Colonial Waterbird Monitoring with Aerial Photographic Surveys in the Northern Gulf of Mexico, 2010–2021

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Executive Summary

This report summarizes colonial waterbird (CWB) monitoring data collected from seven years of aerial photographic surveys in the northern Gulf of Mexico (nGOM) from 2010 to 2021, as requested in the *Monitoring and Adaptive Management Activity Implementation Plan: Colonial Waterbird Monitoring* developed by the Regionwide Trustee Implementation Group (RW TIG) in 2020 (RW TIG 2020). The report summarizes the abundance, distribution, and breeding status of more than 20 CWB species. The monitoring and adaptive management activity implementation plan (RW TIG 2020) also proposed that regionwide surveys be conducted in 2021 from Brownsville, Texas, through the Big Bend of Florida, resulting in the broadest survey coverage among all years. All count data and photographs from all years are available through the Avian Data Monitoring Portal, which can be accessed through a designated link within the *Colonial Waterbird Monitoring* activity (DIVER Project #257) or directly (https://arcg.is/09LCra).

In 2021, more than 450,000 nests (or 900,000 breeding birds; nests multiplied by two) of 33 species were counted throughout the selected region of the nGOM. More than 90% of the nests were in Texas and Louisiana. Individual birds of another 22 species for which evidence of nesting was not observed also were counted. Species with evidence of nesting represented five taxonomic groups, principally seabirds and wading birds, but also raptors (one species), shorebirds (two species), and waterfowl (three species). Laughing Gull (*Leucophaeus atricilla*) was the most abundant species (more than 160,000 nests) followed by Royal Tern (*Thalasseus maximus*), Sandwich Tern (*Thalasseus sandvicensis*), and Brown Pelican (*Pelecanus occidentalis*). More than 53,000 Brown Pelican nests were counted regionwide in 2021. These same four species were the most abundant in all survey years, though their rank varied. Among wading bird species in 2021, White Ibis (*Eudocimus albus*) was the most abundant (> 19,000 nests), with just three colonies (South Deer Island in Texas, Bird Island East in Louisiana, and Gaillard Island in Alabama) accounting for 76% of all nests. Tricolored Heron (*Egretta tricolor*) was the second most abundant wading bird species (> 14,000 nests) and was more widely distributed. The only breeding shorebird species regularly documented in aerial photographs was the American Oystercatcher (*Haematopus palliates*), because of its large size.

Among all survey years, available data (given variable survey coverage) indicate that nest totals appear to have been highest in 2011 and 2018. For example, in Louisiana, notable peaks in statewide nest totals for Brown Pelican and Tricolored Heron were documented in 2018; Laughing Gull and Sandwich Tern peaks seemed to occur in both 2011 and 2018.

Ongoing CWB breeding habitat loss at marsh and barrier islands in Louisiana was well documented. Post-restoration colony count data are discussed for selected islands in Louisiana, Mississippi, and Alabama, including Year 1 post-restoration (2021) data for Queen Bess Island in Louisiana.

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1.0 Introduction

Colonial waterbirds (CWB or waterbird) and their important habitats incurred substantial injuries during and following the 2010 *Deepwater Horizon* oil spill (the Spill) in the northern Gulf of Mexico (nGOM). These injuries were documented, in part, by 2010–2013 aerial photographic surveys (surveys) and subsequent analyses (Colibri and Ford 2015). Colonial waterbirds continue to be affected in the region, especially due to habitat loss at historical nesting islands. To help inform, monitor, and evaluate future restoration, the Regionwide Trustee Implementation Group (RW TIG) developed and implemented the *Monitoring and Adaptive Management Activity: Colonial Waterbird Monitoring* (DIVER 257; RW MAM activity; RW TIG 2020).

Information generated from this RW MAM activity is intended to assist Trustees in the estimation of CWB relative abundance, distribution, and breeding status across selected geographic regions of the nGOM. Implementing the plan involved (1) conducting regionwide aerial photographic surveys and analysis of waterbird nesting colonies in 2021, (2) analysis of 2015 aerial photographs, and (3) summarizing aerial photographic survey data from all survey years (2010–2013, 2015, 2018, and 2021). All survey data were collected by Colibri Ecological Consulting and R. G. Ford Consulting.

This report includes a broad overview of 2010–2021 CWB colony count data in the nGOM, describing the regional distribution and abundance of nesting species, identifying large colonies, discussing restored islands and beneficial use projects, other habitat changes, and annual variation in nest numbers. Distribution and abundance are principally treated in species accounts in Appendix A of the report, for 26 of the 35 species for which nesting was documented during the 2010–2021 period. The other nine species accounted for very few nests and are described in the Introduction of Appendix A.

All data presented in this report are publicly available through the Avian Data Monitoring Portal (https://arcg.is/09LCra) which can be accessed via link within the National Oceanic and Atmospheric Administration's Data Integration Visualization Exploration and Reporting (DIVER) Explorer and the Louisiana Coastal Protection and Restoration Authority's Coastal Information Management System (CIMS). The portal includes an interactive dashboard intended to assist end users' ability to query CWB nest and bird counts by species, survey dates and years, colony, and other spatial criteria. The dashboard also allows end users to view original high resolution aerial photographs that were used for determining colony counts, along with corresponding annotated screen captures. Using designated tabs, end users can download a summary file of nest totals, a Microsoft Access® database of all 2010–2021 count data, a ReadMe file to assist in navigation and understanding of the database, and protocols for surveys and image analysis.

2.0 Methods

2.1 Survey Coverage and Target Species

The spatial extent of aerial photographic surveys varied from 2010 to 2021 (Table 1, Appendix B). In 2010, survey coverage extended from Corpus Christi, Texas, through the Dry Tortugas in Florida. In 2011–2013 and in 2015, survey coverage extended from Vermilion Bay, Louisiana, to a variable endpoint in Apalachicola Bay or western Apalachee Bay, Florida. In 2018, surveys were limited to only Louisiana. In 2021, survey coverage extended from South Texas (near Brownsville) to the Big Bend of Florida.

Colonies were surveyed in both May and June, except in 2010 due to conflicting priorities for air space during oil spill response and because the need for surveys in Texas and Florida was not determined by Trustees until June (Table 1). Only seven colonies were surveyed more than once in 2010, all in Louisiana (see 2.4 Nest and Bird Enumeration (Dotting)). Because south Florida colonies, from Cedar Key (at the southeastern end of the Big Bend coast) to the Dry Tortugas, were surveyed only in June 2010, with no subsequent data for comparison, the associated data are not represented in this report. Numbers of species presented in this report do not include species that were documented only in south Florida, such as Brown Noddy (*Anous stolidus*) and Roseate Tern (*Sterna dougallii*) in the Florida Keys. Nor do total numbers of nests presented in this report include colony counts from south Florida. All south Florida colony counts are available online through the Avian Data Monitoring Portal (https://arcg.is/09LCra).

Target species for this RW MAM activity included colonial-breeding seabirds and wading birds (RW TIG 2020). Target seabirds included but were not limited to Brown Pelican (*Pelecanus occidentalis*), Royal Tern (*Thalasseus maximus*), Sandwich Tern (*Thalasseus sandvicensis*), Caspian Tern (*Hydroprogne caspia*), Gull-billed Tern (*Gelochelidon nilotica*), and Black Skimmer (*Rynchops niger*). Laughing Gull (*Leucophaeus atricilla*) and Forster's Tern (*Sterna forsteri*) were considered secondary target species given the challenges of detecting and completely surveying all colonies (where only these target species breed) in the vast offshore marsh areas of Louisiana. However, at other discrete or traditional colonies both species were surveyed well with aerial photography. Because of their small size, nesting Least Terns (*Sternula antillarum*) were mostly captured in aerial photographs incidentally. However, in 2021, Least Terns nesting on Mississippi and Florida mainland beaches were surveyed for comparison with ground data (Appendix A). Target wading birds included but were not limited to Reddish Egret (*Egretta rufescens*), Little Blue Heron (*Egretta caerulea*), Tricolored Heron (*Egretta tricolor*), Roseate Spoonbill (*Platalea ajaja*), Great Blue Heron (*Ardea Herodias*), and Black-crowned Night-Heron (*Nycticorax nycticorax*). Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), and White Ibis (*Eudocimus albus*) also were surveyed with aerial photography.

Among solitary, breeding shorebird species, only the American Oystercatcher (*Haematopus palliates*) was regularly observed in aerial photographs. Smaller breeding shorebird species such as Wilson's Plover (*Charadrius wilsonia*) typically could not be detected during surveys or during inspection of aerial photographs. Ruddy Turnstone (*Arenaria interpres*), a migrant species with conspicuously contrasting plumage, was the one smaller shorebird species that could be consistently identified in aerial photographs.

Table 1. Survey dates and states by year, including each year's photographers, navigators, and pilot.

Year	May	June	Photographers	Navigators	Pilot	States Surveyed
2010	7–8 17–18	8–9 11–14 23–27	P. Capitolo M. Parker L. Henkel	J. Davis G. Ford G. Himes-Boor	I. Ufford	TX[1], LA, MS, AL, FL[1]
2011	17–20	13–15 17–18	P. Capitolo M. Parker	J. Davis	I. Ufford	LA, MS, AL, FL
2012	27–30	18–21	P. Capitolo M. Parker	J. Davis G. Ford	A. Blasingame	LA, MS, AL, FL
2013	23–25	17–19	P. Capitolo M. Parker	J. Davis	A. Blasingame	LA, MS, AL, FL
2015	16–18	20–22	P. Capitolo M. Parker	J. Davis	A. Blasingame	LA, MS, AL, FL
2018	19–21	23–25	P. Capitolo K. Robison	J. Davis	B. Eastin	LA
2021	17–18 20 22–25	14–20	P. Capitolo J. Medley	J. Reece	J. Blais	TX, LA, MS, AL, FL

[1]Surveyed only in June.

2.2 Colony Inventory

Utilizing colony locality information provided by state and federal agency partners, a geographic information systems (GIS) database of nGOM colony locations was developed by R.G. Ford Consulting in 2010. The GIS database was regularly updated as new colonies were discovered and as former colonies became submerged over time (see 3.2.1 Natural Islands). The GIS database was also imported as a colony inventory table into a relational database of aerial photographic count data (*See Section 2.5 – Archiving and Summarizing Data)*.

Each CWB colony was characterized by a unique Colony Name, typically synonymous with island name, as well as multiple levels of spatial information. When an island name was not known, mostly in Louisiana, colonies were named referencing the closest geographic feature, such as the nearest mainland point from which an island eroded or the bayou in which an island resided. If no nearby geographic feature was distinctive, colonies were named according to the Geographic Region in which they resided and were numbered sequentially (e.g., Terrebonne Bay 1, Biloxi North 3). To better organize colonies across the nGOM and provide possible future analysis areas, 34 Geographic Regions (referred to as GeoRegions in the GIS database and throughout this report) were created from Texas through the Florida Keys (Figure 1). Demarcation of these boundaries was enhanced using the physical and ecological features of the Level IV Terrestrial Ecoregion (EPA 2022) and Level 12 HUC Watershed layers (USGS 2022). Further descriptions of colony naming and colony location information are provided in a ReadMe file available through the Data Management tab within the Avian Data Monitoring Portal (

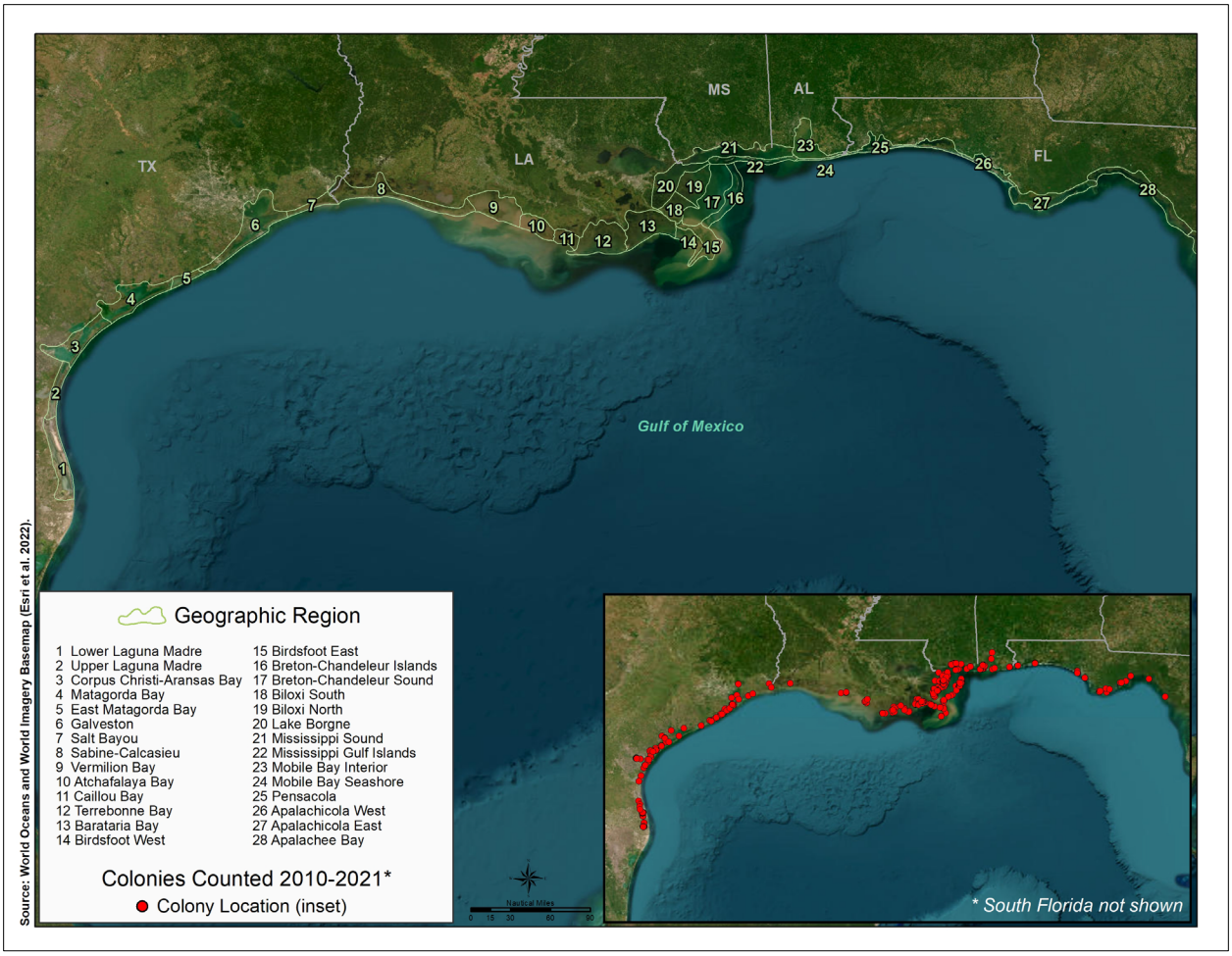

Figure 1. Geographic Regions (GeoRegions) from South Texas to the Big Bend of Florida.

2.3 Aerial Photography

Aerial photographic surveys in the nGOM were conducted with methods adapted from those used in California for long-term monitoring of seabird colonies (Capitolo et al. 2014, 2019; Barton et al. 2017).

Surveys were conducted from a fixed-wing, twin engine, high-wing Partenavia (PN68) Observer aircraft. The Observer model features a plexiglass nose (Figure 2), which allowed the pilot and navigator to see and efficiently approach breeding colonies. The aircraft was equipped with a belly port for vertical/nadir photography and configured such that two photographers could work simultaneously. Oblique photographs through side windows were taken only in May 2010, during the Spill and before the aircraft had been configured for vertical photography. All photographers were familiar with both aerial survey and image analysis protocols, necessary to ensure photograph quality was adequate for determining colony counts of nests and birds (*See Section 2.4 - Nest and Bird Enumeration (Dotting)*). Surveys typically were flown at altitudes of 700 to 1000 feet above ground level at a ground speed less than 90 knots. As of 2021, full-frame,

digital single-lens reflex cameras (Canon® EOS-1D X Mark III) equipped with zoom and prime lenses (focal length range = 16–300 millimeters) were used to acquire photographs. Digital crop-sensor cameras (Canon® D series) were used in previous years. Ground sample distances were typically < 1 cm, with longer focal length lenses needed on full-frame cameras. Aircraft waypoints and time were recorded automatically at intervals of 5 seconds or less. Photograph times were downloaded from exchangeable image file format (EXIF) data, and image file names were interpolated into tracklines to estimate the position of each photograph. As of 2021, latitude and longitude coordinates of photographs, generated from a global positioning system unit attached to each camera, were included among EXIF data.

Survey crews consisted of a pilot, a navigator/data recorder in the co-pilot's seat, and two photographers in the rear of the plane (Table 1). The navigator coordinated with the pilot to determine the sequence of colony visits. During transit between known colonies, observers in the aircraft also searched the surroundings for other potential CWB breeding habitat or conspicuously active new breeding colonies. Similarly, colonies that had become submerged over time were still approached during surveys so that other nearby potential breeding habitat could be inspected (see 3.2.1 Natural Islands). One photographer captured context photographs showing a relatively wide-area view of colonies, while the other photographer concentrated on taking more detailed close-up shots. The context photographer also typically zoomed in to obtain mid-focal length coverage, often useful for counting nests and birds. The navigator recorded the aircraft altitude, the range of frame numbers shot for both cameras for each pass over a colony, and any relevant notes about colonies.

As the aircraft approached a target colony, the crew determined the spatial distribution of birds at the colony. Photographers, navigator, and pilot conferred to determine the best angle of approach and the ideal altitude for photographic census. Altitudes and flight paths were determined based on the extent of the colony, the species present at the colony, the strength and direction of the wind, vegetation around the colony, and angle of the sun. Multiple approaches from different directions or altitudes were often necessary to obtain sufficient photographic coverage. For example, colony areas which included only larger species such as Brown Pelican could be surveyed first from an altitude of about 1000 feet, followed by areas with smaller CWB such as terns at around 700 feet. Lower altitudes were avoided to prevent disturbing breeding birds. For optimal lighting, photography was typically conducted from approximately 3 hours after sunrise to 3 hours before sunset, when solar altitude was at least about 35 degrees. Photographs (Joint Photographic Experts Group [JPEGs]) were downloaded daily to external data-storage devices.

Figure 2. The Observer model of a Partenavia aircraft.

2.4 Nest and Bird Enumeration (Dotting)

Photographs from May and June surveys were evaluated for their representation of peak breeding by each species at a given colony. For some species, such as Brown Pelican and Great Egret, photographs from May surveys often represented peak breeding numbers and were selected for analysis. For other species, especially Black Skimmer, photographs from June surveys better represented peak breeding numbers and were used for analysis. On occasion, in all years, May and June nests counts of different nesting groups within a colony needed to be summed to obtain a total number of nests and the best estimate of breeding population size for a certain species. For example, Brown Pelican, Royal Tern, and Sandwich Tern sometimes had large, well-developed nesting groups that were counted using May photographs, but also new nesting groups that formed after the May survey that were counted from June photographs. Instances of summing May and June nest totals occurred for 20 CWB species (Appendix A; Avian Data Monitoring Portal (https://arcg.is/09LCra)).

All images of each individual colony were inspected for clarity, location within the colony, and extent of colony coverage. Those best suited for determining nest counts and collectively comprising all breeding areas were analyzed using counting software (Image-Pro, Media

Cybernetics®). Nests and birds were marked manually ("dotted"), and the software automatically tallied total counts for each category (See ReadMe and Dotting Protocol). Although the primary objective was to determine numbers of nests, individual adult and subadult birds within colonies were also counted.

For Brown Pelicans, nests were categorized based on stage of development:

1. Well Built Nest (with attending adult typically in incubation posture)
2. Poorly Built Nest (pre-egg laying, but considered a breeding pair)
3. Nest with Chicks, with attending adults
4. Nest with Chicks, without attending adults
5. Brood (dependent chicks away from an obvious nest and not attended by an adult)
6. Abandoned Nest (with eggs, but unattended)
7. Empty Nest (unattended and without eggs or chicks)
8. Territory (in breeding habitat and territorial spacing, but not judged to be a breeding pair)

Together, these categories often provided numbers of pelican nests at a colony from a single survey, even though egg laying dates may have spanned a period of months, given that chicks do not fledge until they are approximately three months old. Empty Nests and Territories were not included in colony nest totals because they were not considered to have been, or to have later become, egg laying sites and therefore were not considered appropriate to include in a breeding population estimate.

Because of their small body size (e.g., terns and gulls), scrape-nesting habits (e.g., terns and skimmers), or partial concealment by vegetation (e.g., waders and gulls), the various nest categories used for pelicans could not always be identified for other species. Therefore, due to the lack of consistently visible nest structures, a bird in incubation posture for all other species was typically categorized as a Site (See ReadMe). For the 2021 image analyses, however, the three nest categories indicating the presence of chicks (categories 3, 4, and 5 in the above list) were used in a standardized manner for all species, not just for Brown Pelicans. The ReadMe file available through the Data Management tab within the Avian Data Monitoring Portal (https://arcg.is/09LCra) specifies the use of nest categories since 2010.

Marking a nest category also accounts for an attending adult, rather than marking the nest and the bird separately. Other birds were also counted, such as a second adult attending a nest, or birds along the shoreline or in colony areas not obviously associated with a breeding group (See ReadMe). Doing so allowed the total number of birds in attendance at the time of the survey to be summed and forced the photo analyst to inspect all attending birds closely for possible breeding status. Exceptions included roosting birds in non-breeding habitat, which were not always dotted due to time constraints. However, these areas were still closely inspected to ensure they did not include chicks that had wandered away from nests that otherwise may not have been accounted for.

Using the dotting annotation software, unique symbol-color combinations were assigned to different nest and bird categories for each species. Where overlapping images were used to analyze portions of a colony, one or more lines were drawn on the selected image to delineate the area to be counted using that image. Areas outside any such lines were counted using different images. This process continued until the colony was counted completely with available photographs.

2.5 Archiving and Summarizing Data

After analyzing each image, a screen capture was saved as a JPEG file. Screen captures showed all manual markings of nests and birds, as well as total counts for each category. Image number, colony name, area number, photo analyst initials, the date the image was analyzed, and any other text annotations are also included. All screen captures were archived with standardized file names in colony-specific folders.

Data from each screen capture were manually entered into a table in a Microsoft Access® database (See ReadMe). Queries were designed to calculate total numbers of nests and birds for individual species or for all species combined at an individual colony. Nest totals can also be queried by GeoRegion and state. Annual, statewide nest totals for individual species are provided in Appendix A. The database and related information are available using the Data Management tab at the Avian Data Monitoring Portal (https://arcg.is/09LCra).

2.6 Statistical Analyses

Statistical analyses were not within the scope of this report. Models could be developed to generate 95% confidence intervals and temporal estimates of percent change for nest totals for species at individual colonies, colony complexes, or regions of interest (Capitolo et al. 2014, 2019; Barton et al. 2017).

3.0 Results

3.1 Nest Counts

3.1.1 Overview

During the seven survey years processed from the 2010–2021 period, over 1.9 million nests of 35 species of birds were documented at approximately 326 colonies, excluding South Florida (i.e., Cedar Key to the Florida Keys along Florida's western coast) data from 2010 (Appendix A; Avian Data Monitoring Portal, https://arcg.is/09LCra). For another 27 species, individual birds were occasionally documented in the aerial photographs, but no evidence of nesting was detected. The 35 nesting species represented five taxonomic groups, principally seabirds and wading birds, but also raptors (one species), shorebirds (two species), and waterfowl (three species). In 2021, 456,049 nests of 33 species were documented, equivalent to more than 900,000 breeding birds (nests multiplied by two). Of those nests, 49% were in Louisiana representing 23 species, 43% were in Texas representing 27 species, 5% were in Alabama representing 20 species, 3% were in Florida representing 17 species, and < 1% were in Mississippi representing six species. The most abundant species in 2021 were Laughing Gull, Royal Tern, Sandwich Tern, and Brown Pelican (Figure 3).

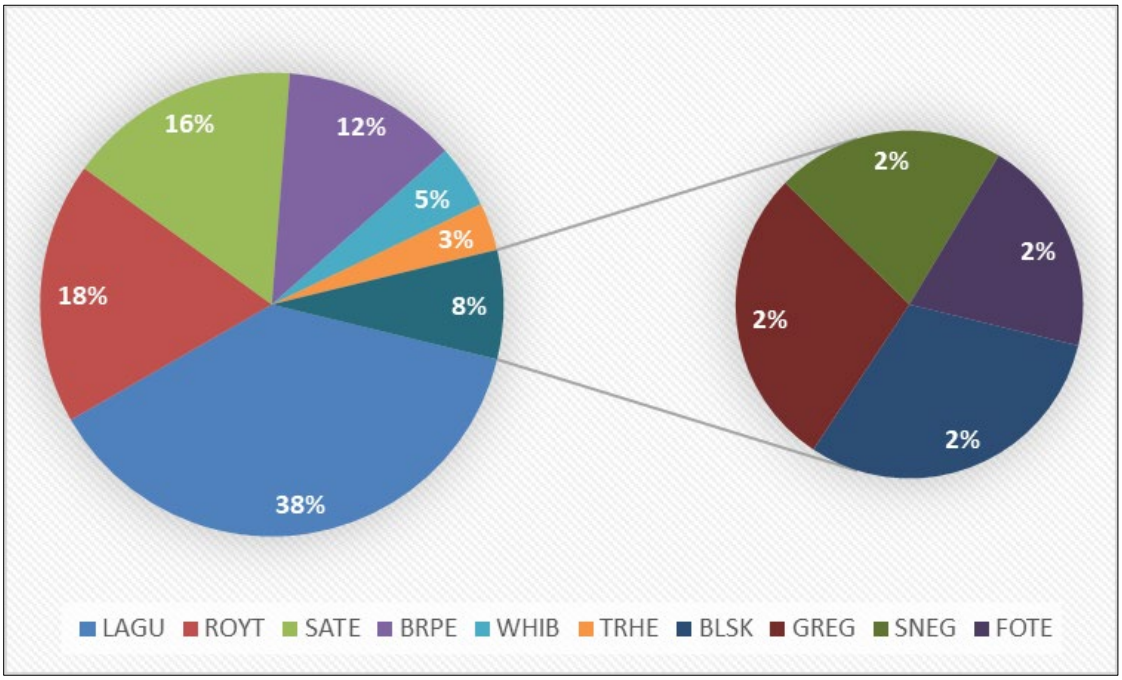

Figure 3. Percentages of the total number of nests counted regionwide in 2021 for the 10 most abundant species. Pie chart on the right is an expansion of the 8% from the left chart. *Species Codes: LAGU = Laughing Gull; ROYT = Royal Tern; SATE = Sandwich Tern; BRPE = Brown Pelican; WHIB = White Ibis; TRHE = Tricolored Heron; BLSK = Black Skimmer; GREG = Great Egret; SNEG = Snowy Egret; FOTE = Forster's Tern.*

3.1.2 Largest Colonies

Among all years, eight colonies had at least one annual count of more than 20,000 nests. Raccoon Island, in the Terrebonne Bay GeoRegion in Louisiana, was the largest colony, with more than 50,000 nests in 2011 and more than 60,000 nests in 2018. Five of the colonies had high species richness (> 10 breeding species), namely North Deer Island in Texas (Galveston); Raccoon, Felicity (Terrebonne Bay), and Queen Bess (Barataria Bay) islands in Louisiana; and Gaillard Island in Alabama (Mobile Bay Interior). Gunn Island (Birdsfoot East), North Breton Island, and one colony at Chandeleur Islands North (Breton-Chandeleur Islands), all in Louisiana, also exceeded 20,000 nests, but with fewer breeding species (Figures 4 and 5).

At the Chandeleur Islands North and South colony groups(within the greater Breton-Chandeleur Islands GeoRegion), tern and skimmer colony locations shifted annually and were named with letters from north to south (See ReadMe file at the Avian Data Monitoring Portal, https://arcg.is/09LCra). At Chandeleur Islands South, all colonies therein exceeded 20,000 nests in 2015 and 2018, though no individual colony did (Figures 6 and 7). In 2018, the colonies from Gunn Island north through Chandeleur Islands North totaled nearly 80,000 nests (Figure 7).

Rabbit Island (Sabine-Calcasieu) and Houma Navigation Canal Island (Terrebonne Bay) in Louisiana, major colonies where restoration has been completed and is planned, respectively, did not have a count of 20,000 nests but also had high overall species richness (Figures 4 and 5).

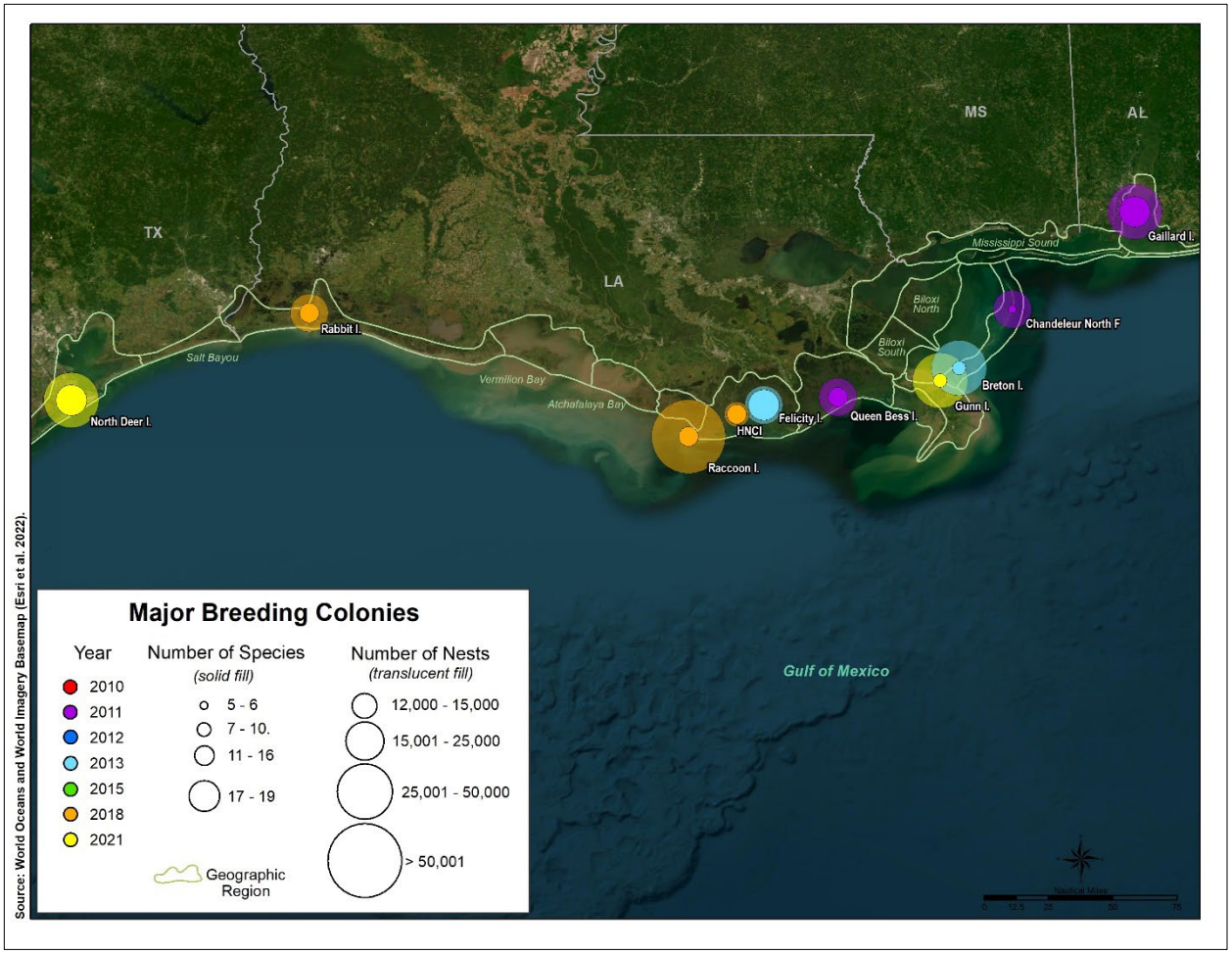

Figure 4. Year of the largest nest total and the total number of breeding species documented at 10 major colonies, eight with at least one count of > 20,000 nests, 2010-2021, plus Rabbit Island and Houma Navigation Canal Island, given completed and planned restoration, respectively.

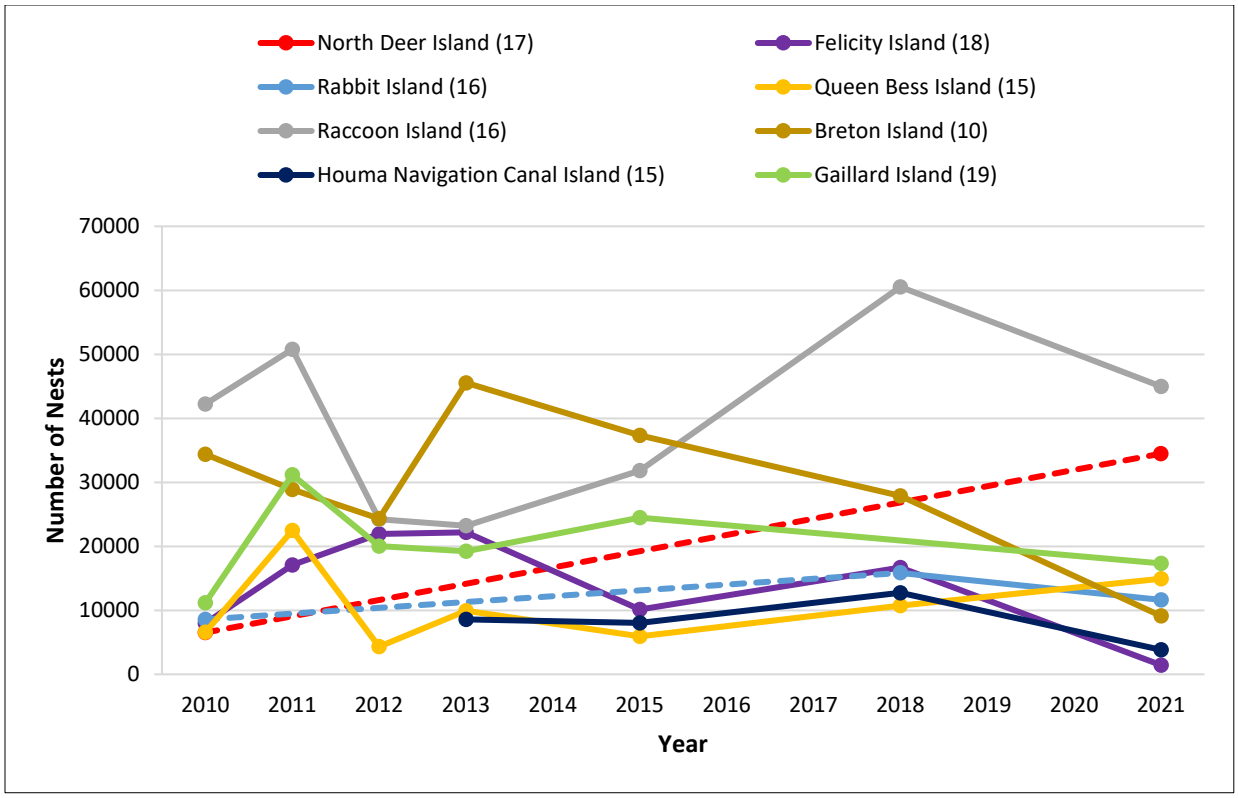

Figure 5. Total numbers of nests counted at eight major colonies with high species richness, 2010–2021. *(X) = number of species; Dashed line = colony not in survey area that year.*

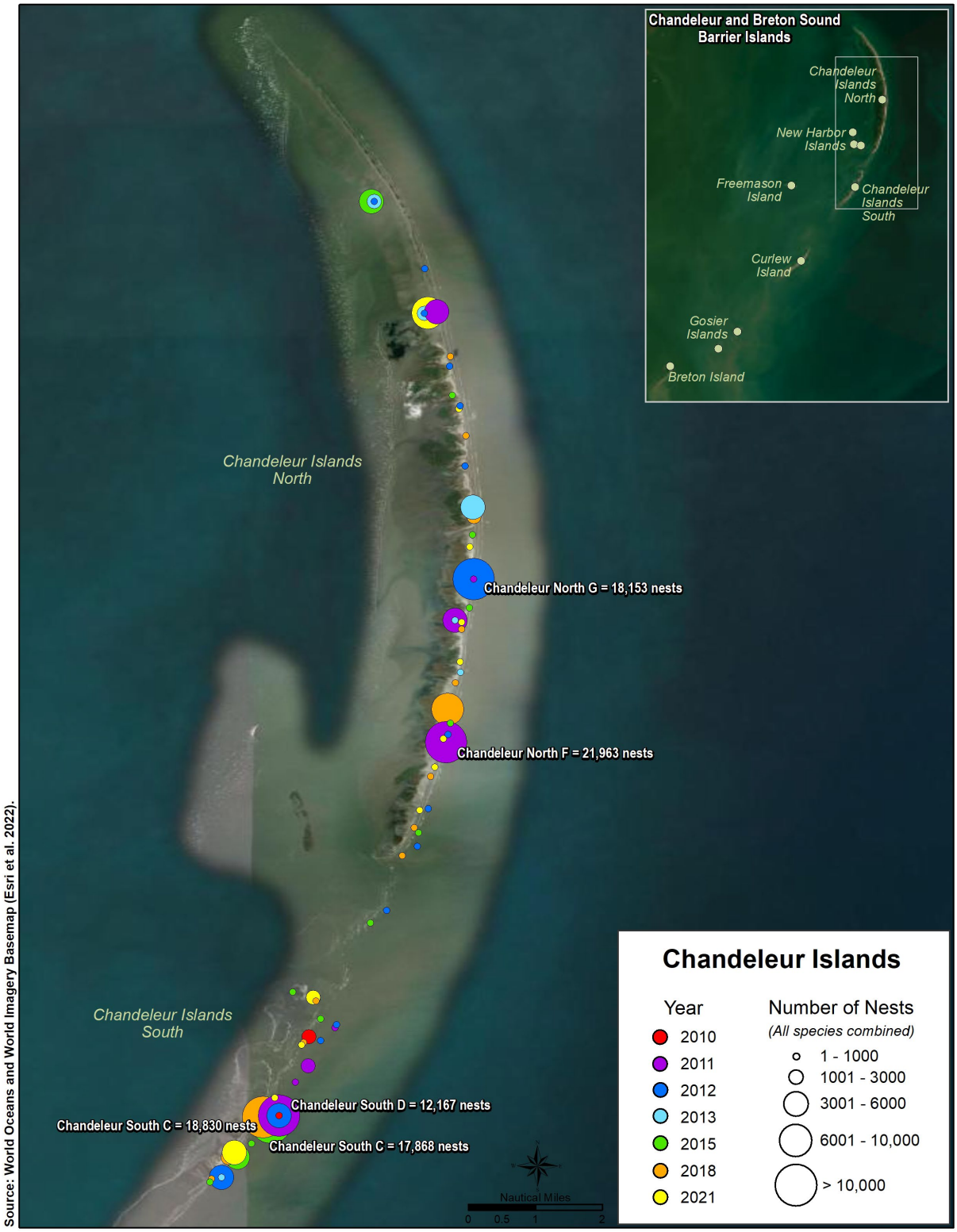

Figure 6. Annual locations and sizes of colonies in the Chandeleur Islands North and South groups.

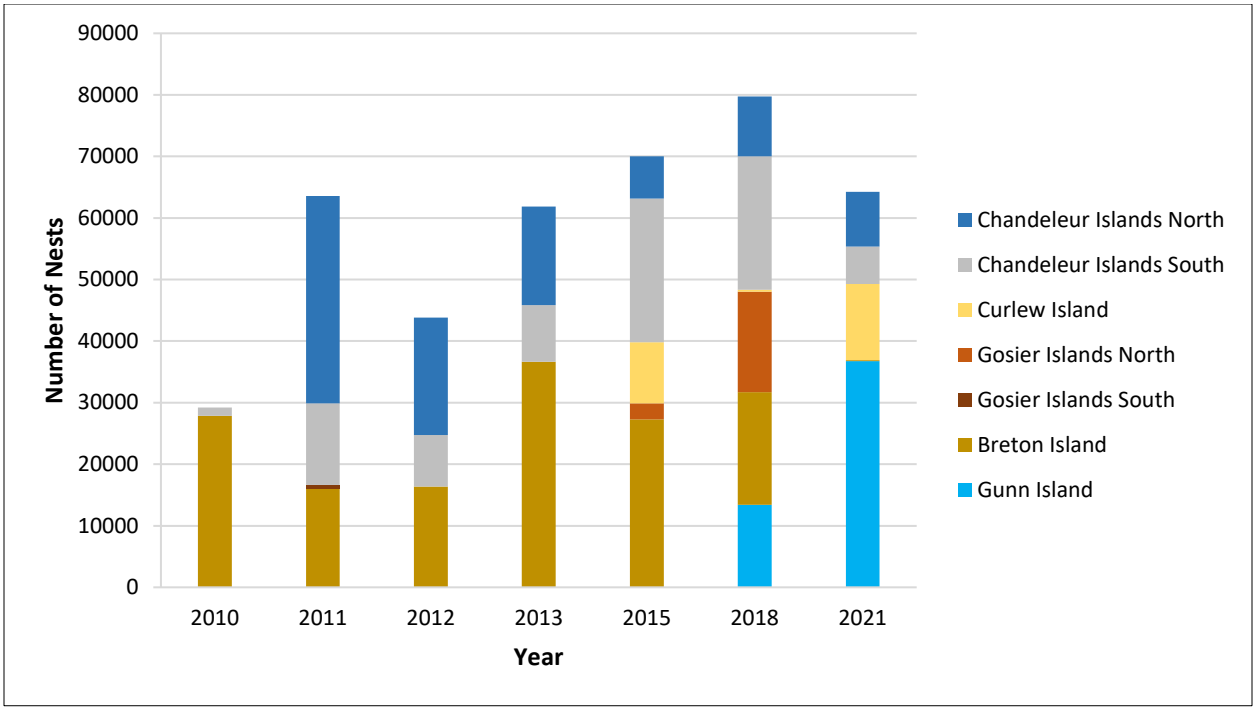

Figure 7. Total numbers of nests of Black Skimmer and all tern species combined in the Breton-Chandeleur Islands GeoRegion, including Gunn Island from the nearby Birdsfoot East GeoRegion. Small numbers of skimmer nests in certain years at Freemason Island and New Harbor Island 1 are not included.

In Texas, aside from North Deer Island (Figures 4 and 5), the other largest colonies were Shamrock Island, Black Skimmer Strip (Corpus Christi-Aransas Bay), Evia Island, South Deer Island (Galveston), and Lavaca Bay Spoils E (Matagorda Bay), each with more than 10,000 nests in 2021. Chester Island (Matagorda Bay) fell just short of 10,000 nests, and another 21 colonies had more than 1000 nests. Most of the region's Reddish Egrets nested in Texas, with white morphs outnumbering dark morphs in the Laguna Madre GeoRegions. At White Pelican Island (Upper Laguna Madre), the only American White Pelican (*Pelecanus erythrorhynchos*) colony in the nGOM, 725 nests were counted in 2021, a sum of May and June counts of distinct groups.

In Louisiana, in addition to the largest overall colonies described above (Figures 4–7), several other colonies or regions were important for individual species. For example, the largest colony of White Ibis (range: 1855 nests in 2011 to 9843 nests in 2021) was in Atchafalaya Bay every year, though the island where the colony was found changed over time. The largest Black Skimmer colonies were typically on newly constructed dredge spoil islands in the Birdsfoot GeoRegions.

In Mississippi, the largest colony was at Ship Island (Mississippi Sound Gulf Islands) in 2021, following its restoration. At New Round Island (Mississippi Sound), few nests were documented in 2021 aerial photographs,. See Section *3.2.3 – Restored Islands and New Beneficial Use Projects* for further details about both colonies.

In Alabama, aside from Gaillard Island (Figures 4 and 5), Marsh Island became a large colony by 2021 after it was restored by 2018, while Cat Island nesting declined as the island shrank and vegetative cover decreased over time. Both colonies are in the Mississippi Sound GeoRegion.

In Florida, Saint George Causeway (Apalachicola East) was the largest colony in all years, although it was not surveyed in 2011. Brown Pelicans were first documented nesting there in 2013. By 2021, the pelican colony size had doubled to 1076 nests.

3.1.3 Annual Variation

Annual variation in nest totals was evident at individual colonies (Figure 5) as well as for individual species at those colonies and regionwide. In Louisiana for example, Brown Pelican (> 38,500 nests) and Tricolored Heron (> 11,500 nests) had clear peaks in statewide nest totals in 2018. Laughing Gull and Sandwich Tern nest totals were at similar peak levels in Louisiana in both 2011 and 2018 (Appendix A; Avian Data Monitoring Portal, https://arcg.is/09LCra).

Annual variation in average timing of breeding was also noted for Brown Pelican, given the consistent use of chick nest categories for that species (Appendix A). At five major Brown Pelican colonies in Louisiana, the percentage of nests with visible chicks was much higher in 2018 than in 2015 and 2021. Most of these colony counts were determined from May photographs, but in 2021 three of the five were determined from June photographs. These data indicate that nesting peaked earlier in 2018. Similarly, at Gaillard Island in Alabama, timing of breeding was on average later in 2021, with just 4% of nests with visible chicks in June, compared with 20% in May 2015 (see 2.4 Nest and Bird Enumeration (Dotting) and Appendix A).

3.2 Habitat Loss

3.2.1 Natural Islands

Habitat and land loss at CWB breeding colonies that was documented during the 2010–2013 period (Colibri and Ford 2015) and was most conspicuous among islands located within Louisiana's vast offshore marshes. All five colonies in Barataria Bay, Louisiana, for which land loss was previously quantified, have since been submerged (identified with an "S_" prefix to their ColonyID in the Microsoft Access® database (https://arcg.is/09LCra), as have another seven Barataria Bay islands that supported waterbird colonies (Table 2). Among these 12 submerged islands, seven had a maximum combined count of 2597 Brown Pelican nests in 2012. Similarly, a maximum combined count of 825 Tricolored Heron nests was documented among six of the islands in 2011. Colonies with nesting Brown Pelicans and Tricolored Herons were all in the vicinity of Cat Bay and Bay Ronquille, within Barataria Bay. For Roseate Spoonbill, 102 nests were counted at Cat Bay Island in 2010, but only one nest was counted at Cat Bay Island North in 2013, and no nests were counted thereafter among these Barataria Bay islands. Four of the 12 islands, three in western Barataria Bay and Manilla Island in north Barataria Bay, had habitat for Forster's Tern.

Table 2. Submerged breeding colonies in Barataria Bay and Terrebonne Bay, Louisiana, 2010–2021.

GeoRegion	Colony Name	Max Nest Count (Year)	Primary Species[1]	Submerged By[2]
Barataria Bay	Barataria Bay 7	160 (2011)	FOTE, LAGU	2019; tidally inundated by 2015
	Barataria Bay 6	194 (2011)	FOTE	2019; present through 2016
	Barataria Bay 5 AB	503 (2018)	FOTE	2019
	Manilla Island	650 (2012)	FOTE	2021
	Grand Island Point	1543 (2011)	ROYT, LAGU, TRHE, BRPE	2016
	Bay Ronquille NE I.	683 (2011)	LAGU, BRPE, TRHE	2015
	Bay Ronquille NW I.	2406 (2011)	LAGU, TRHE, BRPE, BCNH	2018
	Cat Bay North Island	1673 (2011)	BRPE, LAGU, ROYT	2018
	Cat Bay Island	1922 (2010)	BRPE, GREG, ROSP	2018
	Cat Bay South Island	6072 (2012)	ROYT, LAGU, SATE, BRPE	2018
	Barataria Bay 13	207 (2013)	FOTE, TRHE	2018; present through 2016
	Barataria Bay 3	131 (2012)	BRPE, ROSP	2016; tidally inundated by 2015
Terrebonne Bay	Raccoon Island West	1819 (2011)	BLSK	2019
	Wine Island	8678 (2010)	ROYT, SATE, BLSK	2021
	Little Bird Island[3]	2 (2013)	AMOY	2019; tidally inundated by 2015
	Terrebonne Bay 8[3]	1289 (2013)	SATE, ROYT	2019; tidally inundated by 2015
	Terrebonne Bay 1[3]	8656 (2013)	SATE, ROYT, LAGU, BRPE	2019; present through 2015
	Pelican Island	847 (2011)	BRPE	2018; tidally inundated by 2015

[1]Species Codes: FOTE = Forster's Tern; LAGU = Laughing Gull; ROYT = Royal Tern; TRHE = Tricolored Heron; BRPE = Brown Pelican; BCNH = Black-crowned Night-Heron (*Nycticorax nycticorax*); GREG = Great Egret; ROSP = Roseate Spoonbill; BLSK = Black Skimmer; SATE = Sandwich Tern; AMOY = American Oystercatcher. [2]As determined from surveys and inspection of available satellite imagery (Google 2022); present indicates that land was still visible above water in satellite imagery. [3]Little Bird Island, Terrebonne Bay 8, and Terrebonne Bay 1 were not surveyed in 2010–2012.

In Terrebonne Bay, Louisiana, six islands, including Pelican Island and Wine Island (Table 2, Figures 8 and 9), are now submerged, and another, Felicity Island, is greatly reduced in size (Figure 10). Among the six submerged islands, three had a maximum combined count of 994 Brown Pelican nests in 2011, and two had a maximum combined count of 8674 tern nests in 2013. Felicity Island had much higher species richness than the other six islands, with 17 species documented nesting on the island during the 2010–2021 period. Annual declines in nest totals at Felicity Island correlate with a gradual land loss by submersion starting around 2012. The highest combined nest totals of all breeding species on Felicity Island were > 20,000 nests in 2012 and 2013 (Figures 4 and 5), when the highest counts of Brown Pelicans (2620 nests in 2012) and Royal and Sandwich Terns (8497 nests in 2013) occurred. As habitat was lost at Felicity Island, nesting birds appeared to have moved to Philo Brice Islands by 2018, which also has shrunk substantially since 2010. Philo Brice Islands, about 12 km southeast of Felicity Island, was not an active colony during the 2010–2015 period. In 2018, more than 10,000 nests were counted, representing 14 CWB species.

