GREG, 750 SNEG, 1,200 WHIB, and 25 Tricolored Heron (TRHE) nests (**Table 17**). Monthly peak nest abundance was 1,370 WHIB, 1,751 GREG, and 1,028 SNEG nests (**Table 16**). WHIB, GREG, and SNEG nest abundance was 34% higher, 33% higher, and 14% lower, respectively, than the average since 2008 (1,305 ± 854 WHIB nests; 769 ± 492 GREG nests; 1,592 ± 1,062 SNEG nests). The average abundance of GREG, SNEG, and WHIB nests on the lake was higher under the current lake regulation schedule as estimated from peak monthly abundance (3,666 ± 1,920 nests) compared to 1977 to 2007 (2,601 ± 2,364 nests). GREG abundance has remained relatively constant, whereas SNEG and WHIB nest abundance has increased, suggesting conditions in the littoral marsh have improved recently.

Timing and Success

The median clutch initiation date was February 23 for GREG and March 25 for SNEG. This was 33 days earlier for GREG and 11 days earlier for SNEG than the average since 2009, the period for which nest initiation and survival data are available. Overall apparent nest survival of GREG (67%) and small herons (72%) was the same as the average overall apparent survival since 2011.

Figure 23. Map of wading bird colonies detected on Lake Okeechobee from February to June 2018.

Wood Storks and Roseate Spoonbills

Sixty WOST nests and six ROSP nests were detected at the Gator Farm, an off-lake colony north of the Moonshine Bay area. Approximately 50 fledgling WOST were detected from photographs taken on May 9, but this is a conservative estimate given approximately 30 nests were not sufficiently visible from the photographs. WOST have nested at the Gator Farm in 7 of the last 12 years (2007 to 2010 and 2016 to 2018), successfully fledging chicks every year nesting occurred. Although nest numbers are small, it appears WOST and ROSP are now part of the lake wading bird community.

Table 16. Timing and nest numbers for species breeding in wading bird colonies at Lake Okeechobee in 2018.

Month	GREG	GBHE	WHIB	SNEG	LBHE	TRHE	WOST	GLIB	ROSP	CAEG	ANHI
February	545			686	4	155	90[a]		3		11
March	**1,028**	4	1201[a]	**1,370**	5	230	**60**	2	3		4
April	882[b]	**9**	**1,751**	1,105	16	**300**	**60**	77	**6**	144	**37**
May	772[b]	3	937	1,197[b]	**63**	152	**60**	**241**	**6**	450	31
June	166[b]		600	994[b]		+	5	+	1	**1,540**	+

[a] Nest numbers are likely overestimated due to pre-nesting activity.
[b] Nest numbers are likely overestimated due to the presence of fledglings.
+ Species present and nesting but unable to determine number of nests.
Note: Bold values denote peak nest effort for species.

Table 17. Geographic coordinates (NAD83) and species-specific peak nest efforts in observed colonies during the 2018 breeding season at Lake Okeechobee.

Colony	Peak Month[1,2]	Latitude	Longitude	GREG	WHIB	SNEG	WOST	ROSP	GBHE	LBHE	TRHE	GLIB	CAEG	ANHI	Total[1]
Bird Island	April	26.97199	-81.00917								14				**14**
Clewiston Spit	April	26.77573	-80.90938	60	1	220					189	15	3	2	**485**
Eagle Bay Island	May	27.17064	-80.84643	100	250	150			6	4	25	50	500	2	**585**
Gator Farm	April	27.023004	-81.061103	100		100	90	6		50	20		450		**366**
Lakeport Marina	March	26.9726	-81.1144	100		15				1	3		340	2	**119**
Liberty Point	March	26.82562	-81.01068	120		20				1			50		**141**
Liberty Point 2	April	26.817518	-80.99675	20											**20**
Little Bear Beach	March	26.72139	-80.84222	60		200			4	4	100	10	3	4	**378**
Moonshine Bay 1	May	26.91321	-81.02956			42				1	15				**58**
Moonshine Bay 2	April	26.922267	-81.02969		1	100			1	10	44			20	**156**
Moonshine Bay 3	May	26.928044	-81.034227	80	40	90			1		1	2		13	**214**
Moore Haven	March	26.886412	-81.096436	450	1,200	750					25		200	7	**2,425**
Moore Haven East 2	April	26.883044	-81.050762	2	350	50					25				**427**
Moore Haven East 3	March	26.86238	-81.00704	3											**3**
Moore Haven East 4	April	26.892645	-81.050998	21	200	40									**261**
Pahokee Airport	April	26.77908	-80.697596			60							40		**60**
	Total			**1,116**	**2,042**	**1,837**	**90**	**6**	**12**	**71**	**461**	**77**	**1,586**	**50**	**5,712**

[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.

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 the system supported an abundant and diverse bird assemblage, with several recurring breeding colonies of greater 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 total project area) has been partially restored, and the interim response of foraging wading birds has exceeded the restoration expectation when averaged over the interim period (2001 to 2018) (Cheek et al. 2014, SFWMD 2018a). 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 and Melvin 2005a, SFWMD 2017).

While foraging conditions on the floodplain can become optimal for wading birds during parts of the year (see *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 2020, 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 the 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 S-65 water control structure at the south end of Lake Kissimmee (**Figure 24**). Water managers will be better equipped to mimic the historical recession rates and water depths on the Kissimmee River floodplain during the typical wading bird nesting season. Wading bird responses to the river restoration project will be monitored for 5 years after construction is complete.

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).

