FINAL REPORT
Avian Research Subsection
Fish and Wildlife Research Institute
Florida Fish and Wildlife Conservation Commission

Project Title: Refining the FWC beach-nesting bird protocol for threatened ground-nesting seabirds

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INTRODUCTION

Monitoring is an essential component of management at local and regional levels. With 1,350 miles of shoreline, the State of Florida has a massive management and monitoring responsibility for shorebirds, especially for the species that we have designated as state-threatened. Monitoring at this scale would not be tackled by agency employees alone, so the FWC and its conservation partners formed the Florida Shorebird Alliance (FSA) and standardized monitoring protocols. The FSA is a statewide network of partners that includes government agencies, nonprofit organizations and private citizens. It has provided a mechanism for shorebird conservation, management, and monitoring along Florida’s extensive coastline by recruiting, training, and coordinating partners to survey and protect these birds.

The FSA breeding bird monitoring program is based on a standardized data collection protocol, the Breeding Bird Protocol for Florida’s Shorebirds and Seabirds (BBP) (available at: https://public.myfwc.com/crossdoi/shorebirds/instructions-pages/step_4-breeding.html), and the online database, the FSD (www.FLShorebirdDatabase.org). The BBP asks partners to focus their monitoring efforts during specific dates, referred to as count windows, each nesting season in order to standardize the timing of data collection and provide “snapshots” of Florida’s shorebird and seabird populations. The BBP states “counts of breeding birds, nests, and young conducted during these windows provide information on distribution and minimum population estimates of Florida’s seabirds and shorebirds.” The protocol goes on to explain that “more frequent (i.e., weekly) surveys are recommended for better tracking of these nesting species.” We know that frequent monitoring leads to improved conservation and management of beach-nesting birds by providing timely information about predation, disturbance, overwash and movement of birds into or out of an area. However, it was unknown if weekly surveys were need to capture peak events during the nesting season (maximum number of breeding pairs and chicks).

Addressing data gaps is fundamental to our ability to effectively monitor and recover the least tern and black skimmer. Analyses of survey data collected over the last three nesting seasons indicates that the current recommended minimum survey frequency for colonial nesting seabirds is not sufficient to capture
peak nesting pairs and fledgling production (FWC 2013). Additionally, current breeding data for the black skimmer is often limited to only presence or absence of adults at a site. The lack of nest data for the black skimmer can be attributed to a combination challenges related to the observer being able to accurately determine nesting behavior and a restriction in the BBP that prevents observers from entering a colony to verify the occurrence of nests.

In this study we investigated the minimum survey frequency necessary to estimate peak nesting and production for ground-nesting least terns. We also explored methods that will allow FSA partners to accurately estimate nests within a colony from a vantage point outside the nesting area. Results of this study will be used to refine the current FWC BBP and guidance documents for the FSA.

**OBJECTIVES**

Our overall objective was to revise the beach-nesting bird protocol for the ground-nesting least tern and black skimmer to better allow us to determine if we are meeting the conservation objectives of the Imperiled Species Management Plan:

1. Determine the minimum survey frequency required to capture peak nesting colony count information for least terns (nesting pairs, hatching, fledging).
2. Determine accuracy of observer nest counts validated by photos.
3. Determine timing and duration of key events in colony progression from nest initiation through chick development.
4. Determine appropriate survey methods for identifying nesting black skimmers.

**STUDY AREA**

*Least Terns in Northeast Florida*

The study area resided within St. John’s County, where the Florida Shorebird Alliance had documented 7 least tern ground-nesting colony sites spanning ~16 miles (Figure 1). During 2011-2015 the annual population of ground-nesting least terns in the St. John’s County area was approximately 380 pairs (Brush unpubl. Data). The area also included 8 historical rooftop-nesting least tern colonies that were not included in this study. We monitored active ground-nesting least tern colonies at Julia’s Island, Anastasia
State Park, Summer Haven, and the Florida Inland Navigation District SJ-1 Dredge Material Management Area (FIND). No nesting occurred at Porpoise Point or Fort Matanzas National Monument during this study.

Figure 1. Historical beach-nesting least tern colony locations in St. Johns County.

*Black Skimmers in Southwest Florida*

The study area for black skimmer observations was in southwest Florida, including Charlotte, Lee, and Collier Counties (Figure 2). Black Skimmers nests can be very challenging to confirm, we believe the lack reporting on the various life stages is likely a directly related to this challenge. To address this issue we visited historical colonies in southwest Florida to document pre-breeding and breeding behavior to create a guide for colony monitors of the FSA.
Figure 2. The area outlined in grey is the focus of the black skimmer colony behavioral observations.