In the Breton-Chandeleur Islands GeoRegion, mangrove habitat at New Harbor Island 1 and 2 largely disappeared, with pelican nesting shifting to New Harbor Island 3. By 2021, New Harbor Island 1 was reduced to mostly sand with little vegetation and New Harbor Island 2 consisted of just a small mangrove patch nearly submerged. Curlew Island, which hosted an estimated 5200 Brown Pelican nests in 1999 before being submerged by 2004 (Selman et al. 2016), re-emerged and was used by nesting skimmers and terns in 2015, 2018, and 2021.

In the Biloxi North and South GeoRegions, at least 10 islands have been submerged. Colony sizes were smaller than in Barataria Bay and Terrebonne Bay, and species composition differed. Primary nesting species at Biloxi Marsh submerged colonies were Laughing Gull, Forster's Tern, Caspian Tern, Gull-billed Tern, and Black Skimmer.

Other Biloxi Marsh colonies were not yet submerged by 2021 but had experienced dramatic habitat and land loss. At Martin Island, nesting Brown Pelicans had been documented by Louisiana Department of Wildlife and Fisheries in most years from 1998 to 2008 but not in 2009 and 2010 (Selman et al. 2016). In June 2010, 155 Brown Pelican nests were documented from aerial photographic surveys (Appendix A). After 2010, however, Forster's Tern, Laughing Gull, and Black Skimmer were the only breeding CWB species on the island. The island was reduced to a sandbar without vegetation by 2021, when no CWB species nested. Similarly, several wading bird species had nested at Biloxi South 11, as had Brown Pelican in 2012 and 2013, but no nests of any CWB species were documented in 2018 and 2021. Land loss was also conspicuous at Hell Pass Coast in Biloxi North, where the colony group fragmented from three islands in 2010 into five islands over time, one of which was mostly submerged in June 2021.

Outside of Louisiana, similar trends in nesting habitat loss were noted at Cat Island in Alabama. Due to land and vegetation loss, only terns and skimmers were observed nesting there by 2021.

3.2.2 Dredge Spoil Islands

In Texas, most colonies occurred on dredge spoil islands. However, with variable survey coverage only in 2010 and 2021, changes at those islands were not readily evident.

In Louisiana, existing and newly created dredge spoil islands in Vermillion Bay and the Birdsfoot GeoRegions that provided nesting habitat for terns and skimmers became increasingly vegetated over time, leading to reduced nesting and eventual colony abandonment (Appendix A).

In Alabama, habitat loss was not noted at Gaillard Island. The dredge spoil island was created in 1981 and has been a regular site for deposition of spoils from dredging of the Theodore Ship Channel (Landin 1987, USACE 2021).

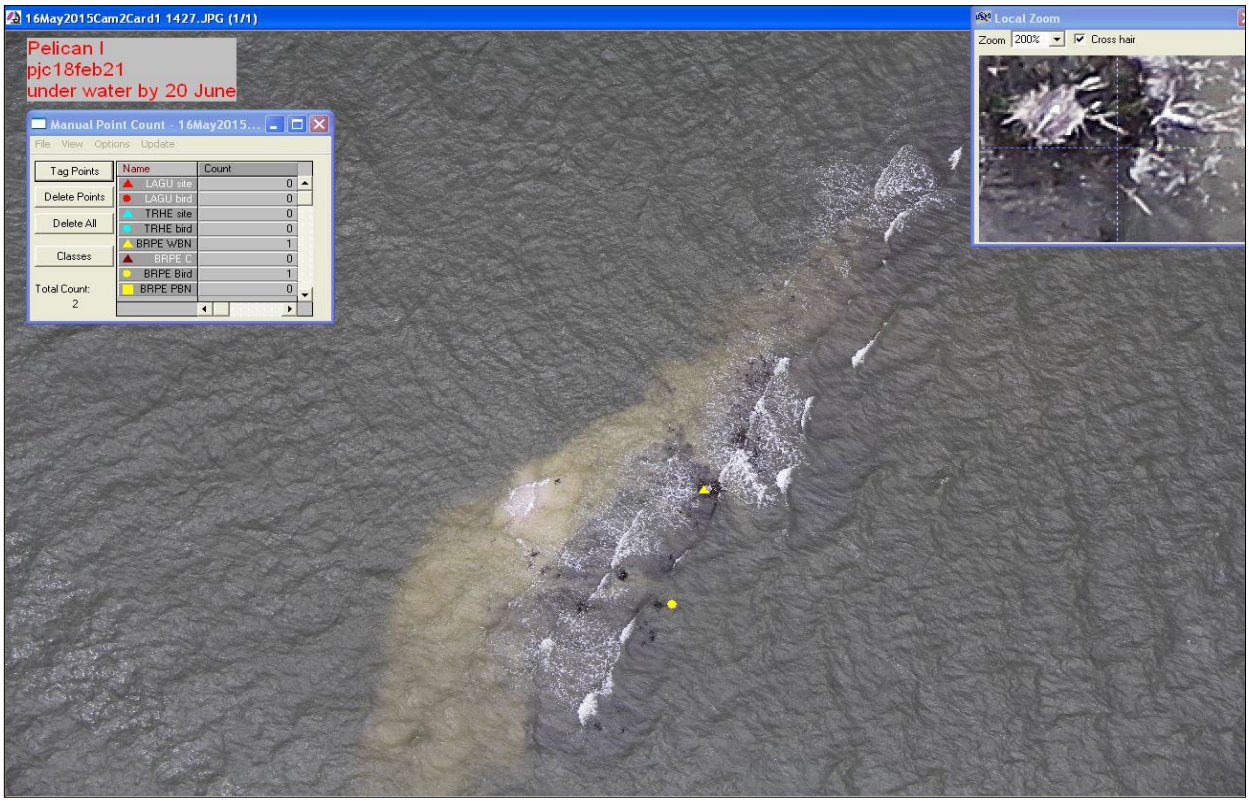

Figure 8. Screen capture of a single Brown Pelican nest at tidally inundated Pelican Island in Terrebonne Bay, Louisiana, May 2015.

Figure 9. Remnants of Wine Island in Terrebonne Bay, Louisiana, June 2018.

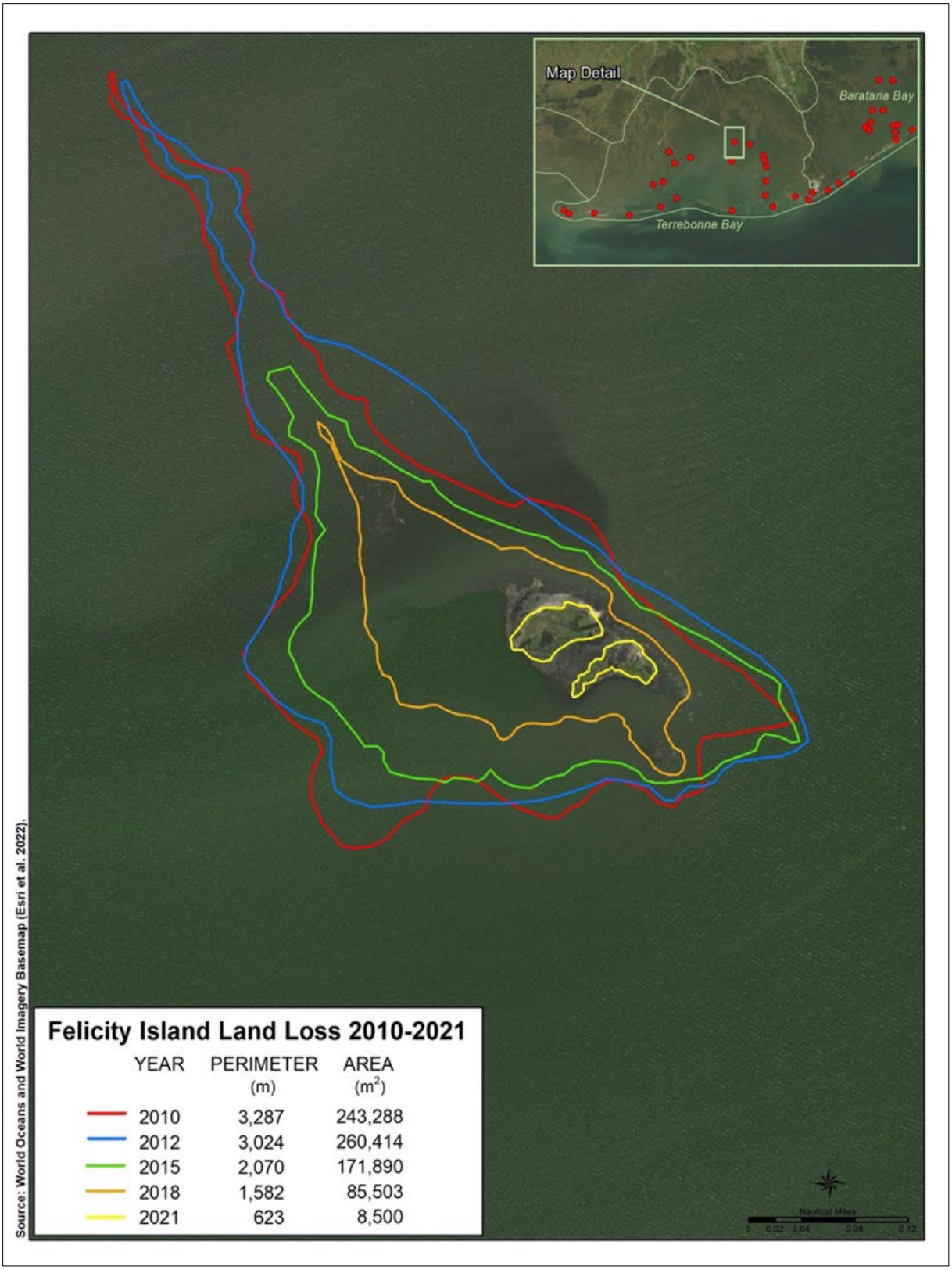

Figure 10. Land loss at Felicity Island in Terrebonne Bay, Louisiana, 2010–2021. Google Earth imagery was used for shoreline delineation, but tidal heights for each image are unknown.

3.2.3 Restored Islands and New Beneficial Use Projects

Since 2015, broad-scale restoration and beneficial use projects resulted in conspicuous changes in waterbird distribution and abundance over time at several colonies. Aerial photographic survey data for selected colonies in Louisiana, Mississippi, and Alabama are discussed below (Table 3). In Texas, because surveys were conducted only in 2010 and 2021, with a more limited survey area in 2010, it was not possible to readily detect which islands had been recently restored or assess changes in bird distribution and abundance.

Table 3. Approximate timing of restoration or creation (shaded cells) of selected islands and aerial photographic surveys (airplane symbol). Years are divided into thirds.

State	Colony Name	2015			2016			2017			2018			2019			2020			2021		
Louisiana	Rabbit Island		✈									✈									✈	
	Whiskey Island		✈									✈									✈	
	Queen Bess Island		✈									✈									✈	
	Shell Island East		✈									✈									✈	
	Gunn Island		✈									✈									✈	
	Breton Island		✈									✈									✈	
Mississippi	Ship Island		✈																		✈	
	New Round Island		✈																		✈	
Alabama	Marsh Island		✈																		✈	

Rabbit Island

From 1955 to 2020, Rabbit Island, Louisiana's westernmost Brown Pelican breeding colony, lost roughly 35% of its 200-acre footprint due to a host of environmental and anthropogenic factors. Restoration took place from September 2020 to April 2021. Dredged sediment from the Calcasieu Ship Channel was used to restore island elevation, and native vegetation was planted throughout the project footprint (165 acres; NOAA 2021). CWB species and nests were documented by aerial photographic surveys in 2010, 2018, and 2021.

The total number of nests at Rabbit Island was 27% lower in 2021 than in 2018 (Figure 5). The timing of nest initiation occurred later than in 2018 also. For example, colony counts in 2021 were derived from June survey photographs, and no Brown Pelican nests had visible chicks, whereas 9% of nests had visible chicks in May 2018. Collectively, it appears that ongoing restoration activities which concluded in April 2021, several weeks into the typical nesting season, contributed to these observations.

For 2018 and 2021, Rabbit Island counts were categorized by subcolony. Subcolonies in 2018 were named Southeast Quadrant, Northeast Shore, East Central Shore, and South Shore. In 2021, they were named Interior Marsh, Northeast Restored area, South Marsh, and Western Restored Area. The east-west channel through the island was used as a border. These data can be queried

from the Microsoft Access® database located within the Avian Data Monitoring Portal (https://arcg.is/09LCra). The most notable change observed was that Brown Pelican nesting shifted from the Southeast Quadrant in 2018 to the Northeast Restored Area in 2021.

Though not present in either 2010 or 2018, Black Skimmer, Caspian Tern, Royal Tern, and Sandwich Tern all nested in 2021. Additionally, Forster's Tern nest numbers were nearly four times higher in 2021 than in 2018.

Among wading birds, six species nested at Rabbit Island in 2021 (Tricolored Heron, Snowy Egret, Great Egret, Black-crowned Night Heron, Reddish Egret, and Roseate Spoonbill). Great Blue Heron and White Ibis had nested in previous years but were absent in 2021. Rabbit Island remained the largest Tricolored Heron colony regionwide (1840 nests).

For more information, see Rabbit Island Restoration Project.

Whiskey Island

Restoration of Whiskey Island, also known as the Caillou Lake Headlands Barrier Island Restoration, began in October 2016 and was completed 25 April 2018, followed by sand fencing installation and vegetation planting in subsequent years. Beach, dune, and back-barrier marsh habitats were restored. From 2010–2021 aerial photographic surveys, CWB nesting was detected only in 2018, just a month following completion of construction. Breeding Black Skimmers (780 nests) and Gull-billed Terns (100 nests) were counted from photographs from the 21 May survey. Far fewer birds were present in June, though the photographs were not analyzed to determine nest counts. In earlier years, Whiskey Island may not have been completely inspected in both months (see the Black Skimmer species account in Appendix A).

For more information, see Louisiana Outer Coast Restoration Project.

Queen Bess Island

Prior to restoration, Queen Bess Island had approximately 5 acres of nesting habitat available but still supported one of Louisiana's most productive Brown Pelican colonies. Island restoration was initiated in the summer of 2019 and completed in February 2020, creating 30 acres of Brown Pelican habitat and 7 acres of habitat for tern species and Black Skimmers (CPRA 2020). For 2015, 2018, and 2021, all Queen Bess Island counts were categorized by subcolony. Subcolonies included Cells 1, 2, and 3, as well as a separate subcolony for count areas along the levee separating Cell 1 from Cell 2. These data can be queried from the Access database at the Avian Data Monitoring Portal (https://arcg.is/09LCra).

In 2021, nearly all of the 3425 Brown Pelican nests counted were in Cell 1 and along the levee separating Cell 1 from Cell 2. No nests were in Cell 3. The 2021 nest total was 50% lower than the 2018 total (6830 nests), which was the highest among all years. Just 3% of nests had visible chicks in May 2021, compared with 64% of nests in May 2018 (Appendix A). Brown Pelicans also

nested at Mendicant Island, 1 km west of Queen Bess Island, in 2021, the only year nesting was documented there. A total of 373 nests were counted, along with twice as many empty nests.

In 2021, Royal and Sandwich Tern appeared to benefit from the restoration. Both species were abundant on Queen Bess Island in 2011 (3421 and 1202 nests, respectively), declined in 2012 and 2013, and did not nest in 2015. Just 20 Royal Tern nests were counted in 2018. In 2021 both species were abundant again, with 2743 Royal Tern nests and 3653 Sandwich Tern nests counted.

Conversely, while at least five wading bird species nested at Queen Bess Island in all previous survey years, only Great Egrets nested in 2021. The most conspicuous change was for Tricolored Heron, which had counts ranging from 421 to 1136 nests during the 2010–2018 period before being absent in 2021.

For more information, see Queen Bess Island Restoration Project.

Shell Island East

Restoration of Shell Island East in Louisiana took place in three stages over multiple years. In 2010, an emergency berm was constructed in response to the Spill. This activity created an approximately 1.5-mile stretch of sandy beach with little vegetation. In 2013, the berm width was expanded with dredged sediment. From 2016 to 2017, an additional 2.7 miles of sediment was added. In total, these projects restored 1031 acres of beach, dune, and marsh habitat (Thompson 2018).

In 2011, when Shell Island East was in the berm stage, skimmers and terns nested in large numbers, with a total combined count of 10,825 nests. Sandwich Tern was the most abundant species (6330 nests), followed by Royal Tern (2516 nests), Black Skimmer (1703 nests), Gull-billed Tern; 178 nests), and Caspian Tern (98 nests). After further restoration, fewer than 10 skimmer and tern nests were documented on Shell Island East in May 2015, with no nests documented in June 2015. No nests were documented in 2018 and 2021.

For more information, see Louisiana Outer Coast Restoration Project.

Gunn Island

Gunn Island, a dredge spoil island in the Birdsfoot East GeoRegion of Louisiana, approximately 14.3 kilometers southwest of North Breton Island (see below), was newly constructed as a beneficial use project in 2016 by the U.S. Army Corps of Engineers (USACE; New Orleans District). Additional dredged sediment from the Mississippi River was deposited from 2018 to 2020 to raise the height of the island. USACE documented nesting terns and skimmers attending chicks in early August 2020, suspecting they had renested at Gunn Island after a tropical storm overwashed nests at North Breton Island (McCormack 2020). However, nesting was first documented on Gunn Island from 24 June 2018 aerial photographs, with a combined total of 13,444 nests among six species; Royal and Sandwich Tern accounted for 97% of nests. Whether nesting occurred at

Gunn Island in 2016 and 2017 is unknown, but the island was still under construction in June 2016. Nest numbers at Gunn Island had nearly tripled by 2021 (Figure 7), with a combined total of 37,001 nests among eight species. The Royal Tern (16,646 nests), Gull-billed Tern (1378 nests), and Caspian Tern (627 nests) colony sizes at Gunn Island in 2021 were the largest recorded for those species across the Study Area and all years. Furthermore, for 2021 alone, the Sandwich Tern and Black Skimmer colony sizes (16,505 and 1923 nests, respectively) were the largest regionwide.

For more information, see Gunn Island Success Story.

North Breton Island

Work to restore North Breton Island in Louisiana began in December 2020, with the goal of creating and enhancing 400 acres of bird nesting habitat. Sand was first placed on the island's north end, adjacent to existing mangroves, which is the principal nesting habitat for Brown Pelicans on the island. When nesting began in 2021, restoration work moved to the southern portion of the island in an attempt to limit disturbance (USDOI 2021). Construction equipment was still present on the island during 2021 surveys.

The lack of Royal and Sandwich Tern nesting was the most conspicuous change at North Breton Island in 2021. For the two species combined, more than 15,000 nests were counted in all previous survey years. The 2021 observations at North Breton may have been related to expected disturbance associated with ongoing habitat restoration activities, but movement of terns from North Breton to Gunn Island was suspected the previous year due to overwash from a tropical storm during the breeding season (McCormack 2020). A small colony of Black Skimmers and Gull-billed Terns did eventually form by June 2021 at North Breton Island. Nesting by Royal and Sandwich Terns at North Breton Island resumed in 2022 and increased substantially in 2023 (beyond the scope of this report).

Brown Pelican and Laughing Gull breeding populations were relatively high at North Breton Island in 2021 (more than 4000 nests for both species), though perhaps with slightly later timing of nest initiation on average than in previous years. Nest counts were determined entirely from June photographs in 2021 versus primarily May photographs in all previous years except 2010; some new nesting was also counted from June photographs in certain years. While 43% of Brown Pelican nests had visible chicks in 2021, 15 poorly built nests were counted, along with another 133 territories, indicating some egg laying likely occurred after the June survey.

For more information, see Louisiana Outer Coast Restoration Project.

Ship Island

Restoration of Ship Island in Mississippi, completed in late 2020, included the addition of sediment to connect Ship Island East and West and to raise the island to approximately 5 feet

above sea level, as well as dune vegetative planting (USACE 2020). During the 2010–2015 period, only small numbers of nesting Black Skimmers and Gull-billed Terns were documented at either the East or West islands, with a high count of 272 skimmer nests in 2015. Changes in CWB distribution and abundance in 2021 following restoration were clear. All nesting occurred on restored areas within the island's center, with a combined total of 1725 nests. The number of Black Skimmer nests (513) was nearly twice as high as in 2015, with the nests distributed in a long, linear colony in the restored area. Gull-billed Terns (51 nests) were also more abundant than in earlier years. The other conspicuous change was the presence of nesting Royal Terns (245 nests), Sandwich Terns (908 nests), and Least Terns (8 nests), none of which were detected nesting at Ship Island previously (see Appendix A for comparisons with ground-based surveys, which also detected nesting Common Terns).

New Round Island

At New Round Island in Mississippi, island construction was completed in February 2017. Only 65 Least Tern nests and 50 Black Skimmer nests were counted from 15 June 2021 aerial photographs, and the island was not inspected during 2015 aerial surveys. Ground-based surveys did, however, document greater diversity and abundance of beach-nesting birds in 2017 and 2018, including large Royal and Sandwich Tern colonies. In 2021, however, ground-based surveys detected only nesting Least Terns and Black Skimmers, consistent with aerial surveys. Two breeding shorebird species, American Oystercatcher and Wilson's Plover, were also detected from ground-based surveys (Gamblin et al. 2022). See Appendix A for comparison of aerial photographic and ground counts of Least Terns.

For more information, see DWH Regionwide TIG Final Restoration Plan/Environmental Assessment 1.

Marsh Island

Construction on Marsh Island in Alabama began in March 2016 and ended in December 2017. The project restored 50 acres of salt marsh through the placement of sediments and breakwaters, as well as the planting of native marsh vegetation (NOAA 2012). No nesting was documented at Marsh Island during surveys from 2010 to 2015, but waterbird breeding colonies were evident on Marsh Island in 2021.

Laughing Gull (2229 nests) was the most abundant species in 2021, followed by Royal Tern (1227 nests). Only small numbers of Sandwich Terns nested with the Royal Terns. Four wading bird species nested at Marsh Island (Great Egret, White Ibis, Cattle Egret, and Tricolored Heron), with White Ibis being the most abundant (404 nests). On the 24 May 2021 survey date, small proportions of the White Ibis and Great Egret nests had visible chicks. Wader nesting at Marsh Island likely reflected movements of birds from nearby Cat Island where land and vegetation loss had occurred over time. In 2021, only skimmers and terns nested at Cat Island.
For more information, see Marsh Island Restoration Project.

4.0 Discussion

During the 2010–2021 period, Laughing Gull, Sandwich Tern, Royal Tern, and Brown Pelican were consistently the most abundant breeding waterbirds documented along the nGOM, with their rank varying among years. Their habit of nesting in large aggregations on the surface of islands or on low vegetation with little concealment makes aerial photography ideally suited for estimating their breeding population sizes. Similarly, along the Pacific Coast, the U.S. Fish and Wildlife Service has identified aerial photographic surveys as the preferred method for monitoring breeding populations of two other surface-nesting seabirds, Common Murre (*Uria aalge*) and Brandt's Cormorant (*Urile penicillatus*; Bridgeland et al. 2018). For wading birds, aerial photographic surveys were also effective for estimating colony sizes at most locations regionwide. However, trees and tall shrubs at some locations can conceal some nests. Only one study with ground counts of breeding pairs of wading birds was available for a rough comparison with aerial photographic counts. Wading birds were counted at Raccoon Island, Louisiana, in late June in 2010 (Raynor et al. 2013). Aerial photographic counts of nests from 17 May were much higher for Great Egret, Tricolored Heron, and Roseate Spoonbill, whereas late June ground counts detected more nests of the less abundant Snowy Egret (30 nests), Reddish Egret (5 nests), and Black-crowned Night-Heron (15 nests). However, June aerial photographic surveys of Raccoon Island were not conducted in 2010.

Conducting surveys in both May and June (rather than in just one of the months) continues to be necessary for determining best estimates of breeding population sizes. During the 2015–2021 period, the percentage of colony nest totals for individual species that were determined from May photographs ranged from 41% in 2021 (regionwide) to 67% in 2018 in (Louisiana only). Furthermore, for the entire 2010–2021 period, 187 colony nest totals for individual species were sums of May and June counts, to account for new breeding groups in June or early breeders in May.

Annual variation in nest totals, such as the peaks observed in Louisiana in 2018 for Brown Pelican and Tricolored Heron, may be influenced by several factors. The proportion of the adult population of a species that breeds annually can vary. Some female Brown Pelicans, for example, may skip breeding in some years (Wilkinson and Jodice 2022). Skipping breeding is well described for Brandt's Cormorant and can lead to "boom or bust" breeding seasons depending on prey availability (Ainley et al. 2018). The degree of recruitment of first-time breeders can also vary depending on breeding success in previous years and survival rates until birds reach breeding age. Weather events that cause overwash and nest failures may also contribute to annual variation in nest counts from aerial photographs.

Aerial photographic surveys have been shown to be highly effective throughout the nGOM for estimating CWB breeding population sizes (Colibri and Ford 2015, Remsen et al. 2019). They are also effective in documenting CWB responses (e.g., presence/absence, habitat utilization over

time) to island restoration, as well as informing and monitoring adaptive management need and performance (e.g., Ainley et al. 2018), so much so that the State of Louisiana has memorialized aerial photographic surveys within its DWH Colonial Waterbird MAM plans.

Observations made during this activity indicated that addressing potential uncertainties such as nest detection probability for selected species may prove beneficial in assisting Trustees with future bird abundance estimates and related statistical analyses. For example, in a 1990s study of aerial photographic data in California, detection probabilities of Brandt's Cormorant nests and birds was near 100%, but detection probabilities for Common Murres was closer to 90% given that they nest shoulder-to-shoulder in great densities (Steinkamp et al. 2005). For Brown Pelicans and Royal and Sandwich Terns at most colonies in the nGOM, detection probabilities can reasonably be expected to be similar to those for Brandt's Cormorants, given the large size of pelicans and given the open habitats that pelicans and terns occupy. Among tern species, Royal and Sandwich Tern nest in the highest densities, but detection of nests and birds in aerial photographs is straightforward, as the terns do not nest shoulder-to-shoulder as Common Murres do. For other species, detection probabilities may be lower due to nest concealment by even low-lying vegetation (Laughing Gulls) or shrubs and trees (wading birds), and degree of vegetation cover may vary among colonies. Species Accounts in Appendix A provide qualitative descriptions of the detectability of nests and birds in aerial photographs. Nonetheless, nest totals determined from May and June aerial photographic surveys for some seabird and wading bird species in the nGOM, especially the most abundant ones identified in this report, are generally higher, more accurate, and more repeatable than counts conducted from ground or boat vantages or from aerial visual estimates (Colibri and Ford 2015, Remsen et al. 2019).

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Common and Scientific Names of Species Mentioned

Common Name	Scientific Name	Nests Counted
Black-bellied Whistling-Duck	*Dendrocygna autumnalis*	✓
Fulvous Whistling-Duck	*Dendrocygna bicolor*	✓
Canada Goose	*Branta canadensis*	✓
Blue-winged Teal	*Spatula discors*	
Northern Shoveler	*Spatula clypeata*	
Mottled Duck	*Anas fulvigula*	
Greater Flamingo	*Phoenicopterus roseus*	
Common Gallinule	*Gallinula galeata*	
American Coot	*Fulica americana*	
Black-necked Stilt	*Himantopus mexicanus*	✓
American Avocet	*Recurvirostra americana*	
American Oystercatcher	*Haematopus palliatus*	✓
Black-bellied plover	*Pluvialis squatarola*	
Wilson's Plover	*Charadrius wilsonia*	
Marbled Godwit	*Limosa fedoa*	
Ruddy Turnstone	*Arenaria interpres*	
Red Knot	*Calidris canutus*	
Short-billed Dowitcher	*Limnodromus griseus*	
Willet	*Tringa semipalmata*	
Wilson's Phalarope	*Phalaropus tricolor*	
Laughing Gull	*Leucophaeus atricilla*	✓
Herring Gull	*Larus argentatus*	✓
Lesser Black-backed Gull	*Larus fuscus*	
Kelp Gull	*Larus dominicanus*	
Sooty Tern	*Onychoprion fuscatus*	✓
Least Tern	*Sternula antillarum*	✓
Gull-billed Tern	*Gelochelidon nilotica*	✓
Caspian Tern	*Hydroprogne caspia*	✓
Black Tern	*Chlidonias niger*	
Common Tern	*Sterna hirundo*	
Forster's Tern	*Sterna forsteri*	✓
Royal Tern	*Thalasseus maximus*	✓
Sandwich Tern	*Thalasseus sandvicensis*	✓
Black Skimmer	*Rynchops niger*	✓
Wood Stork	*Mycteria americana*	✓
Magnificent Frigatebird	*Fregata magnificens*	
Anhinga	*Anhinga anhinga*	✓
Double-crested Cormorant	*Nannopterum auritum*	
Neotropic Cormorant	*Nannopterum brasilianum*	✓
American White Pelican	*Pelecanus erythrorhynchos*	✓
Brown Pelican	*Pelecanus occidentalis*	✓
Least Bittern	*Ixobrychus exilis*	
Great Blue Heron	*Ardea herodias*	✓
Great Egret	*Ardea alba*	✓
Snowy Egret	*Egretta thula*	✓
Little Blue Heron	*Egretta caerulea*	✓
Tricolored Heron	*Egretta tricolor*	✓
Reddish Egret	*Egretta rufescens*	✓

Common Name	Scientific Name	Nests Counted
Cattle Egret	*Bubulcus ibis*	✓
Green Heron	*Butorides virescens*	✓
Black-crowned Night-Heron	*Nycticorax nycticorax*	✓
Yellow-crowned Night-Heron	*Nyctanassa violacea*	✓
White Ibis	*Eudocimus albus*	✓
Glossy Ibis	*Plegadis falcinellus*	✓
White-faced Ibis	*Plegadis chihi*	✓
Roseate Spoonbill	*Platalea ajaja*	✓
Osprey	*Pandion haliaetus*	✓
Red-shouldered Hawk	*Buteo lineatus*	
Crested Caracara	*Caracara plancus*	
Fish Crow	*Corvus ossifragus*	
Great-tailed Grackle	*Quiscalus mexicanus*	

Contents

Introduction

Overview of Species Accounts

These accounts summarize broad patterns of distribution and abundance of breeding colonial waterbirds (CWB) along the northern coast of the Gulf of Mexico, from South Texas through the Big Bend of Florida, based on seven years of aerial photographic survey (survey) data collected from 2010 to 2021. Included are 20 accounts of breeding CWB species commonly encountered during surveys, plus three other accounts that each address two related species that were less common. The accounts are intended to describe regionwide highlights of the data, such as largest colonies, statewide nest totals in each survey year, and timing of breeding. Additional details were provided for Louisiana because it was the only state surveyed in all years. All individual colony counts (including for southwest Florida, surveyed only in 2010), as well as many notes describing nuances associated with the counts, are included in a database available through the Avian Data Monitoring Portal (https://arcg.is/09LCra).

These species accounts differ in two main ways from those in the appendix of the report that summarized 2010–2013 data (Colibri and Ford 2015). The 2010–2013 accounts included thorough literature reviews of the history of the breeding populations of these species in the study area. Here, only literature that is most relevant to interpreting the 2010–2021 aerial photographic counts is referenced. In addition, adjustments that were made to some Louisiana colony counts so as to account for early survey timing in 2010 and variable coverage during the 2010–2013 period, are not presented here as future statistical models may treat variable survey coverage differently. Specifically, in 2010 most colonies were surveyed only once, and some colonies in Louisiana were surveyed as early as 7 or 8 May, earlier than in subsequent years and before much nesting (especially by gulls and terns) had begun. For colonies surveyed on 7 and 8 May, 2010, nest counts for each species were adjusted with a correction factor that considered the 2010 Study Area population estimate divided by the mean Study Area population estimate during 2011–2013, for colonies surveyed in all four years. For three colonies in Terrebonne Bay, Louisiana that were not surveyed during the 2010–2012 period (including Houma Navigation Canal Island), estimates of nest totals for individual species for those years were similarly derived using 2013 data for those colonies and Study Area totals during 2010–2013. These adjusted and derived nest counts were included in tables in the species accounts and coded to indicate that they represent adjusted data. In this report, however, only raw data are presented. In instances in which a colony was not surveyed, No Data (ND) is indicated.

Text

Each species account begins with a description of the species and features used to identify it. This description is intended to provide the reader with a qualitative sense of species detectability in the aerial photographs. The first paragraph includes the number of breeding colonies

documented since 2010, with a breakdown by state and a reference to the distribution maps that appear at the end of the account.

In the following paragraph of each account, 2021 data are highlighted. This section is included for several reasons. First, survey coverage in 2021 was the most complete and widespread of all survey years, extending from Brownsville, Texas through the Big Bend of Florida. If regionwide surveys are conducted in future years, that same survey area is likely to be used. The colony inventory used for 2021 surveys was also the most comprehensive. It incorporated new state-provided colony locations, included all previously surveyed locations, and identified all past colony locations that had become submerged. Full-frame cameras, which improved image resolution, also were used for the first time in 2021. Finally, the counting methods were fully developed and standardized with 2021 image analysis, having been improved and refined since 2010. This paragraph identifies the number of nests and colonies regionwide, with state percentages listed in decreasing order. It also lists the largest colonies and indicates how many other large colonies of a certain size were active. Regional differences in the proportion of colony counts derived from May or June photographs are also included in some instances.

The subsequent paragraphs provide additional detail for each state, highlighting largest colonies and any conspicuous patterns in abundance and distribution since 2010. For Texas, however, only limited comparison of the data could be made. Surveys were conducted in Texas only in 2010 and 2021, and the extent and timing of the surveys differed. Surveys in 2010 extended south only to Corpus Christi, whereas surveys in 2021 were statewide, extending south through the Upper and Lower Laguna Madre. In 2010, much nesting had already concluded by the time surveys were conducted in late June, leading to underestimates of nest numbers for that year.

Tables

Most species accounts include two standardized tables. Table 1 provides the total numbers of nests and colonies counted by state from 2010 to 2021, ordered west to east, as well as grand totals for that year's survey area.

Table 2 includes annual nest totals for all colonies of a certain minimum size. That minimum size varies by species and was selected to highlight the largest colonies and help show patterns described in the text. The main exception is in the Brown Pelican account, where all colonies ever counted (i.e., with at least one nest) were tabulated. Colonies in Table 2 are arranged from west to east by state and then by GeoRegion; within each GeoRegion, colonies are listed alphabetically.

Table 2 was populated by inspecting survey tracklines and survey notes to determine if a colony was surveyed in those instances in which the database query did not yield a result for that colony in a certain year because no nests or birds were counted. If the survey trackline was deemed too distant from the colony for the surveyors to have been able to determine if nesting birds were present, No Data (ND) is indicated in the cell representing that survey. Furthermore, certain

query results of zero nests (i.e., but with a count of birds in the query results) had to be further verified to consider, for example, if the colony was inspected in both May and June. Satellite imagery also was inspected as needed to determine when islands became submerged or were created. This evaluation was conducted for all Brown Pelican colonies but only for the colonies listed in Table 2 for all other species. Further effort would be required to clarify "true zeroes" for all colonies of a certain species, except for Brown Pelican. Pertinent information such as differences in methods in 2010 or variable monthly inspections of colonies is footnoted.

Figures

For most species accounts, Figure 1 consists of a bar chart of nest counts per GeoRegion in Louisiana. GeoRegions are indicated in Distribution Maps, and the process for creating them is described in a ReadMe file (Avian Data Monitoring Portal,(https://arcg.is/09LCra). A GeoRegion bar chart is included only for Louisiana because it was the only state surveyed in all seven years and because the data are largely comparable among years. Accounts for species infrequently detected in Louisiana (e.g., Least Tern, Reddish Egret, and Cattle Egret) or never detected in Louisiana (e.g., White-faced Ibis and Glossy Ibis) do not include this bar chart.

Some species accounts include additional figures. For example, the Brown Pelican account includes a line chart of the percent of nests with visible chicks at selected colonies, and the Reddish Egret account incudes a bar chart showing the proportions of dark and white morph nest counts by GeoRegion in Texas in 2021. Photographs are included in some species accounts as well.

Maps

Each species account concludes with up to four distribution maps that illustrate colony locations and the year and range of the maximum nest count. Maps are ordered west to east, from Texas to Florida. One map includes an inset image of the largest colony. GeoRegions are indicated on all maps.

Additional Species Observed

Nests of nine other bird taxa and non-breeding individuals of many more were counted (see Common and Scientific Names of Species Mentioned). The latter included a Greater Flamingo that has been spotted occasionally along the Texas coast since it escaped from a Kansas zoo in 2005. It was standing amid nesting Laughing Gulls and Brown Pelicans at Lavaca Bay Spoils E on 20 June 2021.

Waterfowl

Mottled Duck was encountered more often than any other waterfowl species, but no nesting was observed. In Texas in 2021, photographs revealed a single Fulvous Whistling-Duck nest and three

Black-bellied Whistling-Duck nests. One Black-bellied Whistling-Duck nest, located in a bed of prickly pear cactus at Lavaca Bay Spoils E (Figure 1) was evidently abandoned. It was identified by the enormous clutch size. Nesting Canada Geese (14 nests) were documented just once, at Gaillard Island, Alabama, in 2021. Blue-winged Teal (two birds) and Northern Shoveler (three birds) were also encountered in 2021 photographs.

Figure 1. Abandoned Black-bellied Whistling-Duck nest (indicated by red arrow) in Texas at Lavaca Bay Spoils E in 2021.

Rails

The survey methods used here are not appropriate for detecting rails in obscured, marshy habitat, but the related Common Gallinule (four birds) and American Coot (nine birds), which occupy more open habitats, were occasionally encountered.

Shorebirds

Other than Black-necked Stilt and American Oystercatcher, described in a combined species account, the only other locally breeding shorebird species identified was Wilson's Plover (four birds at Raccoon Island, Louisiana). Notably, it was only in 2021, after switching to full-frame cameras with higher resolution, that this species was counted. The surveys are not designed to detect breeding shorebirds. Aerial surveys designed for breeding shorebirds would likely need

to be flown at lower altitudes with continuous photography or videography of all potential nesting habitat.

Among nonbreeding or migrant shorebirds, the larger-bodied and colorful American Avocet was the most confidently identifiable species. A total of 187 avocets were counted among seven CWB colonies, with a high count of 145 birds at Queen Bess Island, Louisiana on 16 May 2015. Among smaller shorebirds, the unique calico plumage of the Ruddy Turnstone made it relatively easy to identify. A total of 175 Ruddy Turnstone were counted among 27 CWB colonies. Other species identified were Black-bellied Plover, Short-billed Dowitcher, Marbled Godwit, Red Knot, Willet, and Wilson's Phalarope. Most shorebirds, though, were left unidentified and assigned the unknown shorebird (UNSB) category. Doing so was necessary as image resolution was insufficient for discerning among the many shorebird species that winter in and migrate through the northern Gulf of Mexico (nGOM).

Gulls and Terns

Aside from Laughing Gull—the most abundant breeding waterbird species in the nGOM—Herring Gull was the only other gull species documented nesting. One nest was at North Breton Island, Louisiana in 2015, and another was at Raccoon Island, Louisiana in 2021. The nest site at Breton Island in 2015 was occupied in both May and June. The bird at Raccoon Island in May 2021 was in apparent breeding habitat and incubation posture with its bill tucked into its back feathers. Herring Gull was not identified at that location in June photographs. Both Herring Gulls were identified by their obviously larger size and paler mantle compared with Laughing Gull. Small numbers of nesting Herring Gulls, and hybrid pairs of Herring and Kelp gulls, have been noted in the southern part of the Chandeleur Islands chain in Louisiana since the 1990s (Dittmann and Cardiff 2005, Remsen et al. 2019). Loafing Herring Gulls, including subadults, were occasionally encountered in all states. One Lesser Black-backed Gull, an adult at Gaillard Island, Alabama, was documented in 2021. In other cases, large, loafing gulls were not identified to species.

Six breeding tern species were commonly encountered. In addition, a total of 21 Sooty Tern nests among five colonies, four of them in Texas, were also documented. The highest count was 10 nests at Shamrock Island, Texas in 2021. In Florida, one nest was at Saint George Causeway in 2021. Sooty Tern can be distinguished from other tern species by its jet-black cap and back that contrast with white underparts and a white patch on the forehead (Figure 2).

Figure 2. Sooty Terns nesting near Laughing Gulls at Shamrock Island in Texas, with the Sooty Tern in the lower right portion of the image (indicated by red arrow) in clear incubation posture. The contrast of the Laughing Gull's built nest with the Sooty Tern's preference for nesting on bare sand is also apparent.

Loafing Common Terns were occasionally counted but at other times if present were indistinguishable from loafing Forster's Terns. No Common Tern nests were documented, but ground surveys conducted by local biologists did document at least four nests at Ship Island, Mississippi in 2021 (National Park Service, unpublished data). The highest count of Common Terns from aerial photographic surveys was also at Ship Island (nine individuals in June 2015). If Common Terns were present in 2021 photographs of Ship Island, they may have been misidentified as Gull-billed Terns, especially if shorter focal length images were used for counting.

Migrant Black Terns were also rarely detected, with a high count of 246 birds in Florida at Flag Island South on 12 June 2010.

Storks and Herons

In 2010, one Wood Stork was at a nest at Smith Island in Florida, while a gathering of 58 birds (no nests) were at High Island in Texas. Yellow-crowned Night-Heron and Green Heron were encountered in low numbers. Eleven Yellow-crowned Night-Heron nests were counted among

five CWB colonies. Single Green Heron nests were counted at Battery McIntosh in 2011 and at Beauregard Island in 2021. Four Least Bitterns were counted, three of them at Raccoon Island in 2021.

Other Species

Hundreds of non-breeding Magnificent Frigatebirds typically roosted among the mangroves of New Harbor Islands and the bald cypress swamps of Birdsfoot West in Louisiana. They often took flight and circled beneath the plane during surveys of the Brown Pelican colony at New Harbor Islands and the cormorant colony at Birdsfoot West 6. Because many of them were in flight and none were nesting, they were not always counted. Among those that were counted, the high count was nearly 800 birds at New Harbor Island 3 in 2012.

Other species noted in aerial photographs included raptors and two passerines. Three Osprey nests were counted, including one with nestlings on a tower on Ship Island in Mississippi in 2015. One Red-shouldered Hawk was seen at Queen Bess Island in 2013, and three Crested Caracaras were spotted in Texas (two in 2010 and one in 2021). A Fish Crow was counted at New Round Island in Mississippi, and a Great-tailed Grackle was counted at High Island in Texas.

Avian Data Monitoring Portal

Only a subset of all colony nest totals is presented in Table 2 of the species accounts. However, all colony count data for each species are available online at the Avian Data Monitoring Portal (https://arcg.is/09LCra), which is developed and maintained by The Water Institute. A Data Management tab on the portal includes links to a summary file of nest totals, a Microsoft Access® database, and a ReadMe file. Survey and image analysis protocols also are provided. The portal also includes a dashboard powered by Environmental Systems Research Institute (Esri®) Geographic Information Systems (GIS) software linked to a Web Mapping Service (WMS). This dashboard presents nest and bird counts numerically and graphically and can be filtered by species, year, state, GeoRegion, colony, and watershed. High resolution aerial photographs and screen captures of analyzed and annotated images are also archived there.

Species Accounts

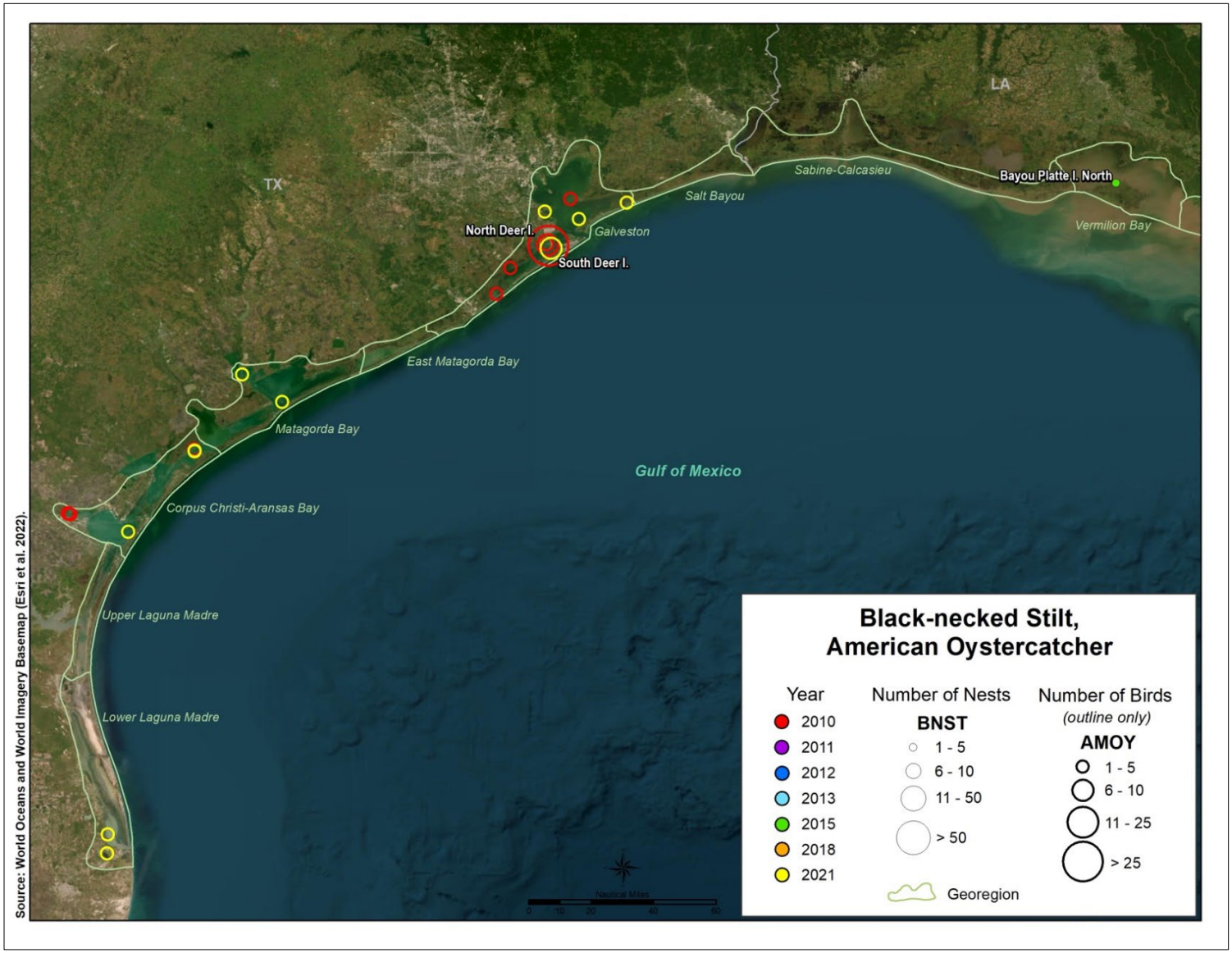
Black-necked Stilt and American Oystercatcher

The tall, but small-bodied, Black-necked Stilt is black above and white below with pink legs. Stilts were therefore conspicuous when occasionally encountered foraging in shallow, open water, such as in Louisiana at Queen Bess Island (six birds) and Felicity Island (seven birds) in 2015. During the 2010–2021 survey period, 38 birds were counted, nine of which were in incubation posture at apparent nest sites. Birds in incubation posture were not as easily identified as foraging birds, but they often had their wings not fully closed such that the white tail and white "V" on the back could be seen (Figure 1). Nests were documented at six colonies—five in Louisiana and one in Alabama (Maps 1–4). All nests except one at Felicity Island were on spoil islands. The highest nest count was three nests in 2010 at Birdsfoot West 2 in Louisiana.