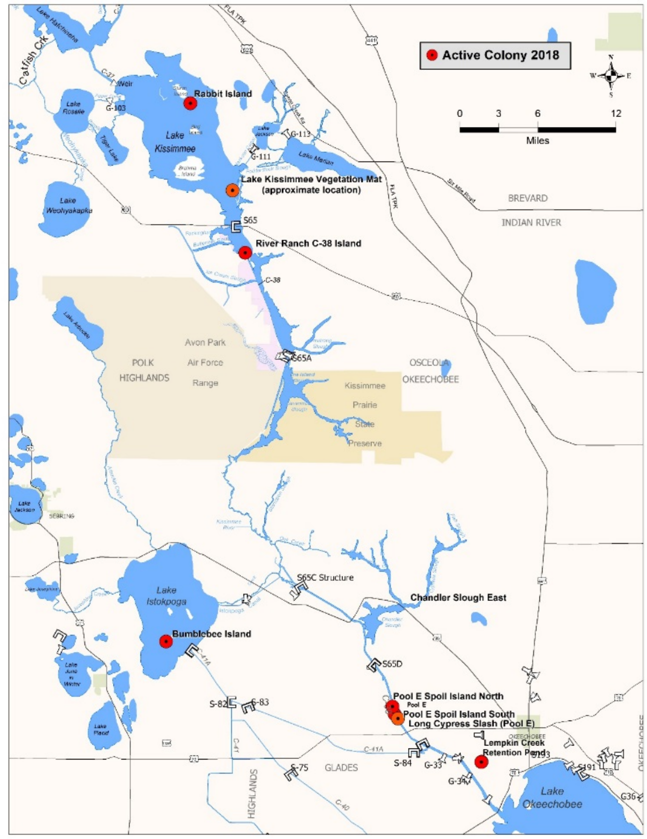

Figure 24. Nesting colony locations in Lake Kissimmee, Lake Istokpoga, and the Kissimmee River Restoration Project Area (i.e., within approximately 10 kilometers of the C-38 Canal backfill) during 2018.

Methods

As part of the KRREP, the SFWMD performed five surveys (March 27, April 10, May 15, May 29, and June 6, 2018) at 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 while flying 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 photographs 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 17** and **18** are considered conservative. Nest fate and nesting success were not monitored.

Results

Eight colonies were active during the 2018 season within the KRREP area, Kissimmee River Pool E, and Lakes Istokpoga and Kissimmee (**Tables 18** and **19**, **Figure 24**). All colonies combined (5,287 total nests) were dominated by White Ibis (WHIB; 2,505 nests), followed by smaller numbers of Cattle Egret (CAEG; 1,745 nests), Great Egret (GREG; 934 nests), small unidentified dark herons (SMDH; 53 nests), Great Blue Heron (GBHE; 38 nests), small unidentified white herons (SMWH; 5 nests), and Wood Stork (WOST; 7 nests). The largest of these colonies was Bumblebee Island in Lake Istokpoga (3,025 nests), followed by Rabbit Island in Lake Kissimmee (1,249 nests), Pool E Spoil Island North (410 nests), Pool E Spoil Island South (230 nests), Lempkin Creek Retention Pond (152 nests), Lake Kissimmee floating mat (105 nests), Long Cypress Slash (Pool E) (104 nests), and River Ranch C-38 (12 nests).

Similar to last season, none of the colonies occurred within 10 kilometers of the partially restored portions of the Kissimmee River, but several occurred in unrestored portions of the river north, east, and south of the restoration area (**Figure 24**). The Bumblebee Island colony is approximately 15 kilometers away from the Kissimmee River Restoration Project Area, which is approaching the farthest limits of regular foraging flight distances for most wading bird species. The Rabbit Island and River Ranch Island colonies (40.6 and 23 kilometers away, respectively) are too far north of the restoration area for regular foraging by nesting species. The Kissimmee River Restoration Project Area likely was not used by any nesting wading birds for foraging this breeding season as much of the floodplain was dry and unsuitable for foraging by early April, although it remains unclear to what extent breeding wading birds utilize the river floodplain.

Table 18. Peak (maximum) number of wading bird nests within the Kissimmee River Restoration Project Area[a] (2003-2018; sites were surveyed during February, April, and May 2018).

Year	CAEG	GREG	WHIB	GBHE	SMDH	SMWH	WOST	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
2018	1,264	484	416	33	53	5	7		**2,262**	7	998

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

[a] Kissimmee River Restoration Project area sites include Lakes Kissimmee, Cypress, and Hatchineha, and colonies within approximately 10 kilometers 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, S-65C Boat Ramp, S-65C Structure, S-65D Boat Ramp, Seven Mile Slough, Pool E Spoil Island, and S-65E 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) (2010-2018; sites surveyed during April and May 2018).

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
2018	481	450	2,089	5				**3,025**	1	2,544

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

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 (S-65C Boat Ramp Colony) has formed within 5 kilometers of the partially restored portion of the Kissimmee River, and during most years, it has contained fewer than 50 nests of aquatic wading bird species. The continued small numbers of aquatic wading bird species nesting along the restored portion of the river suggests prey availability on the floodplain is not yet sufficient to support successful breeding for wetland-dependent birds. Another possible factor preventing breeding colony site formation within the restoration area is a lack of suitable habitat conditions (e.g., woody substrate surrounded by water, nesting materials, nearby foraging areas) during the January to June breeding season (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 S-65 structure and ending at the S-65D structure (**Figure 24**). 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 kilometers per hour. 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 are lumped together as small unidentified dark herons (SMDH). Likewise, SNEG and immature LBHE were classified as small unidentified white herons (SMWH).

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 [2002-2018] = 41.5 ± 5.8 birds/km²) (**Figures 25** and **26**). The long-term annual 3-year running mean (2002-2018) is 41.1 ± 3.7 birds/km², significantly greater than the restoration expectation of 30.6 birds/km² (t-test, $p = 0.007$, SAS Institute, Inc. 2016, Williams and Melvin 2005b). However, only the 3-year running means for the periods 2002-2005 and 2004-2006 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 2017-2018 season was 56.5 ± 9.0 birds/km², bringing the 3-year (2016-2018) running average down slightly to 37.2 ± 12.1 birds/km².

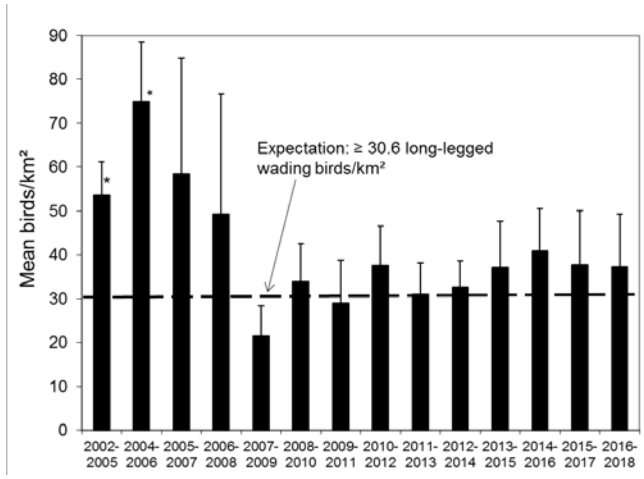

Figure 25. Post-restoration abundance as 3-year running averages ± standard error of long-legged wading birds/km², excluding CAEG, during the dry season (December to May) within the Phase I, IVA, and IVB restoration areas of the Kissimmee River. Each 3-year running mean was not significantly different from the restoration target of 30.6 birds/km² when examined on an annual basis (t-test; SAS Institute, Inc. 2016).