METHODS

Least Tern Survey Frequency Data Analysis

We analyzed least tern nesting and productivity data from the 2014 and 2015 nesting seasons to determine the ability of the current, and alternative protocols to detect peak nesting and chick counts. In our analysis of least tern survey frequencies, we used data collected by members of the Florida Shorebird Alliance and entered into the FSD during 2014-2015 in addition to the data we collected in 2015. We used either 2014 or 2015 data for each colony. We selected the eight colonies from the FSD during that time that had at least 20 non-duplicate monitoring records (Anastasia North, Julia’s Island, Summer Haven, Causeway, SAISSA_Residence, Amelia Island Beach, Gasparilla RangeLight and SKBN Access 3-4). On dates with duplicate monitoring records
we selected the record with the greatest nest count for colonies monitored in 2014 and the data collected during this study over that by FSA partners in 2015. We identified the max nest count (peak nesting), downy chick counts, and feathered chick counts as the top 90th percentile from each colony and season. Only colonies with sufficient non-zero downy and feathered chick counts were used (n=3).

We identified four potential sampling windows: weekly, 2-week (i.e., one visit per 14 days), 3-week (i.e., one visit per 21 days), and the monthly count window that is currently recommended in the protocol (Appendix A). The first week of observation corresponded with the first monthly count window in each year. The first two weeks of observation for each colony were combined for the 2-week period and the first three were combined for the 3-week period. For some colonies the number of weeks did not exactly correspond with the time windows, or there was only a single data point in a given week. In those cases additional weeks were combined to produce appropriate sampling windows.

To determine the likelihood of observing peak nesting and productivity during the given sampling period we randomly resampled (bootstrapped) the available nesting data using PROC SURVEYSELECT (SAS v9.4, Cary, NC). We assumed that all counts were accurate, and this bootstrapping exercise assumed that the eight colonies represented in the dataset are in fact representative of least tern nesting statewide (across colonies and years) and that the data collected are an accurate representation of nesting counts longitudinally. We tallied the total number of resamples, across all colonies, which correctly identified the peak (90th percentile). For weekly time periods we drew 1,000 samples from each colony while for the 2 and 3-week sampling periods we drew 10,000 samples. The total number of resamples were low for weekly sampling given the relatively few possible combinations for some colonies.
Validating least tern nest and chick counts with photos

Stationary Game Cameras and image processing were field tested and evaluated as a potential method for reducing disturbance and increasing accuracy during field surveys. We tested two stationary game cameras, the Moultrie M-880 Game Camera and the Moultrie Panoramic 150 Scouting Camera. Cameras were set up at discrete locations at the Julia’s Island and Summer Haven colonies to determine which camera was best for recording nesting least terns and chicks. The game cameras were programmed to take pictures every 5 minutes during daylight hours. Images were viewed to determine if this type of camera-setup would be a useful tool for sampling a subsection of the nesting colony. One camera also was programmed to record at 5 minute intervals during night hours to document bird behavior and detect night predation events at the Julia’s Island colony.

Least Tern Colony Timing and Duration of Key Events

Monitoring at all historical nesting sites for pre-nesting least terns began April 1 to determine timing and duration of key events (nest initiation, max adults, hatching, fledgling). We focused on colonies which were active. Each active colony was monitored until nesting was completed. The largest colony in the area was monitored daily when possible, and two smaller colonies were visited every other day during the 2015 nesting season. Surveys were conducted following the FWC’s Breeding Bird Protocol for Florida’s Seabirds and Shorebirds. Surveys were conducted from outside the posted area. We recorded number of adults, nests, chicks, and fledglings at each colony. We also documented mammal tracks, evidence of colony overwash, and disturbance events. In order to optimize counts and reduce missed detections, surveys were conducted first thing in the morning for chick and fledgling counts and mid-day for nest counts.

Black Skimmer Colony Surveys

We worked with local managers to coordinate site visits to maximize behavioral observations at key times during the nesting season. We aimed to observe both potential nesting and breeding black skimmers. Behavioral differences between loafing and nesting birds were documented. We took photographs and video footage as appropriate to help distinguish between the two behaviors of loafing and nesting, particularly
when in a scrape. We also took photos of chicks at various ages from hatch through fledge. We used our observations and photos to create online information resources for partners to facilitate accurate field observations.

RESULTS

Least Tern Survey Frequency Data Analysis

There were clear differences in the probability of detecting a peak across the four sampling windows for nesting as well as productivity (Table 1). Figure 3 shows the nesting trend, as well as monthly count windows while Figure 4 shows the productivity trends and their associated count windows.