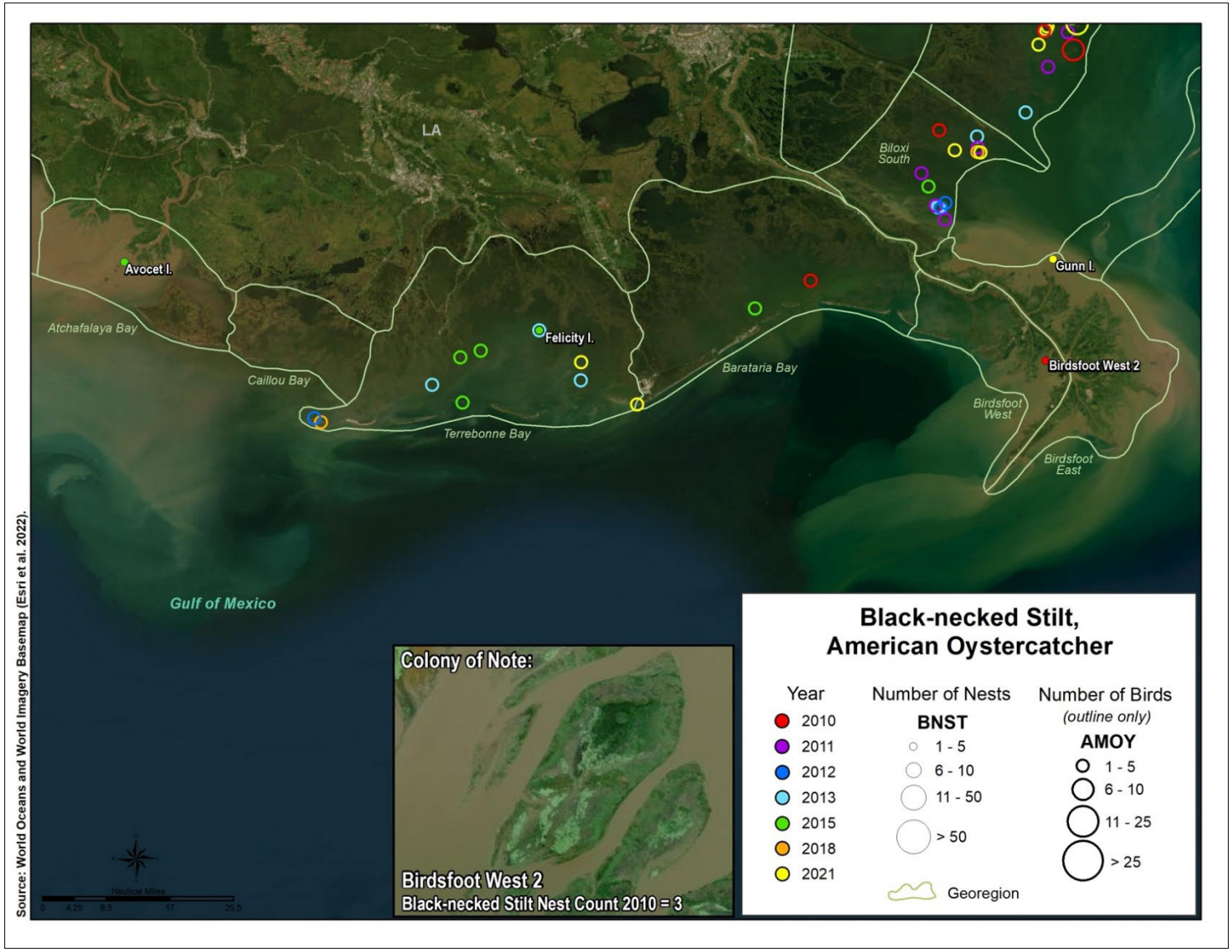
Figure 1. A Black-necked Stilt in incubation posture (indicated by red arrow) at Gunn Island, Louisiana, 17 June 2021, amid nesting Black Skimmers and Gull-billed Terns.

American Oystercatcher is a large shorebird with distinctive plumage contrast and a thick, red bill. Single or pairs of oystercatchers were often conspicuous on beaches. A total of 348 American Oystercatchers were documented at 91 waterbird colonies—59 in Louisiana, 22 in Texas, five in Florida, four in Alabama, and one in Mississippi. However, a total of only 55 nests were at only 35 colonies—25 in Louisiana, six in Texas, three in Florida, and one in Alabama. These were nearly all birds in incubation posture, though two nests in Florida at Lanark Reef-

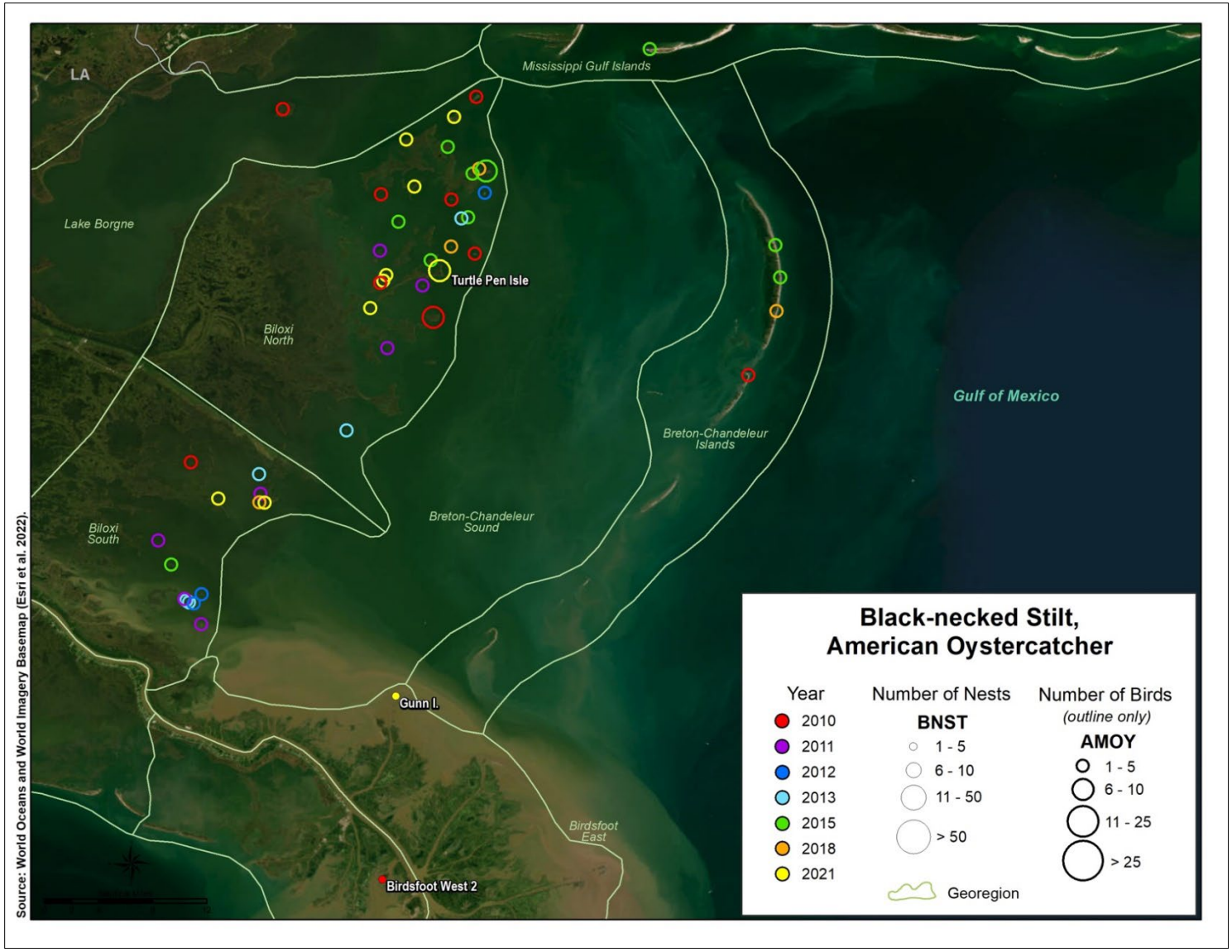
Pelican Lump in 2021 consisted of adults attending a chick. More than half of the 55 nests were in Biloxi Marsh in Louisiana. Standing birds at other locations were still in breeding habitat, so they could have had chicks hidden in vegetation or could have completed breeding. For example, Selman and Davis (2015) noted fledgling-sized chicks at Rabbit Island, Louisiana in May 2013 and April 2014. Because those observations indicate breeding may occur before the May and June surveys, counts of birds rather than nests are presented in Maps 1–4.



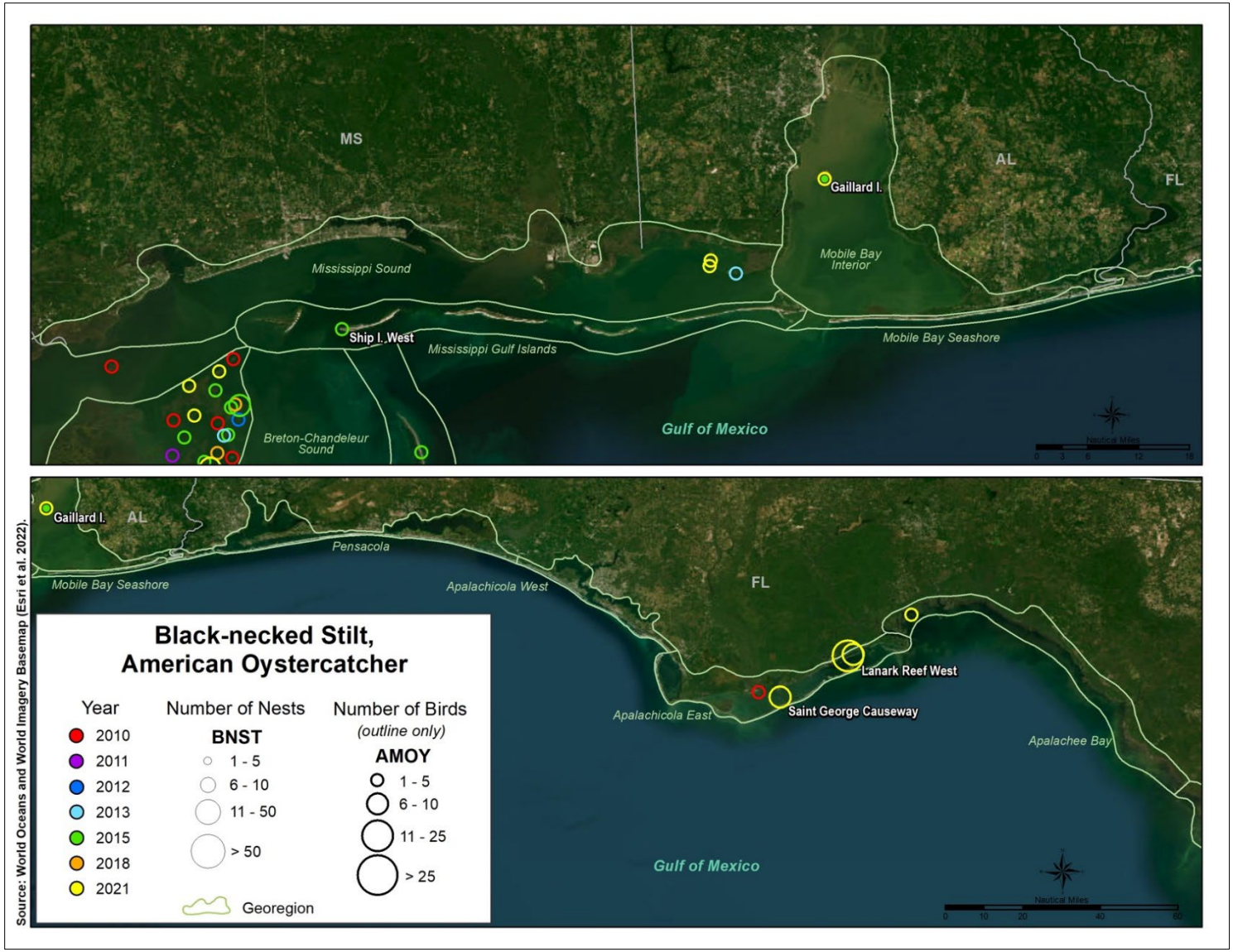
Map 1. Black-necked Stilt nests and American Oystercatcher birds counted in Texas and southwest Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Black-necked Stilt nests and American Oystercatcher birds counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Black-necked Stilt nests and American Oystercatcher birds counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Black-necked Stilt nests and American Oystercatcher birds counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Laughing Gull

Laughing Gull was the most abundant breeding CWB species counted throughout the nGOM. Nesting was documented at 207 colonies—123 in Louisiana, 75 in Texas, five in Florida, three in Alabama, and one in Mississippi (Maps 1–4). Nests were often widely distributed across a colony or island. Laughing Gull was readily identifiable in open habitat by its dark gray mantle and black hood, but even just the glimpse of black primary tips or white tail feathers often revealed a gull partly concealed by grass or other vegetation. However, given some concealment and the ubiquity of the species especially in Louisiana and Texas, the estimates of colony size and numbers of active colonies provided herein should be considered low.

In 2021, 164,832 Laughing Gull nests were counted among 129 colonies (Table 1). Of those nests, 57% were among 56 Texas colonies and 37% were among 67 Louisiana colonies. In Texas, 61% of colony counts were derived solely from May photographs. Three counts were primarily from May with small numbers of nests added from June surveys. In contrast, in Louisiana, 88% of colony counts were derived solely from June photographs; four colony counts were sums of May and June counts. In Alabama and Florida, 10,674 nests were at just six colonies. The largest colony by far was at North Deer Island in Texas (27,074 nests), with Raccoon Island in Louisiana (12,574 nests) and Evia Island in Texas (9317 nests) distant followers (Table 2). The North Deer Island colony size estimate in 2021 is among the largest documented across the species' range (Burger 2020). Another 31 colonies had more than 1000 nests—14 in Texas, 13 in Louisiana, two in Alabama, and two in Florida.

Table 1. Numbers of Laughing Gull nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	13,872 (36)	-	-	-	-	-	93,753 (56)
LA	30,125 (65)	82,489 (68)	56,844 (59)	57,232 (72)	44,534 (69)	80,068 (72)	60,405 (67)
MS	0	1 (1)	0	0	0	0	0
AL	433 (1)	2215 (1)	1021 (1)	2358 (2)	2467 (1)	-	6870 (2)
FL	430 (4)	203 (1)	663 (5)	1083 (4)	2840 (4)	-	3804 (4)
Total	**44,860 (106)**	**84,908 (71)**	**58,528 (65)**	**60,673 (78)**	**49,841 (74)**	**80,068 (72)**	**164,832 (129)**

() = number of colonies; - = state not included in survey area that year.

In Texas, Remsen et al. (2019) reported a 2011–2014 average of 136,726 breeding Laughing Gulls from unpublished data in the Texas Colonial Waterbird Society database, equivalent to an average total of 68,363 nests. The 2021 survey nest total (Table 1) was 37% higher than that 2011–2014 average. As described in the Introduction, comparisons with 2010 survey data are problematic. For example, compared with 2021 counts, the low nest counts at Evia and North Deer islands in 2010 (Table 2) were noted as being affected by the advanced nesting stage of the colony, with many large chicks wandering away from nests. Furthermore, an effort was not made to count those chicks as broods at Evia Island. However, photographic coverage was noted as 100% at Evia Island and 85% at North Deer Island. So, both colonies may have increased substantially since 2010.

In Louisiana, the 2010 nest total is similar to previous decadal estimates from other researchers (Portnoy 1977, Martin and Lester 1993, Michot et al. 2003). However, that number is likely to be an underestimate, especially given the challenges associated with conducting surveys during spill response activities. Totals from 2011 to 2021 show a higher but fluctuating breeding population, with peaks of more than 160,000 breeding birds in 2011 and 2018. Remsen et al. (2019) reported an estimate of 100,000 breeding birds for Louisiana, based in part on an average of the 2010–2013 aerial photographic counts, along with other past data. Annual variation was also conspicuous at the colony level (Table 2). Queen Bess Island in the Barataria Bay GeoRegion experienced a significantly higher nest count in 2011 compared with the other six years (Table 2, Figure 1). Breeding success also was evident at Queen Bess Island in 2011, with chicks readily observed in June at about a third of all nests. In contrast, fewer birds nested at Queen Bess Island in 2013, and no chicks were seen in June, likely indicating poor reproductive success that year. Nest counts at Half Moon Island also varied widely from year to year, with more than 5000 nests in 2013 and just three counted in 2021, with thorough photographic coverage. The decline in nest totals at Felicity Island by 2021 can be attributed to land loss. Atchafalaya Bay nesting (Figure 1) is represented only by Skimmer Island, where two nests were counted in 2010, before an influx to more than 3000 nests in 2011. Nest numbers gradually declined through 2015 as the island became progressively vegetated. Numbers of colonies counted in Louisiana remained high over the decade, fluctuating from 59 to 72.

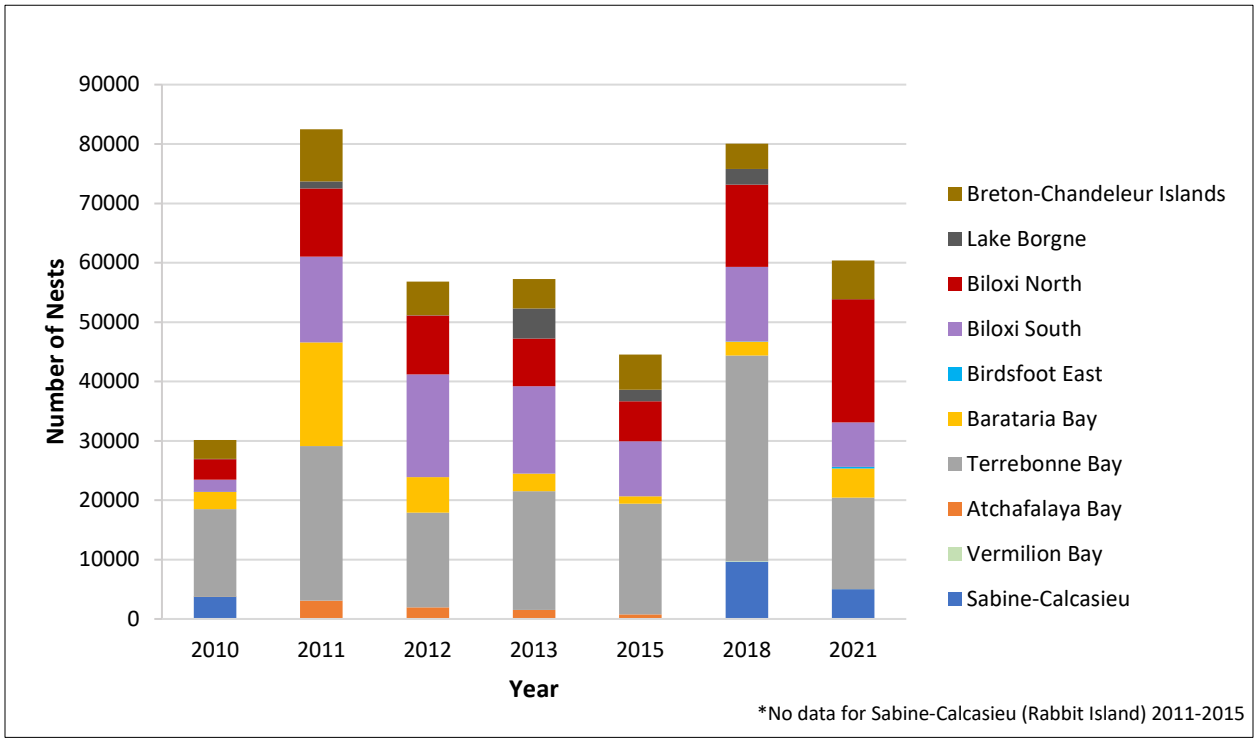


Figure 1. Numbers of Laughing Gull nests in Louisiana by GeoRegion, 2010–2021.

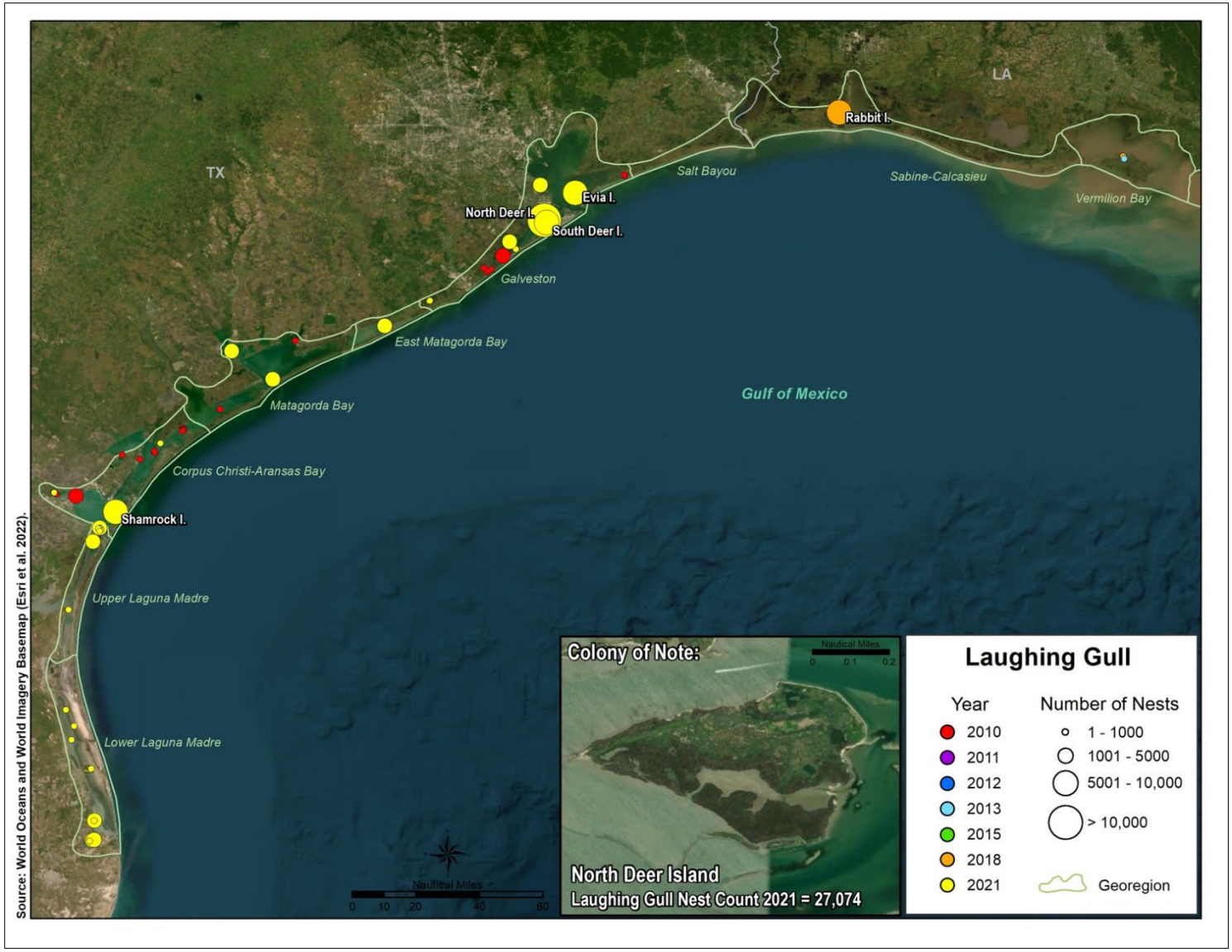
In most years in Alabama, Gaillard Island hosted the only active colony counted. The increased statewide nest total in 2021 (Table 1) reflects a high count at Gaillard Island (4641 nests) and a large colony at Marsh Island (2229 nests) following its restoration, completed in 2017.

In Florida, Audubon Island was the largest colony (1992 nests in 2021), followed by Saint George Causeway (1472 nests in 2021). Both colonies increased in size dramatically since 2010. Given that both colonies are on discrete, artificial islands where complete photographic coverage is easily achieved, the increase in nest counts is clearly attributable to population growth. Nearly identical counts at Saint George Causeway in 2015 and 2021 may indicate the approximate limit to colony size at that location.

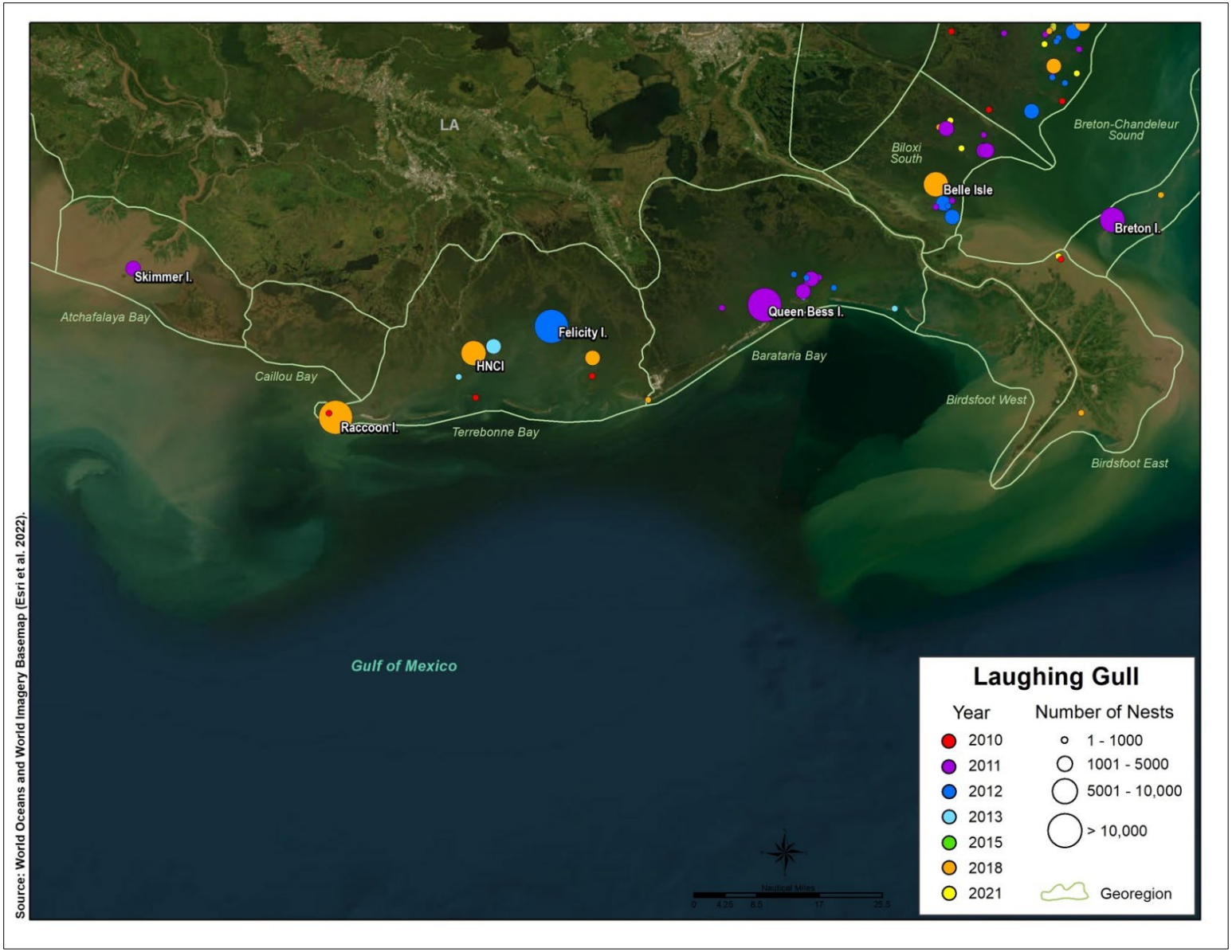
Table 2. Laughing Gull nest counts for all colonies with at least one count of 5000 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Corpus Christi-Aransas Bay	Shamrock Island	-	-	-	-	-	-	6451
	Galveston	Evia Island	103	-	-	--	-	-	9317
	Galveston	North Deer Island	3808	-	-	--	-	-	***27,074***
	Galveston	South Deer Island	0[1]	-	-	--	-	-	5081
Louisiana	Sabine-Calcasieu	Rabbit Island	3734	-	-	-	-	9647	5031
	Terrebonne Bay	Felicity Island	4116	10,626	11,757	9684	6503	8877	709
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	4719	4011	5536	1171
	Terrebonne Bay	Raccoon Island	10,576	15,430	4191	4278	7656	17,306	12,574
	Barataria Bay	Queen Bess Island	1957	12,060	1717	1604	1105	2285	4930
	Biloxi South	Belle Isle	248	1255	3286	4578	3262	8081	4353
	Lake Borgne	Half Moon Island	70	1197	41	5076	1901	2680	3
	Breton-Chandeleur Islands	Breton Island	3116	7442	5329	4384	***5269***	***3089***	4668

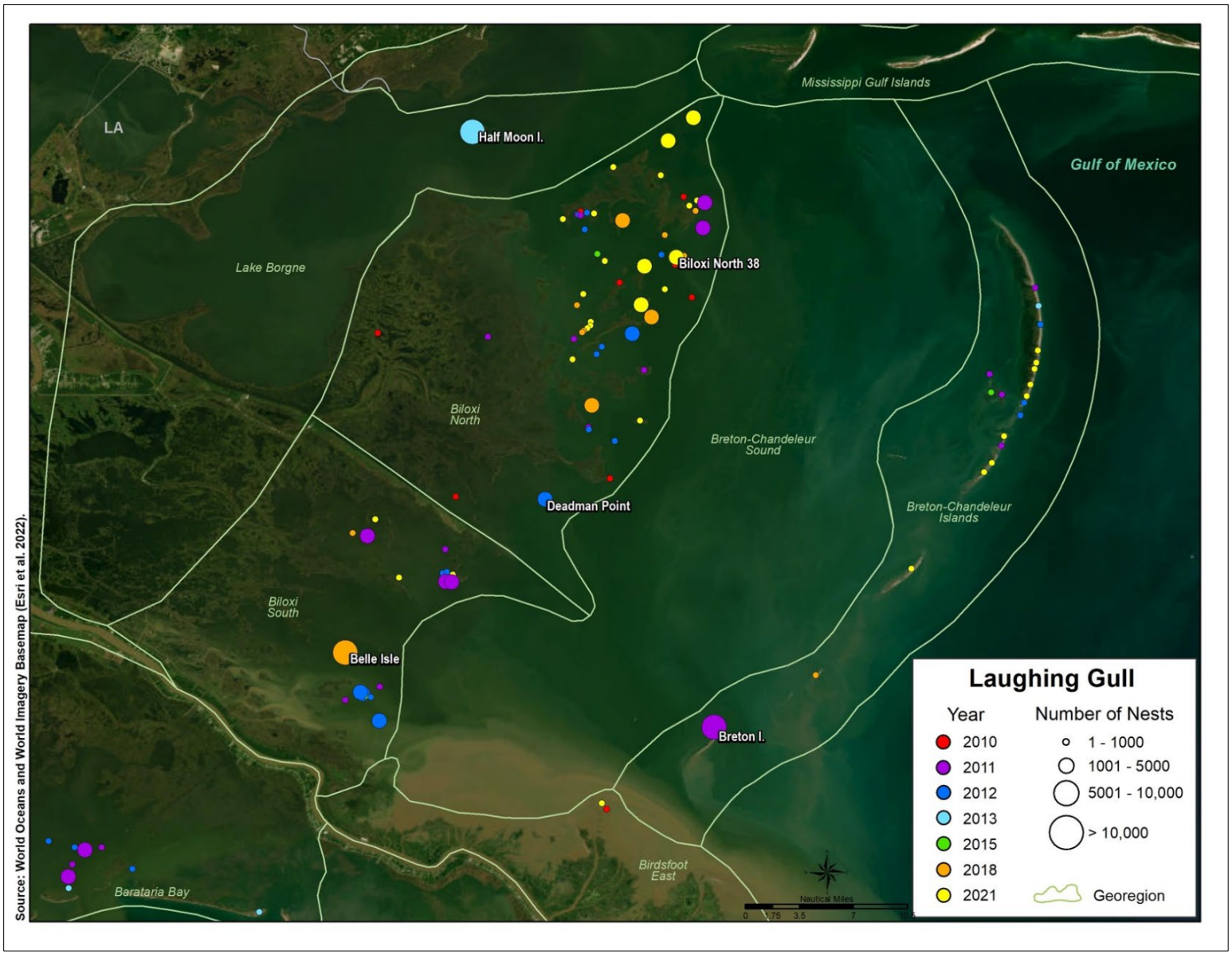
- = Outside intended survey area; ND = No Data; **Bold italics** indicates a sum of counts from May and June surveys.
[1]Presumably 0; on 25 June 2010, the survey team flew directly over South Deer Island and took no photographs.



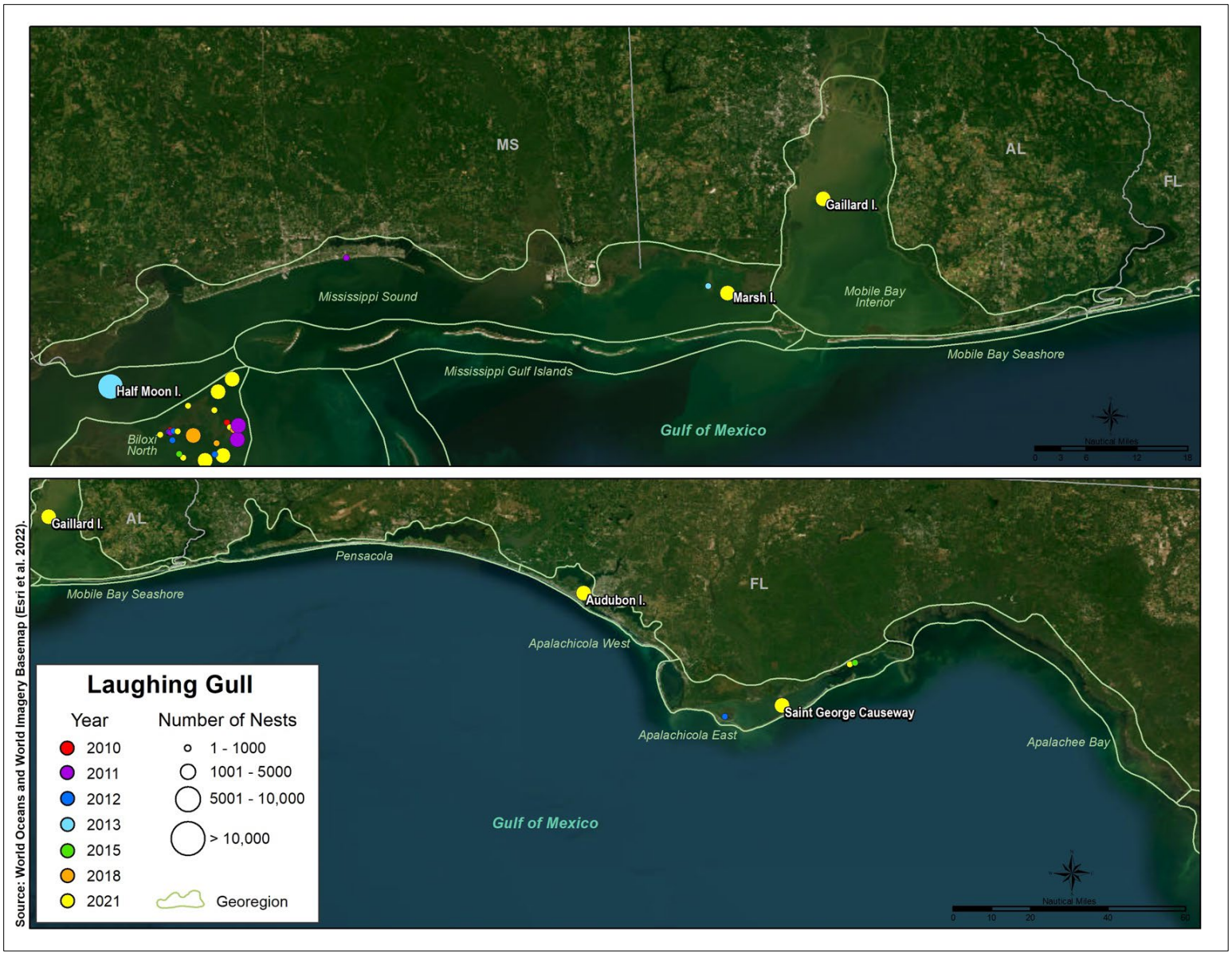
Map 1. Laughing Gull colonies counted, 2010–2021, in Texas and western Louisiana, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Laughing Gull colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Laughing Gull colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Laughing Gull colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Least Tern

Due to its small size, Least Tern is usually undetectable during surveys flown at standard survey altitudes. Only at a larger colony where many birds are in flight can the survey team have confidence they are directly over a colony. At lower altitudes or from an oblique perspective, flying Least Terns are more conspicuous. Consequently, most Least Terns are photographed incidentally while photographing other beach nesting birds. In 2021, however, the Regionwide Trustee Implementation Group (RW TIG) provided specific coordinates and buffers of colonies, mostly along mainland beaches, from Mississippi to Florida. At these locations, overlapping photographs were taken with a zoom lens throughout the buffered area, regardless of whether birds were observed. Ground survey data from 2015 and 2021 for Mississippi colonies were also provided for comparison with aerial photographic survey results (Audubon Mississippi, unpublished data; National Park Service, unpublished data).

During the 2010–2021 survey period, Least Terns were documented nesting at 20 colonies—seven in Mississippi, six in Florida, six in Louisiana, and one in Alabama (Maps 1–4). Colonies were detected in more than one year at Chandeleur North in Louisiana, Beauvoir in Mississippi, and Flag Island South in Florida, such that the database includes a total of 24 colony counts with nest totals > 0 (Table 1). Least Tern is distinguished in aerial photographs from other tern species by its smaller size and wider nest spacing. To determine whether a Least Tern is in fact a bird, photo quality must be excellent; a hint of a black cap often helps confirm the identification.

Table 1. Numbers of Least Tern nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
LA	24 (1)	33 (1)	37 (1)	0	64 (2)	0	34 (2)
MS	0	349 (1)	0	116 (1)	0	0	1293 (7)
AL	0	0	0	25 (1)	0	-	0
FL	0	0	15 (1)	0	108 (1)	-	94 (5)
Total	**24 (1)**	**382 (2)**	**52 (2)**	**141 (2)**	**172 (3)**	**0**	**1421 (14)**

() = colonies counted; - =state not included in survey area that year.

In 2021, a total of 1421 Least Tern nests were documented at 14 colonies (Table 1). The Beauvoir colony in Mississippi (970 nests) accounted for 68% of all nests counted and was by far the largest colony encountered during the 2010–2021 survey period (Table 2, Map 4). In Louisiana, the two colonies detected were good examples of incidental detection of Least Terns. At Point au Fer, 12 nests were on a beach with nesting Black Skimmers and Gull-billed Terns on 18 June 2021. At Chandeleur North D, 22 nests were photographed also on 18 June 2021, along with nests of Black Skimmers, Gull-billed Terns, and Forster's Terns. In Mississippi, Least Terns were at just five of 27 mainland locations surveyed; nests were at Round Island and Ship Island. No Least Terns were found in Alabama. However, the coordinates for the restored area at Lightning Point, where Least Terns may have been present, were evidently inaccurate. In Florida, the highest nest total was at Navarre Causeway A (46 nests; the west side of the causeway). This count was likely precise, as habitat on either side of the causeway was limited to strips of beach about 20 meters

wide by 500 meters long, allowing complete photographic coverage to be easily obtained. However, no survey was conducted in this area in May 2021 due to airspace restrictions. Surprisingly, given the small size of the species, one Least Tern chick was identified at a nest at Crooked Island North in a 14 June photograph.

Comparisons with 2015 and 2021 Ground Survey Data

In 2015, of the 13 Mississippi colonies for which ground survey data were provided for this report (Audubon Mississippi, unpublished data), only Beauvoir was inspected during aerial photographic surveys. Nesting Black Skimmers had been documented there in 2010, and Beauvoir was thus inspected in subsequent years. On 18 May and 22 June 2015, no nesting birds were detected, with only two photographs taken in May. Ground surveys on 18 May 2015 estimated 10 Least Tern nests and 329 birds. On 19 and 26 June 2015, ground surveys estimated 12 nests and 20 birds and 1 nest and 51 birds, respectively, and no Black Skimmers. Weekly ground surveys thereafter through 7 August detected no nests. With no nesting Black Skimmers to photograph, it is not surprising that the small numbers of Least Terns present in 2015 were not detected during aerial photographic surveys. Least Terns were detected at Beauvoir in June 2011 (349 nests) and June 2013 (116 nests) when active skimmer colonies were photographed.

In 2021, Least Terns were detected at five of the 27 Mississippi mainland locations provided by the RW TIG. Ground data were later provided for 24 of these locations (plus others); at 17 of them at least one nest was counted among the seasonal, ground surveys. Ground data were also provided for six offshore islands in Mississippi, including Deer Island. Ground surveys detected at least one nest on all Mississippi islands except Horn Island, whereas 2021 aerial photographic surveys detected Least Terns only at Ship Island and Round Island. However, for the Mississippi islands, it was not clear to the aerial survey team that they were explicitly surveying for Least Terns. At Deer Island, for example, the habitat encountered had the team searching the trees more so than the beaches, and four Great Blue Heron nests were found there. At Round Island, the team did not photograph all beaches, and only photographed the beach where a Black Skimmer colony (Southern Shell Field West in ground data) was found, whereas ground surveys monitored Least Terns at multiple locations.

Mid-June 2021 aerial photographic survey dates seemed to coincide with dates when peak numbers of Least Terns were detected from ground surveys. At Beauvoir, 970 nests and 1,144 birds were counted from 16 June 2021 aerial photographs, while the 15 June counts of 889 nests and 1,535 birds were the highest among seasonal ground surveys. Similarly, highest nest counts from ground surveys of Broad and Cowan were on 15 and 18 June, respectively. Ground counts declined dramatically thereafter at all three colonies. Other colonies had highest nest counts slightly earlier or later, however. The high count at Woodward was on 8 June (117 nests and 202 birds) and at Great Southern it was on 5 July (18 nests and 220 adults). Sherman also had later nesting or perhaps re-nesting after failed attempts elsewhere. Aerial photographic surveys did not detect nests at Sherman on 16 June; only two nests were counted there during 15 June ground surveys, but up to 38 were counted during July ground surveys.

However, unlike for large, dense colonies of Royal and Sandwich terns with synchronous breeding, higher Least Tern nest numbers on a certain survey date may not necessarily be best for estimating breeding population sizes. At East Ship Island, for example, a total of 101 nests and 158 birds were estimated from ground surveys on 14 June 2021, but most birds may have been scraping and may not have yet laid eggs. On subsequent ground surveys in June and July, only one nest was recorded anywhere on Ship Island. Ground surveys on 14 June took place at three separate points on "the neck," a restored area connecting Ship Island West and East. An interior (inside the colony) ground survey of the area farthest west on "the neck" described all 15 birds observed as scraping and counted none of them as nests. At an exterior survey of a second area on "the neck," 63 Least Terns were estimated sitting adjacent to a colony of Royal and Sandwich terns. At the farthest east 14 June ground survey location, 38 nests associated with nesting Black Skimmers were estimated during an exterior survey. The total count from 16 June aerial photographs was just eight nests and nine birds but may still have overestimated the actual number of egg-laying sites.

Factors that may affect aerial photographic and ground survey count differences include the small size of Least Terns and the completeness of colony viewing. In aerial photographs, standing postures of other, larger tern species are easy to distinguish from incubation postures. Thus, aerial photographic surveys may overestimate nest counts of Least Terns because of the difficulty of distinguishing postures. Ground surveys conducted outside a colony may similarly overestimate nest numbers compared with those conducted inside the colony. On the other hand, where aerial photographic counts are higher than ground counts, such as at Beauvoir and Broad, the vertical view of aerial surveys may allow for more complete colony viewing compared with external ground surveys. Finally, but importantly, daily variation in attendance patterns may be affected by disturbance of various sources (Darrah 2020).

Conclusion

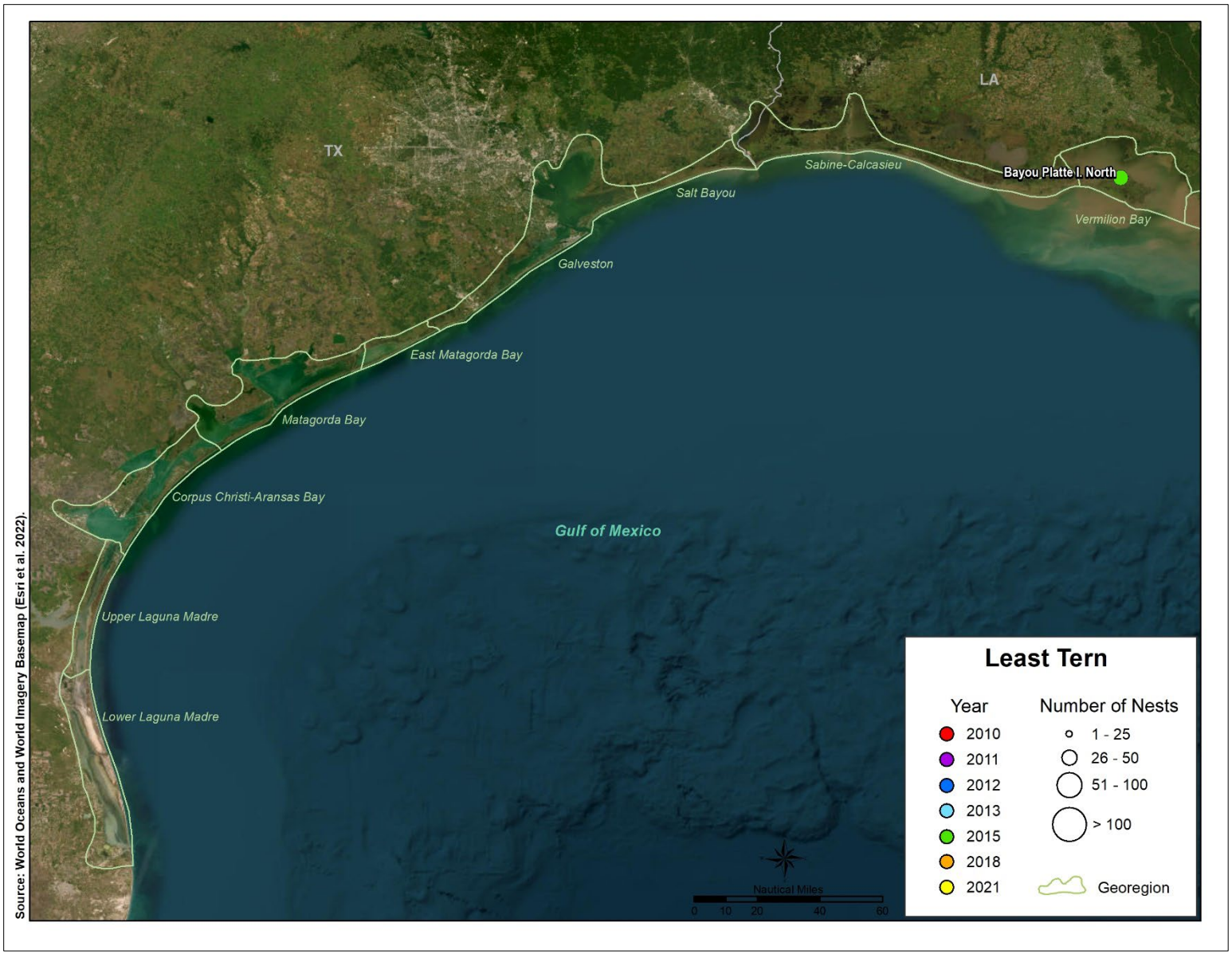
If aerial photographic survey data of certain Least Tern colonies are desired from future surveys, the surveys should be flown at lower altitudes, and the colonies should be photographed with zoom lenses at different focal lengths (i.e., without the telephoto lens). However, Least Tern data from aerial photographic surveys may be of greater value for colonies not easily monitored from the ground and for more remote colonies (such as Point au Fer, Louisiana in 2021), rather than for comparison with ground survey data of colonies monitored throughout the breeding season.

Table 2. Least Tern nest counts for all colonies with at least one count of 20 nests, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Louisiana	Vermilion Bay	Bayou Platte Island North	0	0	ND	0	35	0	0
	Biloxi North	Isle au Pitre	24	0	0	0	0	0	0
	Breton-Chandeleur Islands	Chandeleur North D	0	0	0	0	0	0	22
	Breton-Chandeleur Islands	Chandeleur North G	0	33	0	0	29	0	0
	Breton-Chandeleur Islands	Chandeleur South A	0	0	37	0	0	0	0
Alabama	Mississippi Sound	Terrapin Island	0	0	0	25	0	-	0
Mississippi	Mississippi Sound	Beauvoir	0	349	0	116	0	ND	970
	Mississippi Sound	Broad	0	0	0	ND	0	ND	161
	Mississippi Sound	Cowan	0	0	0	ND	0	ND	61
	Mississippi Sound	New Round Island[1]	0	0	0	0	ND	ND	65
	Mississippi Sound	Tegarden	0	0	0	ND	0	ND	26
Florida	Pensacola	Navarre Causeway A	ND	ND	ND	ND	ND	-	46
	Apalachicola East	Flag Island North	0	0	0	0	108	-	0
	Apalachicola East	Flag Island South	0	0	15	0	0	-	26

ND = No Data; - = Outside intended survey area.

[1]New Round Island construction was completed in 2017.



Map 1. Least Tern colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.