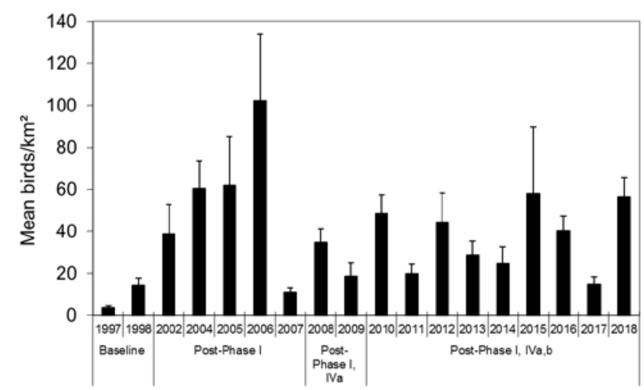

Figure 26. Baseline and post-Phases I, IVA, and IVB mean abundance ± standard error of long-legged wading birds/km² (excluding CAEG) during the dry season (December to May) within the 100-year floodline of the Kissimmee River.

Wading bird abundance was high during the initial fall recession in November, December, and into mid-January, with ≥100 birds/km² observed during four surveys (**Figure 27**). Abundance estimates stayed close to the restoration target through mid-February, until numbers dropped to 21.6 birds/km² during the February 27 survey. The following two surveys in March showed an uptick in numbers, possibly due to the northward movement of spring migrants, before numbers fell below the target in late March through early May, at which point the floodplain was almost completely dry and unsuitable for foraging.

WHIB dominated numerically (59.6%), followed in order of abundance by GREG (10.5%), SMWH (10.1%), GLIB (6.8%), GBHE (5.7%), BCNH (3.1%), WOST (1.9%), SMDH (TRHE and adult LBHE; 1.7%), and Roseate Spoonbill (0.7%).

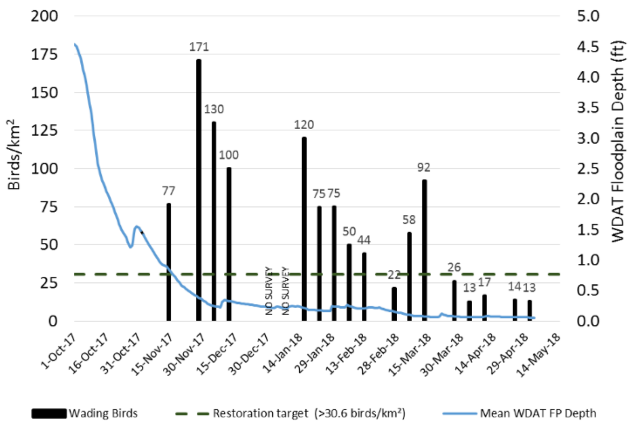

Figure 27. Wading bird abundance and mean floodplain depth in the Kissimmee River Restoration Area (Phases I, IVA, and IVB) during the 2018 dry season (December to May). Floodplain depth was obtained from the South Florida Water Depth Assessment Tool (SFWMD 2018b).

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SAVANNAS PRESERVE STATE PARK

The Savannas Preserve State Park is a 5,000-acre property in northern Martin County and southern St. Lucie County, situated just west of Indian River Lagoon. The property is bisected by an oligotrophic, linear basin marsh system that stretches from Jensen Beach to southern Fort Pierce. It is the longest contiguous freshwater marsh system of its kind remaining in southeastern Florida, spanning approximately 10 miles north and south. The western preserve is dominated by a pine flatwood community with numerous depression marshes and wet prairie. The eastern preserve is along the Atlantic Coastal Ridge and typically dominated by sand pine scrub and scrubby flatwood communities. The marsh and associated wetlands provide a stopover for migrating birds and support nesting activities in small tree islands and dense sawgrass patches.

During late February 2018, Florida State Park staff resumed surveys of a historical wading bird rookery at Savannas Preserve State Park. This rookery, along with two others to the south, originally was surveyed between 1995 and 2003 by the South Florida Water Management District. Surveys were conducted in 2016; however, drought conditions in 2017 prevented surveying of the site due to low nest numbers and lack of access.

Marsh hydrologic conditions are driven primarily by annual rainfall patterns but also are influenced by local runoff. Rainfall accumulation for 2018 peaked near 16 inches in May. The roughly 2-week event inundated the basin marsh. Prior to the May rains, the basin marsh was in a drying trend from late February through late April, peaking around April 17.

Methods

The North Marsh Rookery (**Figure 28**) is a shrub island within the basin marsh north of Walton Road, just north of the canoe launch area. This island primarily consists of pond apple and wax myrtle with sawgrass edges. Surveys were completed by canoe along the island's western edge. The eastern portion of the island is inaccessible by canoe due to thick aquatic vegetation, so some nests in this area may have been missed. The colony was surveyed four times this season: mid-February, late May, late June, and late July, with peak nesting in February and May.

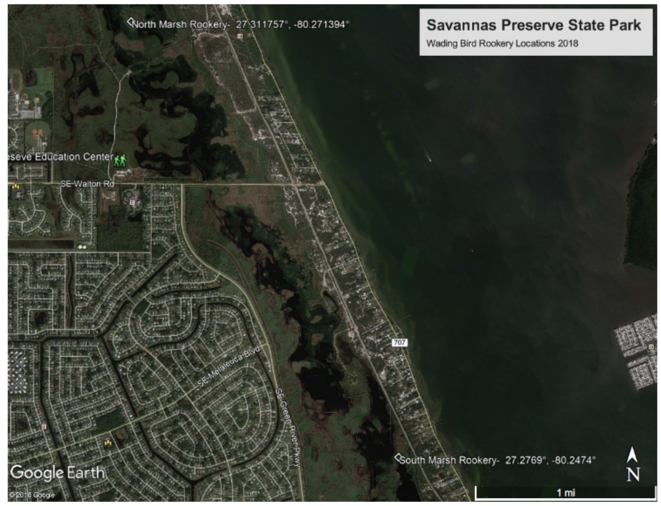

Figure 28. Location of wading bird nesting colonies at Savannas Preserve State Park during the 2018 nesting season.