Table 1. Proportion of resampled surveys that correctly identified peak nesting, peak downy chick, and peak feathered chick numbers (90th percentile) according to different sampling frequencies.

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Proportion Peak Nesting</th>
<th>Proportion Downy</th>
<th>Proportion Feathered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly</td>
<td>97%</td>
<td>93%</td>
<td>95%</td>
</tr>
<tr>
<td>2-Week</td>
<td>61%</td>
<td>72%</td>
<td>73%</td>
</tr>
<tr>
<td>3-Week</td>
<td>46%</td>
<td>53%</td>
<td>54%</td>
</tr>
<tr>
<td>Monthly</td>
<td>34%</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Figure 3. Daily nest count for each colony and the observations that occurred during the currently recommended monthly count windows. Percentages correspond to the proportion of observations, within the appropriate count window, that captured the peak. The peak is identified by the dashed red line and indicates the 90th percentile.
Figure 4. Daily chick counts for each colony and the observations that occurred during the currently recommended monthly count windows. Percentages correspond to the proportion of observations, within the count window, that capture the peak. The peak is identified by the dashed red line and indicates the top 90% of the data.
Validating least tern nest and chick counts with photos

Efforts to validate least tern nest and chick counts with photos yielded mixed results. There are some valuable uses of cameras but mostly they do not work to validate counts by an observer.

The Go Pro mounted camera, while able to capture video footage, had limited capabilities due to low image quality. The unit was not capable of capturing quality images of birds and nests due to high pixilation, poor contrast, and unreliable clarity. It was difficult to distinguish birds when collecting images from outside the colony. This was due to bird size and lack of color contrast between birds and the beach. In the end the images could not be used to accurately validate counts.

The DSLR camera was able to produce less pixelated images allowing for enlargement and better analysis, however there is a limited amount of information that can be interpreted from still images. The majority of count accuracy is being able to correctly identify bird behavior to determine if they have nests or chicks. This not only takes a lot of time, patience and knowledge of bird behavior, it is a process that can’t be replicated in still photographs. A picture is a ‘snap-shot’ of the colony at the moment it was taken and the likelihood that birds are not present in the colony during the time the photo was taken is very high. In addition, the lack of perspective in the photographs also hindered accurate detection.

We compared two types of mounted game cameras. The Moultrie M-880 Game Camera Game Camera was durable and collected better images than the more expensive Moultrie Panoramic 150 Scouting Camera. The mounted game cameras provided the advantage of being time-lapsed and had minimal colony disturbance. Only a small section of a colony could be observed, making it best suitable for sub-sampling or small colonies. This method produced valuable data on bird behavior, incubation, abandonment, depredation, and disturbance. The game camera collected images of chicks at various stages from hatch through fledge were obtained and a least tern aging guide and chart were created (See Appendix B and guidance documents at: http://flshorebirdalliance.org/resources/bird-guide.aspx).

Least Tern Colony Timing and Duration of Key Events
We monitored ground-nesting least tern colonies at Julia’s Island (Julia’s), Anastasia State Park (Anastasia), Summer Haven, and the Florida Inland Navigation District SJ-1 Dredge Material Management Area (FIND). Nest scraping began on April 16th at Summer Haven and on April 23 at Anastasia, Julia’s Island, and FIND. Nest initiation occurred an average of eight days after scraping was first observed. Peak nest counts for the season were: Julia’s 140, Anastasia 61, Summer Haven 139, FIND 31. The max adult count was 575 and was recorded in early June. The timing of the max adult counts was correlated with the max nest counts and either can be used to estimate maximum breeding adults in the study area (Figure 5).

Figure 5. The peak number of nests observed validated the corresponding adult count.

Both Julia’s Island and Summer Haven lost nests early in the season due to predation & natural disturbance, resulting in the delayed presence of downy chicks. The first downy chick was observed at Summer Haven on May 24th. Julia’s Island had downy chicks on June 2nd. We documented chick counts >20 for three consecutive weeks at Julia’s Island which was followed by a partial colony abandonment most likely due to chick predation events. A sudden drop in observed downy chicks (56 to 6) occurred over a 5 day period after the first wave of hatching had completed (n= 60). Peak downy chick counts (one day totals) were as follows: Julia’s Island: 62, Anastasia: 2, Summer Haven: 31, and FIND: 2. It is possible that
predation was taking place during the entire nest hatching period, limiting the actual number of downy chicks to be observed on a given day.