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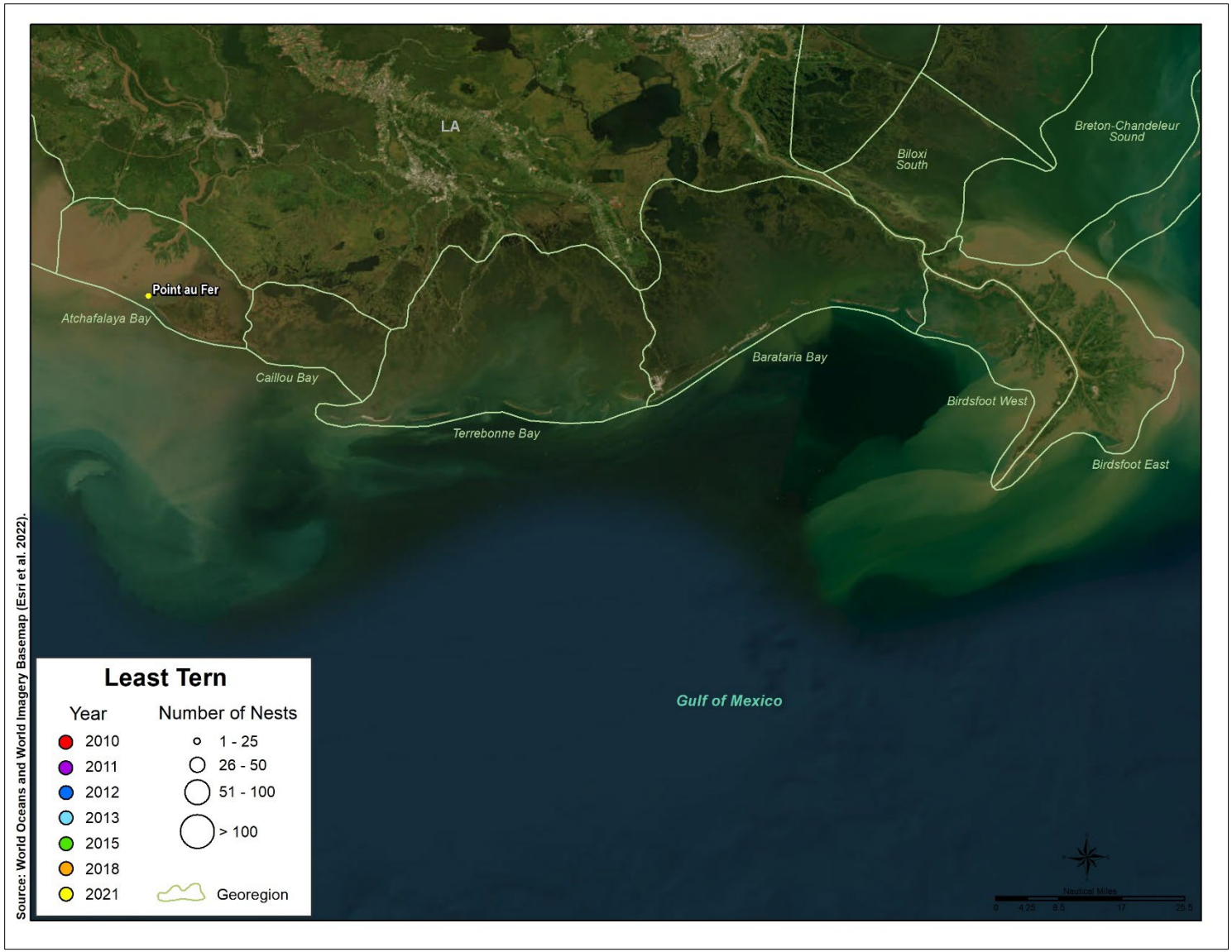
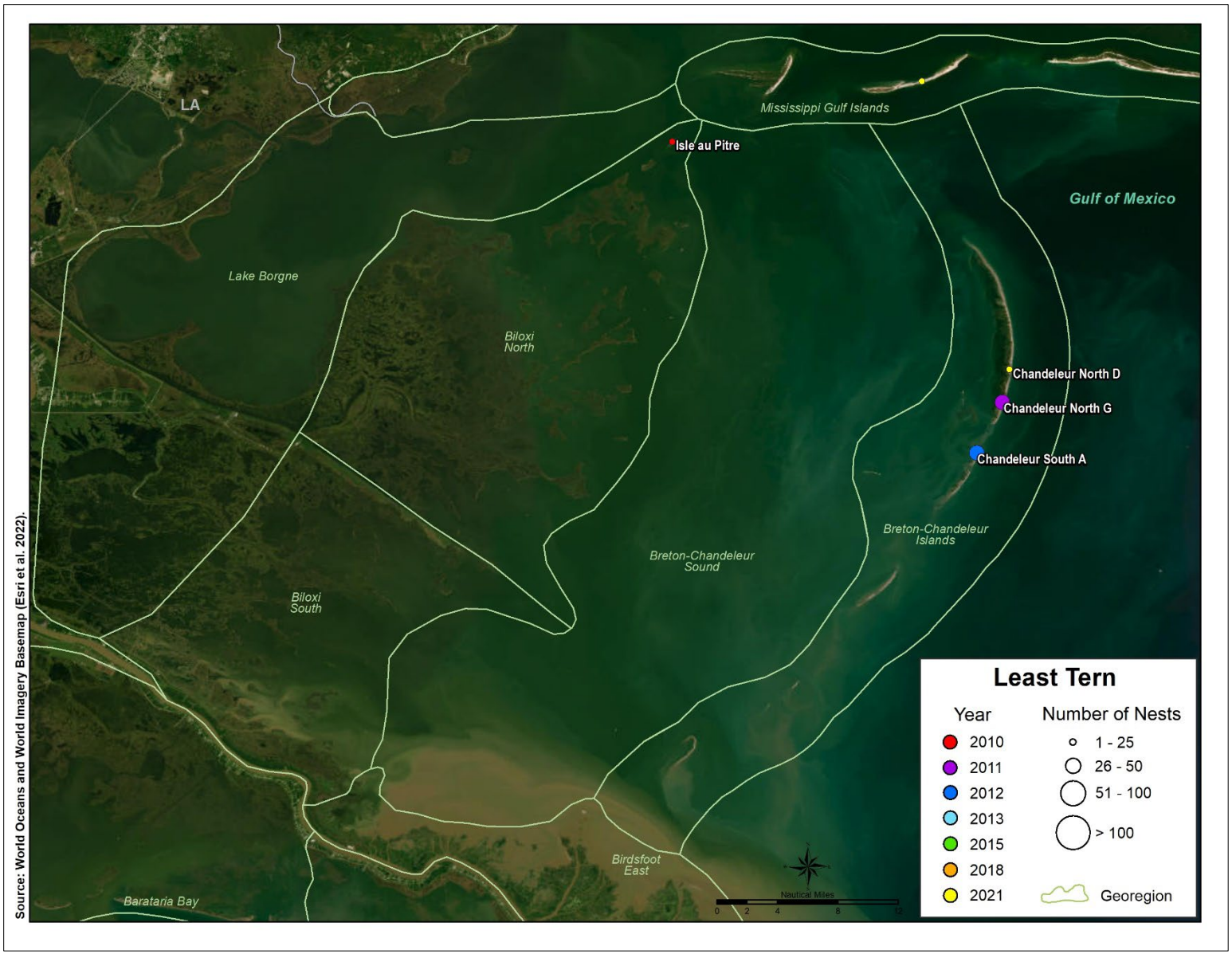


Map 2. Least Tern colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Least Tern colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.

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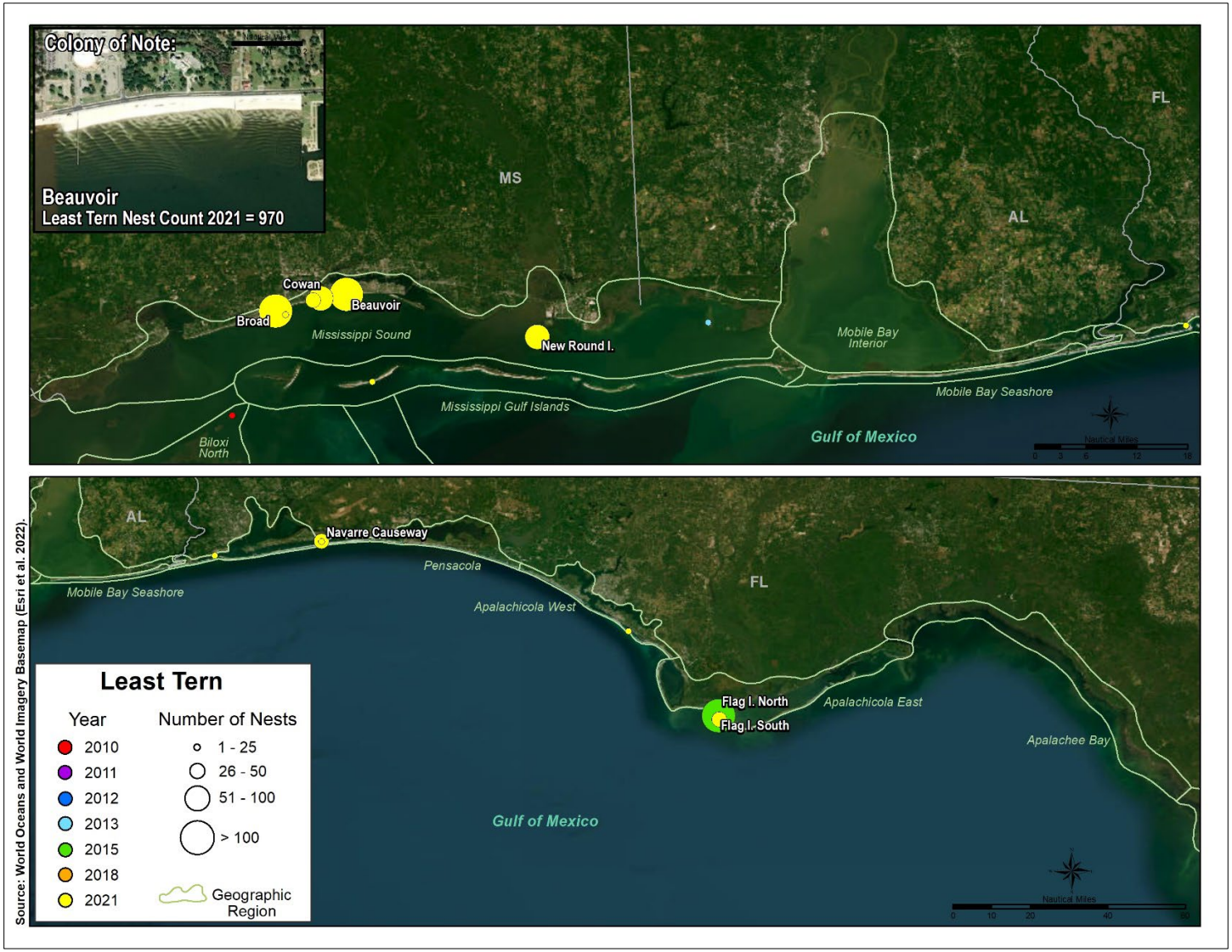


Map 4. Least Tern colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.

Gull-billed Tern

Gull-billed Tern nesting was documented at 114 colonies—66 in Louisiana, 31 in Texas, eight in Alabama, six in Florida, and three in Mississippi (Maps 1–4). Gull-billed Tern is identified in aerial photographs in part by its association with the more conspicuous Black Skimmer. In fact, Gull-billed Terns were intermixed with Black Skimmer at 95% of the colonies counted during the 2010–2021 survey period. Gull-billed Terns nested in low densities, often inconsistently spaced, and typically amid larger numbers of Black Skimmer nests. They often appear to have a wider body and thicker bill compared with similarly sized species such as Forster's Tern or Sandwich Tern. In the nGOM, Gull-billed Terns usually nest on sandy beaches or barrier islands (Molina at al. 2020) and often take advantage of dredge spoil islands (Chaney et al. 1978, Leberg et al. 1995, Mallach and Leberg 1999).

In 2021, a total of 3813 Gull-billed Tern nests were counted among 50 colonies (Table 1). Of those nests, 62% were among 23 Louisiana colonies and 33% were among 19 Texas colonies, with small numbers in Mississippi, Alabama, and Florida. Gunn Island in Louisiana (1378 nests) accounted for 49% of all nests. The Gunn Island nest total was by far the highest across the Study Area and all years (Table 2, Map 2). Another five colonies had more than 100 nests in 2021—three in Texas and two in Louisiana. Most colony counts (40) were from June photographs; seven were from May photographs (two because the colony was abandoned by June), and three in the Lower Laguna Madre in Texas were sums of May and June counts. Chicks were seen in June photographs at six colonies—Rabbit Island in Louisiana and five Texas colonies.

Table 1. Numbers of Gull-billed Tern nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	491 (12)	-	-	-	-	-	1246 (19)
LA	258 (7)	821 (22)	1475 (19)	1838 (32)	871 (29)	1000 (27)	2367 (23)
MS	12 (1)	0	18 (1)	12 (1)	0	-	51 (1)
AL	17 (3)	40 (2)	28 (1)	24 (1)	124 (2)	-	77 (3)
FL	38 (2)	13 (1)	30 (2)	0	53 (3)	-	72 (4)
Total	**816 (26)**	**874 (25)**	**1551 (23)**	**1874 (34)**	**1048 (34)**	**1000 (27)**	**3813 (50)**

() = colonies counted; - =state not included in survey area that year.

In Texas, Gull-billed Tern nesting occurred primarily on spoil islands. In 2021, more than half the colonies and more than half the nests were in the Lower Laguna Madre GeoRegion.

In Louisiana, the highest nest counts were in the Birdsfoot East, Birdsfoot West, and Vermilion Bay GeoRegions, which are also associated with dredge spoil islands (Figure 1, Table 2). Colony switching and fluctuations in nest totals occurred with changes in nesting habitat. Gunn Island was built as a beneficial use project in 2016, with additional dredged material added from 2018 to 2020, leading to an influx of Gull-billed Terns, Black Skimmers, and other species in 2021. In 2013, a colony moved from Birdsfoot West 2 to Birdsfoot West 4 after the latter was newly created. Nesting at Birdsfoot West 4 then ceased by 2018 as shrubby vegetation began to cover

the island. In the Vermilion Bay GeoRegion, Bayou Platte Island North did not have nests through 2013. However, the island was expanded in 2014, and then hosted 257 nests in 2015 and 102 nests in 2018. Few nests were present at Bayou Platte Island North and South in 2021, as the islands had become more vegetated.

In Mississippi, Gull-billed Tern nests were only documented at Horn Island and Ship Island but not in all years, with a high count of 51 nests at Ship Island on 16 June 2021. No nests were found at Horn Island in 2021, but ground surveys by local biologists confirmed one nest on 30 June (Audubon Mississippi, unpublished data).

In Alabama, aside from a high count at Gaillard Island in 2015 (Table 2), Terrapin Island was the only other colony with nesting in most years. The high count there was 60 nests in 2021.

In Florida, Flag Island South was the largest colony, with 32 nests counted in both 2010 and 2015.

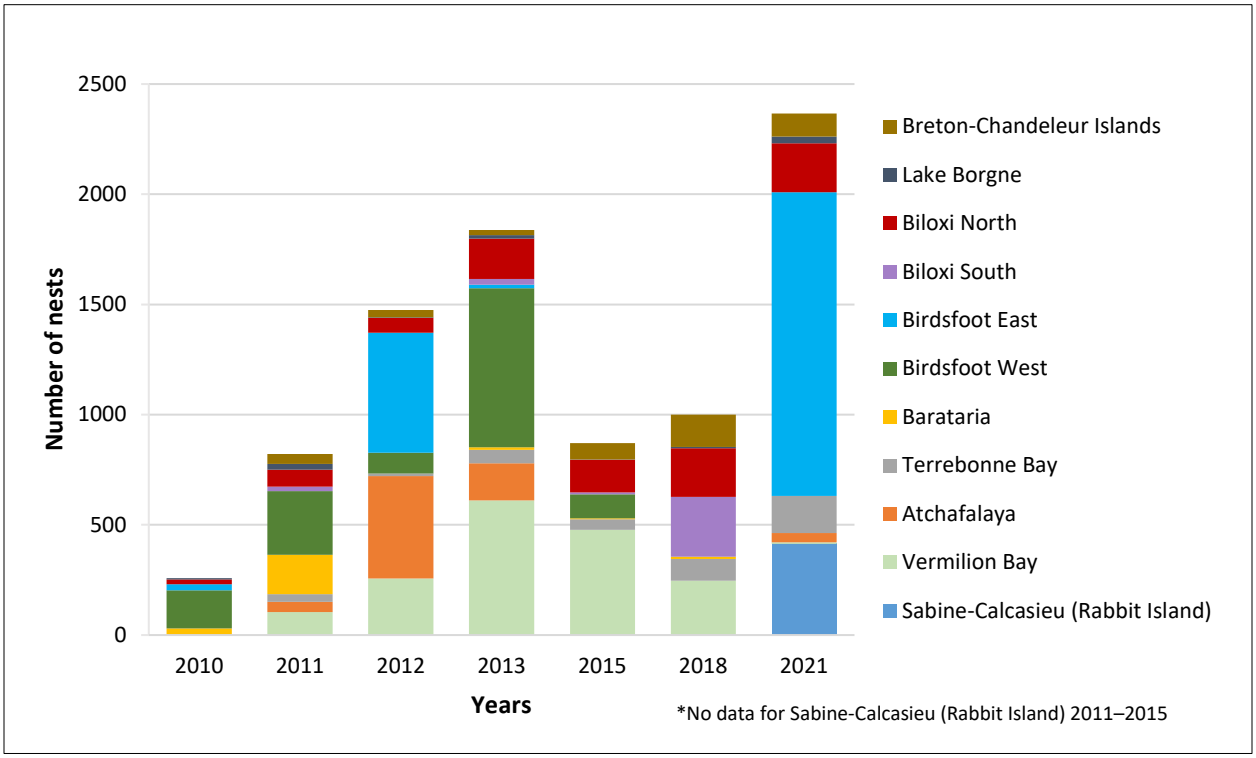
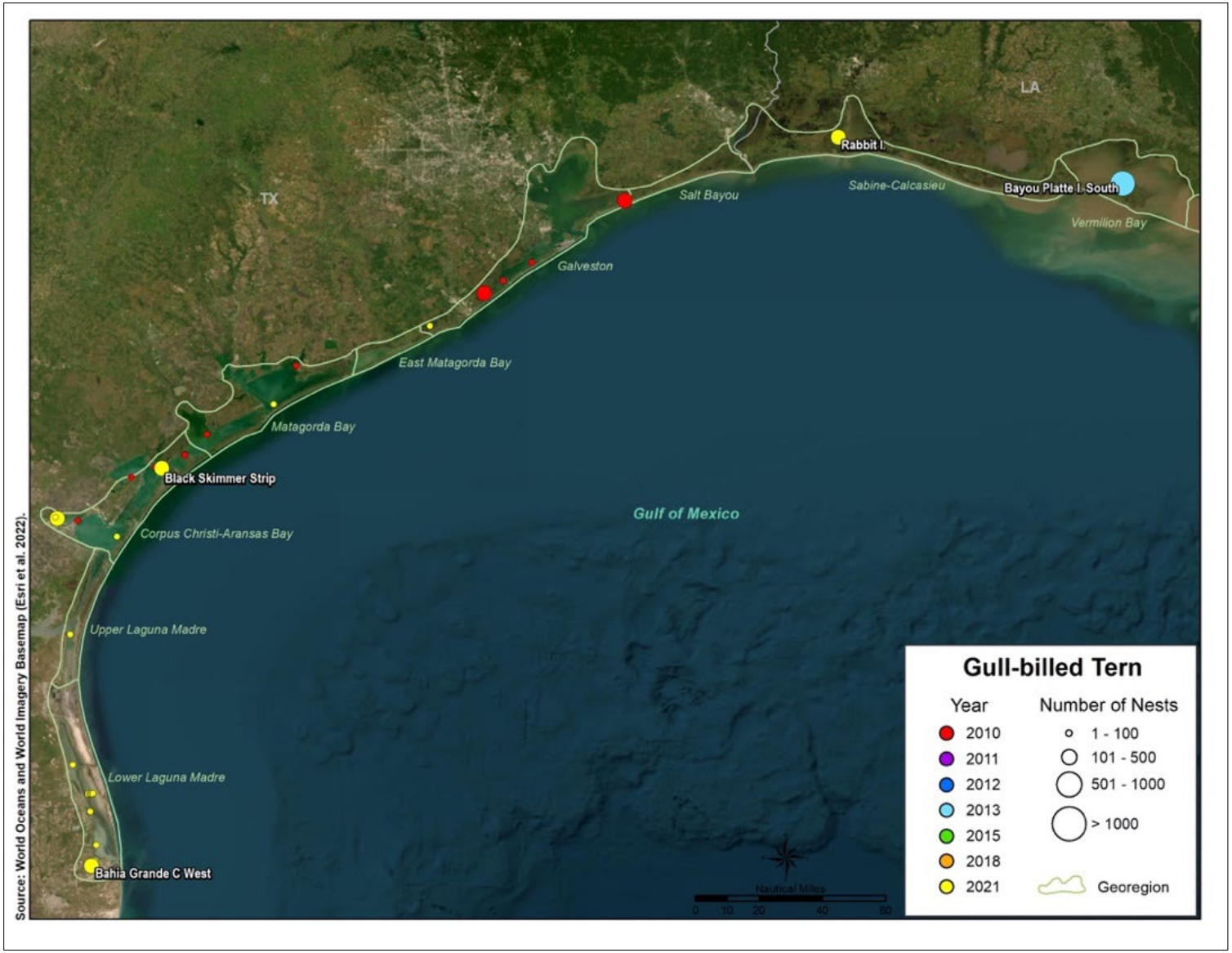


Figure 1. Numbers of Gull-billed Tern nests in Louisiana by GeoRegion, 2010–2021.

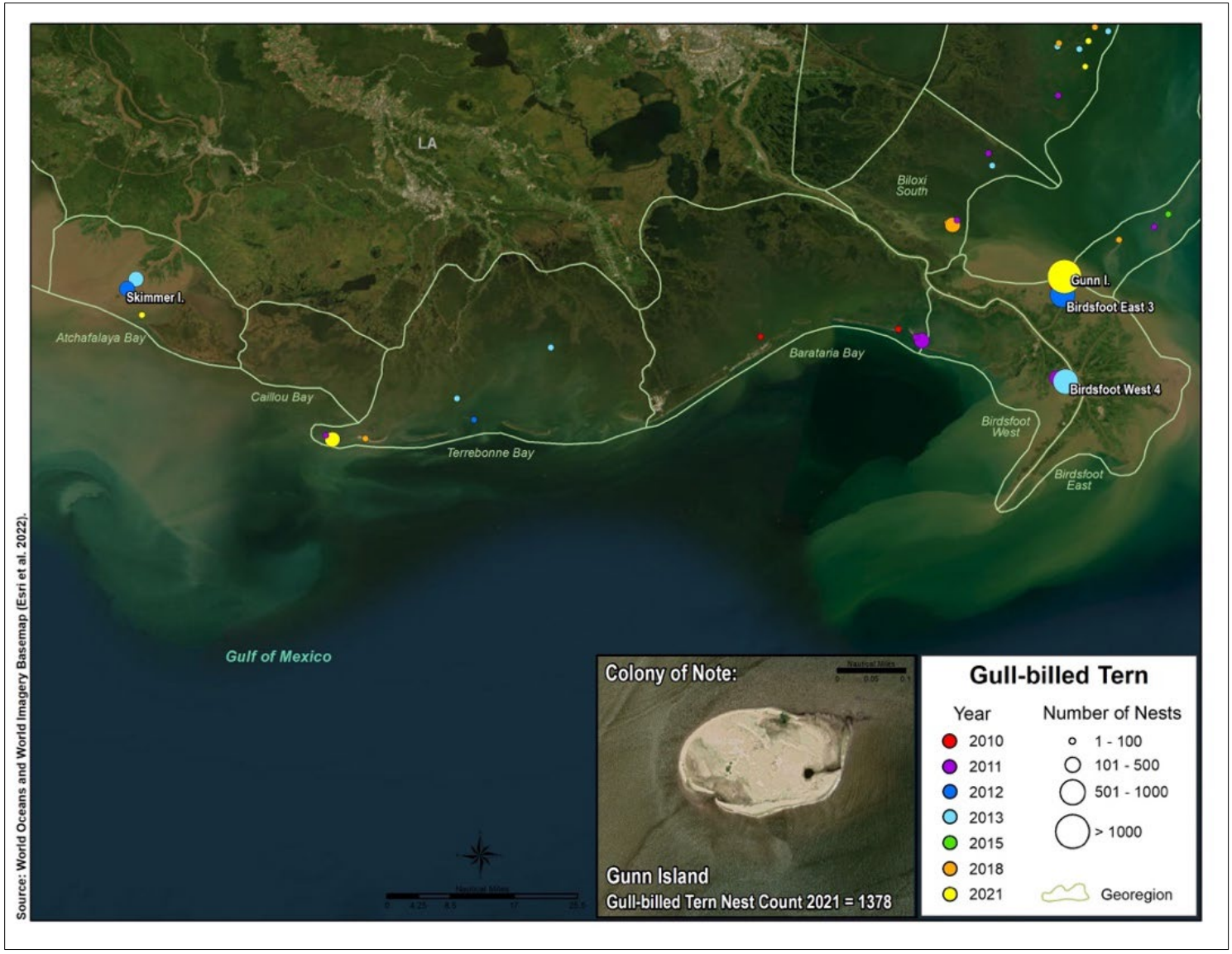
Table 2. Gull-billed Tern nest counts for all colonies with at least one count of 100 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Lower Laguna Madre	Bahia Grande C West	-	-	-	-	-	-	***436***
	Corpus Christi-Aransas Bay	Black Skimmer Strip	ND	-	-	-	-	-	266
	Corpus Christi-Aransas Bay	West Nueces Bay 51W A	0	-	-	-	-	-	156
	Galveston	Rollover Bay B	168	-	-	-	-	-	0
	Galveston	Wolf Lake Skimmer Area	169	-	-	-	-	-	0
Louisiana	Sabine-Calcasieu	Rabbit Island	0	-	-	-	-	0	414
	Vermilion Bay	Bayou Platte Island North	0	0	0	0	257	102	4
	Vermilion Bay	Bayou Platte Island South	0	105	257	611	221	144	3
	Atchafalaya Bay	Avocet Island	NA	NA	ND	168	0	0	0
	Atchafalaya Bay	Skimmer Island	0	46	464	0	0	0	0
	Terrebonne Bay	Raccoon Island	0	5	6	11	47	0	168
	Terrebonne Bay	Whiskey Island	0	0	0	0	0	100	0
	Barataria Bay	Shell Island East	S	178	0[1]	0[2]	5	0[3]	0
	Birdsfoot East	Birdsfoot East 3	S	0	545	15	0	0	0
	Birdsfoot East	Gunn Island	NA	NA	NA	NA	NA	0	1378
	Birdsfoot West	Birdsfoot West 2	173	289	94	0	0	0	0
	Birdsfoot West	Birdsfoot West 4	NA	NA	NA	722	109	0	0
	Biloxi South	Biloxi South 10 D	0	0	0	0	0	221	0
Alabama	Mobile Bay Interior	Gaillard Island	0	0	0	0	106	-	14

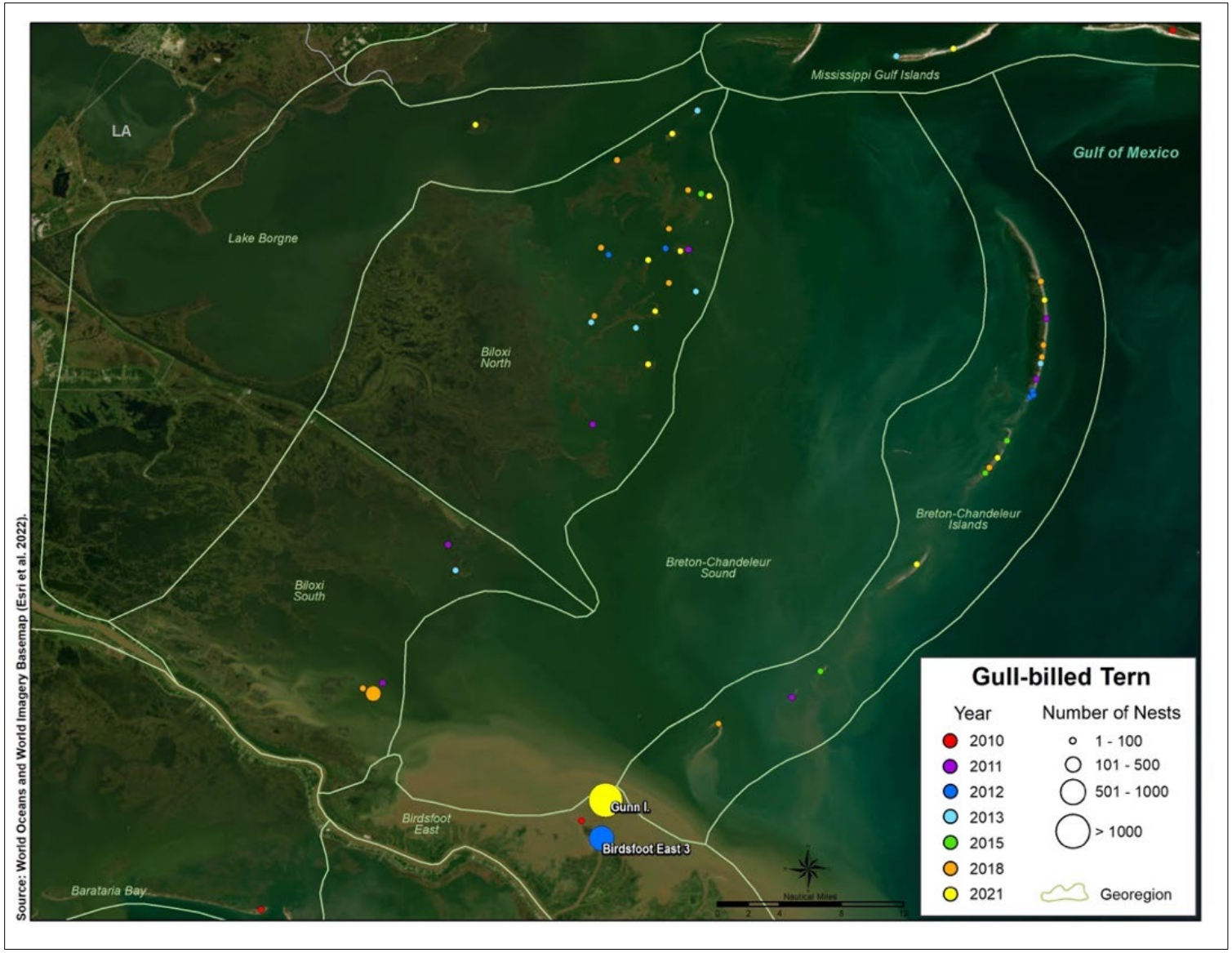
ND = No Data; S = Submerged; NA = Not applicable, Island not yet created; - = Outside intended survey area; Bold italics indicate a sum of counts from May and June surveys.
[1]Not inspected in June, [2]Presumed active construction, [3]Not Inspected in May



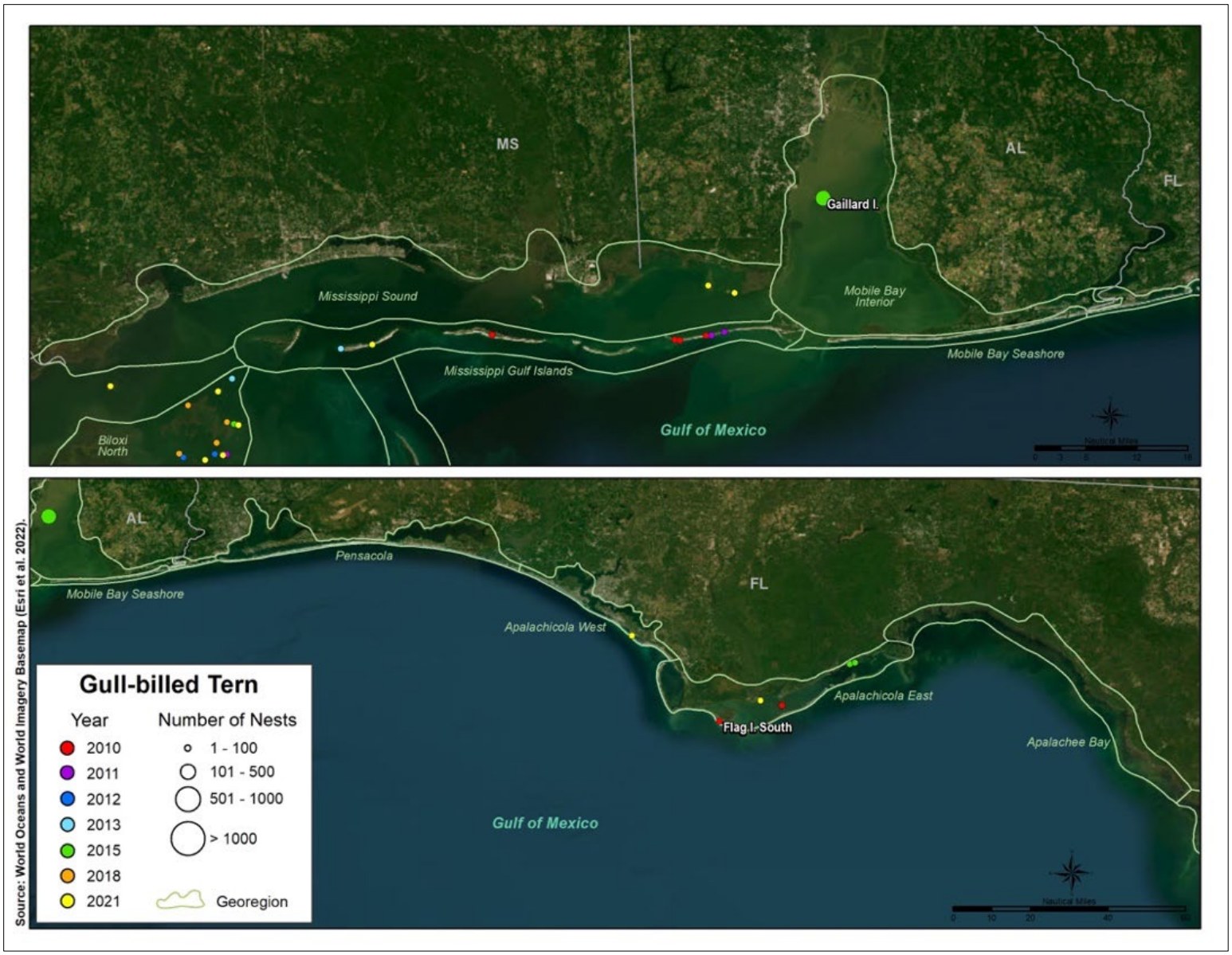
Map 1. Gull-billed Tern colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Gull-billed Tern colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 3. Gull-billed Tern colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Gull-billed Tern colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Caspian Tern

Caspian Tern is the largest of all tern species, identified by its thick red bill, black cap, and stout body. Its smaller colonies, with more widely spaced nests, were often on the periphery of dense Royal Tern and Sandwich Tern colonies. Nesting occurred at 89 colonies—55 in Louisiana, 27 in Texas, four in Alabama, and three in Florida. Like other tern species, Caspian Tern tends to nest in areas with little to no vegetation.

In 2021, 2980 nests were distributed among 48 colonies (Table 1). Of those nests, 45% were among 17 Louisiana colonies, 40% were among 26 Texas colonies, and 10% were among two Alabama colonies. In Louisiana, 100% of nest counts occurred in June, whereas 83% of Texas counts occurred in May. Chicks were noted at 14 colonies, all in Texas. Twelve of the counts were from May photographs, further indicating earlier timing of breeding in Texas compared with other states. The largest colonies were at Gunn Island in Louisiana (627 nests), Gaillard Island in Alabama (216 nests), and Green Island Spoils H in Texas (157 nests). Another 16 colonies had more than 50 nests—nine in Texas, five in Louisiana, one in Alabama, and one in Florida.

Table 1. Numbers of Caspian Tern nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	54 (2)	-	-	-	-	-	1200 (26)
LA	297 (7)	858 (16)	960 (12)	895 (21)	729 (19)	1729 (24)	1341 (17)
AL	49 (4)	521 (1)	294 (1)	388 (2)	332 (2)	-	296 (2)
FL	180 (2)	44 (1)	220 (2)	183 (1)	184 (2)	-	143 (3)
Total	**580 (15)**	**1423 (18)**	**1474 (15)**	**1466 (24)**	**1245 (23)**	**1729 (24)**	**2980 (48)**

() = colonies counted; - = state not included in survey area that year.

In Texas in 2021, Green Island Spoils H in the Lower Laguna Madre GeoRegion was the largest colony, and 49% of nests (77 of 157) had visible chicks in May. Six of the 14 colonies with visible chicks were in the Lower Laguna Madre. The Lower Laguna Madre accounted for 63% of all Caspian Tern nests. In 2010, when survey coverage extended south only to Corpus Christi, nests were found only at West Bay Bird Island New and West Nueces Bay 51W K.

In Louisiana, as with Gull-billed Tern, Caspian Tern nesting did not persist annually at dredge spoil islands in the Birdsfoot GeoRegions (Table 2, Map 2). These islands became increasingly vegetated over time, which reduced the amount of nesting habitat. For example, Birdsfoot East 3 hosted 349 Caspian Tern nests in 2012 but none by 2015. Birdsfoot West 4 also decreased from 67 nests in 2013 to 19 nests in 2015 and none by 2018. Large colonies were then observed at Gunn Island in 2018 and 2021. Of note (though beyond the scope of this report), during 2022 surveys Gunn Island was much more vegetated, though some nesting Caspian Terns were still present.

Among other Louisiana GeoRegions, Biloxi North and Biloxi South combined for more than 200 nests in all years except 2010 (Figure 1). Despite Biloxi South 9 gradually shrinking in size over

the decade, nest counts fluctuated and exceeded 200 nests in 2018. The island was eventually submerged by 2021 (Table 2, Map 3). In Terrebonne Bay, terns previously nesting at Felicity Island likely shifted to Philo Brice Islands in 2018 in response to land loss at Felicity Island. At Raccoon Island, Caspian Tern nests were observed only in 2018 (52 nests) and 2021 (80 nests).

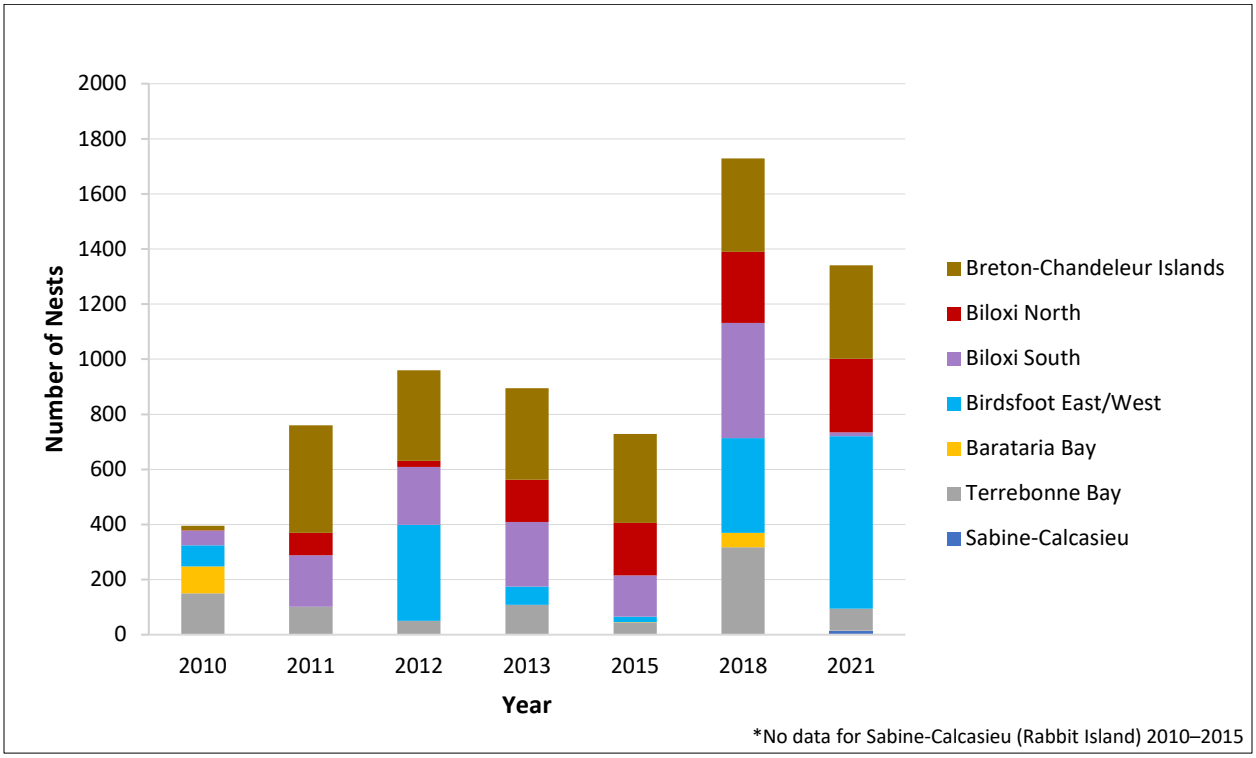


Figure 1. Numbers of Caspian Tern nests in Louisiana by GeoRegion, 2010–2021.

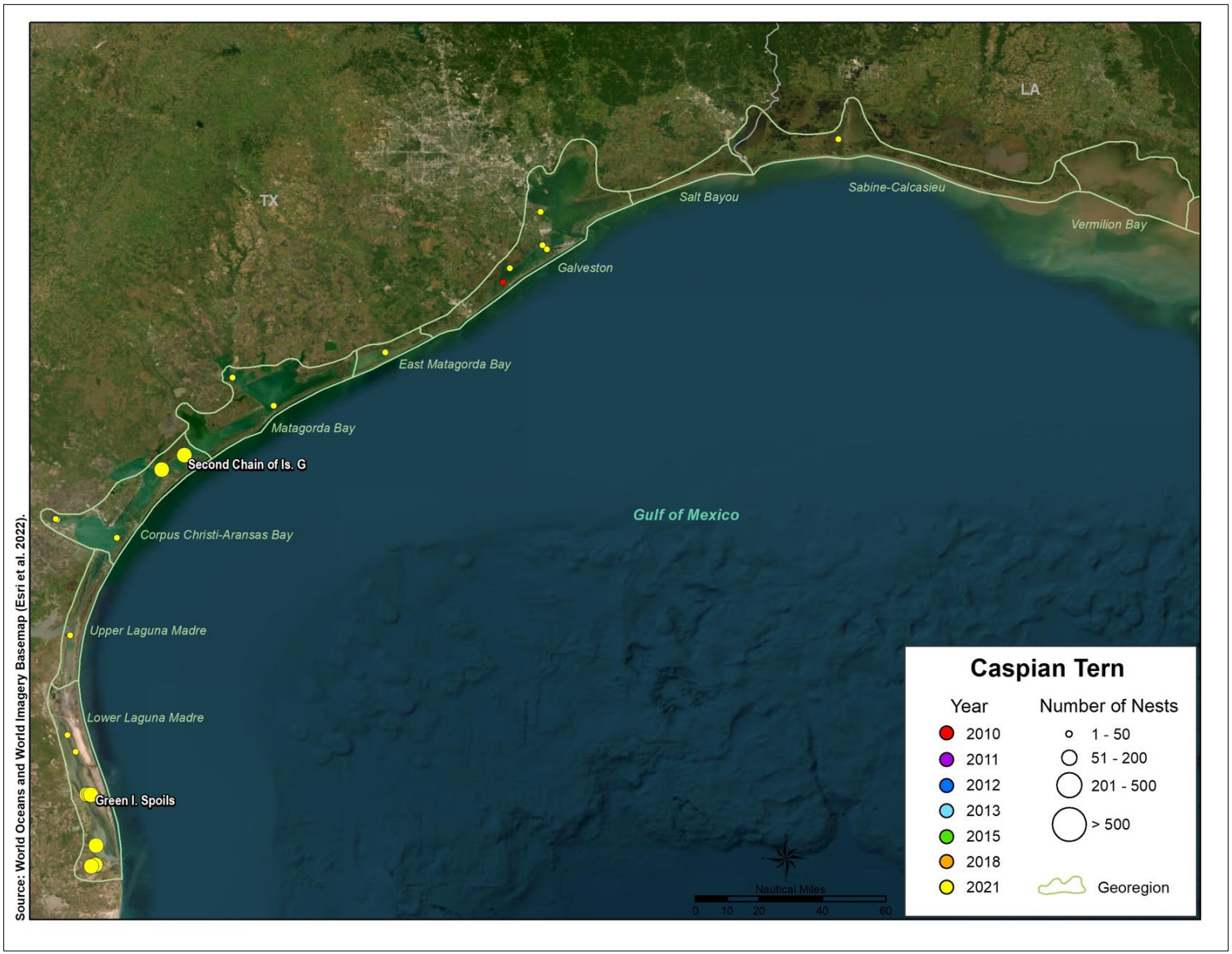
In Alabama, Gaillard Island hosted the largest colony in all years, with a high count of 521 nests in 2011 (Table 2, Map 4). The only other location in the state with documented nesting was Terrapin Island, with a high count of 80 nests in 2021. No nests were detected at Terrapin Island in 2011 or 2012.

In Florida, Saint George Causeway was the largest colony (183 nests in 2013), with similar numbers each year it was surveyed (Table 2, Map 4). Flag Island South hosted nests in all years surveyed except for 2013, with a high of 104 nests in 2012. Lanark Reef West was the only other location with Caspian Tern nests, with three in 2021. No nests were found at Apalachicola Bird, but as many as 40 birds were there in 2021. Caspian Tern nesting there was first documented in 1996, after the island was created in early 1995 (McNair and Gore 2000).

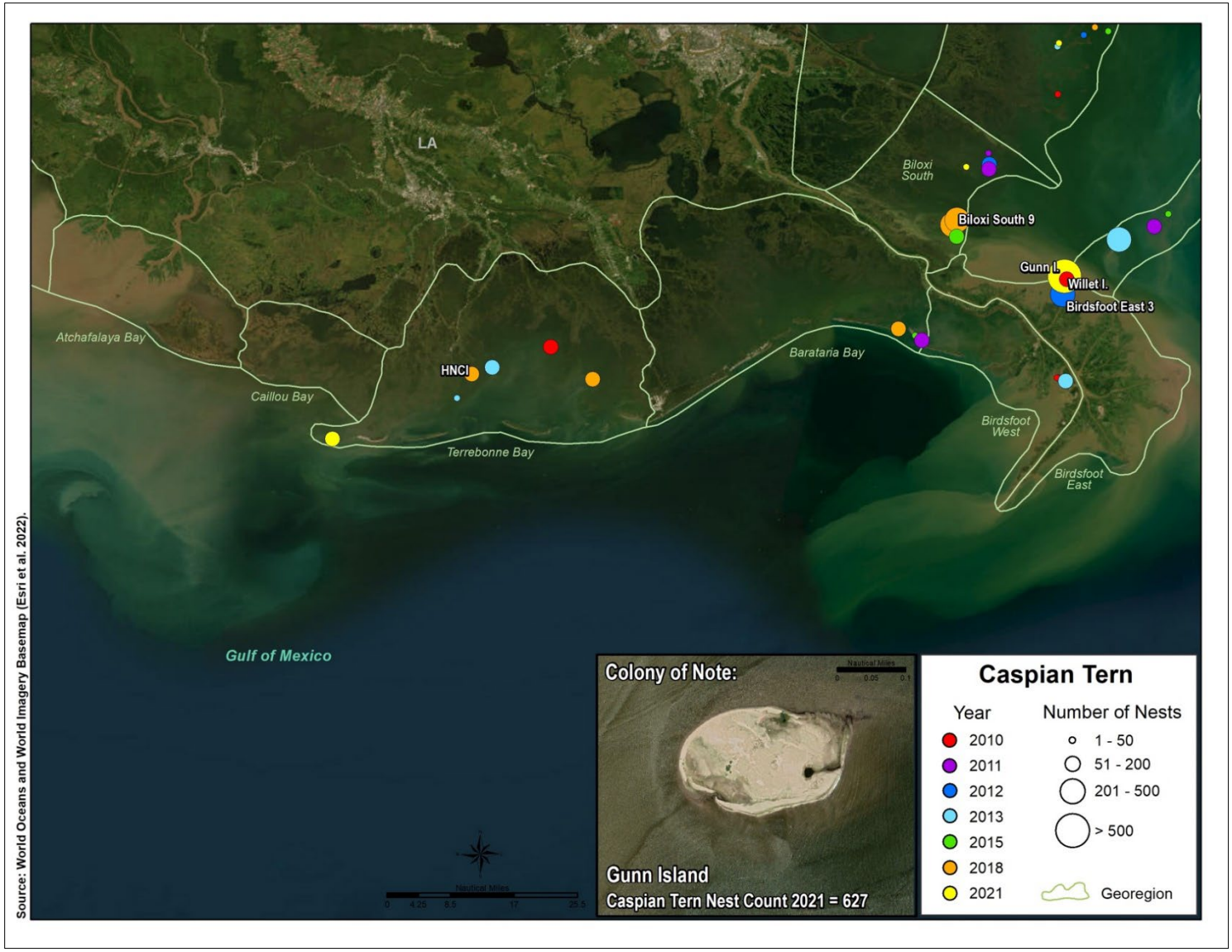
Table 2. Caspian Tern nest counts for all colonies with at least one count of 100 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Lower Laguna Madre	Green Island Spoils H	-	-	-	-	-	-	157
	Corpus Christi-Aransas Bay	Second Chain of Islands G	0	-	-	-	-	-	102
Louisiana	Terrebonne Bay	Felicity Island	150	102	50	9	0	0	0
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	0	45	152	0
	Terrebonne Bay	Philo Brice Island	0	0	0	0	0	114	0
	Birdsfoot East	Birdsfoot East 3	S	0	349	0	0	0	0
	Birdsfoot East	Gunn Island	NA	NA	NA	NA	NA	344	627
	Biloxi South	Biloxi South 9	40	96	124	196	89	216	S
	Biloxi South	Biloxi South 10 D	0	0	0	0	0	201	0
	Biloxi North	Bayou Pintou	-	0	-	1	0	121	156
	Biloxi North	Biloxi North 4	0	0	0	0	103	0	1
	Breton-Chandeleur Islands	Breton Island	0	104	0	231	***130***	0	0
	Breton-Chandeleur Islands	Chandeleur Islands North	0	82	51	35	65	105	181
	Breton-Chandeleur Islands	Chandeleur Islands South	16	132	278	66	13	209	148
Alabama	Mobile Bay Interior	Gaillard Island	30	521	294	377	323	-	216
Florida	Apalachicola East	Flag Island South	52	44	104	0	27	-	7
	Apalachicola East	Saint George Causeway	128	-	116	183	157	-	133

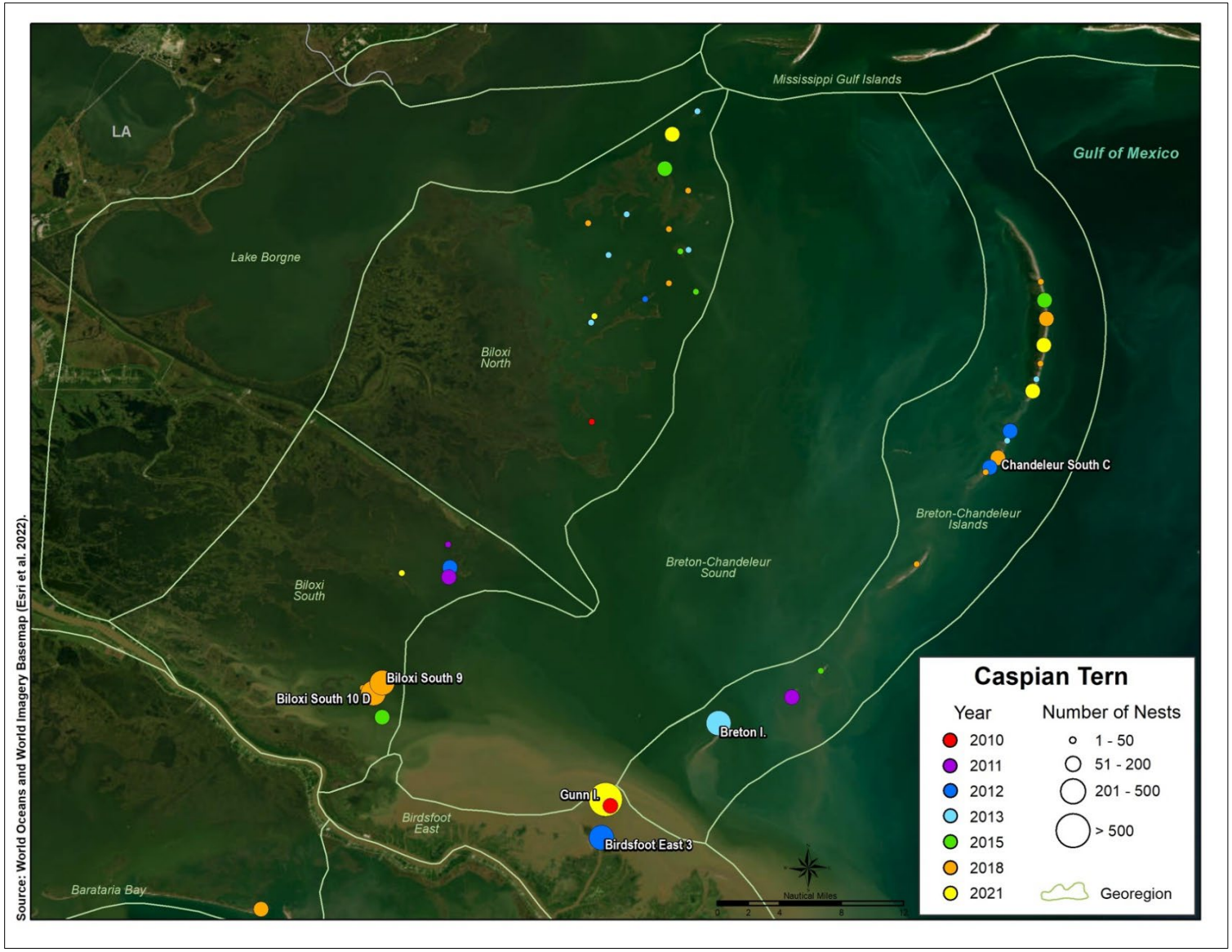
- = Outside intended survey area; ND = No Data; NA = Not applicable, as island not yet created; S = Submerged.