Results

Nest numbers in 2018 appear to be similar to those from 2016 and those between 1995 and 2003. Nest counts for the North Marsh Rookery are provided in **Table 20**.

Future Plans

Plans are to continue surveys at the North Marsh Rookery and resume surveys at the South Marsh Rookery (27.2769, -80.2474) between January and July 2019.

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Table 20. Peak nest counts for each species in Savannas Preserve State Park.

Year	Colony	Latitude	Longitude	GREG	SNEG	GBHE	LBHE	BCNH	WHIB	GLIB	ANHI	Total
2018	North Marsh Rookery	27.3117	-80.2713	7	3	10	5	1	1	5	17	**49**

Note: CAEG nests were not observed (count = 0).

SOUTHEAST FLORIDA (VARIOUS LOCATIONS)

METHODS

The Florida Fish and Wildlife Conservation Commission conducted nest counts at eight wading bird colonies in 2018.

Bird Island Critical Wildlife Area (CWA; 27.190821, -80.187908) is a spoil island in the Indian River Lagoon. The island is closed year-round to protect nesting and roosting birds. It is cooperatively managed with Martin County and monitored monthly throughout the year. 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. Only Wood Storks (WOST) and Tricolored Herons (TRHE) were counted, but other species were present.

The 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. Counts were done by boat, and it is certain that some interior nests are not counted.

Wakodahatchee Wetlands (26.479889, -80.142326) is a manmade wetland where many wading bird species nest. WOST and other species were counted from the boardwalk, but not all species present were recorded.

Sawgrass Ford (26.149837, -80.337621) is a spoil island behind the Sawgrass Ford dealership. The counts were conducted by circling the island on a kayak. One count was conducted in April 2018.

Griffin (26.063633, -80.366492) is in the Emerald Estates Park. Surveys were done from the road on the south side of the colony. It is likely that nests on the east side were not counted.

ABC Islands CWA (25.956980, -81.703354) encompasses three spoil islands on the eastern side of Marco Island. The islands are closed to public access year-round to protect nesting, migratory, and wintering birds.

Bird monitoring was conducted with assistance from Rookery Bay National Estuarine Research Reserve (NERR). Counts were conducted by boat or kayak circling each island, and it is certain that some interior nests were not counted.

RESULTS

Nest count data from each region are presented in **Table 21**.

Table 21. Peak numbers of nests at various locations from January to July 2018.

Colony	ANHI	BCNH	BRPE	CAEG	DCCO	GBHE	GLIB	GREG	LBHE	ROSP	REEG	SNEG	TRHE	WOST
Bird Island CWA		2	41	2	9	1		47	1	6		8	1	123
Ballen Isles													1	17
Solid Waste Authority							2	27	4	22		5	15	365
Wakodahatchee Wetlands	22					7		14	2				5	164
Sawgrass Ford	5							36					4	80
Griffin	13			26	24								3	56
ABC Islands CWA	4		91	2	37	10		151	1		4	13	13	
Rookery Bay NERR								6						
Total	**44**	**2**	**132**	**30**	**70**	**18**	**2**	**281**	**8**	**28**	**4**	**26**	**42**	**805**

Note: GRHE and WHIB nests were not observed (count = 0).

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PALM BEACH COUNTY NATURAL AREAS

Staff at Palm Beach County Environmental Resources Management surveyed wading bird colonies in natural areas between January and May 2018 to assess nesting efforts. This included four known locations within the Cypress Creek, Pine Glades, and Loxahatchee Slough natural areas. Three of the four known colonies had nesting this year. All of the colonies are located in northwestern Palm Beach County within a pine flatwoods, marsh, and cypress swamp habitat matrix

METHODS

Staff conducted monthly surveys of the Cypress Creek colony. During each visit, counts were made from multiple vantage points encircling the colony to ensure full coverage. The Cypress Creek colony occupies an approximately 0.4-acre island of mixed willow and cypress that bisects a deeper pond. The pond and island are within a shallow wet prairie surrounded by pine flatwoods.

The Pine Glades colony occurs on an approximately 1.1-acre willow head adjacent to a deepwater marsh that holds water during most of the year. The colony was surveyed from multiple vantage points, recording the number of nests and the presence of chicks.

The Central Loxahatchee Slough colony had no nesting activity this year. No previous nesting had occurred at this location and last year's use may have been due to a lack of suitable opportunities during extreme dry conditions.

The Northeast Loxahatchee Slough colony was active this year. The 1.4-acre colony consists of two deepwater pond apple and willow heads within a larger cypress dome. The site was visited on April 27 by staff and Florida Atlantic University researchers as part of a small heron diet study.

RESULTS

The Cypress Creek colony had three Great Egrets (GREG) nest attempts. One nest was abandoned as water levels fell. The remaining two nests fledged two and three chicks, respectively. The Pine Glades colony had four GREG nests, with three chicks observed on April 3, and one unidentified abandoned nest (**Table 22**).

Although the purpose of the visit to the Northeast Loxahatchee Slough colony was not to count nests, a conservative estimate from that visit and flight line surveys has been included.

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Table 22. Peak number of wading bird nests, by species, observed at Palm Beach County colonies between January and May 2018.

Colony	Latitude	Longitude	GREG	CAEG	LBHE	TRHE	BCNH	Total
Cypress Creek	26.94936	-80.18768	3					**3**
Pine Glades	26.93611	-80.25591	4					**4**
Northeast Loxahatchee Slough	26.86861	-80.17780		8	60	15	4	**87**

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. 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 to attain 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 (RECOVER) program established Performance Measures (PMs) (http://www.evergladesplan.org/pm/recover) that include the 3-year running average of the numbers of nesting pairs of key avian species in the mainland Everglades, the timing of Wood Stork (WOST) nesting, and the proportion of the population that nests in the coastal ecotone (Ogden et al. 1997). In addition to these three PMs, the annual Stoplight Reports have added two other PMs: 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 PMs 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 the PMs. When thinking about progress towards these restoration PMs, it should be remembered that the hydrological system is not yet restored to provide anything like the ecological functions expected in a completed CERP. The exceptional conditions in 2018 notwithstanding, based on the recent status of the hydrological 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), this 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:TRHE). 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 the data for the three Water Conservation Areas (WCAs) and mainland Everglades National Park (ENP).