Feathered chicks appeared at all sites on average two weeks after the first respective downy chick sighting. Peak feathered counts (one day totals) are as follows: Julia’s Island 15, Anastasia 2, Summer Haven 15, and FIND 2. The highest single day count for downy/feathered chicks was on June 16th at Julia’s Island (101 chicks). The first fledge of the season was observed at Julia’s Island on June 29th, followed by observations at Summer Haven on June 30th.

**Black Skimmer Colony Surveys**

We monitored black skimmer colonies along the coast of Southwest Florida in Charlotte, Lee, and Collier County. We conducted behavioral observations focusing on prenesting (scraping, pair forming, feeding), loafing, and breeding black skimmers. Courtship and nesting behaviors, such as scrape digging and egg-shading, were observed and recorded on camera. Behavioral observations showed that incubating and brooding pairs had subtle but distinct key postures when on their nest and/or chicks. Black skimmers still in the prenesting stage could also be observed sitting in their scrape, however their postures deviated from those that had reproduced. Oftentimes heads of prenesting birds would be lowered or at rest and their keel angled low within the scrape. Tail feathers were positioned at an upward angle, or close to the ground. Incubating or brooding black skimmers, on the other-hand, consistently sat in their scrape with an erect head and neck, a level body, and a slightly dropped tail and sometimes wing tips. Incubating black skimmers were also often observed in the aforementioned posture but hovering with slightly splayed wings, under which shaded eggs could often be found.

A photo identification guide for nesting Black Skimmers was produced from photographs of individual birds displaying identifiable reproductive behaviors was produced (Appendix C and guidance documents at [http://flshorebirdalliance.org/resources/bird-guide.aspx](http://flshorebirdalliance.org/resources/bird-guide.aspx)). This photographic guide was incorporated into informational materials aimed at improving nest and chick detection among observers.
DISCUSSION

Least Tern Survey Frequency Data Analysis

Monitoring is central and critical to evaluating effectiveness of management and conservation actions, assessing population status and trends and understanding ecological processes that effect birds. An effective monitoring protocol should consider: 1) maximizing integration of surveys across agencies and organizations; 2) appropriate survey design that incorporates natural history information about focal species; 3) timing and frequency of surveys for monitoring objectives. Typically surveys are timed to capture key events such as peak incubation (as indicated by nests or adults) or chick counts (Jodice et al. 2007, Angehr and Kushlan 2007, Erwin et al. 2003). This information is often used to calculate annual breeding populations and productivity.

Frequent monitoring can improve conservation and management of beach-nesting birds by providing timely information about predation, disturbance, overwash, and movement of birds into an area. The Breeding Bird Protocol for Florida’s Shorebirds and Seabirds encourages monitoring partners to survey breeding shorebirds and seabirds during established monthly survey windows, and recommends weekly surveys where possible. Critical monitoring information (peak nest counts, peak feathered/flight capable chick counts) is used to estimate the statewide breeding population as well as productivity. Both values are used to determine if we are meeting the conservation objectives of the Imperiled Species Management Plan. Our results indicate that weekly surveys increase the probability of capturing peak events during the nesting season (max number of breeding pairs, downy chicks, and feathered and flight capable chicks). This probability drops as survey frequency decreases. In addition, the probability of capturing peak events by only surveying during the count window is low and will fluctuate from year to year based on events such as weather and predation. The study results provide evidence that weekly monitoring will increase our confidence in answering crucial questions about if and how management and conservation efforts are benefiting the protected birds. However, we are aware that not all partners can survey more frequently than the count windows. Even though the probability of catching peak
events during the nesting season is lower with less frequent monitoring, the data collected during the count windows are still valuable contributions to statewide population and productivity estimates. Another way to population and productivity estimates is to improve the accuracy of survey counts.

*Validating Least Tern Counts*

While the camera portion of this study did not lead to a useful colony survey validation technique, we discovered that stationary game cameras do provide important information about predation and bird behavior. For example, the game cameras were used to document least tern nesting behavior during the July 4th firework display over Julia's Island. The images revealed that the majority of least terns were not bothered by the fireworks and were observed to be motionless throughout the entire event. Other least terns in the same colony, however, flew off during the initial start of the event and were captured on stationary game cameras returning in the early morning the following day. Images were collected for 6 nights and we determined that a portion of adults left the colony nightly. This may have been a result of the night predation events at the colony or it may be a normal behavior for adults at this colony. The game cameras are useful tools for answering a lot of questions about bird behavior, however the game cameras, as well as other cameras used during this project were not effective at validating observer counts.