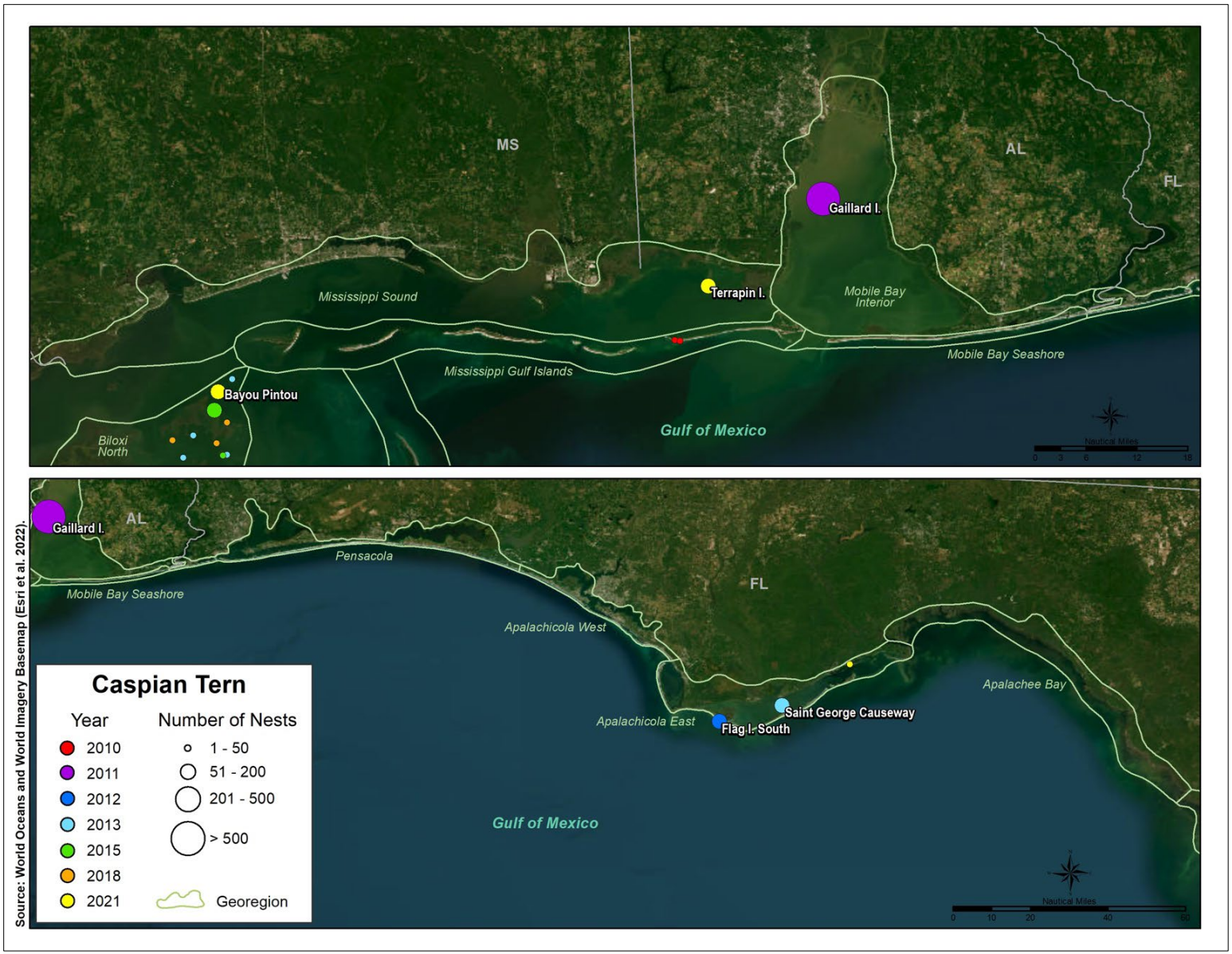
Map 1. Caspian Tern colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Caspian Tern colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 3. Caspian Tern colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Caspian Tern colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Forster's Tern

Forster's Tern nesting was documented at 95 colonies—76 in Louisiana, 18 in Texas, and one in Alabama (Maps 1–4). Forster's Tern preferentially nests on wrack lines, and colonies with high nest counts were consistently on marsh islands with grassy vegetation. At a few colonies, Forster's Terns nested in sandy habitat, sometimes adjacent to Gull-billed Terns. In these cases, a hint of orange in the bill often increased confidence in identifications that were otherwise based on subtleties of body and bill shape. Small islands are easily surveyed, but larger ones like Half Moon Island in Louisiana take longer to inspect. Given the vastness and ever-changing nature of marsh areas in Barataria Bay and Biloxi Marsh in Louisiana, all active colonies were not necessarily detected in any year.

In 2021, a total of 6658 Forster's Tern nests were counted among 38 colonies (Table 1). Of those nests, 81% were among 23 Louisiana colonies, 19% were among 14 Texas colonies, and only two nests were in Alabama (at Gaillard Island). Rabbit Island accounted for 33% of all nests in 2021, having increased from 573 nests in 2018 to 2185 nests in 2021 following restoration (Table 2). The 2021 Rabbit Island nest count was the highest across the Study Area and all years (Map 1). Beauregard Island accounted for another 13% of nests (889 nests) in 2021. Another 13 colonies had more than 100 nests—nine in Louisiana and four in Texas.

Table 1. Numbers of Forster's Tern nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	205 (6)	--	--	--	--	--	1260 (14)
LA	3165 (24)	5437 (30)	2755 (18)	4523 (24)	3487 (27)	5640 (28)	5396 (23)
AL	0	0	0	0	0	--	2 (1)
Total	**3370 (30)**	**5437 (30)**	**2755 (18)**	**4523 (24)**	**3487 (27)**	**5640 (28)**	**6658 (38)**

() = number of colonies; -- = state not included in survey area that year.

In Texas, in addition to South Deer Island (Table 2), other colonies with more than 100 nests in 2021 were at West Bay Mooring Facility in May and two colonies in West Nueces Bay in June. No chicks were seen at any colonies in Texas, including at West Bay Mooring Facility in June. In 2010, of the six colonies counted in June, none had more than 100 nests and no chicks were seen.

In Louisiana, most nesting occurred in Barataria Bay, Biloxi South, and Biloxi North GeoRegions, apart from Rabbit Island in 2021 (Figure 1). Barataria Bay nest totals fluctuated among colonies each year, likely due to yearly habitat changes of marsh islands. For example, four islands with at least one count of 250 nests or more were submerged by 2021, perhaps leading to the large colony size at Beauregard Island in 2021 (889 nests; Table 2) as birds converged on habitat there. Nest totals in Biloxi North and South GeoRegions also indicated colony switching from year to year. Lack of nesting in 2021 at Belle Isle, which hosted hundreds of pairs in previous years, was not obviously associated with land loss. Therefore, other factors such as prey availability or availability of wrack may also affect locations of colonies.

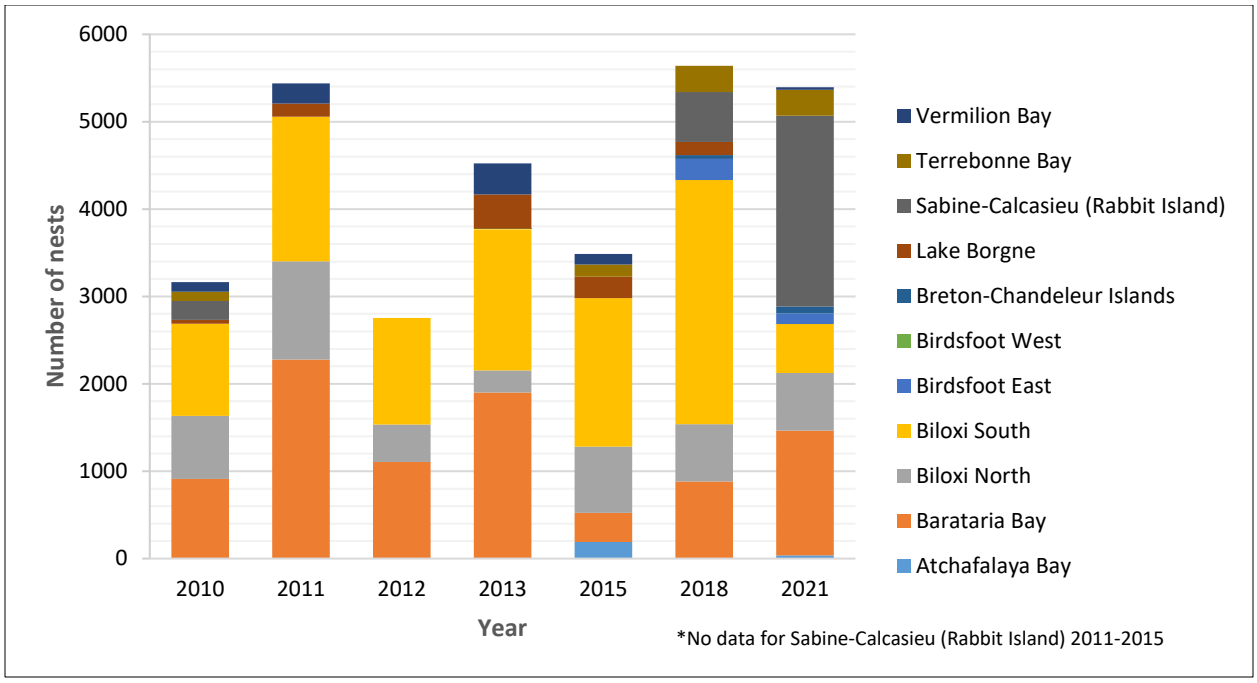


Figure 1. Numbers of Forster's Tern nests in Louisiana by GeoRegion, 2010–2021.

Forster's Tern nest counts were typically derived from June photographs, though colonies were sometimes abandoned by June, possibly due to overwash, and therefore counted from May photographs. In 2021, only five of 38 colony counts were determined from May photographs (three others were combinations of May and June counts). Chicks were documented at just nine colonies among the seven survey years. Only one of those instances was in May, at Biloxi North 28 in 2011, possibly indicating good nesting conditions that year, as also indicated by the high statewide nest total in Louisiana in 2011, even without Rabbit Island data (Figure 1).

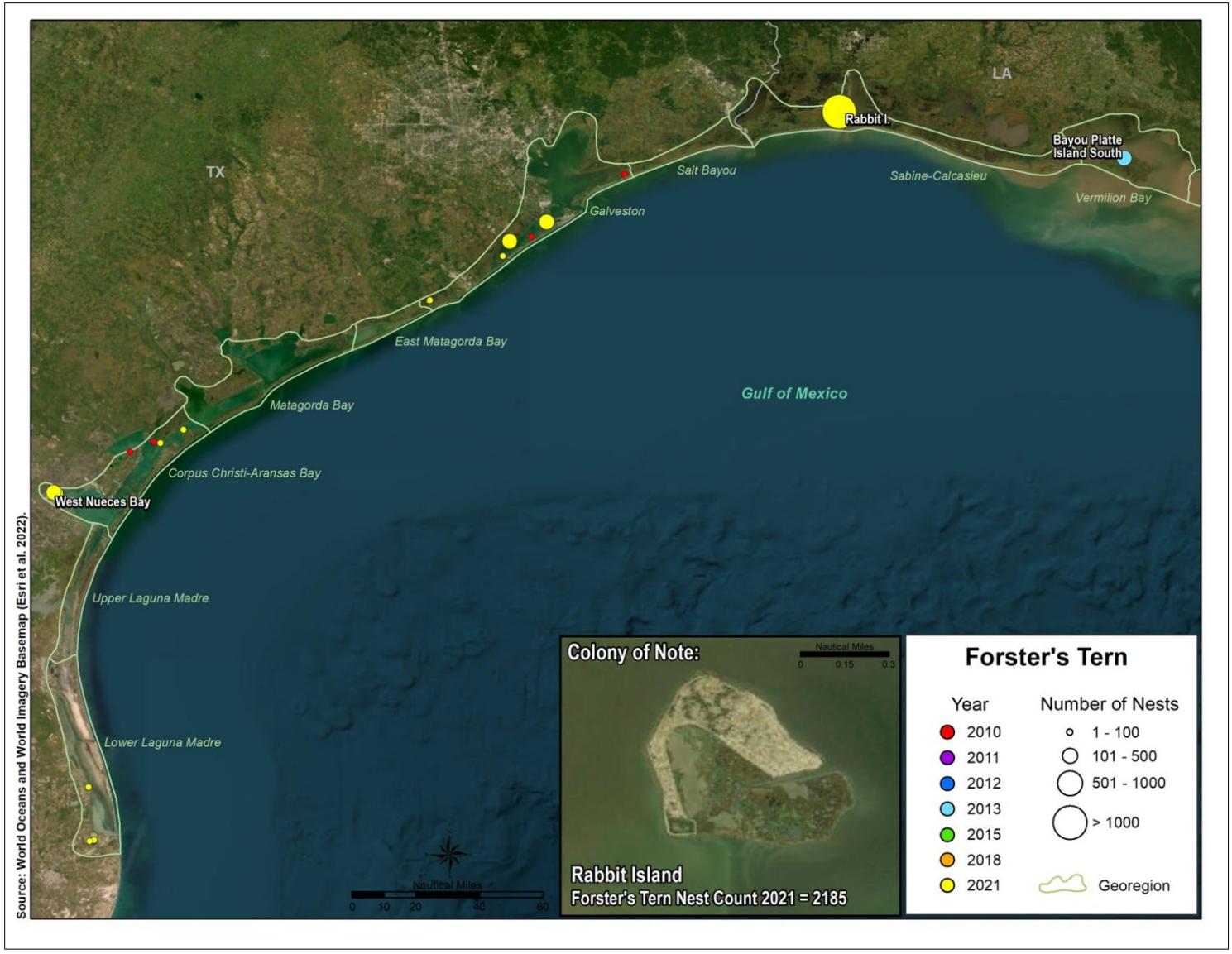
In Alabama, the two nests at Gaillard Island in 2021 were the only nests documented. No nesting was observed in Mississippi or Florida.

Table 2: Forster's Tern nest counts for all colonies with at least one count of 250 nests or more, 2010–2021.

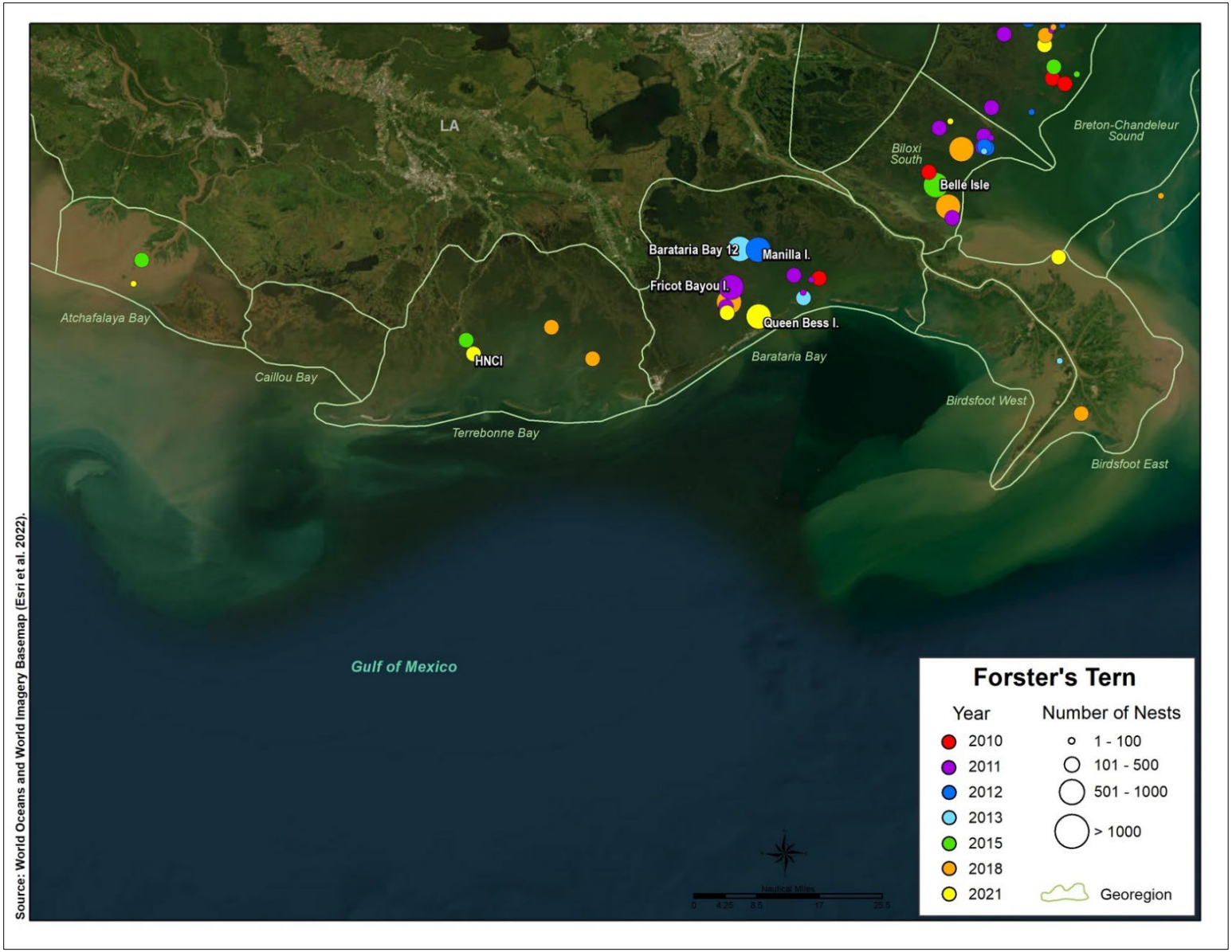
State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Louisiana	Barataria Bay	Barataria Bay 12	0	ND	ND	952	0	0	232
	Barataria Bay	Barataria Bay 5 AB	ND	144	ND	175	0	503	S
	Barataria Bay	Bay Joyeux Islettes	ND	0	ND	ND	ND	0	307
	Barataria Bay	Bay Ronquille Northeast Island	338	0	0	S	S	S	S
	Barataria Bay	Beauregard Island	230	0	61	100	0	0	***889***
	Barataria Bay	Fricot Bayou Island	124	887	395	363	0	274	0
	Barataria Bay	Grand Island Point	47	380	0	0	0	S	S
	Barataria Bay	Manilla Island	173	485	650	152	333	107	S
	Biloxi North	Biloxi North 28	35	313	0	87	0	0	ND
	Biloxi North	Dry Bread Island	0	16	79	41	312	193	177
	Biloxi South	Belle Isle	420	398	143	802	***930***	696	0
	Biloxi South	Biloxi South 10 D	0	54	0	0	3	794	0
	Biloxi South	Biloxi South 14	0	0	316	***201***	133	152	115
	Biloxi South	Biloxi South 2	55	426	352	***262***	274	399	0
	Biloxi South	Biloxi South 6	13	0	0	15	67	601	357
	Biloxi South	Long Bay Island	357	406	74	193	0	0	0
	Lake Borgne	Half Moon Island	42	150	-	394	247	150	0
	Sabine-Calcasieu	Rabbit Island	218	-	-	-	-	573	2185
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	0	0	0	296
	Vermilion Bay	Bayou Platte Island South	111	231	0	355	121	0	31
Texas	Galveston	South Deer Island	0[1]	-	-	-	-	-	***303***

ND = No Data; S = Submerged; - = Outside intended survey area. ***Bold italics*** indicate a sum of counts from May and June surveys.

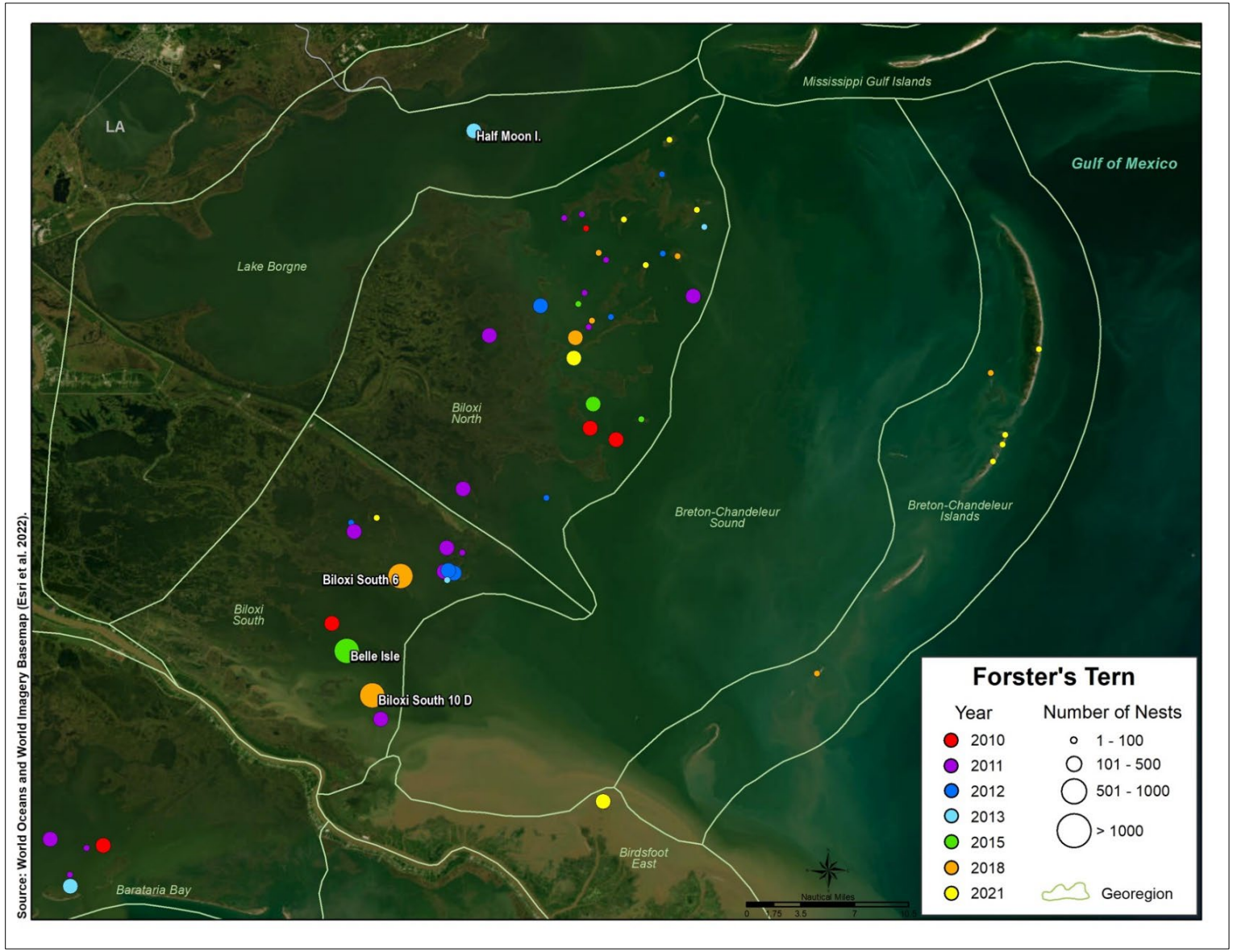
[1]On 25 June 2010, we flew directly over South Deer Island and did not take any photographs, indicating no nesting waterbirds were present.



Map 1. Forster's Tern colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Forster's Tern colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Forster's Tern colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.

Map 4. Forster's Tern colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Royal Tern

Royal Tern nested at 85 colonies—49 in Louisiana, 27 in Texas, four in Florida, four in Alabama, and one in Mississippi (Maps 1–4). This species nests on barren, sandy barrier beaches, shell bars, and dredge spoils, including those susceptible to overwash. Royal Tern nests are often intermixed with and adjacent to Sandwich Tern nests in large, dense colonies (see Appendix A cover photograph, for example). Larger colonies were generally conspicuous, while smaller colonies (< 100 nests) were more difficult to detect. Surveys of tern colonies were largely flown at or near an altitude of 700 feet, lower than the survey altitude needed for Brown Pelican, for example. This lower altitude was necessary to obtain images of sufficient resolution to rapidly identify each bird to species during the counting process. In the aerial photographs, Royal Tern was identified by its larger size and slightly greater nest spacing compared with Sandwich Tern. Often the white forehead of Royal Tern, unique during the breeding season among the locally breeding tern species, aided identification. The yellow-orange bill was often conspicuous too. Caspian Tern, on the other hand, is even larger with wider nesting spacing than Royal Tern, and it has an obviously larger and redder bill.

In 2021, a total of 79,492 Royal Tern nests were distributed among 51 colonies (Table 1). Of those nests, 54% were among 19 Louisiana colonies, 37% were among 23 Texas colonies, and 9% were among nine colonies in Mississippi, Alabama, and Florida. Overall, 53% of nests occurred at the four largest colonies—Gunn Island (16,646 nests) and Raccoon Island (13,643 nests) in Louisiana and Black Skimmer Strip (6023 nests) and Shamrock Island (5641 nests) in Texas. Another 22 colonies had more than 500 nests—12 in Texas, seven in Louisiana, two in Alabama, and one in Florida. Royal Tern nest initiation was earlier in Texas than in Louisiana. For example, 74% of Texas nest counts were derived solely from May photographs, whereas 84% of Louisiana nest counts were derived solely from June surveys.

Table 1. Numbers of Royal Tern nests by state, 2010–2021.[1]

State	2010	2011	2012	2013	2015	2018	2021
TX	3518 (9)	-	-	-	-	-	29,155 (23)
LA	25,614 (11)	47,665 (20)	35,087 (13)	38,961 (21)	32,729 (20)	55,018 (16)	43,358 (19)
MS	0	0	0	0	0	-	245 (1)
AL	791 (1)	5318 (1)	5427 (1)	4767 (1)	5171 (1)	-	4023 (4)
FL	1402 (2)	112 (1)	1902 (2)	1944 (2)	2256 (2)	-	2711 (4)
Total	**31,325 (23)**	**53,095 (22)**	**42,416 (16)**	**45,672 (24)**	**40,156 (23)**	**55,018 (16)**	**79,492 (51)**

[1] Nests of unspecified Royal Tern/Sandwich Tern during the 2010–2013 period (23,985 nests) are not included.
() = number of colonies; - = state not included in survey area that year.

In Texas, of the four colonies with at least 2500 nests in 2021, only Chester and Evia islands were also surveyed in 2010 (Table 2). However, by the late June survey dates in 2010, most Royal Tern eggs had hatched and counts were likely to have been underestimates. For example, at Evia Island 80% of nests in 2010 were dotted as broods. At Chester Island, all Royal and Sandwich tern nests were dotted as broods and not identified to species. As such, any comparison of Royal

Tern nest counts from 2010 and 2021 should be done with caution. Remsen et al. (2019) reported an average of 35,000 breeding birds for the 2011–2014 period from the Texas Colonial Waterbird Society database. The 2021 aerial photographic survey estimate of 58,310 breeding birds (nests x 2) was 67% higher.

In Louisiana, the highest annual nest total of 55,018 was in 2018 (Table 1, Figure 1) and was about 31% higher than the 2011–2021 average of 42,136. Nest counts from 2010 were not included in this average because early survey dates that year led to an underestimate of breeding population size. For example, Royal Tern nests were not found at Chandeleur North because it was surveyed only on 7 May. June surveys were not conducted for most Louisiana colonies in 2010. Most nesting occurred in the Terrebonne Bay and Breton-Chandeleur GeoRegions, where Raccoon and Breton islands, respectively, were consistently the largest Louisiana colonies (Table 2). The only exception was in 2021 when Royal Terns did not nest at Breton Island. Instead, the colony is presumed to have shifted to nearby Gunn Island (16,646 nests) in the Birdsfoot East GeoRegion, approximately 14.3 kilometers southwest of Breton Island. Royal Terns may not have nested at Breton Island in 2021 due to disturbance associated with ongoing habitat restoration activities in 2021 or due to other unidentifiable factors (e.g., overwash, reduced prey availability, etc.). Some islands, including Wine Island, which hosted substantial colonies became submerged over time. At Shell Island East, on the other hand, a substantial colony occurred in 2011 (2516 nests) after a berm was created in 2010, but no nesting was detected after subsequent restoration (Table 2).

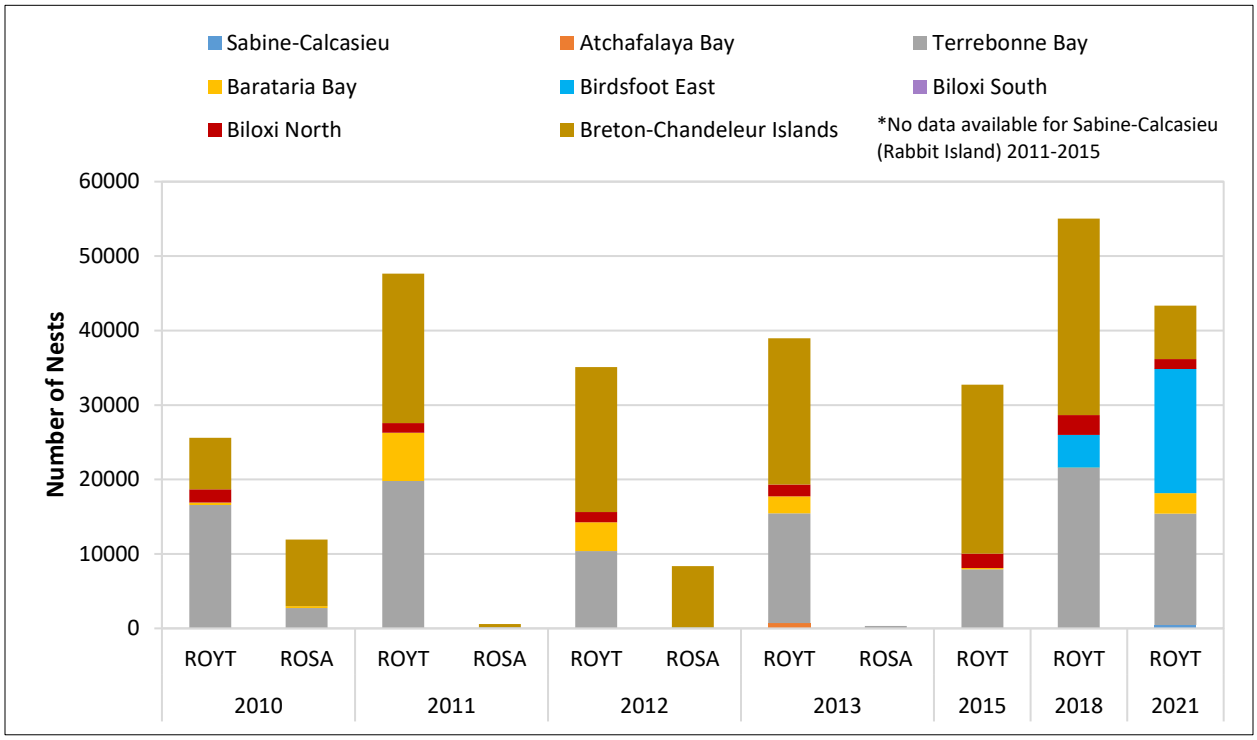


Figure 1. Numbers of Royal Tern nests in Louisiana by GeoRegion, 2010–2021.

In Mississippi, the only colony was at Ship Island in 2021, following restoration activities. A total of 245 nests and 369 birds were counted from 16 June photographs. Among ground survey data

from local biologists, counts from 1 July 2021 were the most complete, with a direct count of 318 nests among three groups (National Park Service, unpublished data). At the farthest west group, where ground surveys found 43 nests, nests were not detected from aerial photographic surveys. For the other two groups combined, 1 July ground counts were 12% higher than the aerial photographic count. These observations indicate some additional egg laying at Ship Island may have occurred after the 16 June aerial survey.

In Alabama, Gaillard Island was the largest colony in Alabama in all years, with a mean of 3982 nests counted during six survey years (Table 2). Annual nest numbers at Gaillard Island appear to be related to habitat availability, as they were lower in years when vegetation or water reduced areas of open substrate.

In Florida, the largest colony was at Saint George Causeway (high count = 2418 nests in 2021). Royal Tern nesting on the causeway was first documented in 1996 (McNair and Gore 1999). Flag Island South also had an active colony each year (ranging from 51 to 369 nests per year), whereas Audubon Island and Lanark Reef West had nests only in 2021.

Conducting surveys in both May and June was important in obtaining the best breeding population estimates for this species. Of the 120 Royal Tern colony counts in Louisiana since 2010, 48% were derived using May photographs, 45% were derived using June photographs, and 7% were derived using a combination of May and June photographs. Regionwide, colony totals that were sums of May and June counts occurred in all years except 2010, when most colonies were not surveyed in both months. Combined colony totals included three in 2011, one in 2012, one in 2013, three in 2015, one in 2018, and seven in 2021. Twelve (75%) of these combined counts occurred at large Royal Tern colonies (Table 2). As such, conducting surveys for this species (and Sandwich Tern) during the second half of May and June was necessary for obtaining the best breeding population estimates.

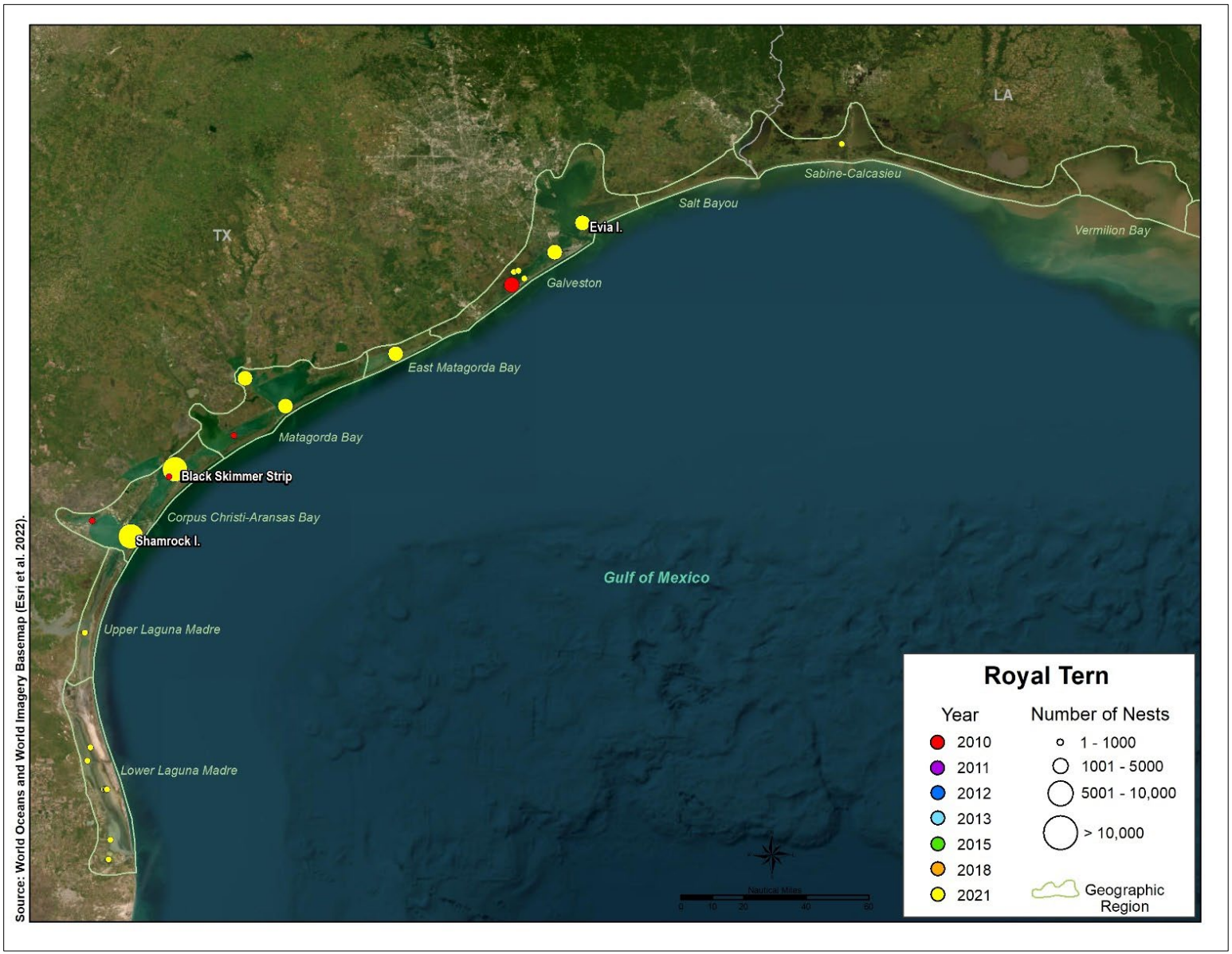
Occasionally, nests of Royal Tern were indistinguishable from those of Sandwich Tern. In those cases, nests were categorized using the "ROSA" code (i.e., Royal Tern or Sandwich Tern; Figure 1, Table 2). Two situations necessitated using the ROSA code. One occurred when a breeding area was no longer attended, chicks were crèching along the shoreline, and nest scrapes were still evident. In that situation, counting scrapes as ROSA Empty Nests provided a better estimate of breeding population size compared with estimating a nest total from counting chicks. The second situation occurred when the only photographs available of a tern colony were of shorter focal lengths and lower resolution, preventing the photo analysts from confidently identifying nests and birds to species. ROSA designations were used on 16 occasions—eight in 2010, three in 2011, four in 2012, and one in 2013 (Figure 2). The ROSA code was not used during 2015, 2018, or 2021 surveys, likely because of better photo quality and coverage, and survey dates that were better aligned with the timing of tern breeding. Of the 16 occasions where ROSA was used, nine were attributed to photo quality or coverage issues, six were attributed to crèching chicks, and one was attributed to both conditions. To fully assess the implications of ROSA nest counts toward counts of the individual species, colonies need to be assessed independently. For 2010, notes were often recorded in the database with rough estimates of the possible proportions of

Royal and Sandwich terns. Here, unproportioned ROSA nest counts are included in the Royal and Sandwich tern species accounts. Determining if and how to proportion ROSA nest counts to Royal or Sandwich tern nest counts will depend on the application of these data.

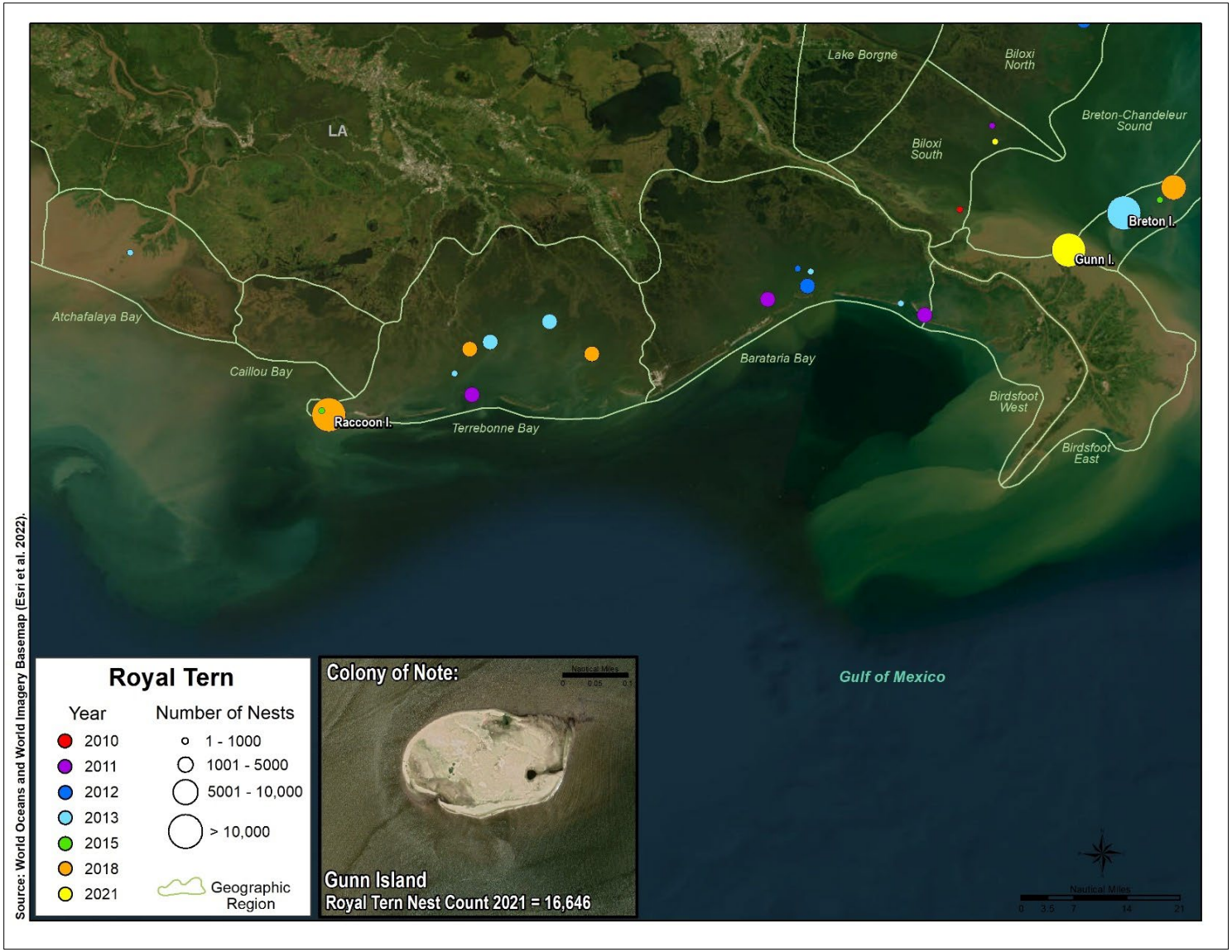
Table 2. Royal Tern nest counts for all colonies with at least one count of 2500 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010[1]	2011[2]	2012[3]	2013[4]	2015	2018	2021
Texas	Corpus Christi-Aransas Bay	Black Skimmer Strip	ND	-	-	-	-	-	6023
	Corpus Christi-Aransas Bay	Shamrock Island	-	-	-	-	-	-	***5641***
	Matagorda Bay	Chester Island	0[1]	-	-	-	-	-	***2837***
	Galveston	Evia Island	959	-	-	-	-	-	4336
Louisiana	Terrebonne Bay	Felicity Island	1107	2422	3911	4605[4]	186	3156	400
	Terrebonne Bay	Raccoon Island	11,434[1]	***12,849***[2]	6479	6572	7578	16,177	***13,643***
	Terrebonne Bay	Terrebonne Bay 1	ND	ND	ND	3427	15	S	S
	Terrebonne Bay	Wine Island	3936	4509	0	0	0	0	S
	Barataria Bay	Cat Bay South Island	0	526	3234	935	0	S	S
	Barataria Bay	Queen Bess Island	310[1]	3421	33	239	0	20	***2743***
	Barataria Bay	Shell Island East	0	2516	0[a]	0[b,c]	0	0[b]	0
	Birdsfoot East	Gunn Island	NA	NA	NA	NA	NA	4395	16,646
	Breton-Chandeleur Islands	Breton Island	6545[1]	9370	10,966	14,729	***12,993***	10,903	0
	Breton-Chandeleur Islands	Chandeleur North	0	***7798***[2]	5742[3]	3871	1666	1460	2404
	Breton-Chandeleur Islands	Chandeleur South	400	***2923***	***2750***	1021	***4706***	7536	3567
	Breton-Chandeleur Islands	Gosier Islands North	S	S	S	S	1037	***6469***	0
Alabama	Mobile Interior Bay	Gaillard Island	791[1]	***5318***	5427[3]	4767	***5171***	-	2422

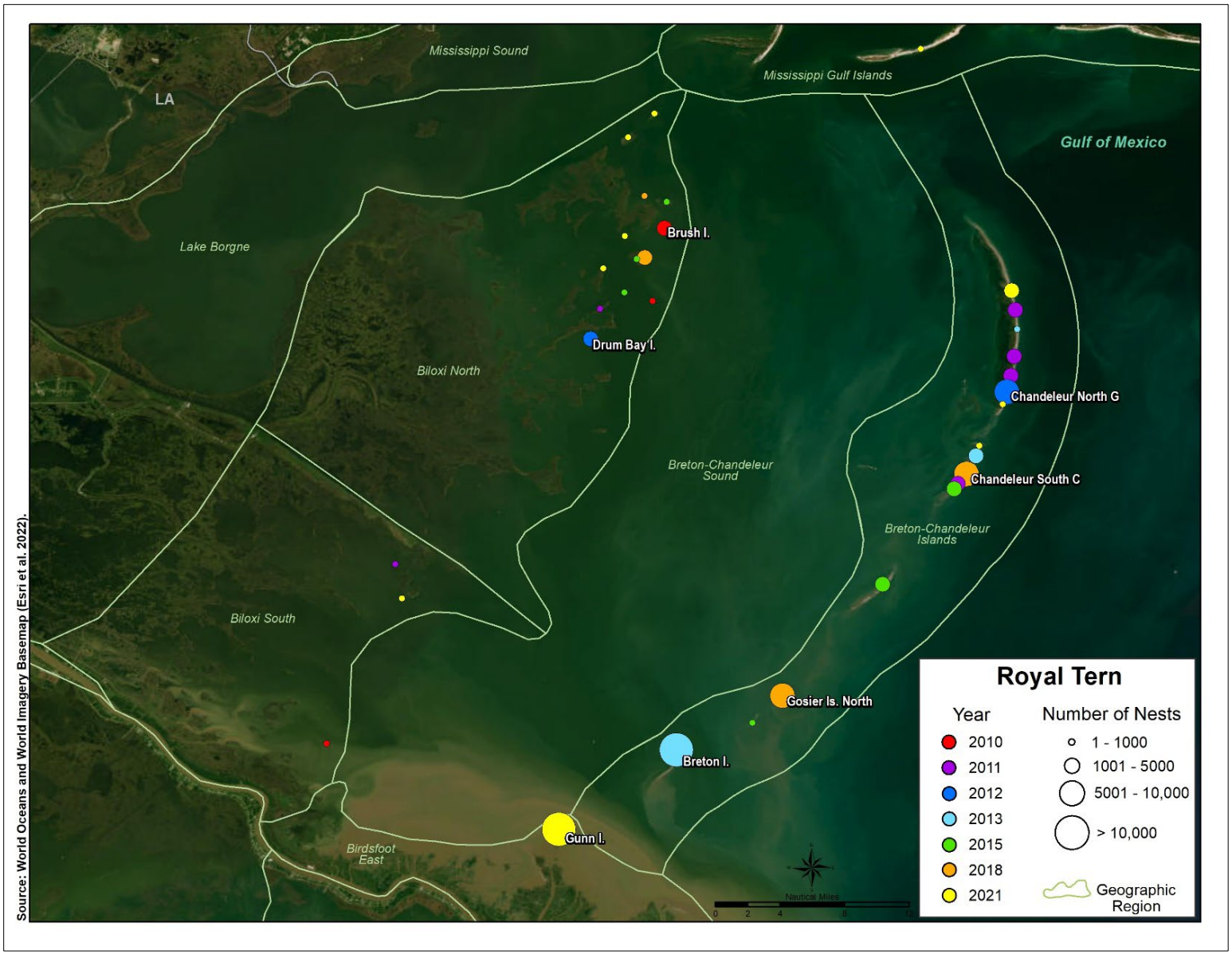
- = Outside intended survey area; Bold italics indicate a sum of counts from May and June surveys; NA = Not Applicable because the island was not yet created; ND = No Data; S = Submerged.
[1]Excludes ROSA nest counts at Chester (1482 nests), Raccoon (159 nests), Queen Bess (265 nests), Breton (8937 nests), and Gaillard (73 nests) islands; [2]Excludes ROSA nest counts at Raccoon (159 nests) and Chandeleur North (441 nests) islands; [3]Excludes ROSA nest counts at Chandeleur North (8284 nests) and Gaillard (73 nests) islands; [4]Excludes ROSA nest counts at Felicity Island (305 nests).
[a]Not inspected in June; [b]Not inspected in May; [c]It is likely we steered away from Shell Island in June 2013 because of active construction.