RESTORATION METRICS

Numbers of Nesting Pairs

The 3-year (2016 to 2018) running average for nesting pairs in the mainland Everglades (the three water conservation areas and Everglades National Park) are 8,803 GREG pairs, 1,224 SNEG pairs, 41,465 WHIB pairs, and 2,152 WOST pairs. Trends for GREG over time (**Table 23**, **Figure 31**) for this PM increased markedly from 1988 to 2004, and have been roughly stable since 2004, with the 3-year running average meeting or exceeding restoration criteria for 23 consecutive sampling periods (since 1996). Trends for SNEG also increased noticeably from 1986 to 2004 but dropped dramatically beginning in 2005. However, the 2018 season pulled the average up markedly. Generally, big nesting years for flock-foraging species show a big increase in SNEG nesting. However, 3-year running averages of breeding SNEG consistently have been well below the target restoration goal in the time they have been monitored since 1986. The 3-year running average for WHIB increased 2.7 times between 1986 and 2001, and remained variable but arguably stable from 2002 to 2011. The final period in this record (2011 to 2018) showed substantial fluctuation in WHIB nesting, with a 50% reduction in three of the years, and three of the eight years in that period being well below the average of the previous decade. The huge nesting effort in 2018 pulled the running average up substantially, and the running average may remain high for the next 3 years because of the 2018 contribution. WHIB nesting populations have met or exceeded the breeding population criterion during the past 19 years. WOST showed a clear increase from averages in the 2- to 300-pair range (1986 to 1992) to averages above 1,000 pairs in many years after 1999. WOST have met or exceeded the restoration population criterion during 9 of the last 18 years, including in 2018.

Together, these statistics illustrate there has been a substantial increase in the numbers of GREG, WOST, and WHIB since 1986, followed by a period of relative stability during which these species have 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 Water Conservation Area 3 (see *Hydrologic Patterns for Water Year 2018* section) that breeding populations of the other two small herons in the genus *Egretta* (TRHE and Little Blue Heron [LBHE]) also are declining sharply in the Everglades.

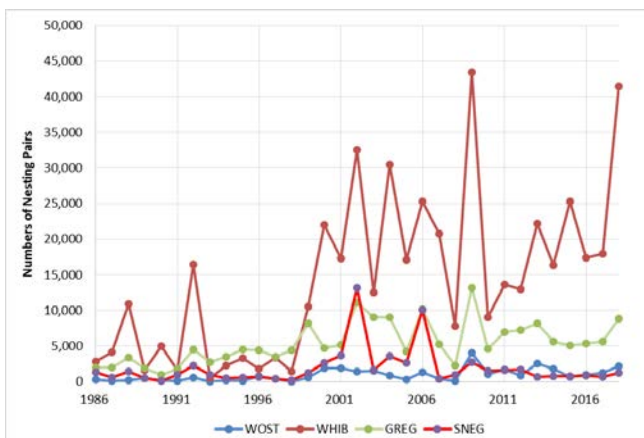

Figure 31. Trends in the 3-year running average of nesting pairs of the four target species since 1986.

Table 23. 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
2016-2018	**8,803**	1,224	**41,465**	**2,152**
Target Minima	4,000	10 - 20k	10 - 25k	1.5 - 2.5k

Note: Bold entries are those that meet minimum criteria.

Coastal Nesting

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 the coastal region that has reduced secondary productivity and resulted in the abandonment of the area by nesting wading birds. The proportion of the entire mainland Everglades nesting population that nests in the coastal zone is one of the restoration indicators, with at least 50% of nesting as the restoration target (Ogden et al. 1997). This PM has shown considerable improvement since the lows of the mid-1990s and early 2000s (2% to 10%; **Figure 32**), and during the last several years has ranged between 15% and 46%. In 2018, the proportion was 32.8%. While the proportion does not appear to meet the 50% nesting target, it is worth noting that 2018 showed more total nests in the coastal ecosystem than any time since the 1940s.

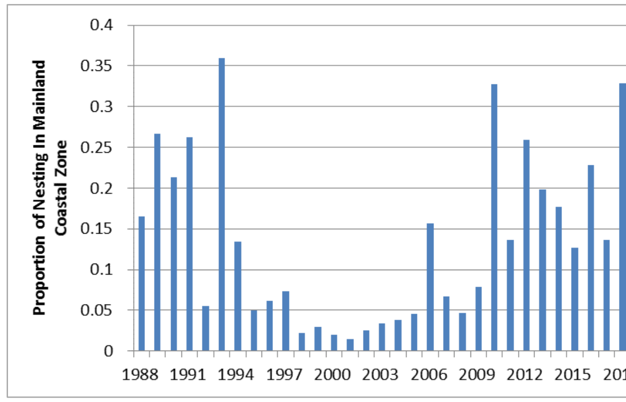

Figure 32. Proportion of all mainland Everglades nesting that is located in the coastal estuarine zone, 1986 to 2018.

Ratio of Visual to Tactile Foragers

This PM 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 both in groups and solitarily 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 PM 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 PM in 2018, however, was the highest at any point since the 1980s, at 4.07. This was largely due to the spectacular increase in the number of nesting WHIB in 2018.

Timing of Nesting

This parameter applies only to the initiation of nesting for WOST, which has shifted from November-December (1930s through 1960s) to January-March (1980s 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 PM has shown a consistent trend towards later nesting between the 1930s and the 1980s, with variation around a February mean initiation date since the 1980s (**Figure 33**). Although some years in the mid-2000s stimulated earlier nesting, there has been no lasting improvement. The 2018 season start (late December) was quite early compared to recent years and was only 1 of 3 years in the last 30 years in which WOST have initiated nesting by the end of December. The 4-year running average was 2.2 nests, which corresponds to an average nest initiation date of early February.