The BBP for conducting direct colony counts for adults, nests and chicks states, “For colony nest counts, the average of at least two counts should be reported on your form. If you are the only observer, count twice and average your counts. If two or more observers are available, each person can count once and the counts can be averaged together. If the counts are significantly different, conduct additional counts until you are confident in your numbers”. We could modify the protocol so that two (or more) observers are surveying together but not comparing counts. In this scenario, two observers are still conducting the survey at the same time, however the counts reported would be collected independently. This approach allows for estimation of observer-specific detection probabilities (Nichols et al. 2000). The challenge with using this method for nest counts is that detection probability is not necessarily the primary cause for the variability in
counts. Often observers are not accurately identifying if birds are nesting so you end up with a lot of false-positives or negatives in the data. One of the ways to improve counts is by referencing the guidance documents produced by this project that outline important adult bird behavioral cues. In addition, count accuracy can be improved by adjusting the timing of the surveys.

The observer relies on the presence of at least one adult bird exhibiting behavior cues in order to detect a nest or a chick. Unfortunately, adults are not always present during colony counts, leading to undetected nests and chicks. The resulting scenario is similar to a temporary emigration scenario which leads to imperfect detection of nests and chicks within a colony (Chandler et al. 2011). This potential circumstance can be minimized by adjusting the timing of surveys to maximize when you expect adults to be present. Nests surveys should be conducted mid-day when adults are more likely to be incubating nests or brooding very young chicks. Surveys that occur at first light will help to maximize chick counts because adults are typically feeding chicks at this time.

Least Tern Colony Timing and Duration of Key Events

Some unusual observations were made this season regarding timing of chicks fledging and moving out of the vicinity of the nesting colony. All sites had high levels of predation which could have encouraged the chicks to leave the colony sooner (4-6 days premature) to escape danger. Feathered chicks can manage short flights but typically stay near the colony at the water’s edge even once they can fly and continue to receive food from adults (Thompson et al. 1997). For example, once chicks became flight capable at Julia’s Island, they dispersed about half a mile to Anastasia State Park, as indicated by timing of observations there. Observations of fledges at Anastasia then continued for several weeks until the Julia's Island colony stopped producing successful fledges due to predation.

Black Skimmer Nesting Behavior

Distinct behaviors were observed in prenesting and breeding black skimmers. Being able to spot nest scraping and other courtship cues is important to discerning that breeding will commence, however, it is vital to improved data collection and the future of the species that observers be able to distinguish between
birds loafing in an empty scrape versus those incubating and brooding. By providing informational resources created during this study, we hope to educate colony surveyors so we can increase the quality and quantity of data collected at black skimmer nesting colonies.

ACKNOWLEDGEMENTS

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LITERATURE CITED


APPENDIX A. The count window calendar from the Breeding Bird Protocol for Florida’s Shorebirds and Seabirds.

<table>
<thead>
<tr>
<th>Count</th>
<th>Dates</th>
<th>Primary purpose</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>March 18-24</td>
<td>Locate early shorebird nests.</td>
<td>Many plovers and American oystercatchers are on nests by mid-March.</td>
</tr>
<tr>
<td>2</td>
<td>April 15-21</td>
<td>Locate early seabird colonies; check status of shorebird nests.</td>
<td>Some seabird colonies begin forming in early April. Plover, willet, American oystercatcher chicks begin to appear.</td>
</tr>
<tr>
<td>3</td>
<td>May 13-19</td>
<td>Locate new nests &amp; colonies and check status of existing ones. Locate shorebird chicks.</td>
<td>May and June represent the peak of nesting season. Seabird chicks present at most colonies by June.</td>
</tr>
<tr>
<td>4</td>
<td>June 10-16</td>
<td>Check the status of all nests &amp; colonies. Count shorebird and seabird chicks.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>July 8-14</td>
<td>Locate new nests &amp; colonies and check status of existing ones. Count chicks and fledglings.</td>
<td>July is often the time when second clutches and re-nesting attempts are initiated.</td>
</tr>
<tr>
<td>6</td>
<td>August 5-11</td>
<td>Count chicks and fledglings.</td>
<td>August represents the tail end of the nesting season when recent fledges are most apparent.</td>
</tr>
</tbody>
</table>
APPENDIX B. Least tern aging chart.

Downy Chicks

Week 1
(1-6 days)

Week 2
(7-13 days)

Week 3
(14-20 days)

Feathered Chicks

Flight Capable

Second year bird
(Non-breeding)

Adults Losing
Breeding Plumage

Breeding
Adults
APPENDIX C. Black skimmer aging chart

- Downy Chicks
  - Week 1 (1-6 days)
- Feathered Chicks
  - Week 2 (7-14 days)
  - Week 3 (15-21 days)
  - Week 4 (22-27 days)
- Flight Capable
  - Week 5 (28-30 days)