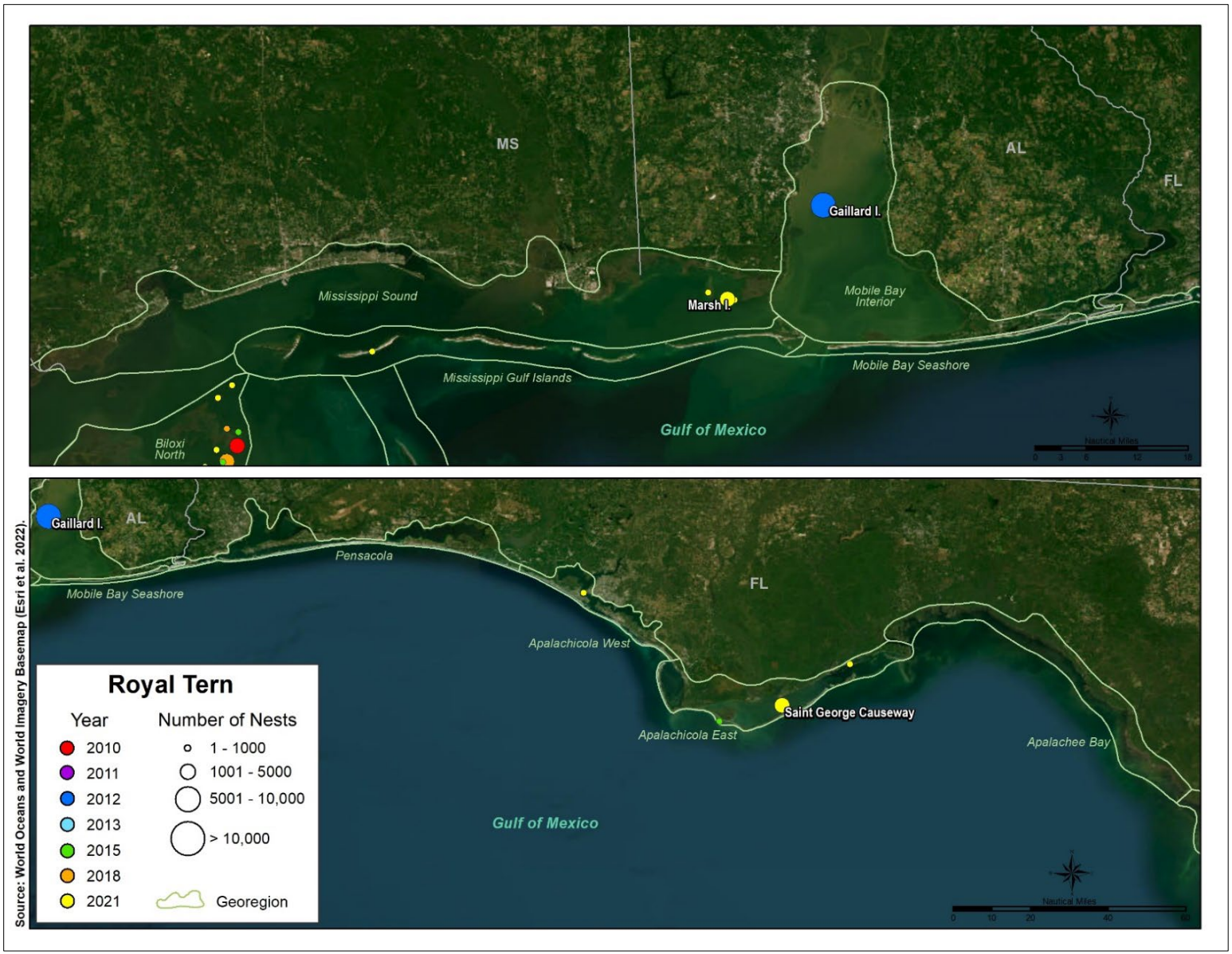
Map 1. Royal Tern colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Royal Tern colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony across the Study Area and all years.



Map 3. Royal Tern colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Royal Tern colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Sandwich Tern

Sandwich Tern nesting was documented at 75 colonies—45 in Louisiana, 21 in Texas, four in Florida, four in Alabama, and one in Mississippi (Maps 1–4). This species nests on barren, sandy barrier beaches, shell bars, and dredge spoils, including those susceptible to overwash. Sandwich Tern nests are often intermixed with and adjacent to Royal Tern nests in large, dense colonies (see Appendix A cover photograph, for example). Larger colonies were generally conspicuous, while smaller colonies (< 100 nests) were more difficult to detect. Surveys of tern colonies were largely flown at or near an altitude of 700 feet, lower than the survey altitude needed for Brown Pelican, for example. This lower altitude was necessary to obtain images of sufficient resolution to rapidly identify each bird to species during the counting process. In the aerial photographs, Sandwich Tern was identified by its smaller size and slightly closer nest spacing compared with Royal Tern. The slender, dark bill (the yellow tip was not visible) and all-black cap also aided identification.

In 2021, a total of 70,616 Sandwich Tern nests were distributed among 43 colonies (Table 1). Of those nests, 68% were among 15 Louisiana colonies, 28% were among 19 Texas colonies, and 4% of were among nine colonies in Mississippi, Alabama, and Florida. Overall, 62% of nests occurred at the three largest colonies—Gunn Island (16,050 nests), Curlew Island (10,805 nests), and Raccoon Island (9543 nests) in Louisiana. Another 13 colonies had greater than 500 nests—seven in Texas, four in Louisiana, one in Mississippi, and one in Florida. Nearly 95% of all Sandwich Tern nests counted in 2021 were among the 16 largest colonies (i.e., colonies > 500 nests).

Table 1. Numbers of Sandwich Tern nests by state, 2010–2021.[1]

State	2010	2011	2012	2013	2015	2018	2021
TX	987 (5)	-	-	-	-	-	19,713 (19)
LA	34,679 (10)	71,322(16)	27,967 (13)	64,482 (22)	56,352 (15)	69,567 (13)	47,793 (15)
MS	0	0	0	0	0	-	908 (1)
AL	40 (1)	670 (1)	741 (1)	394 (1)	252 (1)	-	152 (4)
FL	1096 (2)	661 (1)	1862 (2)	1892 (2)	1992 (2)	-	2050 (4)
Total	**36,802 (18)**	**72,653 (18)**	**30,570 (16)**	**66,768 (25)**	**58,596 (18)**	**69,567 (13)**	**70,616 (43)**

[1]Nests of unspecified Royal Tern/Sandwich Tern during the 2010–2013 period (23,985 nests) are not included.
() = number of colonies; - = state not included in survey area that year.

In Texas, three substantial colonies occurred within two GeoRegions in 2021 (Table 2). Black Skimmer Strip (5174 nests) and Shamrock Island (3432 nests) in Corpus Christi-Aransas Bay GeoRegion were the largest colonies, followed by Evia Island (3004 nests) in Galveston. Of these three colonies, only Evia Island was surveyed in 2010 (Table 2). However, by the late June survey dates in 2010, most Sandwich Tern eggs had hatched and counts were likely to have been underestimates. As such, comparison of Sandwich Tern nest counts from 2010 and 2021 should be made with caution.

In Louisiana, the highest annual nest total of 71,322 in 2011 (Table 1, Figure 1) was 27% higher than the 2011–2021 average of 56,247 nests. Nest counts from 2010 were not included in this average because early survey dates that year led to an underestimate of breeding population size. For example, Sandwich Tern nests were not detected at Chandeleur North because it was surveyed only on 7 May. June surveys were not conducted for most Louisiana colonies in 2010. Most nesting occurred in the Terrebonne Bay and Breton-Chandeleur GeoRegions, joined by the Birdsfoot East GeoRegion in 2018 and 2021 with nesting at Gunn Island (Figure 1, Table 2). Sandwich Tern nest counts varied substantially year to year at each colony. However, Raccoon Island, Breton Island, Chandeleur South, and Chandeleur North consistently had some of the largest colonies. For example, Sandwich Tern nest counts at Chandeleur North ranged from a low of 4567 nests to a high of 25,001 nests (Table 2). Similarly, Breton Island nest counts ranged from 0 nests to 21,550 nests (Table 2). In 2021, Sandwich Terns did not nest at Breton Island but established a large colony (16,050 nests) at nearby Gunn Island (Birdsfoot East GeoRegion), approximately 14.3 kilometers southwest of Breton Island. Gunn Island had been first used by Sandwich Terns when 8621 terns nested there in 2018. Sandwich Terns may not have nested at Breton Island due to ongoing habitat restoration activity in 2021 or due to some other unidentifiable factor (e.g., overwash, prey availability). Other islands that hosted substantial colonies were Gosier Islands North and Curlew Island during the 2015–2021 survey period (Table 2). Prior to 2015, Sandwich Tern was not documented nesting at these three colonies (Table 2). An influx of nesting Sandwich Terns was conspicuous at Queen Bess Island in 2021 after habitat restoration activities there. Wine Island and Terrebonne Bay 1 had hosted substantial colonies but became submerged over time (Table 2).

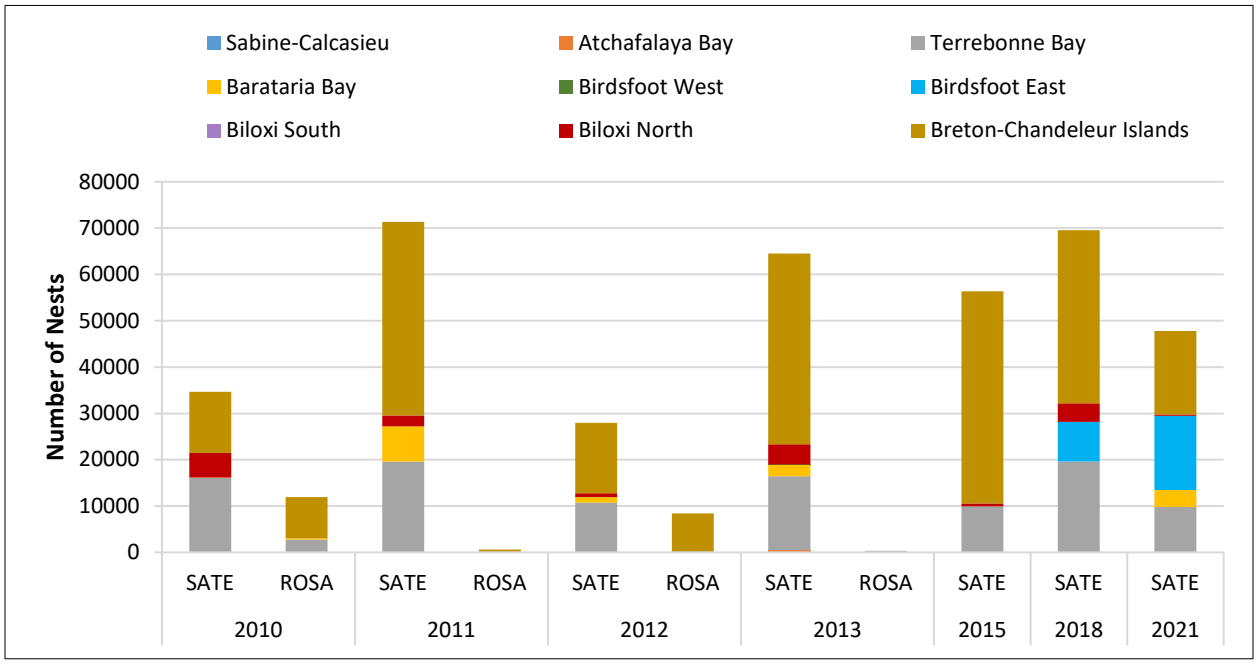


Figure 1. Numbers of Sandwich Tern nests in Louisiana by GeoRegion, 2010–2021.

In Florida, the largest colony was at Saint George Causeway, with more than 1000 nests in each of the five years it was surveyed (high count = 1724 nests in 2021). Sandwich Tern nesting on the

causeway was first documented in 1997 when 18 nests were counted (McNair and Gore 1999). Flag Island South also had an active colony each year (ranging from 74 to 661 nests per year), whereas Audubon Island and Lanark Reef West supported colonies only in 2021.

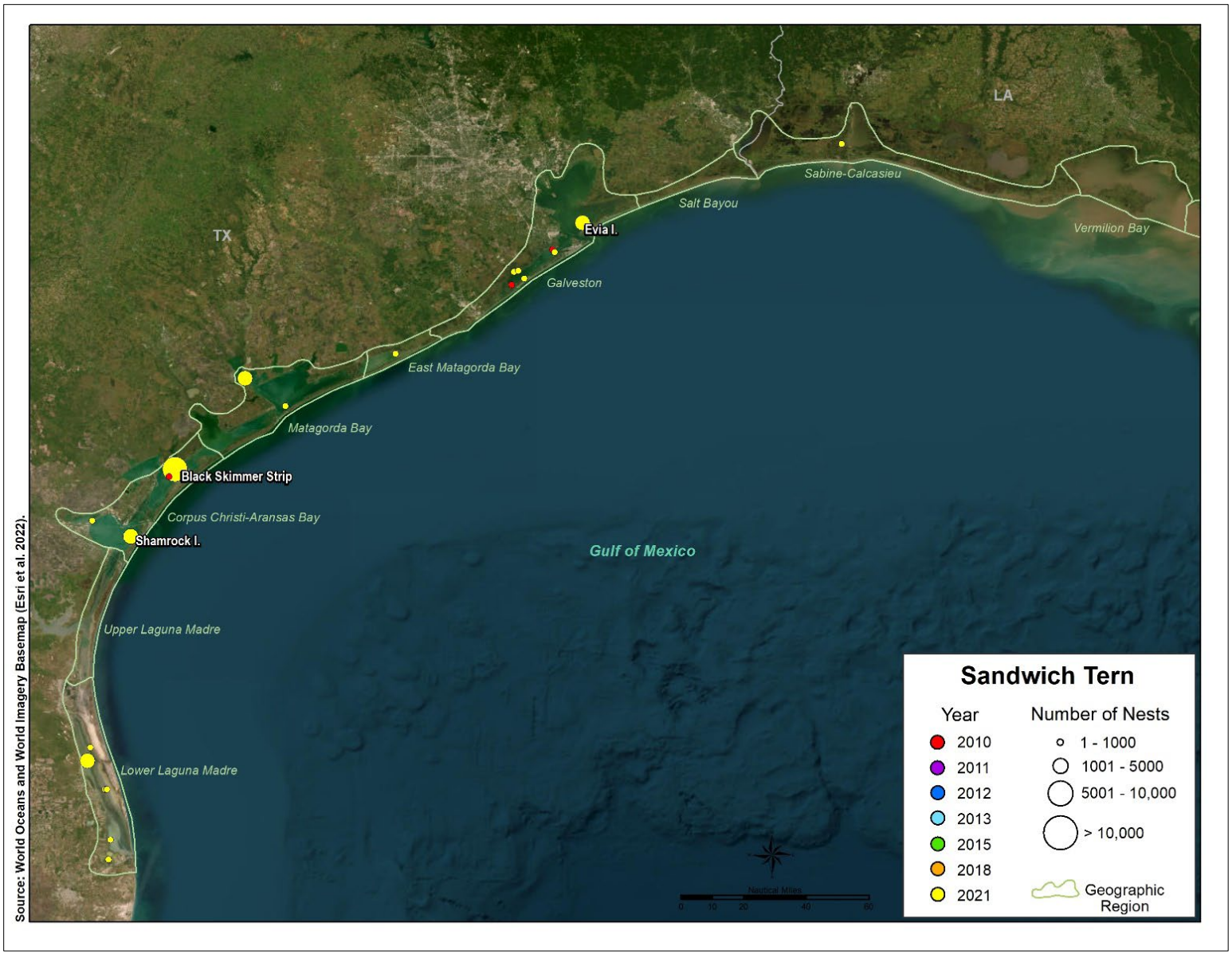
As with Royal Terns, conducting surveys during mid-May and mid-June was necessary to obtain the best breeding population estimates and to understand nest phenology data. Of the 102 Sandwich Tern colony counts, 49% were derived using May surveys, 43% were derived using June surveys, and 8% were derived using combined May and June surveys. Sandwich Tern nest counts were derived from combined May and June surveys on 15 occasions. Ten (67%) of these combined counts occurred at large Sandwich Tern colonies (Table 2). Five (33%) of the combined counts occurred at colonies within the Breton-Chandeleur GeoRegion. No other GeoRegion had more than two combined counts.

Occasionally, nests of Sandwich Tern were indistinguishable from those of Royal Tern. In those cases, nests were categorized using the "ROSA" code (i.e., Royal Tern or Sandwich Tern; Table 2). Two situations necessitated using the ROSA code. One occurred when a breeding area was no longer attended, chicks were crèching along the shoreline, and nest scrapes were still evident. In that situation, counting the scrapes as ROSA Empty Nests provided a better estimate of breeding population size compared with trying to estimate a nest total from counting chicks. The second situation occurred when the only photographs available of a tern colony were of shorter focal lengths and lower resolution that prevented the analysts from confidently identifying nests and birds to species. ROSA designations were used on 16 occasions—eight in 2010, three in 2011, four in 2012, and one in 2013 (Figure 2). The ROSA code was not used during 2015, 2018, or 2021 surveys, likely because of better photo quality and coverage, and survey dates that were better aligned with the timing of tern breeding. Of the 16 occasions where ROSA was used, nine were attributed to photo quality or coverage issues, six were attributed to crèching chicks, and one was attributed to both conditions. To fully assess the implications of ROSA nest counts toward counts of the individual species, colonies need to be assessed independently. For 2010, notes were often recorded in the database with rough estimates of the possible proportions of Royal and Sandwich terns. Here, unproportioned ROSA nest counts are included in the Royal and Sandwich tern species accounts. Determine if and how to proportion ROSA nest counts to Royal or Sandwich tern nest counts will depend on the application of these data.

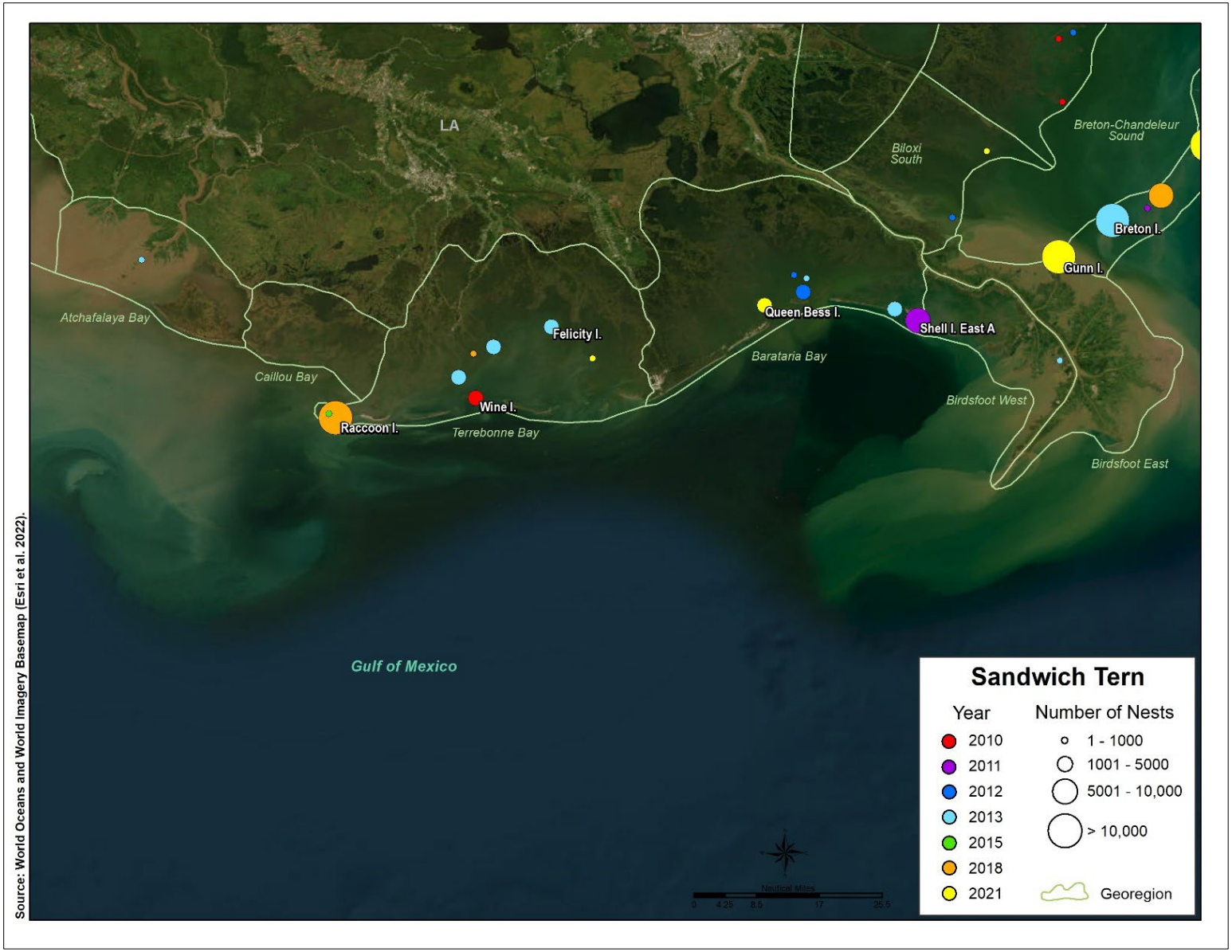
Table 2. Sandwich Tern nest counts for all colonies with at least one count of 2500 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010[1]	2011[2]	2012[3]	2013[4]	2015	2018	2021
Texas	Corpus Christi-Aransas Bay	Black Skimmer Strip	ND	-	-	-	-	-	5174
	Corpus Christi-Aransas Bay	Shamrock Island	-	-	-	-	-	-	***3432***
	Galveston	Evia Island	68	-	-	-	-	-	3004
Louisiana	Terrebonne Bay	Felicity Island	6	222	1692	3892	0	1358	12
	Terrebonne Bay	Raccoon Island	11,485	***16,579***	9095	7563	9760	17,655	***9543***
	Terrebonne Bay	Terrebonne Bay 1	ND	ND	ND	3399	0	S	S
	Terrebonne Bay	Wine Island	4624	2822	0	0	0	0	S
	Barataria Bay	Queen Bess Island	37	1202	0	3	0	0	***3653***
	Barataria Bay	Shell Island East	0	6330	0	0	0	0	0
	Birdsfoot East	Gunn Island	NA	NA	NA	NA	NA	8621	16,050
	Biloxi North	Brush Island	3979	2331	638	***3247***	0	0	6
	Breton-Chandeleur Islands	Breton Island	12,371	6500	5405	21,550	***14,089***	6980	0
	Breton-Chandeleur Islands	Chandeleur North	0	***25,001***	4596	11,799	4567	7143	5375
	Breton-Chandeleur Islands	Chandeleur South	863	10,017	***5176***	7810	***18,325***	13584	1854
	Breton-Chandeleur Islands	Curlew Island	S	S	S	S	7521	0	10,805
	Breton-Chandeleur Islands	Gosier Islands North	S	S	S	S	1219	***9684***	0

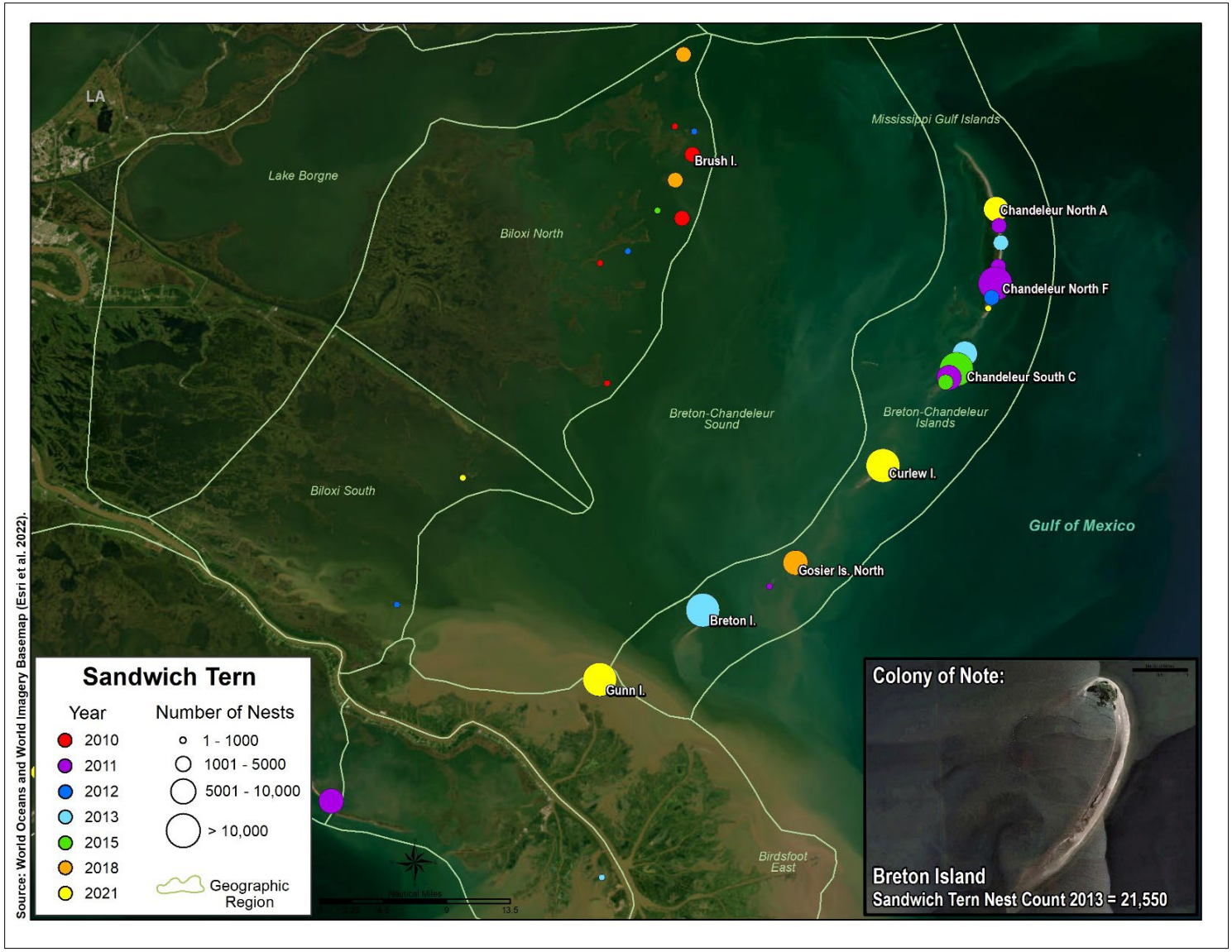
- = Outside intended survey area. ND = No data available. NA = Not applicable. S= Submerged/No available habitat. Bold italics indicate a sum of counts from May and June surveys. Shell Island in 2012 was not inspected in June, in 2013 we avoided active construction, and in 2018 it was not inspected in May. [1]Does not include ROSA nest counts at Raccoon (2728 nests), Breton (8937 nests), or Queen Bess (265 nests) islands. [2]Does not include ROSA nest counts at Raccoon (159 nests) or Chandeleur North islands (441 nests). [3]Does not include ROSA nest counts at Chandeleur North Islands (8284 nests). [4]Does not include ROSA counts at Felicity Island (305 nests).



Map 1. Sandwich Tern colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Sandwich Tern colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Sandwich Tern colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony across the Study Area and all years.

Map 4. Sandwich Tern colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Black Skimmer

Black Skimmer breeding colonies are typically easy to spot during aerial surveys because of the contrast of the black plumage with the sandy beach habitat. They are more difficult to detect when they occur amid patchy vegetation on barrier islands. For that reason, all beaches at barrier islands are typically inspected during surveys. Nesting was documented at 145 colonies—87 in Louisiana, 35 in Texas, eight in Florida, eight in Alabama, and seven in Mississippi.

In 2021, a total of 10,068 Black Skimmer nests were counted among 67 colonies (Table 1). Of those nests, 71% were among 33 Louisiana colonies and 15% were among 21 Texas colonies. In Alabama, Florida, and Mississippi, 1466 nests were among 13 colonies. The largest colonies were in Louisiana at Gunn Island (1923 nests), Raccoon Island (1307 nests), and Turtle Pen Isle (562 nests). Another 24 colonies had more than 100 nests—16 in Louisiana, four in Texas, two in Florida, one in Alabama, and one in Mississippi.

Table 1. Numbers of Black Skimmer nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	952 (16)	-	-	-	-	-	1500 (21)
LA	3172 (24)	6691 (36)	6303 (31)	7368 (43)	4186 (38)	6251 (41)	7102 (33)
MS	413 (3)	452 (1)	189 (2)	143 (2)	271 (1)	-	626 (3)
AL	753 (3)	513 (2)	234 (3)	255 (1)	252 (2)	-	222 (3)
FL	340 (3)	225 (1)	370 (2)	82 (1)	371 (3)	-	618 (7)
Total	**5630 (49)**	**7881 (40)**	**7096 (38)**	**7848 (47)**	**5080 (44)**	**6251 (41)**	**10,068 (67)**

() = colonies counted; - = state not included in survey area that year.

In Texas, the largest colony was at the aptly named Black Skimmer Strip in the Corpus Christi-Aransas Bay GeoRegion in 2021 (380 nests; Map 1).

In Louisiana, several colonies experienced habitat changes and submersion over the decade (Table 2). Across the Study Area and all years, the largest Black Skimmer colony was at Birdsfoot East 3, with more than 3000 nests in June 2012 (Table 2, Figure 1, Map 2). In the Birdsfoot GeoRegions, beneficial use projects with dredged sediment created breeding habitat for skimmers and terns at four colonies. Nesting did not persist annually at Birdsfoot East 3 as vegetation grew, and another Birdsfoot colony was submerged after 2010. including. Gunn Island hosted the most recent new colony. It was constructed in 2016, and dredged sediment was added from 2018 to 2020, leading to an influx of nesting Black Skimmers and other species by 2021. Gunn Island still supported an active colony in 2022 (beyond the scope of this report) but was noticeably more vegetated than in 2021. Fine-textured dredge materials promote rapid vegetation growth, and other studies have documented that tern and Black Skimmer breeding population use of dredge spoil islands tends to be short lived (Leberg et al. 1995; Mallach and Leberg 1999). Raccoon Island West hosted Black Skimmer colonies until its submersion after 2015, with more than 1000 nests in 2011 and 2013. In 2012, it supported just 218 nests in May but was later overwashed by high tide or a storm, and no nests were present in June. Combining

Biloxi North and Biloxi South GeoRegions results in more than 1000 nests in all years except 2010 (Figure 1). The largest Biloxi Marsh colonies were at Bayou Pintou in 2018 (619 nests) and Turtle Pen Isle in 2021 (562 nests; Map 3).

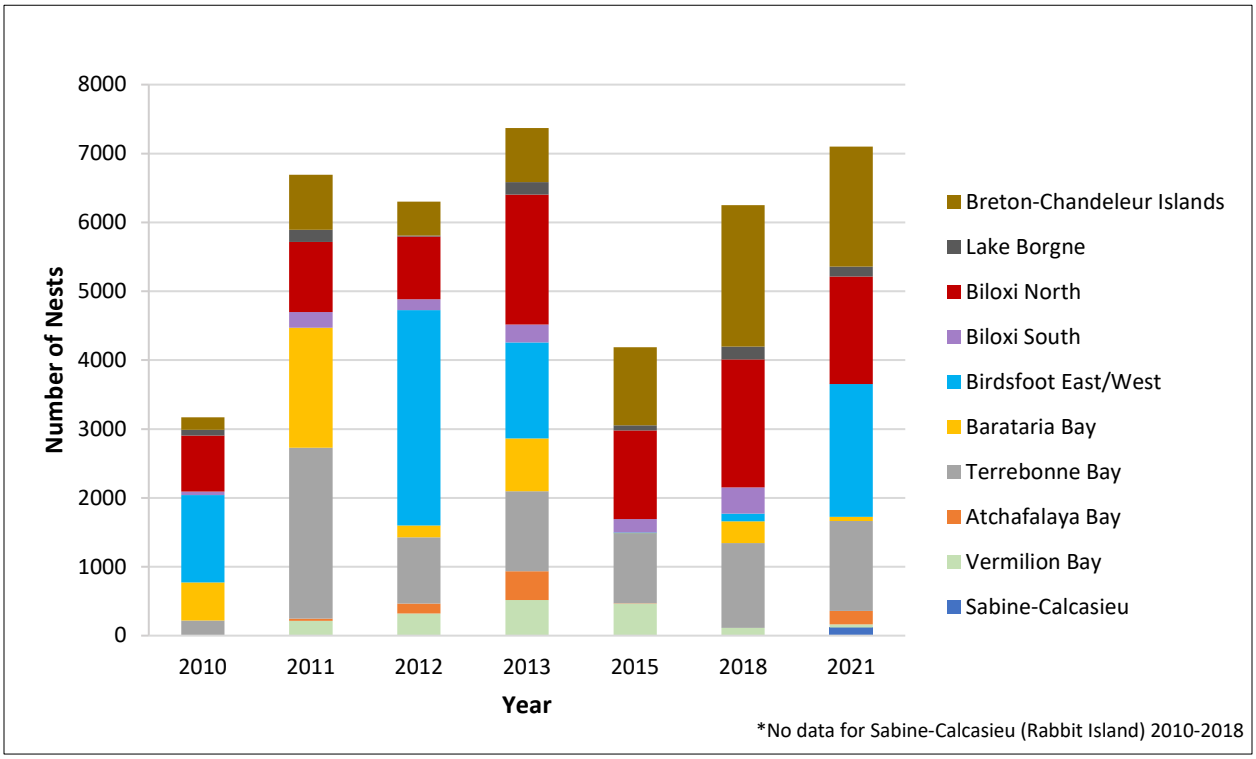


Figure 1. Numbers of Black Skimmer nests in Louisiana by GeoRegion, 2010–2021.

In Mississippi, the largest colony was at Ship Island in 2021 (513 nests). Restoration of Ship Island began in 2019 and was completed in late 2020, connecting Ship Island East and West into one continuous unit. Ship Island East and West both supported nesting Black Skimmers during some of the years when they were separated but in much lower numbers. After restoration, Royal Terns, Sandwich Terns, and Least Terns also nested at Ship Island for the first time.

In Alabama, the largest colony was Dauphin Island 3 in 2010 (593 nests); however, that count was in May, and the colony was not surveyed in June (see further discussion below).

In Florida, the largest colony was Flag Island South each year, reaching 296 nests in 2021.

Nest counts in May for Black Skimmers should be interpreted with caution, as skimmers were often in breeding habitat in greater numbers in May but in postures and distributions that indicate egg laying had mostly not yet occurred. By June, one bird of a pair was usually in obvious incubation posture, and the distance between nesting pairs had increased. In 2021, only nine of 67 colony counts were determined from May photographs, usually because complete or partial abandonment had occurred by the June survey. And only one colony, West Nueces Bay 51W A in Texas, had nests with visible chicks (on the 20 June survey date).

With 2015 and 2021 image analyses, the Territory category was occasionally used for skimmers. For example, at Horn Island in Mississippi in 2021, 60 territories and 117 birds but no nests were counted in May, based on postures and distributions but also the fact that no birds were present in June. Similarly, at Shell Island East in 2015, just two nests but 274 territories were counted from May photographs; only roosting birds were present in June. However, the Territory category was not used in other years. Therefore, for example, the Dauphin Island 3 count in 2010 mentioned above could be an overestimate of breeding population size. Furthermore, certain barrier islands might not have been inspected closely in June in certain years (Table 2). Also, the Louisiana state total in 2010 may be low partly because of early survey dates (Table 1).

Black Skimmers nested sympatrically with Gull-billed Terns, with nesting Gull-billed Terns present at 64% of the Black Skimmer colonies during the 2010–2021 survey period. Typically, smaller numbers of Gull-billed Tern nests were widely spaced throughout a much larger Black Skimmer colony (Figure 2). While Black Skimmers and Gull-billed Terns were associated spatially, no clear correlation was evident in annual numbers of nests for both species at specific colonies. Gull-billed Terns typically nested on shell substrates rather than sandy ones, but Black Skimmer nest locations may be more influenced by the presence of Gull-billed Terns than by substrate composition (Leberg et al. 1995).

Figure 2. Nesting Black Skimmers and Gull-billed Terns at Gunn Island in 2021.

Comparisons with 2021 Ground Survey Data

Certain 2021 ground survey data collected by local biologists were made available for comparison with aerial photographic data (Audubon Mississippi, unpublished data; National Park Service, unpublished data). Ground surveys were conducted throughout the breeding season and included counts from outside the colony as well as inside the colony, in which case nest contents could be confirmed. Ground survey data aligned with the 2021 aerial survey dates at three Mississippi colonies: Broad, New Round Island, and Ship Island.

At Broad, 63 nests and 132 birds were counted from 16 June aerial photographs, compared with 41 nests and 97 adults from 15 June ground surveys. At New Round Island, 50 nests and 93 birds were counted from 15 June aerial photographs, compared with 35 nests and 160 adults counted during ground surveys on the same date. These ground survey counts were conducted from outside the colony and may have slightly underestimated nests compared with more complete colony viewing from the vertical perspective of aerial photographs. Differences in bird counts could also be affected by daily and diurnal attendance patterns. New Round Island ground and aerial photographic surveys on 15 June were conducted at 12:00 and 15:00, respectively. Variable numbers of attending mates or non-breeding birds could have been foraging at the different survey times.

Nest totals on Ship Island differed greatly. From 16 June aerial photographs, 513 nests and 1050 birds were counted, whereas 95 nests and 319 adults were counted from 14 June ground surveys. Ground surveys covered only a portion of the colony, with a much larger group farther east not entered to protect the colony.

Ground surveys provided confirmation that the timing of the aerial surveys was ideal, as the highest nest counts for Black Skimmer were often in mid to late June, with eggs or chicks not present until late June. Some colonies had eggs and chicks well into July, and Ship Island stayed active through August, with the highest count of both chicks (120 downy chicks) and nests (109) on 11 August.

Table 2. Black Skimmer nest counts for all colonies with at least one count of 500 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Louisiana	Vermilion Bay	Bayou Platte Island South	2	213	323	518	298	49	3
	Terrebonne Bay	Raccoon Island	195	57	701	112	851	246	1307
	Terrebonne Bay	Raccoon Island West	22[1]	1789	218	1004	166	S	S
	Terrebonne Bay	Whiskey Island	0[1]	0	0	0[2]	0[2]	780	0
	Barataria Bay	Bastian Island	521	21	173	769	0	315	0
	Barataria Bay	Shell Island East	0	1703	0[1]	0[3]	2	0[4]	0
	Birdsfoot West	Birdsfoot West 4	NA	NA	NA	857	7	0	0
	Birdsfoot East	Birdsfoot East 3	S	0[1]	3127	533	0	0	0
	Birdsfoot East	Bird Island Birdsfoot	1029	S	S	S	S	S	S
	Birdsfoot East	Gunn Island	NA	NA	NA	NA	NA	60	1923
	Biloxi North	Bayou Pintou	ND	0[1]	ND	214	226	619	456
	Biloxi North	Turtle Pen Isle	0	38	0	94	0	222	562
	Breton-Chandeleur Islands	Chandeleur Islands North	0[1]	301	357	326	535	927	820
Mississippi	Mississippi Sound Gulf Island	Ship Island	23 (E)	0	107 (E)	21 (W)	271 (W)	-	513
Alabama	Mississippi Sound Gulf Island	Dauphin Island 3	593	0	0	0	0	-	0[1]

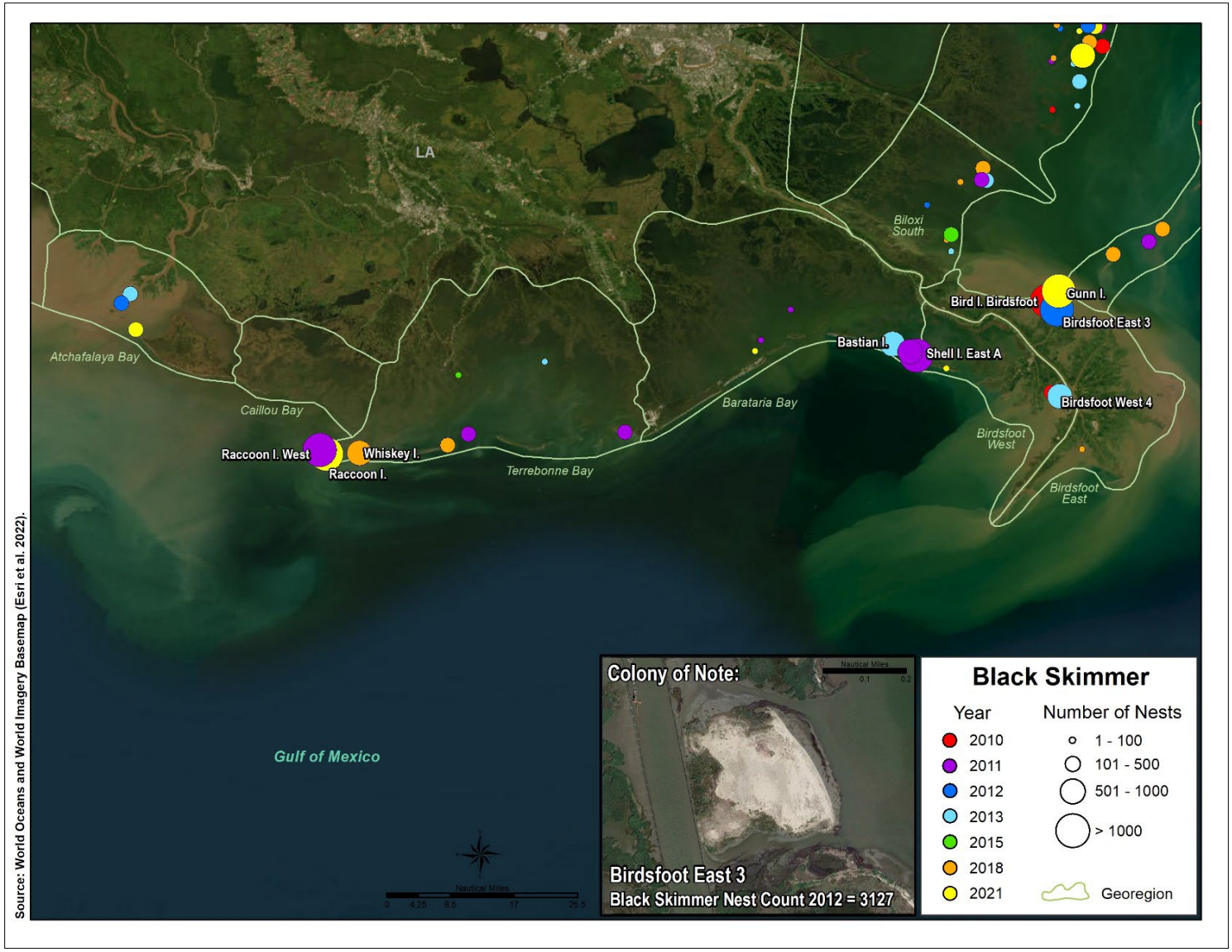
- = Outside intended survey area; ND = No Data; NA = Not applicable, as island not yet created; S = Submerged.

[1]Not inspected in June; [2]In May 2013 and 2015, we only flew within 750 ft of the most western point of Whiskey Island; [3]Based on presumed active construction; [4]Not inspected in May.

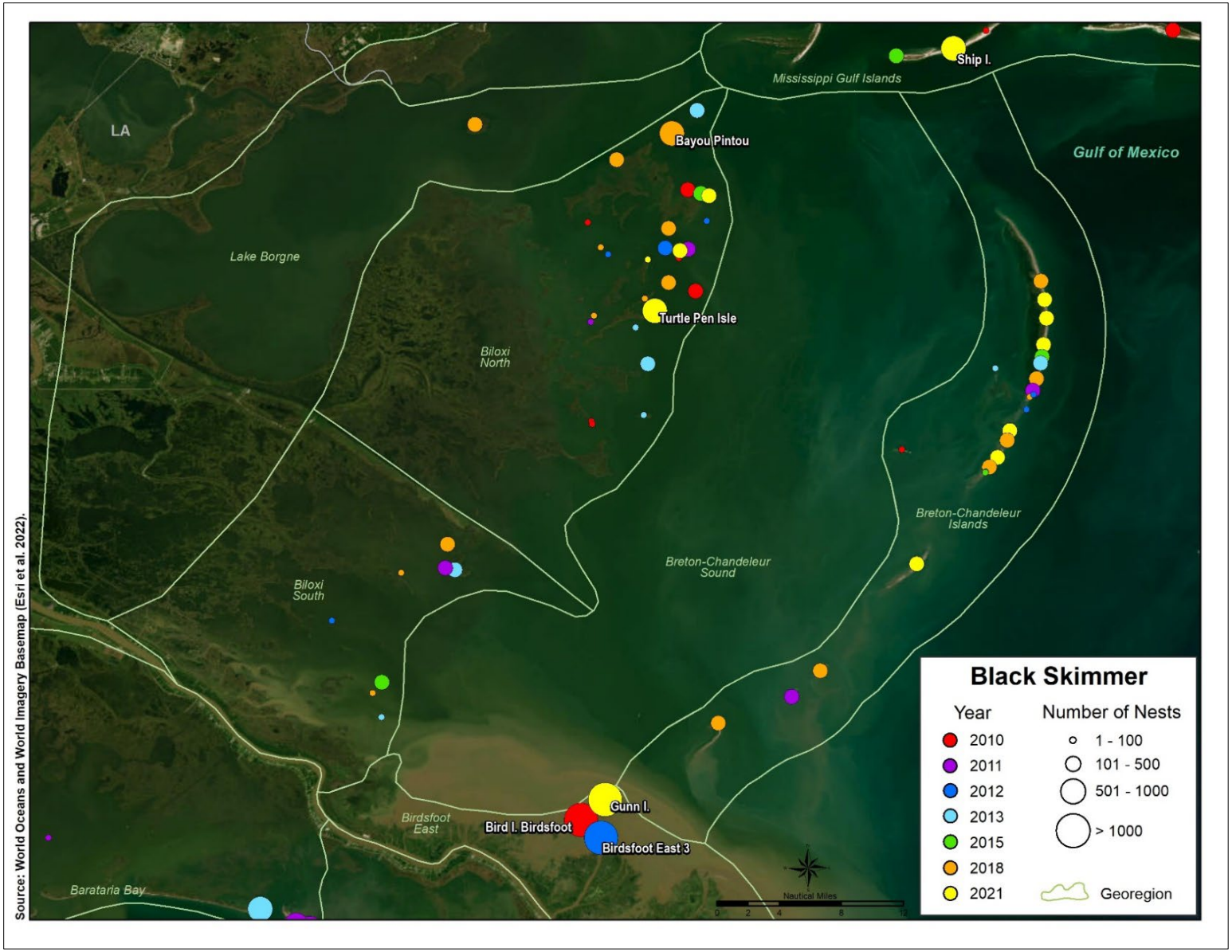
(E) Ship Island East

(W) Ship Island West

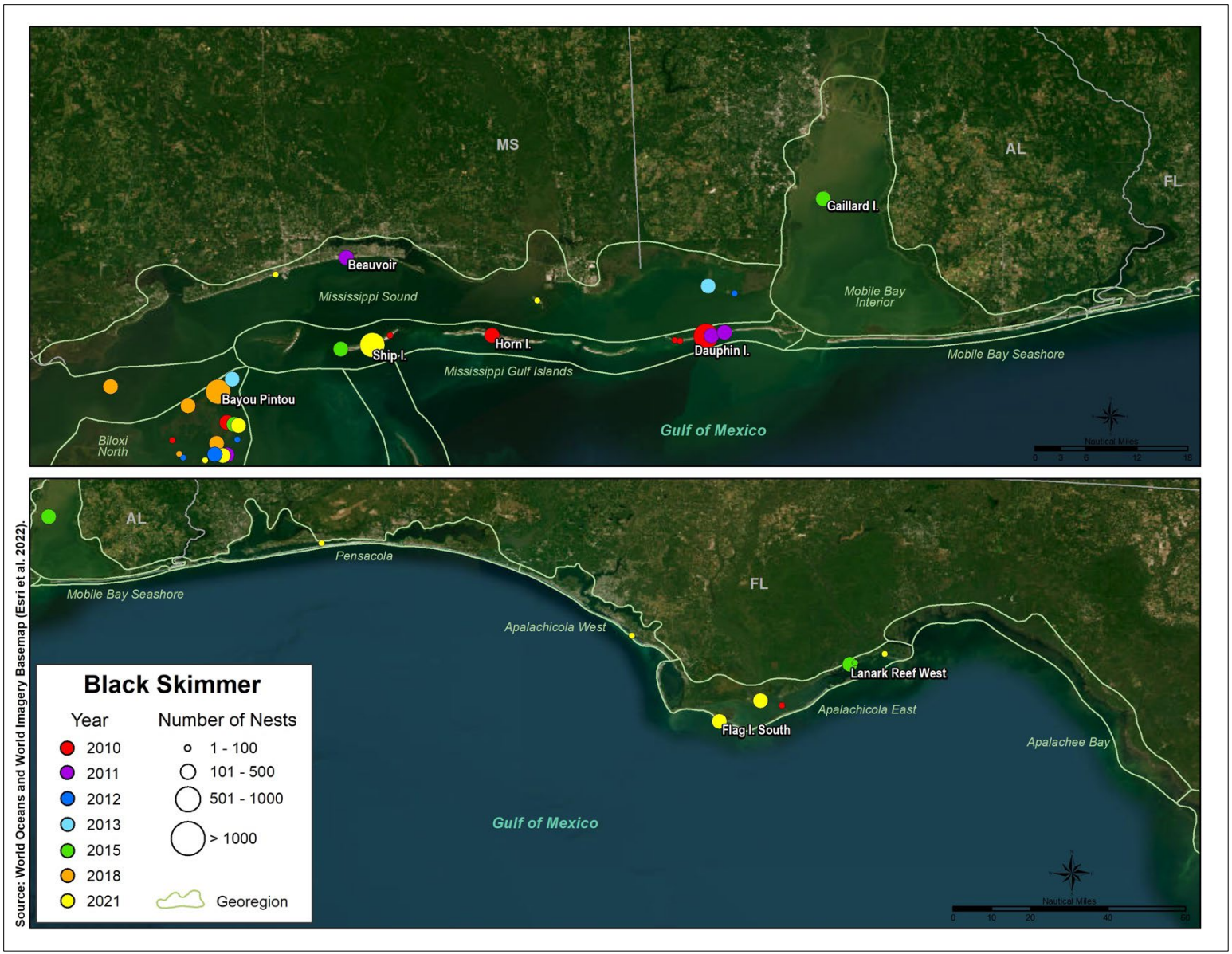
Map 1. Black Skimmer colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Black Skimmer colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 3. Black Skimmer colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Black Skimmer colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Anhinga and Neotropic Cormorant

During the 2010–2021 period, a total of 81 Anhinga nests were documented among eight colonies—four in Louisiana, three in Florida, and one in Texas (Table 1, Maps 1–3). Anhinga has a dark body and long neck—longer than that of a cormorant. Males are entirely black with white markings, while females have a buffy head, neck, and breast. As Anhinga feathers are not water resistant, the birds require logs and branches near the water to sun themselves (Frederick and Siegel-Causey 2020). Anhinga nests and birds can be cryptic due to habitat, and some could have been missed during dotting. Anhinga frequently nest with heron and egret species (Frederick and Siegel-Casey 2020). Nesting Great Egrets co-occurred at all Anhinga colonies documented during aerial photographic surveys. Nesting Tricolored Herons and Snowy Egrets also often co-occurred.