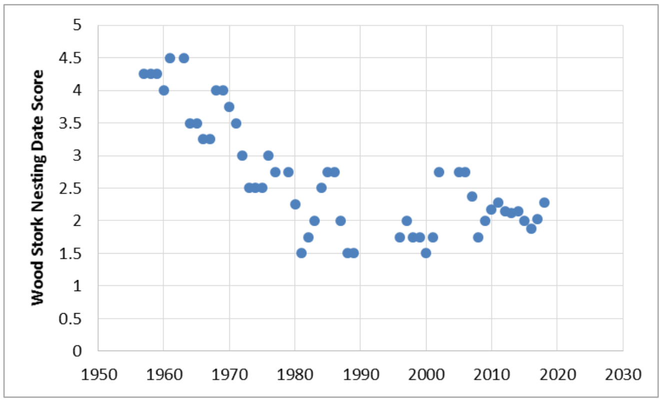

Figure 33. Four-year running average of WOST nest initiation date in the Everglades. Initiation in March is a 1, initiation in November is a 5.

Exceptionally Large Ibis Aggregations

Episodic, exceptionally large breeding aggregations of ibises were characteristic of the pre-drainage system and are thought to be indicators of the wetland system's ability to produce very large pulses of prey, resulting in part from typical cycles of drought and flood. Large breeding aggregations during the recent period are defined as being above 16,977 nests each year (the 70th percentile of the entire period of record of annual nestings). The interval between large ibis nestings in the pre-drainage period was 1.6 years, and this serves as the target for restoration. This PM has improved substantially since the 1970s, with the target achieved in 10 of the last 11 years. The 2018 WHIB nesting did reach the restoration criterion, and the interval averaged over the last 5 years is 1.4 years, slightly more frequent than in the 1930s.

DISCUSSION

As a whole, these PMs of wading bird nesting suggest that while there have been real improvements in several of the PMs during the past one or two decades, several key PMs are stalled and not showing improvement. Two PMs 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 WHIB nesting years has consistently met the restoration target. There has been real progress in the location of nesting, with a dramatic increase in 2018. Nonetheless, the proportion nesting in the coastal zone remains low (5-year running average of 33% compared to 50% target), and there is much room for improvement. Several PMs are not improving. The numbers of SNEG are declining and remain far from restoration targets, despite occasional years like 2018. There is fairly paltry evidence that the timing of nesting for WOST is improving on average, despite the early nesting in 2017 and 2018. 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 the birds probably have responded in the last two decades to a combination of altered water management regimes, good weather, and hydropatterns 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, and that nesting often has been successful, remains a solid indicator of ecological health. The lack of movement of the other PMs 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 suggests 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.

Significance of the 2018 Nesting Season

The 2018 nesting event was unprecedented by any standard in the last half-century of the Everglades. During 2018, the Everglades wetland mosaic was apparently able to provide strong cues for nesting as well as a concentrated and continuous supply of food that supported successful nesting of hundreds of thousands of birds. These responses likely were the result of a rare mix of hydrological conditions occurring in the current and previous years. First, spring 2017 was abnormally dry. This probably reduced populations of piscine predators, which often is a precursor to supernormal nesting events, in part because it allows proliferation of crayfish populations. Second, the 2017 wet season was characterized by record-breaking rainfall driven in part by Hurricane Irma, which flooded short hydroperiod marshes within and outside the Everglades for many more months than typical. This could have boosted small fish and crayfish production over a very large area that usually is not available for prey production. Third, the 2018 dry season was drier than normal, and surface water receded largely uninterrupted, allowing wading birds almost continuous access to dense prey throughout the nesting season and across nearly the entire Everglades.

Several aspects of this combination of events were fortuitous alignments (drying followed by unusually wet wet season, followed by consistent drying) and a strong nesting season would have been predicted based on those characteristics alone. However, extended flooding of the high-elevation marshes appears to be one condition that was different during the 2017-2018 sequence and likely was critical to early nesting, unusual carrying capacity for large coastal colonies, and a long period of prey availability. Regular hydration of high-elevation marshes is a critical difference between the pre- and post-drainage Everglades and is a likely outcome of hydrological restoration under CERP. The results of the 2018 nesting season strongly suggest that 1) the current, smaller footprint of the Everglades ecosystem is still capable of supporting wading bird nesting populations in the same size range as historical populations, and 2) higher frequency of flooding in high-elevation marshes throughout the system may be a key factor supporting early, successful nesting.

SPECIAL TOPICS

AMERICAN FLAMINGO OBSERVATIONS IN FLORIDA IN 2017

American Flamingos (*Phoenicopterus ruber*; AMFL) occurred in large flocks in South Florida through the 19th century but were extirpated under hunting pressures by about 1900 (Audubon 1839, Wurdemann 1860, Scott 1890, Allen 1956, Whitfield et al. 2018). In the early 20th century, captive AMFL colonies were established in South Florida, and through most of the 20th century, AMFL observations have been attributed to escape from captive populations (Allen 1956, Stevenson and Anderson 1994). Because of early consensus that AMFL were escapees, the species was listed as non-native by the Florida Fish and Wildlife Conservation Commission (FWC) and omitted from wading bird monitoring programs and wildlife management plans (Millsap et al. 1990).

However, perspectives on the status of AMFL in Florida have been shifting as new evidence points to AMFL as a naturally occurring but rare component of South Florida's native avifauna (Hunter et al. 2006). Newly synthesized data (Whitfield et al. 2018) has yielded important information about historical baseline population size and evidence for historical nesting in South Florida. The question of whether AMFL are non-native escapees or nearly extirpated natives carries important implications for conservation policy, management, and action. The FWC is conducting a biological status review for AMFL to determine eligibility for listing as a threatened species under Florida's threatened species laws (C. Faulhaber, pers. comm.).

This section provides a compilation of information on occurrence of AMFL throughout Florida between January and December 2017, adding to a recent synthesis of population trends from 1950 to 2016 (Whitfield et al. 2018). In the absence of systematic data from monitoring efforts, citizen science data are used as the only source for evaluating occurrence and trends.

METHODS

The citizen science database eBird (Sullivan et al. 2009, 2017) was used to evaluate observations of AMFL from January to December 2017, following methods used previously to compile similar data from 1950 to 2016 (Whitfield et al. 2018). Briefly, observational reports of AMFL in Florida for 2017 were downloaded from eBird into a database. Records that were unverified (indicating suspicion of incorrect identification or strong evidence of captive origin) and records that were duplicate sightings reported on multiple observer checklists were removed. However, multiple observations from the same date in the same geographic area were kept if they were reported by multiple observers, though these records very likely indicate repeated sightings of the same birds. From these data, three metrics were calculated: number of observations, number of AMFL, and maximum group size. In one case, the number of individual AMFL presented in the data set differed from the number of AMFL in a photograph; in this case, the number of birds in the photograph was used.