In 2021, a total of 53 Anhinga nests were counted six colonies—three in Florida, two in Louisiana, and one in Texas (Table 1). The largest Anhinga colony was at Heron Island in Florida (29 nests), accounting for over half of the nests from that year (Map 2). Birdsfoot West 6 A hosted the second highest nest count. Nests with visible chicks were counted at Nolan Ryan Marsh, Heron Island, and Birdsfoot West 6 A.

Neotropic Cormorant nesting was documented at 15 colonies—11 in Texas and four in Louisiana (Table 2, Maps 1–3). The Neotropic Cormorant has a long neck and is nearly all black with a distinct white "V" outlining the gular pouch. It can be distinguished from Double-crested Cormorant in aerial photographs by its proportionally longer tail. However, at some colonies, Double-crested Cormorant could have been present and misidentified as Neotropic Cormorant, especially at Birdsfoot West colonies in Louisiana. Like Anhinga, Neotropic Cormorant requires trees and branches, so some nests may have been concealed. Like Anhinga, Neotropic Cormorant nested with heron and egret species and were most often nesting with Great Egret (17 of 19 nesting events), followed by Great Blue Heron, Tricolored Heron, and Roseate Spoonbill (13 nesting events each).

A total of 827 nests were counted in 2021, with 79% among 10 colonies in Texas and 21% among two colonies in Louisiana. The largest Neotropic Cormorant colonies were at North Deer Island (219 nests, Map 1) and High Island (155 nests) in Texas, and at Birdsfoot West 6 A (167 nests) in Louisiana. These three colonies alone accounted for 65% of nests in 2021. Nests with visible chicks were observed only at High Island.

Table 1. Anhinga nest counts, 2010–2021.

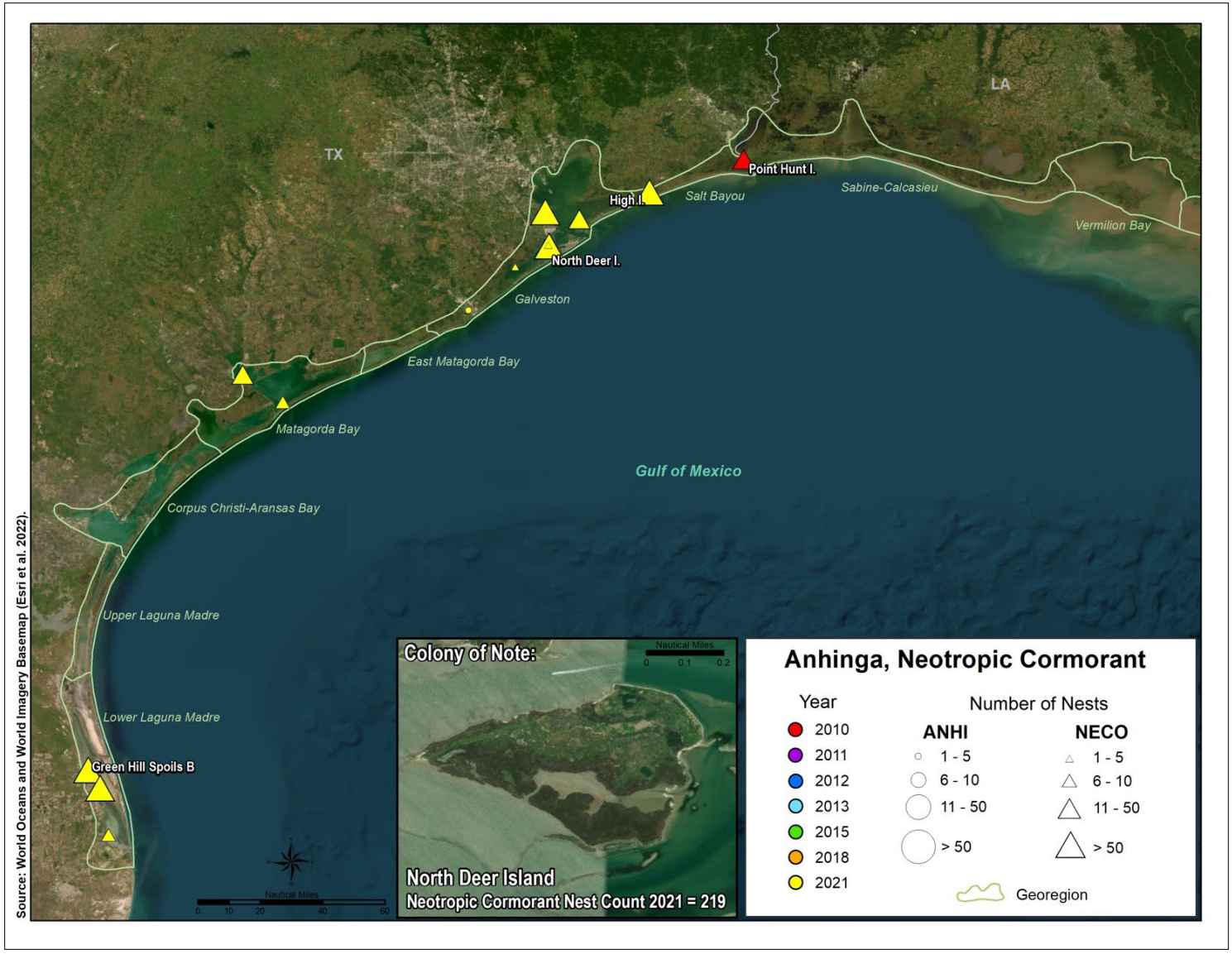
State	GeoRegion	Colony	2010	2011	2012	2013	2015	2018	2021
Texas	Galveston	Nolan Ryan Marsh	0	-	-	-	-	-	1
Louisiana	Atchafalaya Bay	Heron Island	0	0	0	0	11	3	29
	Birdsfoot West	Birdsfoot West 5	ND	0	ND	0	1	0	0
	Birdsfoot West	Birdsfoot West 6 A	ND	0	0	0	3	ND	14
	Biloxi North	Biloxi North 16	0	0	0	0	0	1	0
Florida	Apalachicola West	SASP Buttonwood Marsh	ND	ND	ND	ND	0	-	1
	Apalachicola West	SASP Gator Lake	ND	ND	ND	ND	0	-	6
	Apalachicola East	Lake Number Five	0	0	2	0	7	-	2

- = Outside intended survey area; ND = No Data

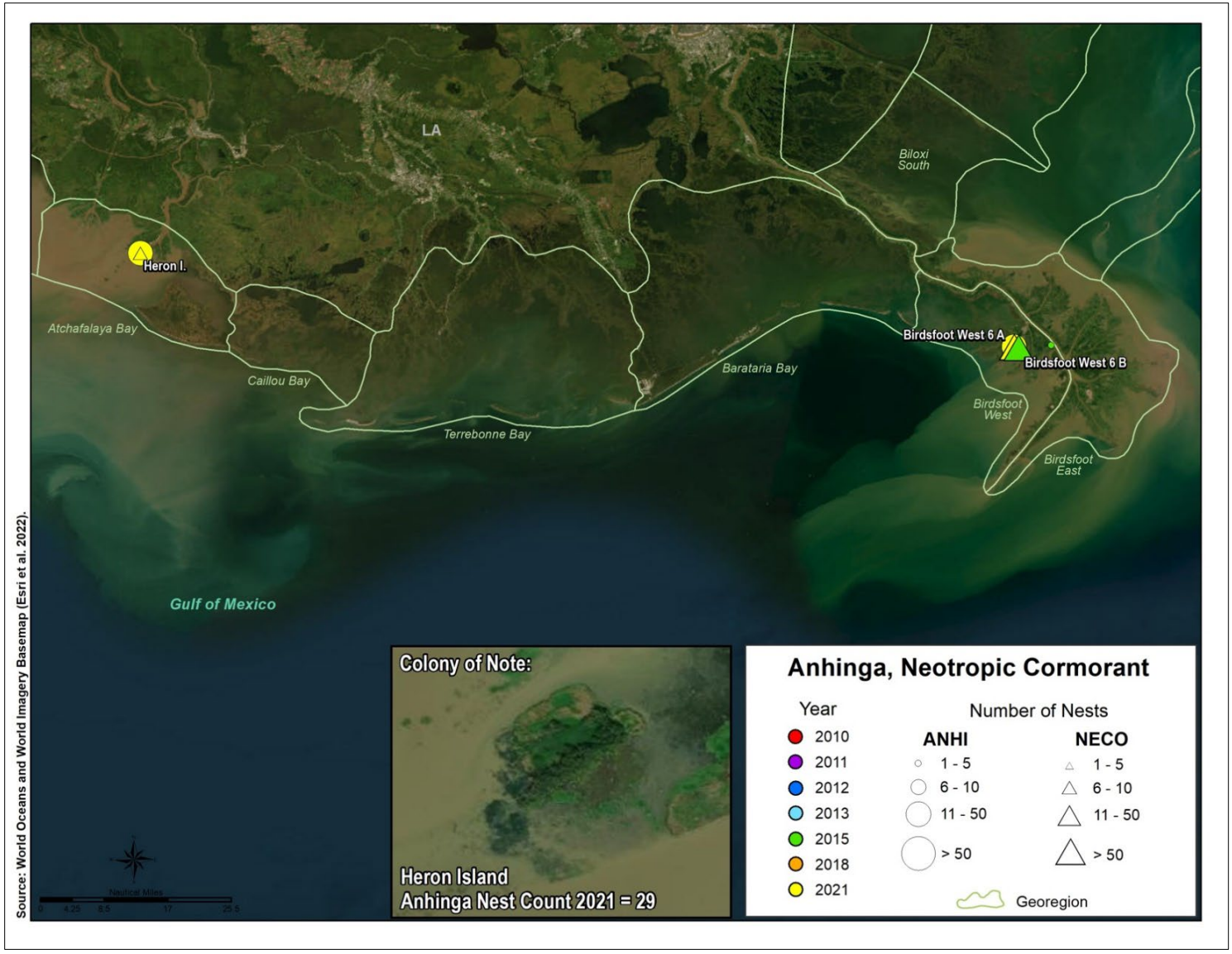
Table 2. Neotropic Cormorant nest counts, 2010–2021.

State	GeoRegion	Colony	2010	2011	2012	2013	2015	2018	2021
Texas	Lower Laguna Madre	Green Hill Spoils B	-	-	-	-	-	-	89
	Lower Laguna Madre	Green Island	-	-	-	-	-	-	67
	Lower Laguna Madre	Laguna Vista Spoils A	-	-	-	-	-	-	10
	Matagorda Bay	Chester Island	0	-	-	-	-	-	8
	Matagorda Bay	Lavaca Bay Spoils E	0	-	-	-	-	-	32
	Galveston	Dickinson Bay Spoil Island	ND	-	-	-	-	-	54
	Galveston	Evia Island	0	-	-	-	-	-	17
	Galveston	Marker 52 Spoil Island	17	-	-	-	-	-	0
	Galveston	North Deer Island	52	-	-	-	-	-	219
	Galveston	West Bay Mooring Facility	0	-	-	-	-	-	1
	Salt Bayou	High Island	0	-	-	-	-	-	155
Louisiana	Sabine-Calcasieu	Point Hunt Island	43	-	-	-	-	0	0
	Atchafalaya Bay	Heron Island	0	0	0	0	0	0	8
	Birdsfoot West	Birdsfoot West 6 A	ND	0	0	0	65	ND	167
	Birdsfoot West	Birdsfoot West 6 B	0	0	0	0	60	0	0

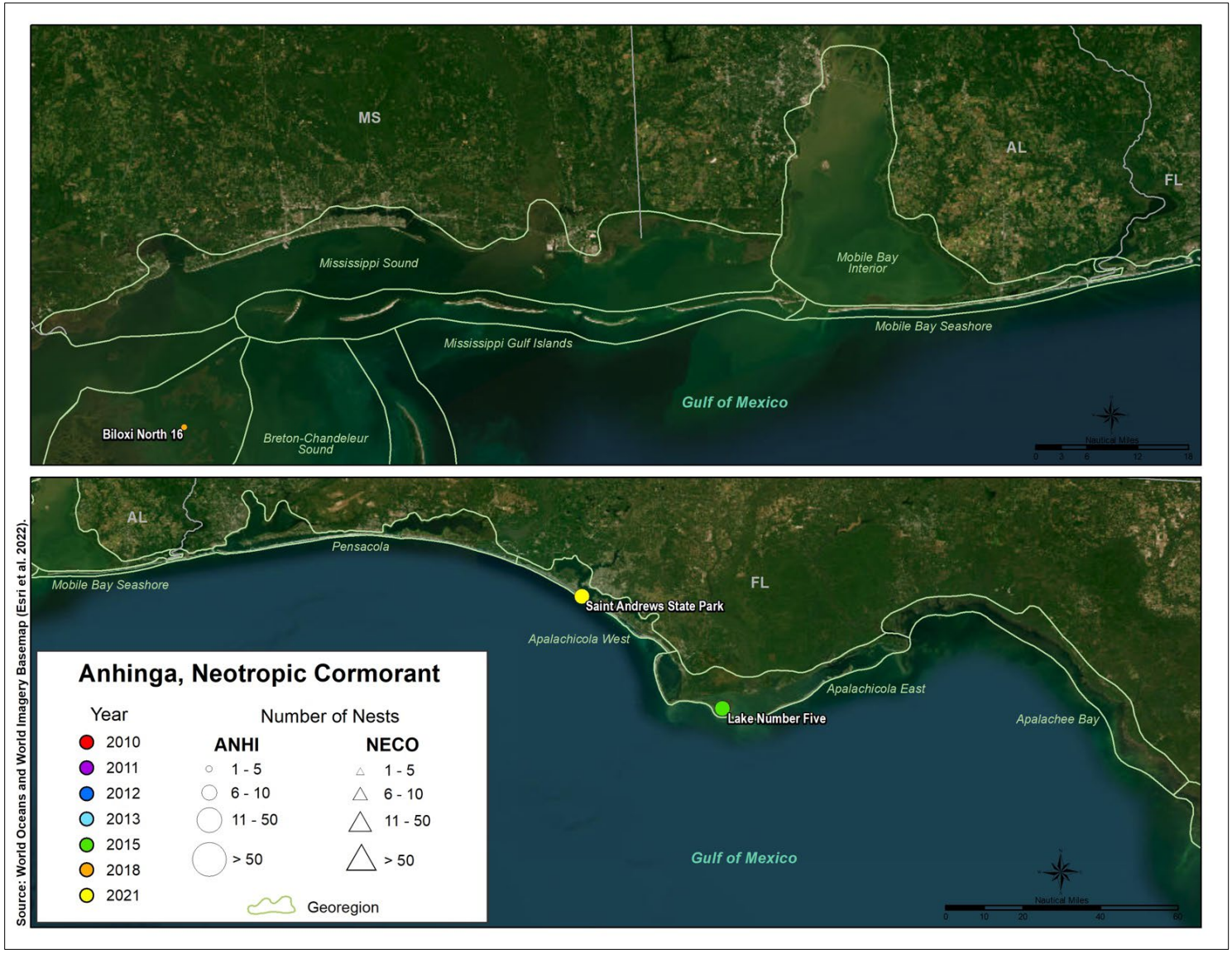
- = Outside intended survey area; ND = No Data



Map 1. Anhinga and Neotropic Cormorant colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest Neotropic Cormorant colony count across the Study Area and all years.



Map 2. Anhinga and Neotropic Cormorant colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest Anhinga colony count across the Study Area and all years.



Map 3. Anhinga and Neotropic Cormorant colonies counted from eastern Louisiana to Florida, 2010–2021, with year and range of maximum count indicated.

American White Pelican

American White Pelican nesting was documented at one colony, White Pelican Island in Texas, in 2021. The 2010 aerial surveys did not extend that far south. This isolated nesting population is the only marine nesting colony for this species and likely the only non-migratory population in North America. Loafing American White Pelicans were documented at 44 other waterbird colonies—33 in Louisiana, six in Texas, three in Alabama, and two in Florida (Maps 1–4). Counts of loafers are not necessarily complete, as American White Pelican was not a breeding species at these colonies and thus not a focus of the dotting effort. Other aggregations away from active waterbird colonies were also seen and sometimes photographed but not counted.

In 2021, 725 nests were counted at White Pelican Island, a total derived by summing 17 May and 20 June counts of non-overlapping parts of the colony (Table 1). This nest total is slightly higher than most available past counts (Chapman 1988, Chaney and Blacklock 2005). In May, at 69 nests where chicks were visible, the chicks were small and still being brooded. On the eastern side of the island, a group not counted in May was largely still in pairs, indicating egg laying had not yet occurred. This group had expanded along the eastern side of the island by the 20 June survey, with nearly all birds in incubation posture. In June photographs, some chicks were present amid the portion of the colony that was counted from May photographs, but they were again small and being brooded. No pods of older chicks were present, indicating chicks present on 17 May did not survive. Additionally, an area in May where 64 active nests were counted was completely unattended in June.

While the summed total of 725 nests represents a best estimate of breeding population size (1450 breeding birds; nests multiplied by two adults), some uncertainty exists in categorizing nests. For example, the number of abandoned nests in May could have been slightly overestimated if some unhatched eggs had rolled out of neighboring nests still attended, due to trampling and the poorly defined rim structure of White Pelican nests. A few dead chicks were also accounted for by being marked as Abandoned Nests. However, breeding population size may have been even higher if territories counted in June at the perimeter of groups on the eastern side on the island eventually became sites where eggs were laid. Lastly, the birds nesting in June could have included some pairs that re-nested after May nest failures.

Table 1. American White Pelican categorical nest counts at White Pelican Island, Texas, in 2021.

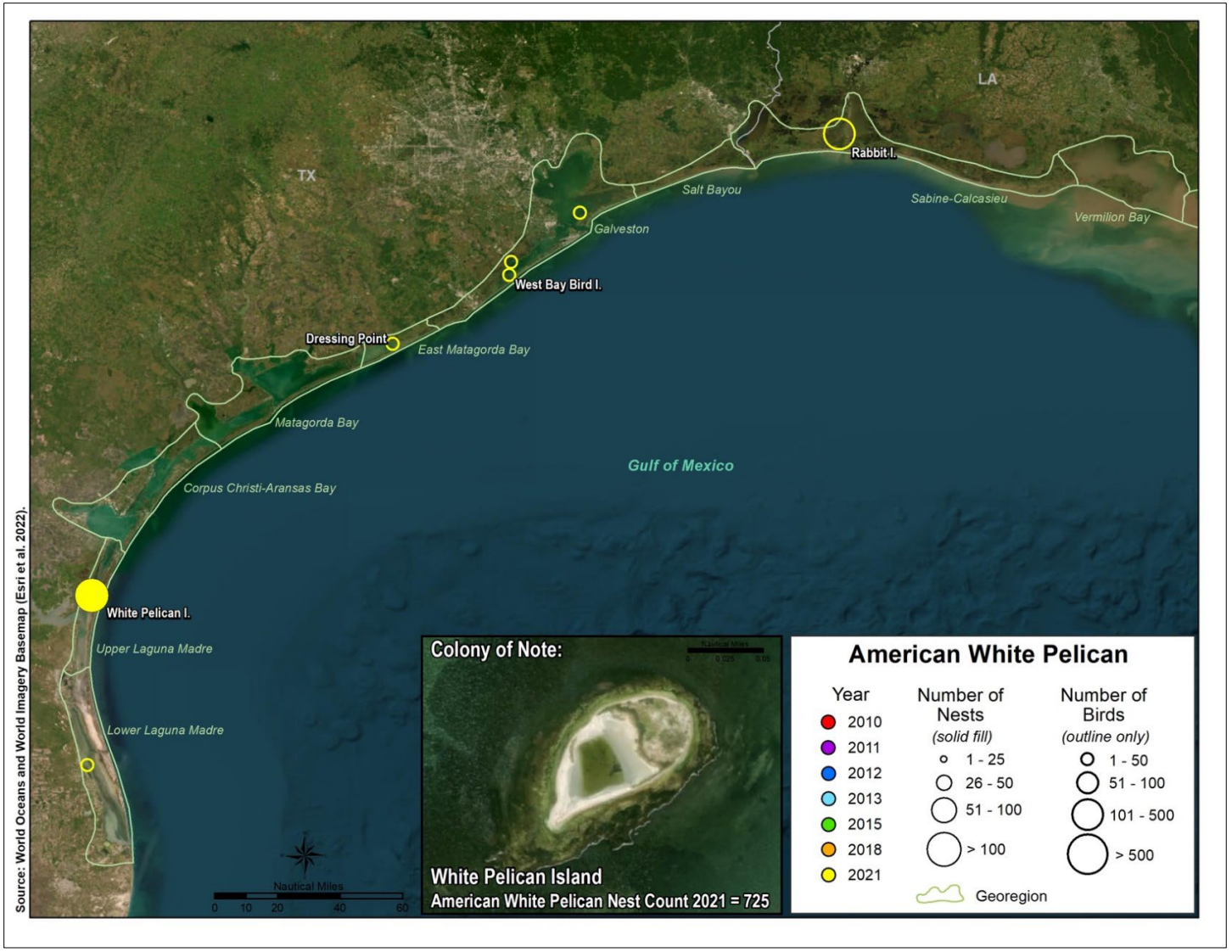
Date	Total Nests	WBN	Chick Nest	Abandoned	PBN	Territory
17-May-21	334	227	69	37	1	35
20-Jun-21	391	385	0	3	3	26

WBN = well-built nest; PBN = poorly built nest.

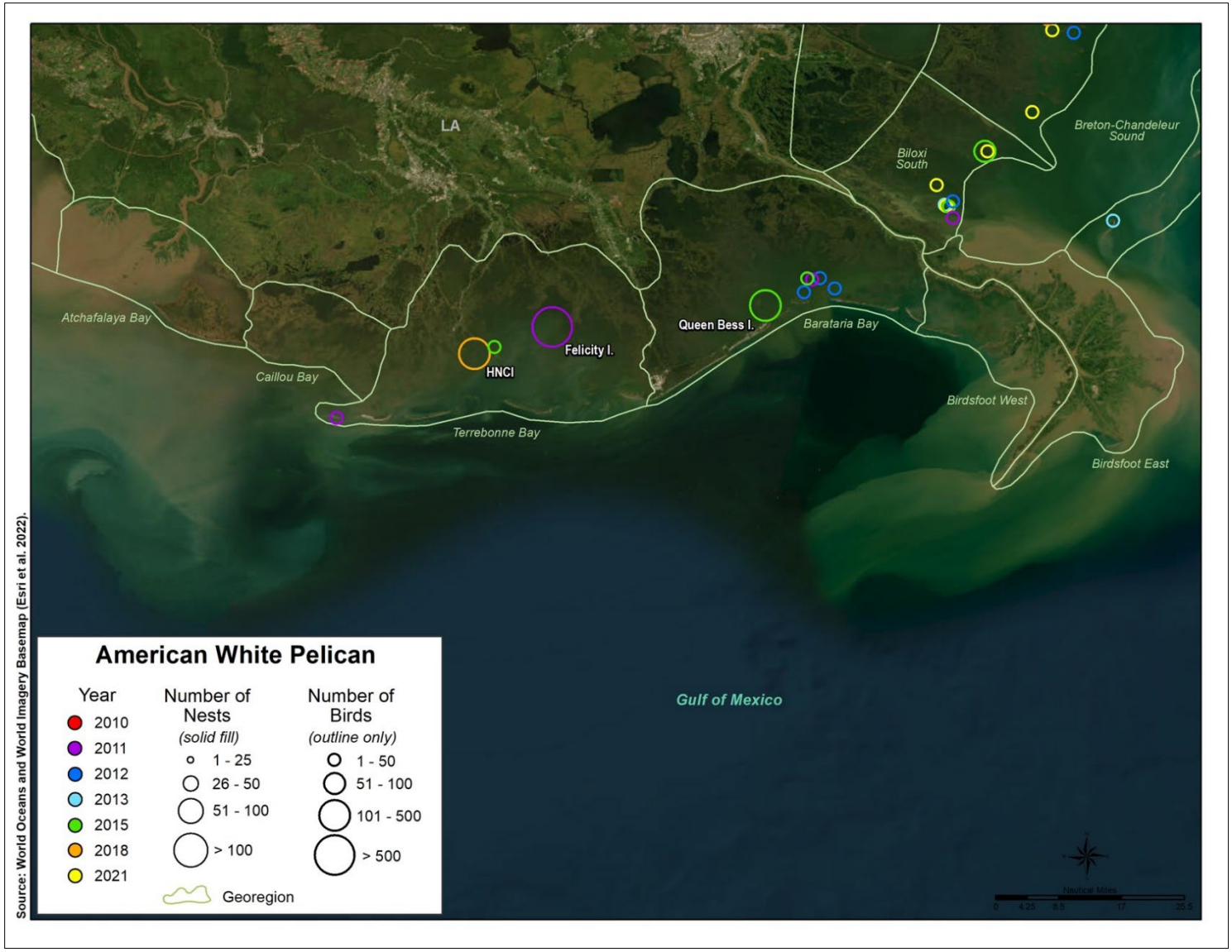
The Louisiana coast is known as an important area for American White Pelican (King and Michot 2002). The majority of the loafing locations and the highest numbers of birds documented during aerial surveys were in Louisiana. The highest count was at Felicity Island in 2011 with 1299 birds on 17 May 2011. Other locations with regular use or counts of more than 100 birds included

Queen Bess Island, Houma Navigation Canal Island, and Rabbit Island. White Pelicans were also present in the Biloxi North and South GeoRegions in all years with counts of over 100 birds at Door Point Lagoon 1 and Biloxi North 5 in 2010.

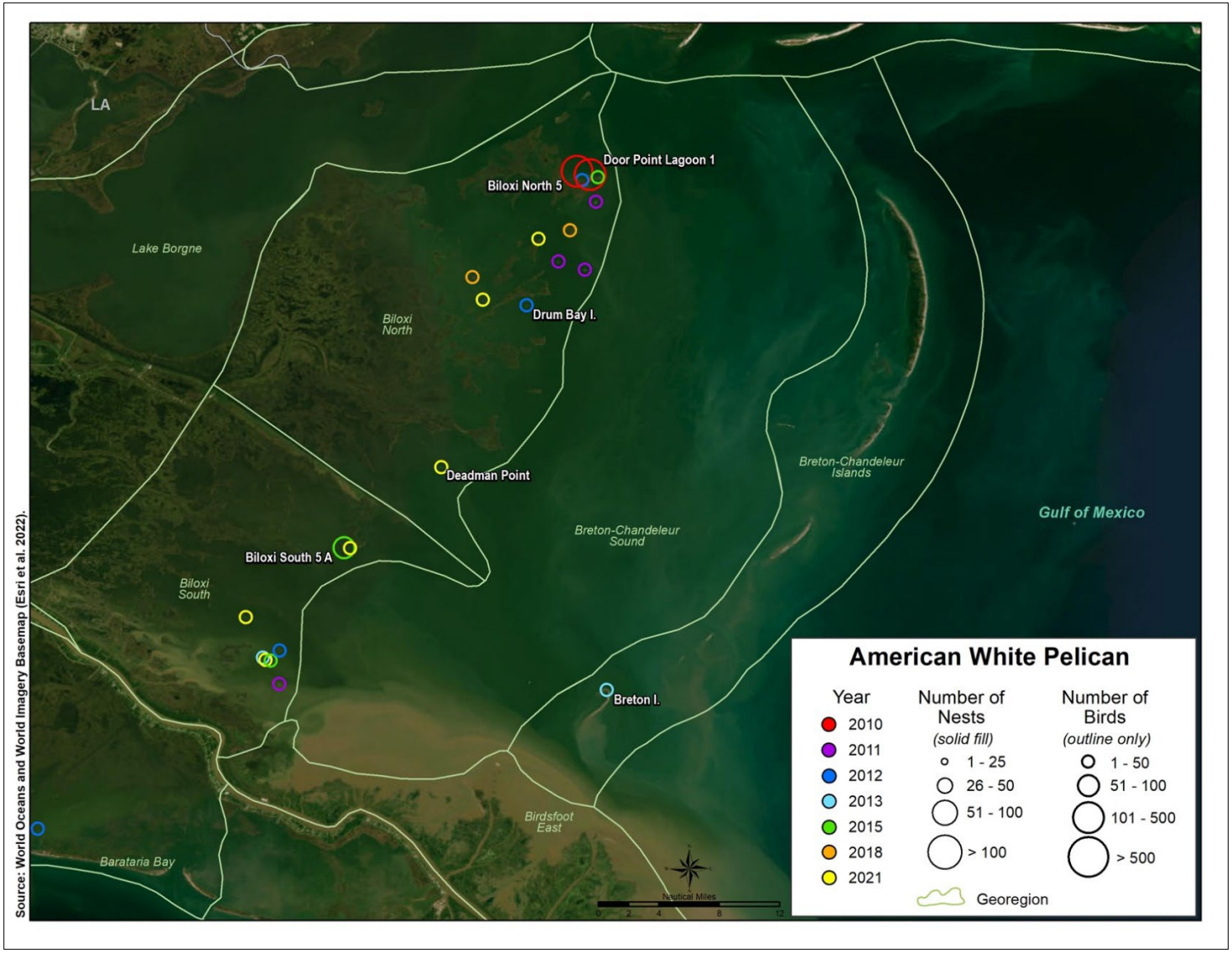
In Mississippi, only 14 birds in 2010 were documented at a location that did not have breeding waterbirds. In Alabama, small numbers of birds were at Terrapin Island, Cat Island, and Gaillard Island. In Florida, small numbers were at Lanark Reef West and Pepperfish Key.



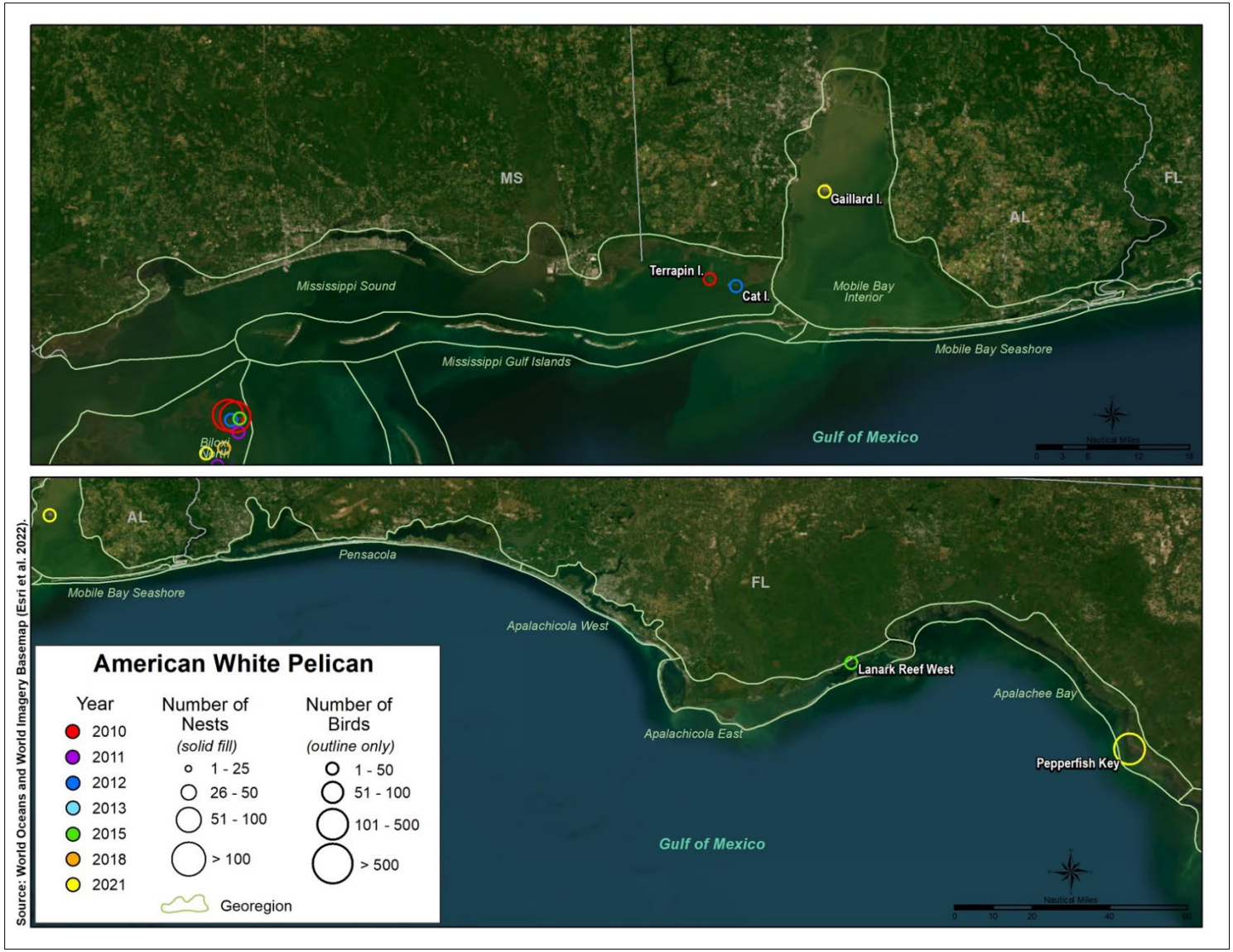
Map 1. Waterbird breeding colonies at which nesting or loafing American White Pelicans were counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the only nest count across the Study Area and all years.



Map 2. Waterbird breeding colonies at which loafing American White Pelicans were counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Waterbird breeding colonies at which loafing American White Pelicans were counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Waterbird breeding colonies at which loafing American White Pelicans were counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Brown Pelican

Brown Pelican nesting was documented at 70 colonies—43 in Louisiana, 19 in Texas, six in Florida, and two in Alabama (Maps 1–4). Because the species is large and nests in flat, open habitat in the nGOM, it is easily surveyed with vertical aerial photography. In contrast, Brown Pelican colonies in California occur on steep cliffs and are best surveyed with oblique photography from a helicopter. Gulf of Mexico colonies are conspicuous from a distance too. For example, the survey team first detected nesting at Philo Brice Islands in 2018 as it was transiting about 1.5 kilometers to the west. Pelican chicks in nests are easily detected in aerial photographs because their mostly white plumage contrasts with adult plumage and vegetation.

In 2021, 53,212 Brown Pelican nests were counted among 38 colonies (Tables 1 and 2). Of those nests, 58% were among 19 Louisiana colonies, 26% were among 15 Texas colonies, 12% were at Gaillard Island in Alabama, and 3% were among three Florida colonies. In Texas, nearly all colony totals were derived from May surveys, with small numbers of nests from June surveys added to colony totals for four colonies. Additionally, two small colonies totaling 10 nests were counted from June photographs. In Louisiana, colony counts were more of a mix of May and June counts. All colonies in Biloxi Marsh and in the Breton-Chandeleurs GeoRegion were counted from June photographs. To the west, the largest colonies at Queen Bess and Raccoon islands were counted from May photographs (one nest from June was added for Raccoon Island). However, Rabbit Island, the state's westernmost colony, was counted from June photographs and no chicks were visible, likely due to a late onset of breeding as restoration was completed in March 2021. Mendicant Island, in Barataria Bay, was unusual with 282 attended nests in May but also nearly 800 empty nests and another 90 abandoned nests; the colony was completely abandoned by June. No nesting had been detected on this island in any prior survey year. The largest colonies were at Raccoon Island in Louisiana (7242 nests), Gailliard Island in Alabama (6614 nests), North Deer Island in Texas (5970 nests), and Philo Brice Islands in Louisiana (5714 nests). Another eight colonies had more than 1000 nests—four in Louisiana, three in Texas, and one in Florida.

Table 1. Numbers of Brown Pelican nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	1996 (11)	-	-	-	-	-	14,095 (15)
LA	17,886 (18)	24,283 (21)	19,886 (25)	23,912 (24)	27,279 (20)	38,662 (16)	31,031 (19)
AL	5970 (1)	9881 (1)	8627 (2)	7799 (2)	10,653 (2)	-	6614 (1)
FL	1151 (5)	106 (1)	1382 (3)	1199 (4)	1561 (3)	-	1472 (3)
Total	**27,003 (35)**	**34,270 (23)**	**29,895 (30)**	**32,910 (30)**	**39,493 (25)**	**38,662 (16)**	**53,212 (38)**

() = number of colonies; - = state not included in survey area that year.

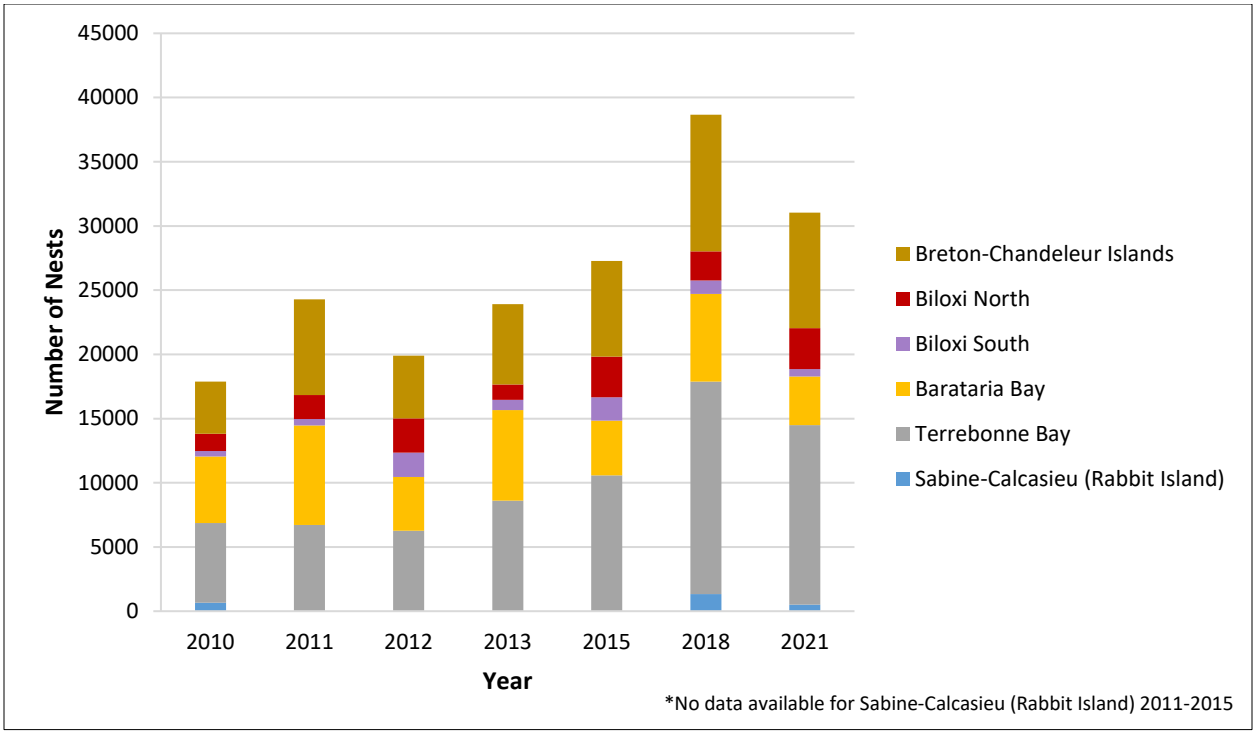


Figure 1. Numbers of Brown Pelican nests in Louisiana by GeoRegion, 2010–2021.

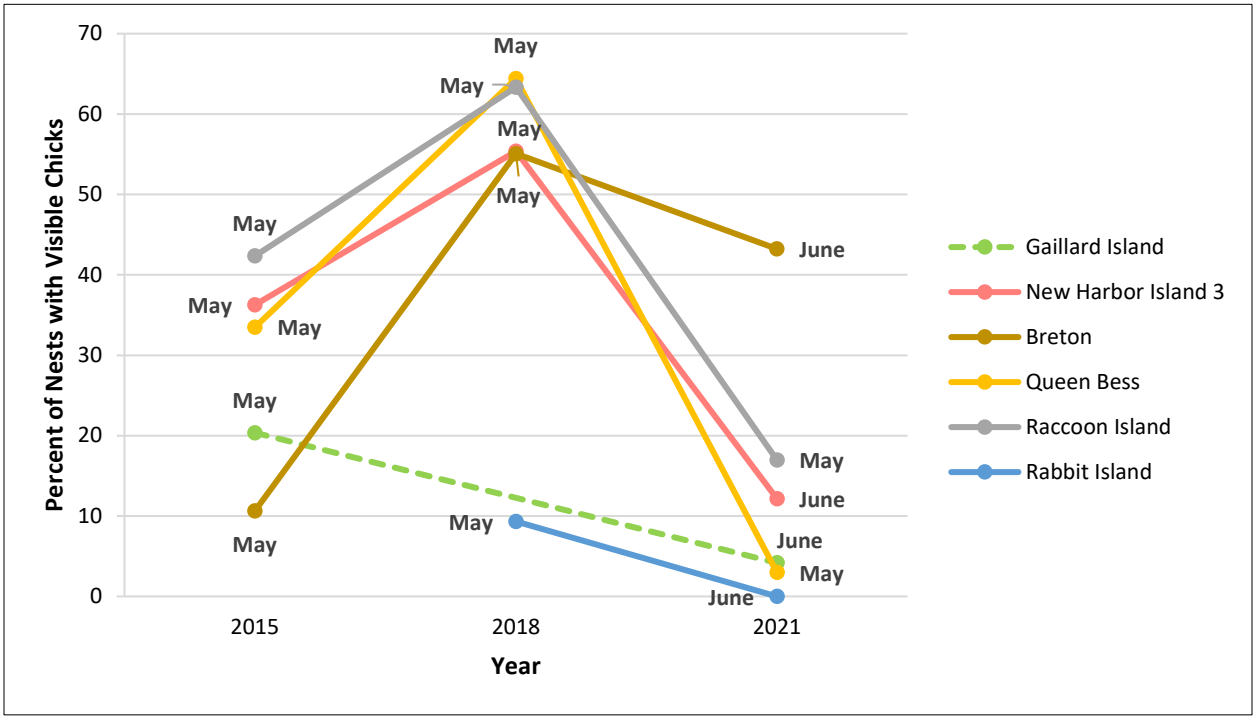


Figure 2. Brown Pelican nests (%) with visible chicks at selected colonies, with the survey month used for the colony count indicated. Dashed line indicates Gaillard Island was not in the survey area in 2018.

In Texas, aside from North Deer Island, colonies with more than 1000 nests in 2021 were Chester Island, Marker 52 Spoil Island, and Shamrock Island. No colonies were active in the Upper Laguna Madre GeoRegion, and just over 100 nests were counted in the Lower Laguna Madre. Comparisons with 2010 data are problematic because Texas surveys were conducted only in late June that year. For example, at Marker 52 Spoil Island on 25 June 2010 nesting had essentially concluded, but hundreds of young of the year were counted along the shoreline. However, because of time constraints during the image analysis efforts then, no attempt was made to estimate a nest total (Table 2). The Texas breeding population of Brown Pelicans has increased in recent decades since earlier declines, with estimates of 3373 breeding pairs in 2001 (Holm et al. 2003) and 8115 pairs in 2012 (Shields 2020). The 2021 statewide total from surveys was 74% higher than that 2012 estimate, likely indicating continued population increase, though comparability of counts is unclear given the different survey methods.

In Louisiana, a clear peak in statewide nest totals occurred in 2018 (Tables 1 and 2, Figure 1). The 2018 peak was 20% higher than the 2021 total. The 2018 peak in nest totals may indicate excellent breeding conditions resulting in a larger percentage of the adult population choosing to breed. For example, Wilkinson and Jodice (2022) documented that some adult female Brown Pelicans on the Atlantic coast occasionally skip annual breeding. It may also reflect high recruitment of first-time breeders if breeding success and survival in recent prior years was excellent. In addition, the timing of nest initiation was earlier (on average) in the calendar year in 2018, based on increased percentages of nests documented with visible chicks at major colonies (Figure 2). The 2018 nest total (38,662) equates to an estimate of more than 75,000 breeding birds (nests x2), more than twice the statewide estimate (35,000) reported by Remsen et al. (2019), which was based on multiple sources including an average of 2010–2013 aerial photographic counts reported here. Of note, the authors stated in the journal's supplemental content that aerial photographic counts documented higher and likely more accurate nest counts than other methods described.

The 2010 statewide total reported here (Table 1) was 68% higher than the Louisiana Department of Wildlife and Fisheries (LDWF) survey total reported by Selman et al. (2016). Although LDWF's exact survey dates were not presented, the documented nest counts suggest that surveys were conducted prior to certain colony formations, resulting in a lower statewide total. For example, pelican colonies at Martin and Drum Bay islands were not active in May 2010 and were only in the incubation stage in late June.

Land loss previously noted at pelican colonies in Louisiana through 2010 (Selman et al. 2016) continued through 2021. Ten islands that hosted Brown Pelican colonies were submerged, three in Terrebonne Bay and seven in Barataria Bay (Table 2). Felicity Island in Terrebonne Bay also shrank dramatically, as did New Harbor Island 1 and 2 in the Breton-Chandeleurs GeoRegion. In contrast, Gosier Islands North re-emerged and in 2018 had adequate vegetation for 50 Brown Pelican nests. Gosier Islands North hosted over 1500 nests from 1992 to 1998, with the largest estimate of 7000 nests in 1995, but was submerged by 2004 (Selman et al. 2016).

In Alabama, the 2015 count of 10,473 nests at Gaillard Island represents the largest Brown Pelican colony size in any state in any survey year (Table 2, Map 4). Timing of breeding at Gaillard Island in 2015 and 2021 may have been on average slightly later than the timing at major colonies in Louisiana (Figure 2). Cat Island, the only other pelican colony in Alabama, had a high count of 234 nests in 2012, but no pelican nesting by 2021, when habitat no longer existed.

In Florida, the highest nest total was 1472 in 2021, with Saint George Causeway as the largest colony (1076 nests), having doubled in size since first documenting them there in 2013. Audubon Island had similar nest counts in each year given its limited habitat.

Table 2. Brown Pelican nest counts for all colonies counted, 2010–2021.