RESULTS

There were 38 AMFL observations of a cumulative 99 individuals in 2017, with the largest group size of 5 birds (**Figure 29**). The majority of reports (31 observations and 84 cumulative individuals) were from Florida Bay, particularly Snake Bight in Everglades National Park (**Figure 30**). Only one observation of a single individual was reported from Palm Beach County (seen from the Florida Turnpike east of Loxahatchee National Wildlife Refuge). There were 6 observations of a cumulative 12 AMFL from the Florida Panhandle, including Escambia, Okaloosa, and Walton counties (**Figure 30**).

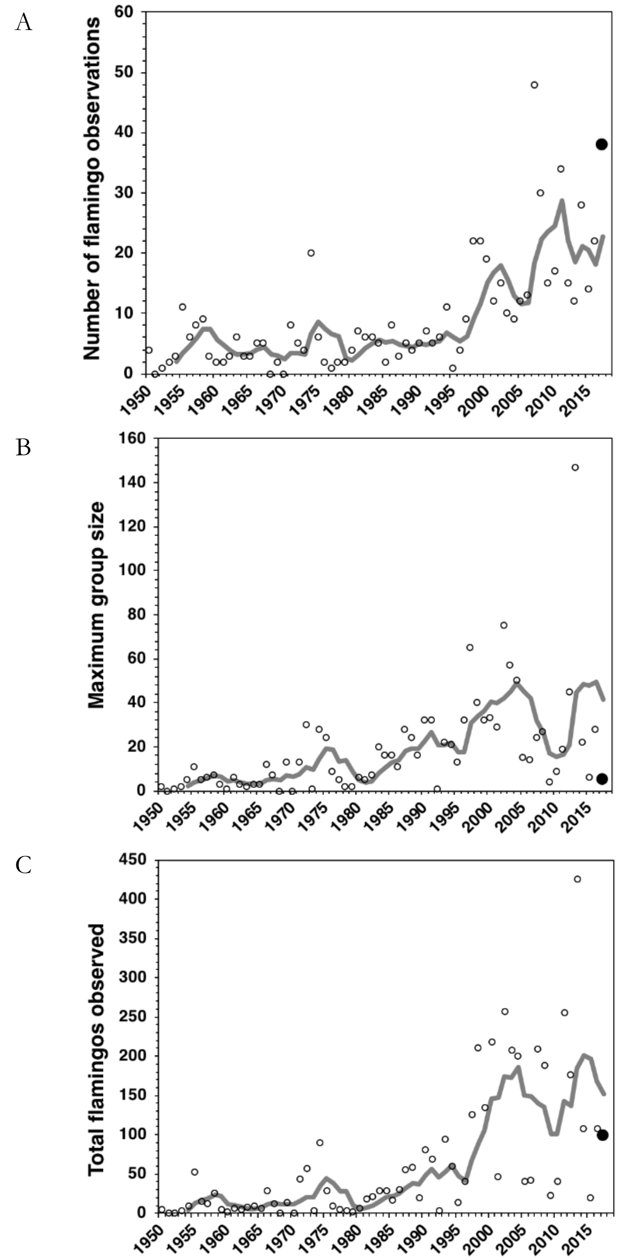

Figure 29. Trends in AMFL occurrence in Florida, from 1950 to 2017. Closed circles indicate data from 2017, while open circles indicate yearly data from previous years. Gray line indicates 5-year moving average.

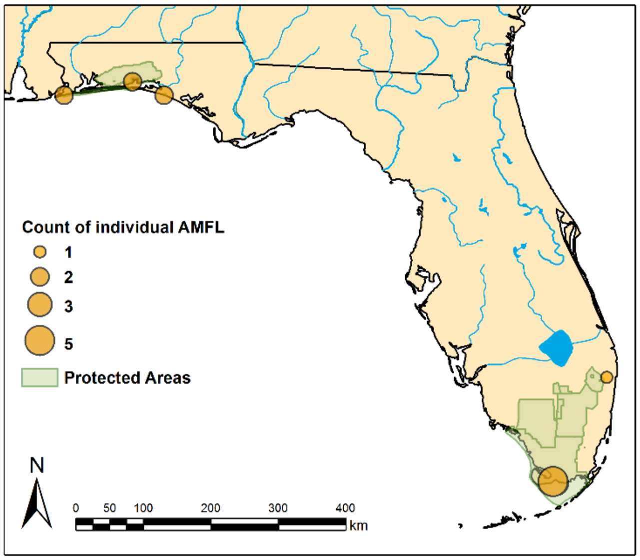

Figure 30. Locations of AMFL observations reported to eBird in 2017. Extralimital protected areas where AMFL were reported include Gulf Island National Seashore, Eglin Air Force Base, and Deer Lake State Park.

Discussion

In 2017, there was a relatively high number of AMFL observations, yet fewer cumulative AMFL reported and lower group size than in recent years. Only in 2007 were there more observational reports of AMFL in Florida, perhaps indicating increasing use of citizen science data portals. The maximum group size was the lowest since 2009, though this is heavily influenced by larger groups of AMFL, which have appeared in Florida Bay in many years since the 1960s, and by larger groups that have appeared at Stormwater Treatment Area 2 (STA-2) in more recent years.

A pair of AMFL in the Florida Panhandle appeared between June 22 and July 2, 2017. This pair first appeared after Hurricane Cindy, which passed over the Yucatan peninsula on June 18, 2017, and made landfall in Louisiana on June 22, 2017. As stated by McNair and Gore (1998), the appearance of AMFL in northwestern Florida is most easily explained as a pair of individuals displaced by tropical storms.

There were no eBird AMFL observations from STA-2 in 2017, where larger groups of AMFL have appeared in recent years. The single AMFL reported from this area in 2017 was in flight nearby. The absence of AMFL sightings at STA-2 heavily influenced all metrics, particularly maximum group size.

Virtually all AMFL sightings in Florida Bay (27 of 31) were from Snake Bight between June 22 and July 29, 2017. These repeated sightings are very likely the same birds over this time period. Many of these reports include descriptions or photographs of a banded AMFL (US01) with a satellite transmitter that is part of an ongoing research project by Zoo Miami. This banded AMFL was present in Florida Bay for at least 9 months in 2017 but only rarely was encountered and reported to eBird, indicating that detection probability through citizen science portals may be surprisingly low.

By all estimates, the number of AMFL in Florida in 2017 was lower than in recent years; however, the number of observations has increased, which likely increases detection probability for rare AMFL. The appearance of an AMFL pair in the Florida Panhandle was unusual and supports evidence that storms are a driver for AMFL appearance in northern Florida (McNair and Gore 1998). However, relatively few AMFL were seen in their usual locations: Florida Bay and STA-2.

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LITTLE BLUE HERONS IN FLORIDA BAY AND FLORIDA KEYS

The Little Blue Heron (LBHE) is a state-listed Threatened species projected to face a 30% population decline as a consequence of foraging and nesting habitat loss (Florida Fish and Wildlife Conservation Commission [FWC] 2013, 2016). As such, LBHE is a species of conservation concern and management interest to various state and federal parties. A predictive model for LBHE foraging habitat within Great White Heron National Wildlife Refuge (GWHNWR) of the Lower Florida Keys found habitat use patterns were best explained by the spatiotemporal availability of shallow water when compared to other habitat attributes in the landscape (Calle et al. 2018). As a continuation of that study, a 3-year project (2016 to 2018) was conducted to refine the existing habitat model and evaluate its performance for application in Florida Bay.

The abundance and distribution of LBHE on the intertidal mudflats in western Florida Bay and central GWHNWR was monitored using a motorboat to perform foraging distribution surveys (see Calle et al. 2016 for details). Sixty-eight surveys were conducted in Florida Bay between March 14, 2016 and July 1, 2018, and 27 surveys were conducted in GWHNWR between March 13, 2016 and June 27, 2018. To locate LBHE nesting colonies whose individuals forage within the study areas, flight-line surveys were performed after foraging distribution surveys to track birds to roosting sites (Erwin 1981). Systematic motorboat and ground surveys of roosting sites in Florida Bay and GWHNWR were performed to search for nesting activity (e.g., copulation, adults carrying nest material, nest starts).

During the course of this study, several patterns of LBHE foraging and nesting habitat were documented that are relevant to future monitoring and management efforts for the species. First, seasonal abundance patterns suggest intertidal mudflats in Florida Bay support more LBHE than nest locally. In 2016 and 2017, peak abundances of adult LBHE were highest in February and March prior to the breeding season, then dropped by approximately 90% in Florida Bay and 65% in GWHNWR in May during clutch initiation (**Table 24**). A periodic decrease in abundance typically is attributed to one parent attending the nest, thus reducing the number of foraging birds by roughly half, which may account for the decline observed in GWHNWR. However, the magnitude of the decline observed in Florida Bay was greater than would be expected from nest attendance, indicating at least half of adult LBHE observed on the tidal flats moved outside the survey area, and likely onto the mainland, for the duration of the 2016 and 2017 breeding seasons.

Table 24. Number of foraging distribution surveys, peak foraging abundance, and peak nest effort of LBHE in Florida Bay and GWHNWR, by month, for the 2016-2018 nesting seasons. Mean clutch initiation dates for the Sandy Key nesting colony were May 9, 2017 and April 18, 2018. Mean clutch initiation dates for the Third Island nesting colony were May 18, 2016; May 4, 2017; and May 2, 2018.

	Florida Bay (Sandy Key)			Great White Heron Refuge (Third Island)		
	No. of Surveys	Peak Abundance	Peak Nest Effort	No. of Surveys	Peak Abundance	Peak Nest Effort
2016						
March	2	107	N/A	2	30	0
April	3	21	N/A	2	22	0
May	2	11	N/A	3	16	0
June	0	N/A	N/A	1	22	9
July	0	N/A	N/A	1	35	25
2017						
February	2	134	0	1	78	0
March	2	84	0	3	54	0
April	2	44	0	2	29	0
May	3	11	0	3	20	0
June	3	20	14	3	21	17
July	1	1	8	0	N/A	N/A
2018						
March	1	7	0	1	0	0
April	2	11	0	1	6	0
May	2	6	14	1	7	0
June	2	14	32	3	18	17
July	1	1	1	0	N/A	N/A

Second, nests of LBHE in coastal areas are not always associated with large colonies of white-plumaged wading birds, as is more typical of freshwater marshes. This difference led to the exploration of the utility of new techniques for locating nests of this dark-plumaged heron in coastal areas. LBHE individuals are more easily detected foraging in open intertidal habitat than nesting beneath a mangrove canopy. Moreover, LBHE in coastal areas seem to forage closer to their nesting colony (approximately 10 kilometers maximum) than LBHE in freshwater marshes. Therefore, the presence of foraging birds during the nesting season can be a starting point for colony searches on nearby islands. As LBHE are diurnal foragers, recording the flight lines of birds flying between foraging sites and roosts at dawn and dusk was useful to pinpoint the nesting colony.

Sandy Key (25.034641, -81.01424) in Florida Bay and Third Island (24.732353, -81.432982) in GWHNWR were roosting sites in the beginning of the breeding season and became the only LBHE nesting colonies in the study areas. Nests on Sandy Key were monitored from 2017 to 2018 and peak nest effort was observed in June of both years (**Table 24**). Nests on Third Island were monitored from 2016 to 2018 and peak nest effort was observed in July 2016, June 2017, and June 2018. Values of peak nest effort resembled values of peak abundance, which supports the assumption that numbers of foraging birds are constrained by nest attendance.

In conclusion, systematic motorboat surveys were an effective approach for locating concentrations of foraging LBHE in intertidal habitat. Due to the openness of tidal flats and conspicuousness of foraging behavior, the detectability of LBHE during foraging distribution surveys was near 100% (Calle et al. 2016). Small, dark-colored herons are more easily detected while foraging in this habitat than in wetland and freshwater habitats where they are more camouflaged by the surrounding vegetation and substrate. Furthermore, when a systematic nest-searching method was used, nesting birds were located that previously were undetected using existing survey methods designed for wading birds with visible plumage. Although the focus was on LBHE, foraging distribution surveys possibly could be used to locate nesting colonies of other small dark-colored heron species such as Tricolored Herons and Reddish Egrets.

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