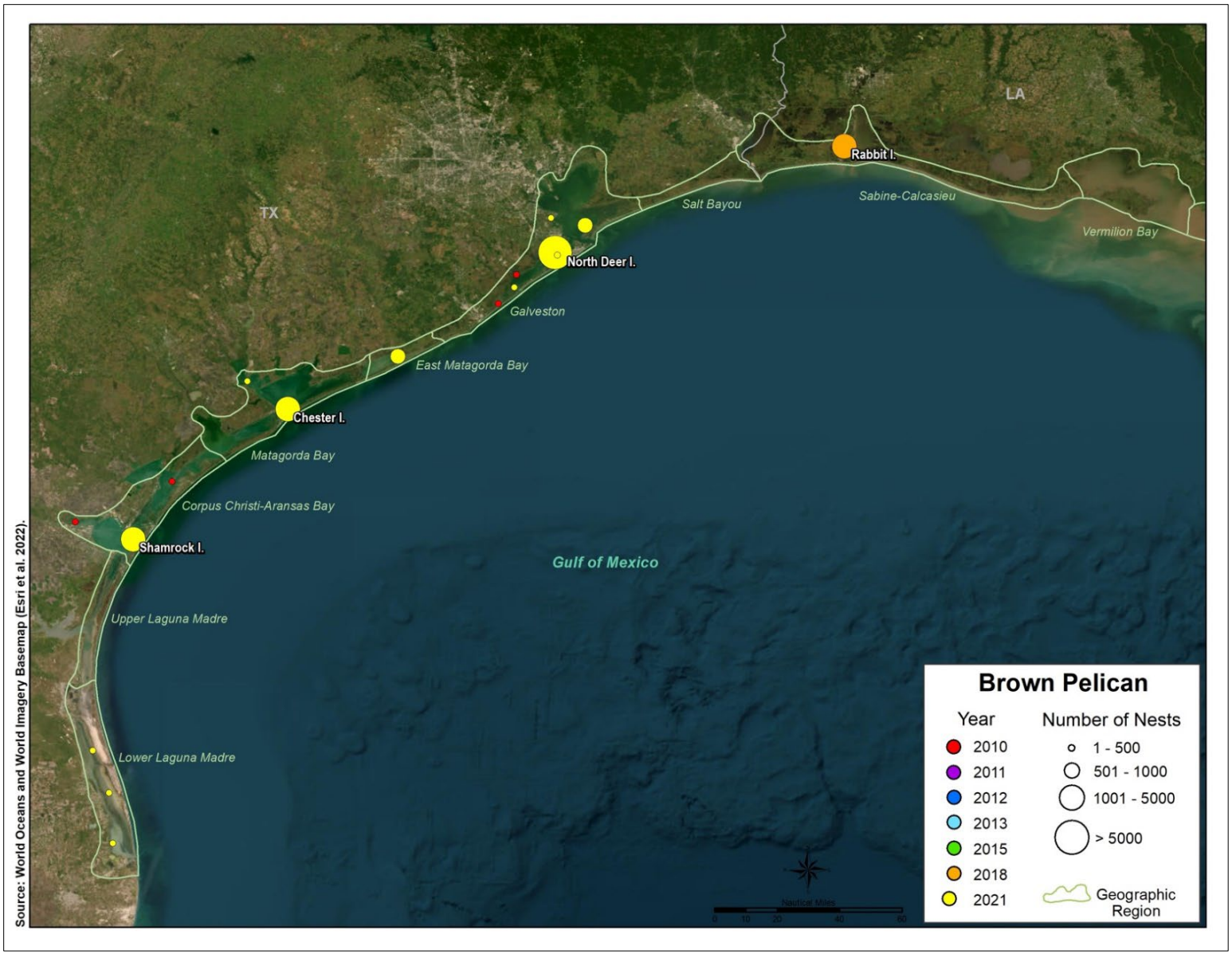
State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Lower Laguna Madre	East Marker Spoil	-	-	-	-	-	-	15
	Lower Laguna Madre	Green Island Spoils K	-	-	-	-	-	-	2
	Lower Laguna Madre	Laguna Vista Spoils A	-	-	-	-	-	-	96
	Corpus Christi-Aransas Bay	Long Reef Deadman Islands A	4	-	-	-	-	-	0
	Corpus Christi-Aransas Bay	Shamrock Island	ND	-	-	-	-	-	***1321***
	Corpus Christi-Aransas Bay	West Nueces Bay 51W D	2	-	-	-	-	-	0
	Matagorda Bay	Chester Island	612	-	-	-	-	-	***2456***
	Matagorda Bay	Lavaca Bay Spoils E	23	-	-	-	-	-	399
	East Matagorda Bay	Dressing Point	141	-	-	-	-	-	568
	Galveston	Dickinson Bay Spoil Island	ND	-	-	-	-	-	166
	Galveston	Drum Bay Islands 2	5	-	-	-	-	-	ND
	Galveston	Evia Island	115	-	-	-	-	-	900
	Galveston	Kanaloa Spoil	-	-	-	-	-	-	542
	Galveston	Kanaloa Spoil East	1	-	-	-	-	-	0
	Galveston	Marker 52 Spoil Island	P[1]	-	-	-	-	-	1347
	Galveston	Mustang Bayou Island	20	-	-	-	-	-	8
	Galveston	North Deer Island	1072	-	-	-	-	-	***5970***
	Galveston	South Deer Island	0	-	-	-	-	-	***141***
	Galveston	West Bay Bird Island New	1	-	-	-	-	-	164
Louisiana	Sabine-Calcasieu	Rabbit Island	656	-	-	-	-	1340	521
	Terrebonne Bay	Felicity Island	298	705	2620	***1793***	1668	764	205
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	1934	3115	3120	811
	Terrebonne Bay	Pelican Island	674	829	307	140	1	S	S
	Terrebonne Bay	Philo Brice Islands	0	0	0	0	0	4039	5714
	Terrebonne Bay	Raccoon Island	5156	***5022***	3350	4336	***5688***	8621	***7242***
	Terrebonne Bay	Terrebonne Bay 1	ND	ND	ND	413	95	S	S
	Terrebonne Bay	Wine Island	93	165	0	0	0	0	S
	Barataria Bay	Barataria Bay 3	ND	0	115	0	0	S	S
	Barataria Bay	Bay Ronquille Northeast Island	0	150	72	0	S	S	S

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
	Barataria Bay	Bay Ronquille Northwest Island	0	309	417	4	149	S	S
	Barataria Bay	Cat Bay Island	1018	1155	491	6	0	S	S
	Barataria Bay	Cat Bay North Island	700	969	685	263	315	S	S
	Barataria Bay	Cat Bay South Island	0	804	574	15	0	S	S
	Barataria Bay	Grand Island Point	0	0	243	0	S	S	S
	Barataria Bay	Mendicant Island	0	0	0	0	0	0	372
	Barataria Bay	Queen Bess Island	3441	4353	1579	6748	3799	6830	3425
	Biloxi South	Belle Isle	0	0	0	0	0	909	291
	Biloxi South	Biloxi South 10 A	440	0	347	55	0	0	0
	Biloxi South	Biloxi South 10 B	0	0	362	102	11	0	0
	Biloxi South	Biloxi South 10 C	0	0	241	0	0	0	0
	Biloxi South	Biloxi South 10 D	0	0	352	154	242	0	0
	Biloxi South	Biloxi South 11	0	0	509	166	0	0	0
	Biloxi South	Biloxi South 5 A	0	17	0	138	164	0	0
	Biloxi South	Biloxi South 5 B	0	0	0	196	828	129	282
	Biloxi South	Biloxi South 9	0	0	84	0	0	0	0
	Biloxi South	Long Bay Island	0	481	0	0	588	0	0
	Biloxi North	Biloxi North 38	0	0	0	0	0	1234	1648
	Biloxi North	Biloxi North 7	391	0	264	143	383	0	431
	Biloxi North	Biloxi North 8	95	0	0	165	0	0	0
	Biloxi North	Brush Island	0	429	0	0	0	3	68
	Biloxi North	Deadman Point	0	402	789	61	484	276	145
	Biloxi North	Door Point Lagoon 1	170	0	837	269	302	0	83
	Biloxi North	Door Point Lagoon 2	175	1033	449	138	1326	123	44
	Biloxi North	Drum Bay Island	361	6	330	418	***655***	0	452
	Biloxi North	Isle au Pitre	0	0	0	0	0	***622***	312
	Biloxi North	Martin Island	155	0	0	0	0	0	0
	Breton-Chandeleur Islands	Breton Island	3401	***5343***	2636	4499	***4790***	***6488***	4301
	Breton-Chandeleur Islands	Chandeleur South B	0	72	0	0	0	0	0
	Breton-Chandeleur Islands	Gosier Islands North	S	S	S	S	0	***50***	0
	Breton-Chandeleur Islands	New Harbor Island 1	12	165	0	0	0	0	0

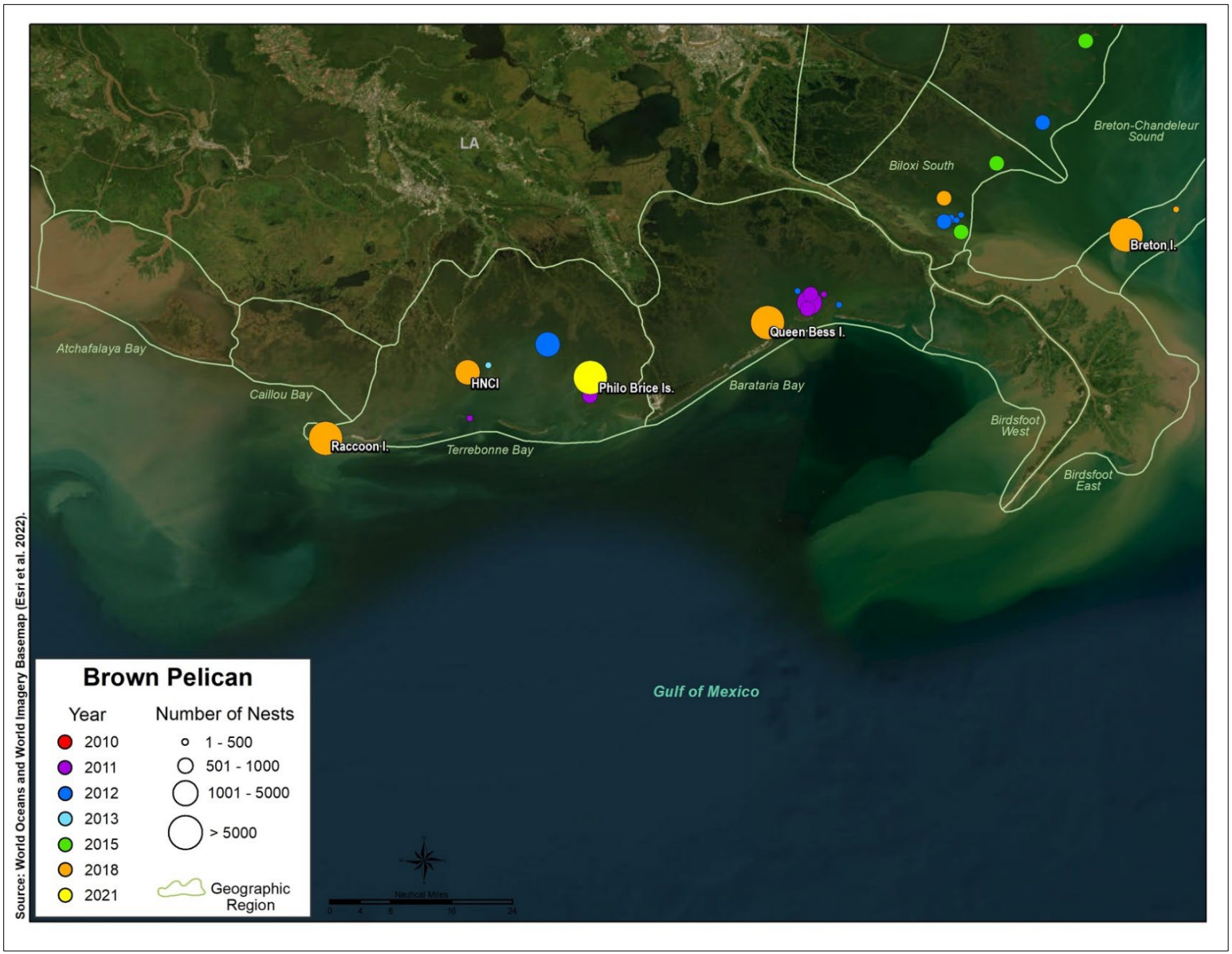
State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
	Breton-Chandeleur Islands	New Harbor Island 2	650	1289	942	0	0	0	0
	Breton-Chandeleur Islands	New Harbor Island 3	0	585	1291	1756	***2676***	4114	4684
Alabama	Mississippi Sound	Cat Island	0	0	234	23	180	-	0
	Mobile Bay Interior	Gaillard Island	5970	***9881***	8393	***7776***	***10,473***	-	***6614***
Florida	Apalachicola West	Audubon Island	110	106	75	106	150	-	160
	Apalachicola East	Apalachicola Bird Island	428	-	996	0	0	-	0
	Apalachicola East	Lanark Reef West	554	-	0	519	455	-	236
	Apalachicola East	Lanark Reef-Pelican Lump	25	-	311	0	0	-	0
	Apalachicola East	Saint George Causeway	0	-	0	543	956	-	1076
	Apalachee Bay	Smith Island	34	-	-	31	-	-	0

- = Outside intended survey area. ND = No Data. S = Submerged. P = Present. Bold italics indicate a sum of counts from May and June surveys.

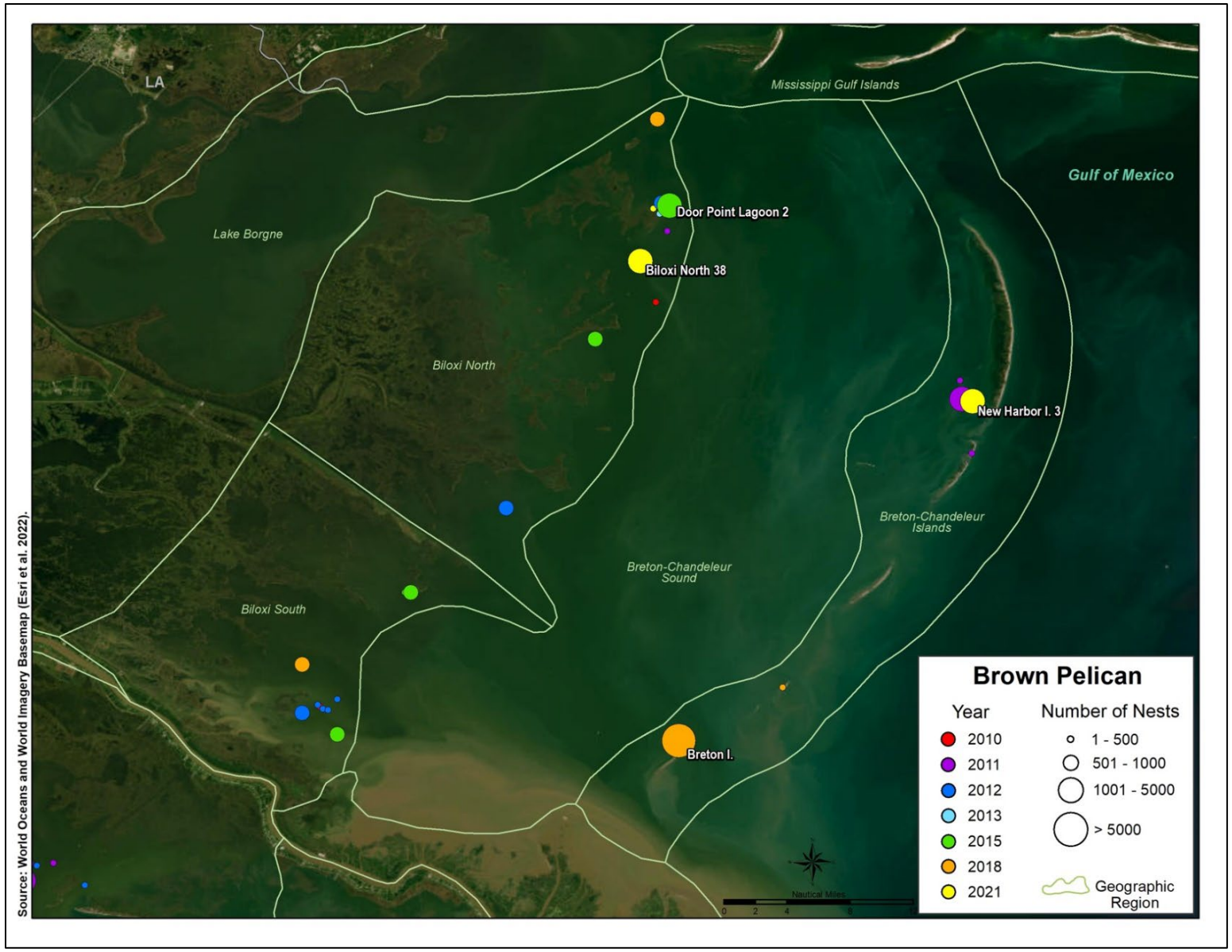
[1]At Marker 52 Spoil Island, hundreds of young of the year, some with some chick plumage remaining, were counted along the shoreline, but an estimate of nests was not determined.



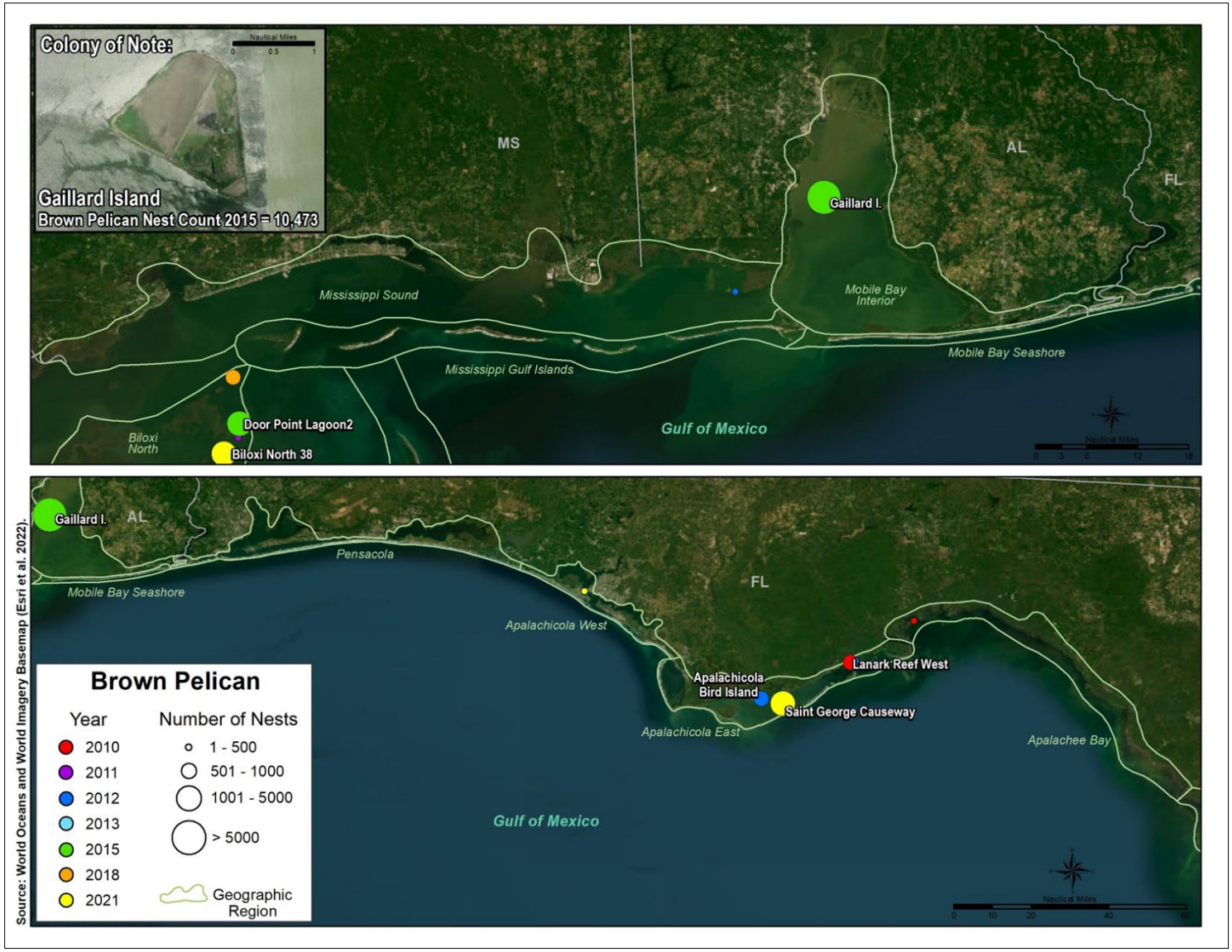
Map 1. Brown Pelican colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Brown Pelican colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Brown Pelican colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Brown Pelican colonies counted from Mississippi to Florida, 2010–2021 with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.

Great Blue Heron

Great Blue Heron nesting was documented at 89 colonies—63 in Texas, 13 in Louisiana, six in Florida, five in Alabama, and two in Mississippi (Maps 1–4). As the largest of the North American herons, the Great Blue Heron was readily identified by its size as well as its shaggy, blue-gray plumage, sinuous neck, and daggerlike bill. It often nests on the tops of shrubs and trees or on the ground on predator-free islands. Great Blue Heron was sometimes difficult to detect in tree-dominated habitat.

In 2021, a total of 1931 nests were counted among 54 colonies (Table 1). Of those nests, 93% (1795) were among 43 Texas colonies. In the remaining four states, just 136 nests were documented among 11 colonies. The largest colonies were in Texas at Chester Island (148 nests), North Deer Island (139 nests), and Pelican Island Spoil B (138 nests). Another 12 colonies had more than 50 nests, all in Texas.

Table 1. Numbers of Great Blue Heron nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	543 (31)	-	-	-	-	-	1795 (43)
LA	24 (3)	47 (5)	27 (6)	32 (4)	50 (3)	42 (4)	26 (1)
MS	0	0	0	0	0	0	8 (2)
AL	11 (1)	26 (1)	8 (1)	38 (2)	9 (1)	-	48 (4)
FL	1 (1)	3 (2)	2 (1)	7 (2)	0	-	54 (4)
Total	**579 (36)**	**76 (8)**	**37 (8)**	**77 (8)**	**59 (4)**	**42 (4)**	**1931 (54)**

() = number of colonies; - = state not included in survey area that year.

In Texas, seventeen colonies had a count of 50 nests or more; no other state had a colony with at least 50 nests from 2010 to 2021 (Table 2). Comparisons of 2010 and 2021 nest counts are problematic, however, because of survey coverage and survey date differences. For example, the Upper and Lower Laguna Madre GeoRegions were only surveyed in 2021, and surveys in 2010 were only conducted in late June, possibly leading to underestimates of colony sizes. In 2021, among 43 active colonies in Texas, nest counts for 21 of them were derived from May photographs, and nest counts for another 11 were sums of May and June counts. Nesting habitat in Texas tended to be more open, with Great Blue Heron nests even on cacti, so greater visibility could have contributed to higher counts there than in other states.

In Louisiana, most nests documented were in the Atchafalaya Bay GeoRegion (Figure 1). Heron Island supported the largest colony overall with 29 nests in 2011 and between 13 and 29 nests in all survey years (Map 2). Tree-dominated habitat at Heron Island likely led to underestimated numbers there. Nesting Great Blue Herons were interspersed with large numbers of nesting Great Egrets, as well as lower numbers of nesting Snowy Egrets, Anhingas, and Roseate Spoonbills. Skimmer Island, the only other colony documented in Atchafalaya Bay, supported 22 nests in 2015 but none in 2021, presumably due to vegetation changes.

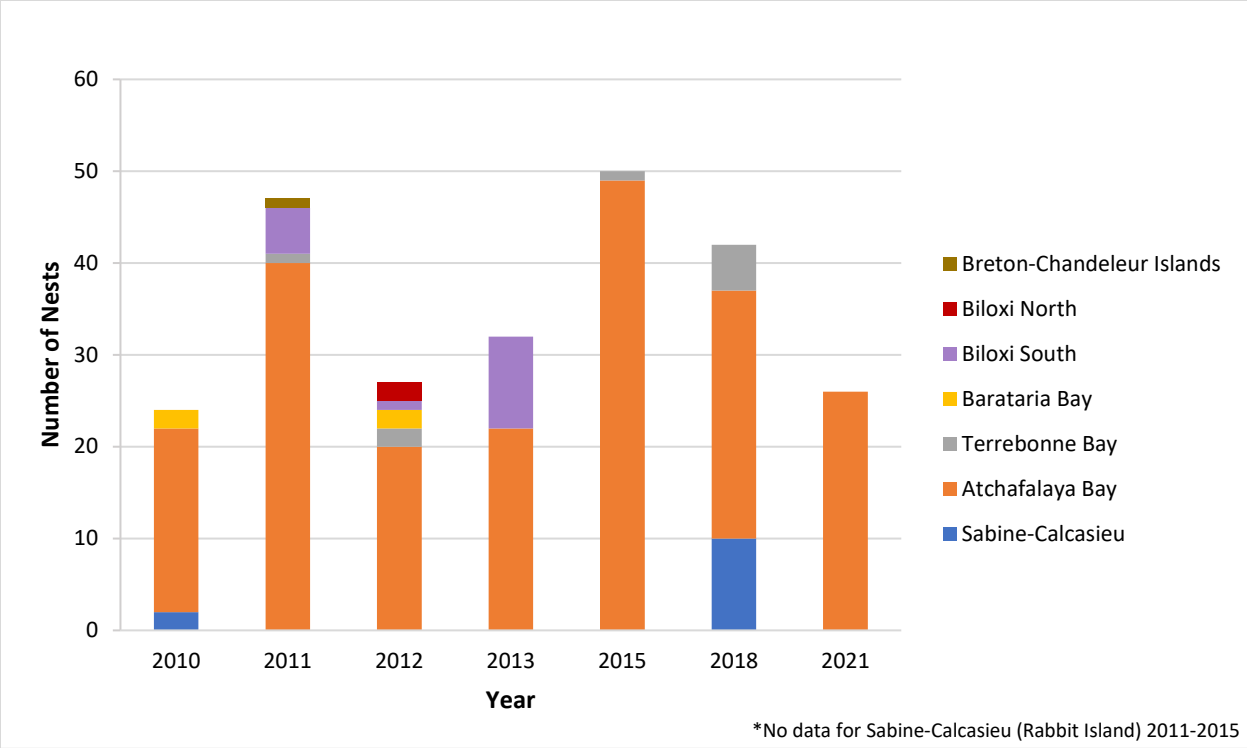


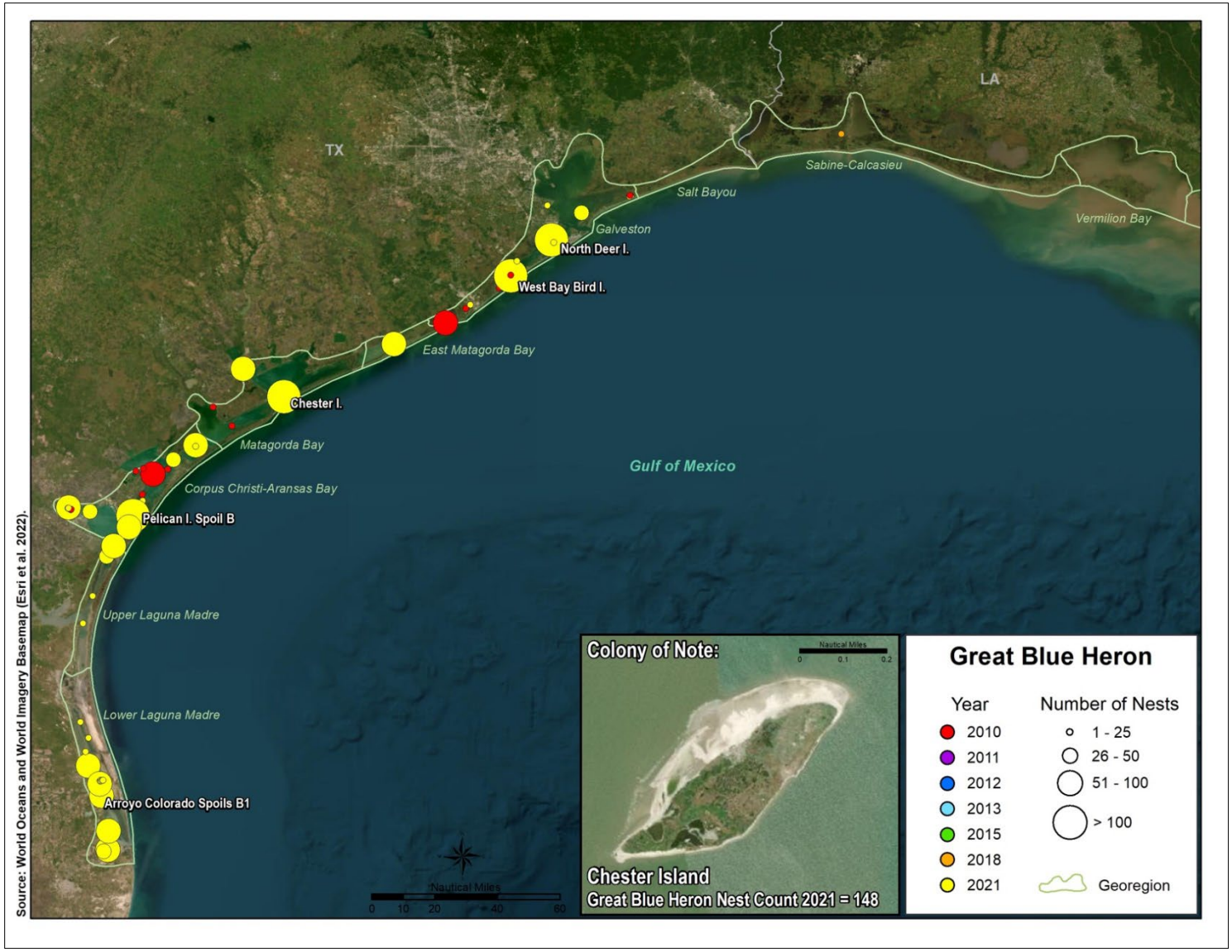
Figure 1. Numbers of Great Blue Heron nests in Louisiana by GeoRegion, 2010–2021.

In Mississippi, nesting was documented only at Deer Island Northeast and Old Round Island in 2021 (four nests each). In Alabama and Florida, colony habitat included more trees and tall shrubs compared with Louisiana and Texas, so nest concealment may have been greater. Alabama's largest colony was at Terrapin Island in 2013 with 32 nests (Map 4). Despite no obvious changes to the island, no nesting was documented the other years. Battery McIntosh was the only island in Alabama to have nests in all years surveyed (6–26 nests) and appeared dense with shrubs and trees. Florida's largest colony was at Saint Andrews State Park Gator Lake in 2021 with 34 nests. Gator Lake was not surveyed in any other year.

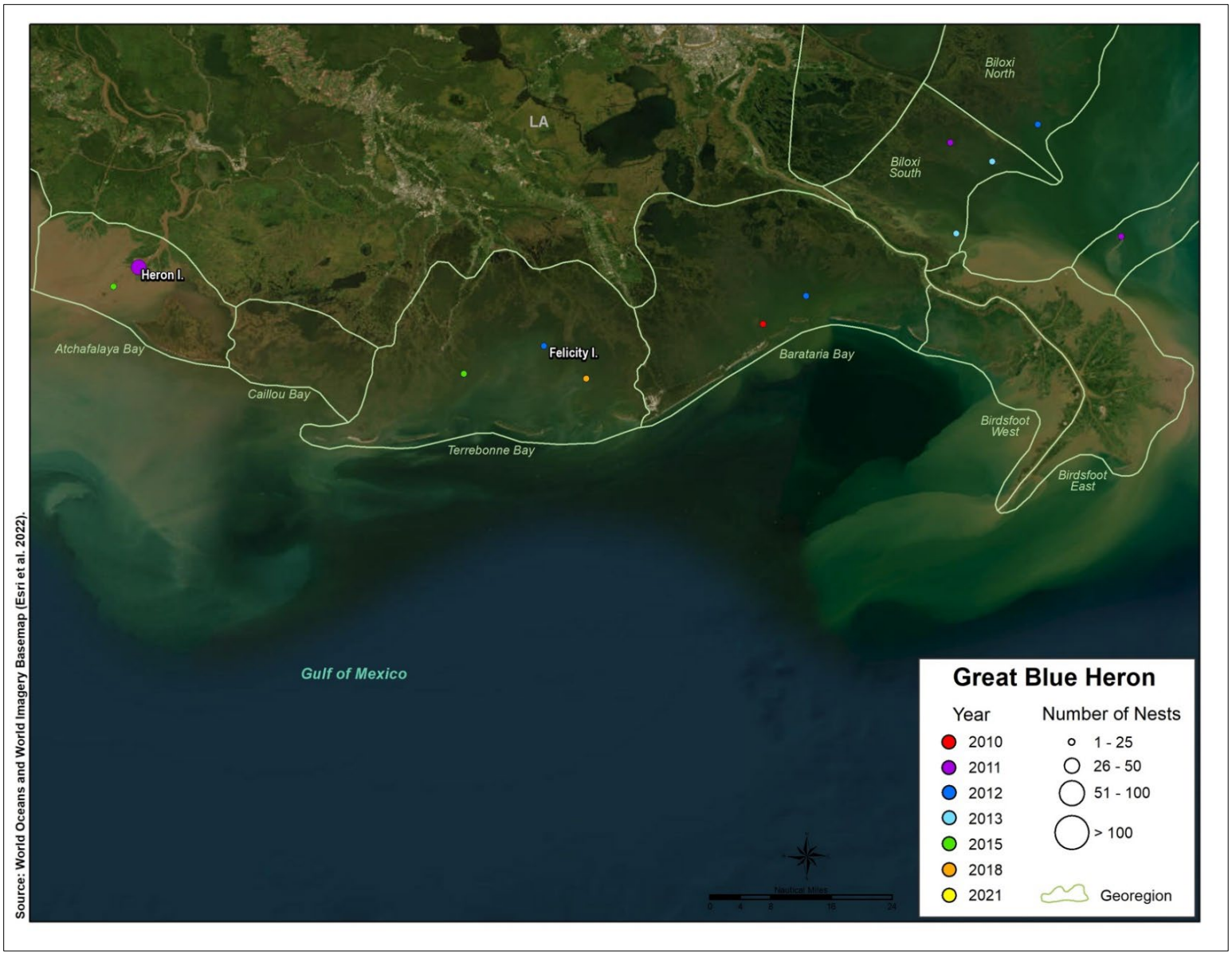
Table 2. Great Blue Heron nest counts for all colonies with at least one count of 50 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2021
Texas	Lower Laguna Madre	Arroyo Colorado Spoils B1	-	99
	Lower Laguna Madre	Bahia Grande C East	-	***62***
	Lower Laguna Madre	Green Hill Spoils B	-	91
	Lower Laguna Madre	Green Island	-	80
	Lower Laguna Madre	Laguna Vista Spoils A	-	62
	Upper Laguna Madre	Tern Island	-	57
	Corpus Christi-Aransas Bay	Pelican Island Spoil B	0	138
	Corpus Christi-Aransas Bay	Pine Oak Woods	99	-
	Corpus Christi-Aransas Bay	Second Chain of Islands G	0	73
	Corpus Christi-Aransas Bay	Shamrock Island	-	61
	Corpus Christi-Aransas Bay	Skimmer Island Nueces Bay	0	60
	Matagorda Bay	Chester Island	67	***148***
	Matagorda Bay	Lavaca Bay Spoils E	50	92
	East Matagorda Bay	Dressing Point	19	60
	Galveston	Cedar Lakes 4	63	-
	Galveston	North Deer Island	47	139
	Galveston	West Bay Bird Island	16	134

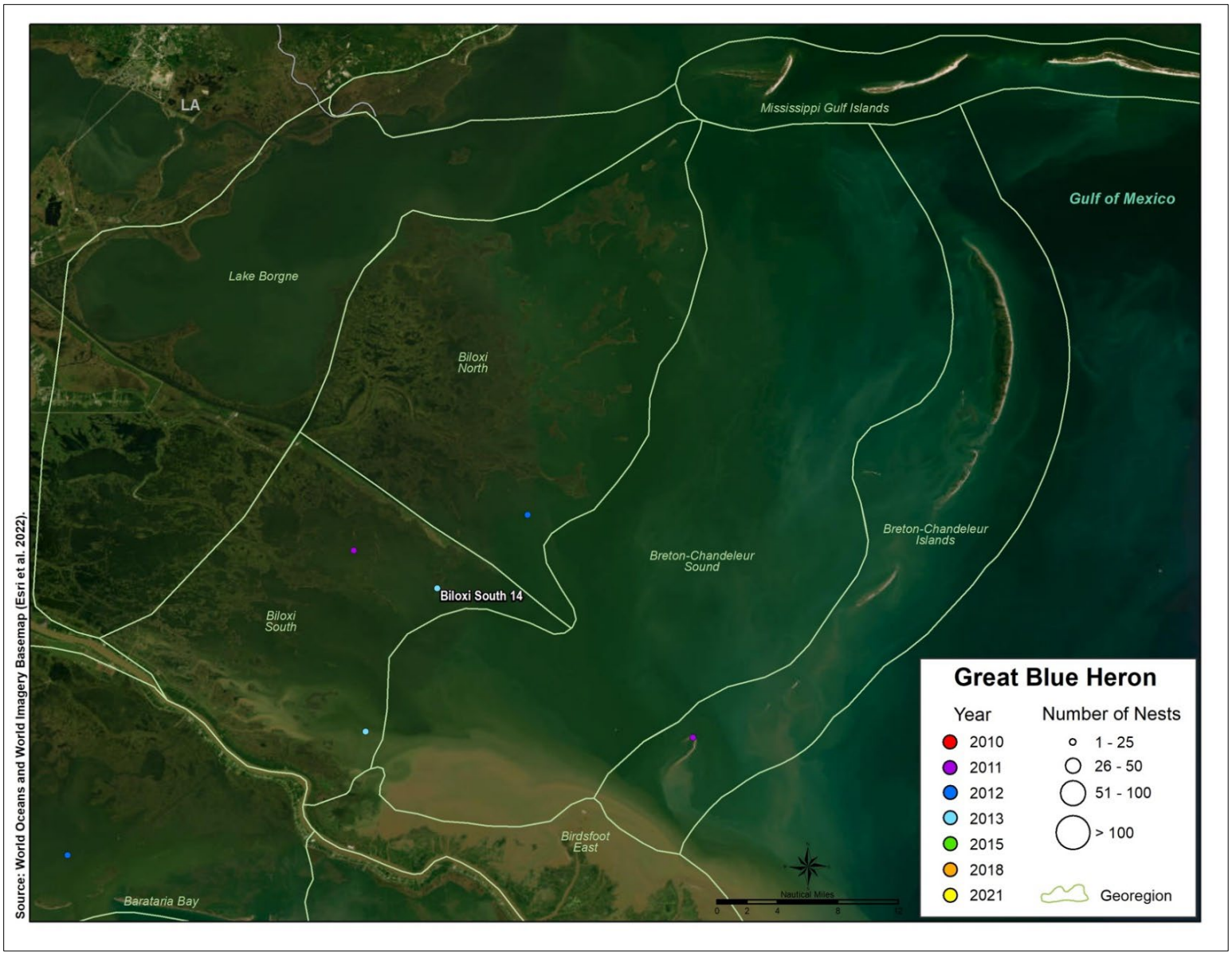
- = Outside intended survey area; ND = No Data; NA = Not applicable, as island not yet created; S = Submerged; **Bold italics** indicates a sum of counts from May and June surveys.



Map 1. Great Blue Heron colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Great Blue Heron colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Great Blue Heron colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.

Map 4. Great Blue Heron colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Great Egret

Great Egret nesting was documented at 127 colonies—60 in Louisiana, 53 in Texas, eight in Florida, and six in Alabama (Maps 1–4). Identifying Great Egret in aerial photography is typically straightforward based on its large size, large yellow bill, and distinct plumes. However, if medium-sized chicks are outside of nests, additional effort is needed to distinguish them from adults to ensure nest counts are accurate.

In 2021, a total of 9244 Great Egret nests were distributed among 79 colonies (Table 1). Of those nests, 67% were among 36 Texas colonies, 29% were among 32 Louisiana colonies, and < 5% were among 11 colonies in Alabama and Florida. The largest colonies were at West Bay Bird Island (857 nests), Chester Island (721 nests), and Dressing Point Island (560 nests) in Texas. Another 24 colonies had more than 100 nests—14 in Texas, nine in Louisiana, and one (Pepperfish Key) in Florida.

Table 1. Numbers of Great Egret nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	1864 (29)	-	-	-	-	-	6171 (36)
LA	3197 (16)	2290 (20)	2666 (18)	2007 (18)	2364 (25)	3606 (27)	2650 (32)
AL	95 (2)	128 (3)	102 (2)	102 (3)	115 (4)	-	120 (5)
FL	195 (3)	100 (1)	100 (2)	128 (3)	101 (2)	-	303 (6)
Total	**5351 (50)**	**2518 (24)**	**2868 (22)**	**2237 (24)**	**2580 (31)**	**3606 (27)**	**9244 (79)**

() = number of colonies; - = state not included in survey area that year.

In Texas, Great Egret was widely distributed, with colonies in all GeoRegions (Map 1). In 2021, the Galveston GeoRegion had the highest number of nests—1858 nests at 12 colonies. Compared with 2010, of the colonies with at least 250 nests in any year (Table 2), all but High Island had much higher nest totals in 2021. Combined totals for the 12 colonies that were active and surveyed in both years were 190% higher in 2021. However, more than half of those colonies were counted from May photographs in 2021, whereas only June surveys were conducted in 2010 in Texas. In 2010, large chicks and fledglings away from nests were noted as leading to underestimates of nest counts at Chester Island and West Bay Bird Island, for example. However, the magnitude of the percent difference may still indicate a higher breeding population in 2021.

Annual nest totals were mostly stable in Louisiana, with a peak in 2018 that was 36% higher than the total in 2021, when survey coverage was the same (Table 1). The largest colony regionwide was in Louisiana at Belle Pass East in 2010 (1214 nests; Table 2, Figure 3). The colony was surveyed on 8 May when chicks were already present in nests; 319 chicks were counted. In the peak year of 2018, Terrebonne Bay accounted for 37% of all nests in Louisiana (Figure 1). Within Terrebonne Bay, nest numbers at Philo Brice Islands increased from 2018 to 2021 as numbers at Felicity Island declined due to habitat loss. Belle Past East hosted the largest colony through 2015, followed by Cat Bay Island in 2010 and 2011. Cat Bay Island nesting ended after 2012, and the island was eventually submerged. Queen Bess Island and Philo Brice Islands supported the

largest colonies in 2018 and 2021, respectively. Land still existed at Biloxi South 11 through 2021, but a decline in nest counts was evidently associated with changes in vegetation due to land loss.

In Alabama, Cat Island hosted the largest colony, with 82 nests in 2010. Numbers declined thereafter as the island shrank and lost vegetation. By 2021, only terns and skimmers nested at Cat Island. In Florida, the largest colony (136 nests) was at Smith Island in 2010. Pepperfish Key, not surveyed in 2010, hosted the largest colony (119 nests) in 2021. No nesting was documented at Smith Island in 2021. However, white waders in satellite imagery from April 2021 (Google 2022) suggested an early nesting effort might have been abandoned.

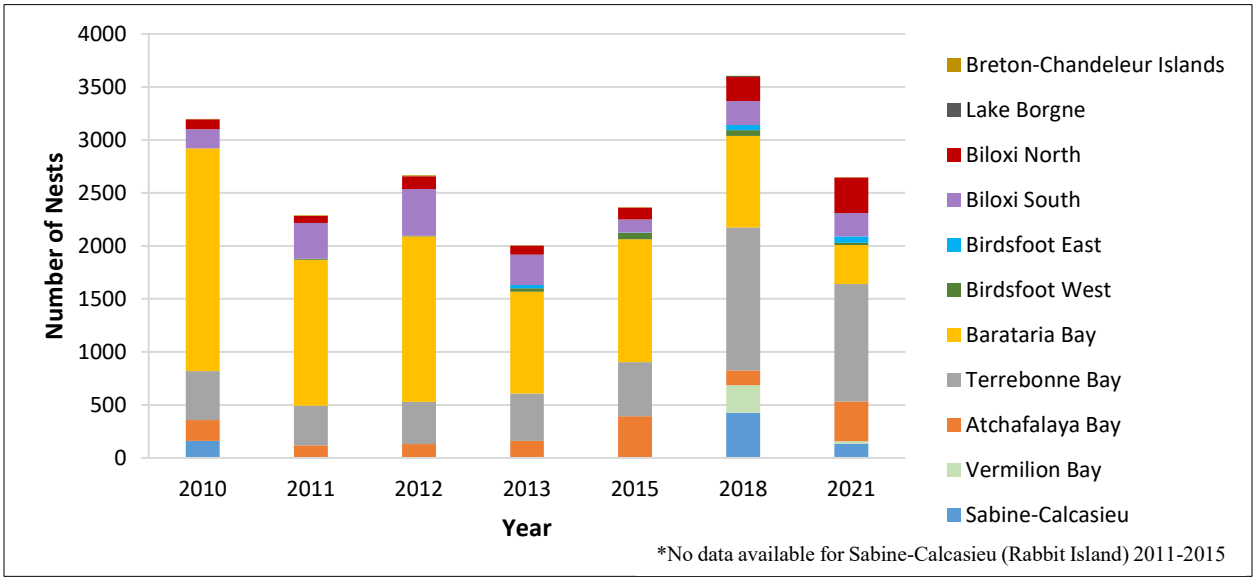


Figure 1. Numbers of Great Egret nests in Louisiana by GeoRegion, 2010–2021. (GeoRegions with < 100 nests are not included.)

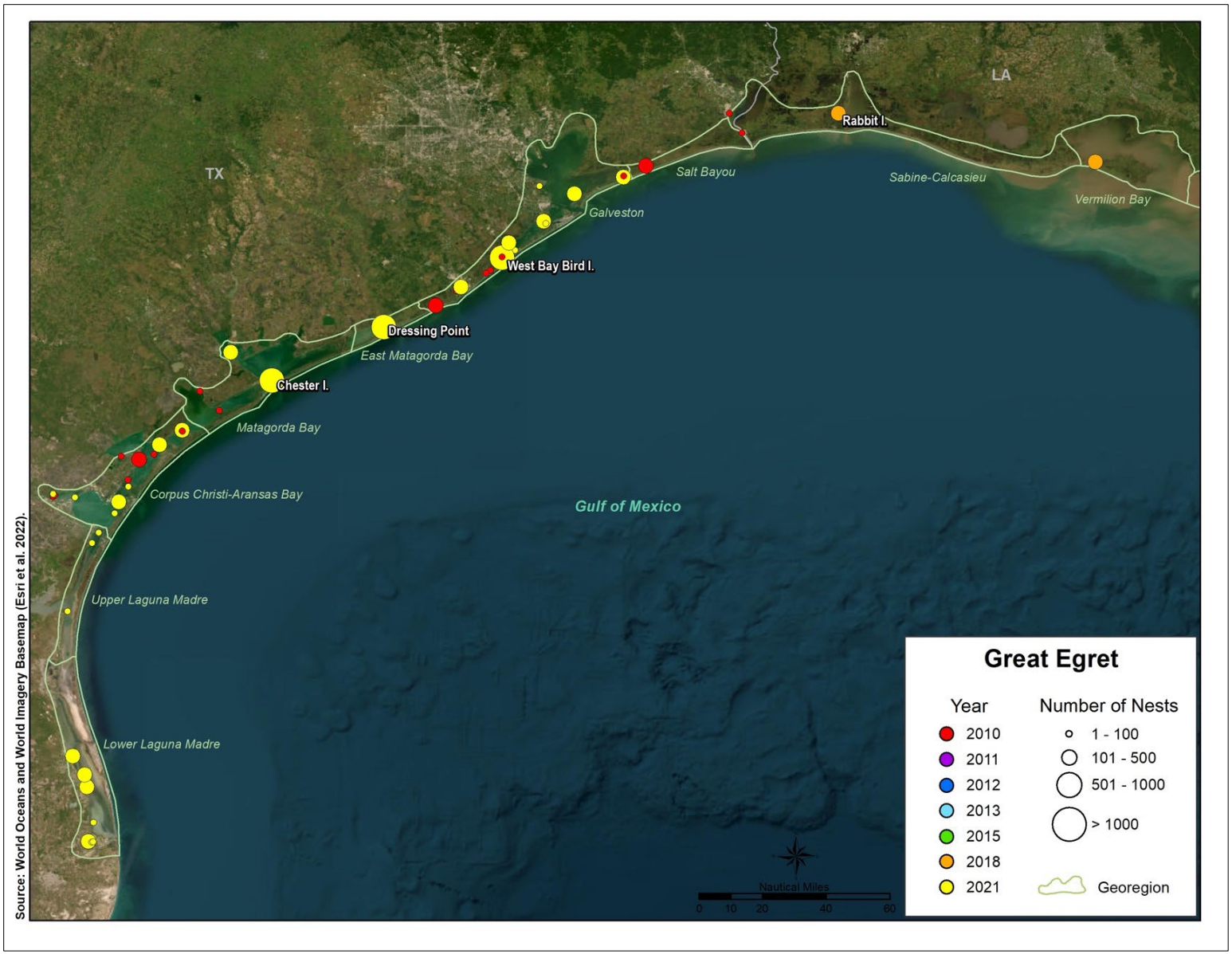
The timing of Great Egret breeding tended to be earlier than for other species, as nests with visible chicks were often present in May. For example, at Belle Pass East, Louisiana in May 2015 nearly 80% of the 832 nests had visible chicks. Similarly, at Queen Bess Island, Louisiana in the same month, 55% of nests had visible chicks. However, the timing or degree of synchronous nesting might also vary annually. In May 2021 at Queen Bess Island, only 24% of nests had visible chicks. Notably, at Rabbit Island in Louisiana, 18% of nests in May 2018 had visible chicks, whereas in June 2021 only two of 135 nests had visible chicks, perhaps reflecting delayed onset of nesting due to island restoration being completed that spring.

Among the percentage of nests with visible chicks were nests where no adult was in attendance. Aside from Brown Pelican, this nest category was most often used for Great Egret. For example, at Chester Island, Texas in June 2021, just over 40% of the 690 nests had chicks without an attending adult. At Belle Pass East in May 2015, over 50% of the 832 nests were chick nests without an attending adult. Notably, adult Great Egrets often left small chicks, perhaps not even a week old, unattended.

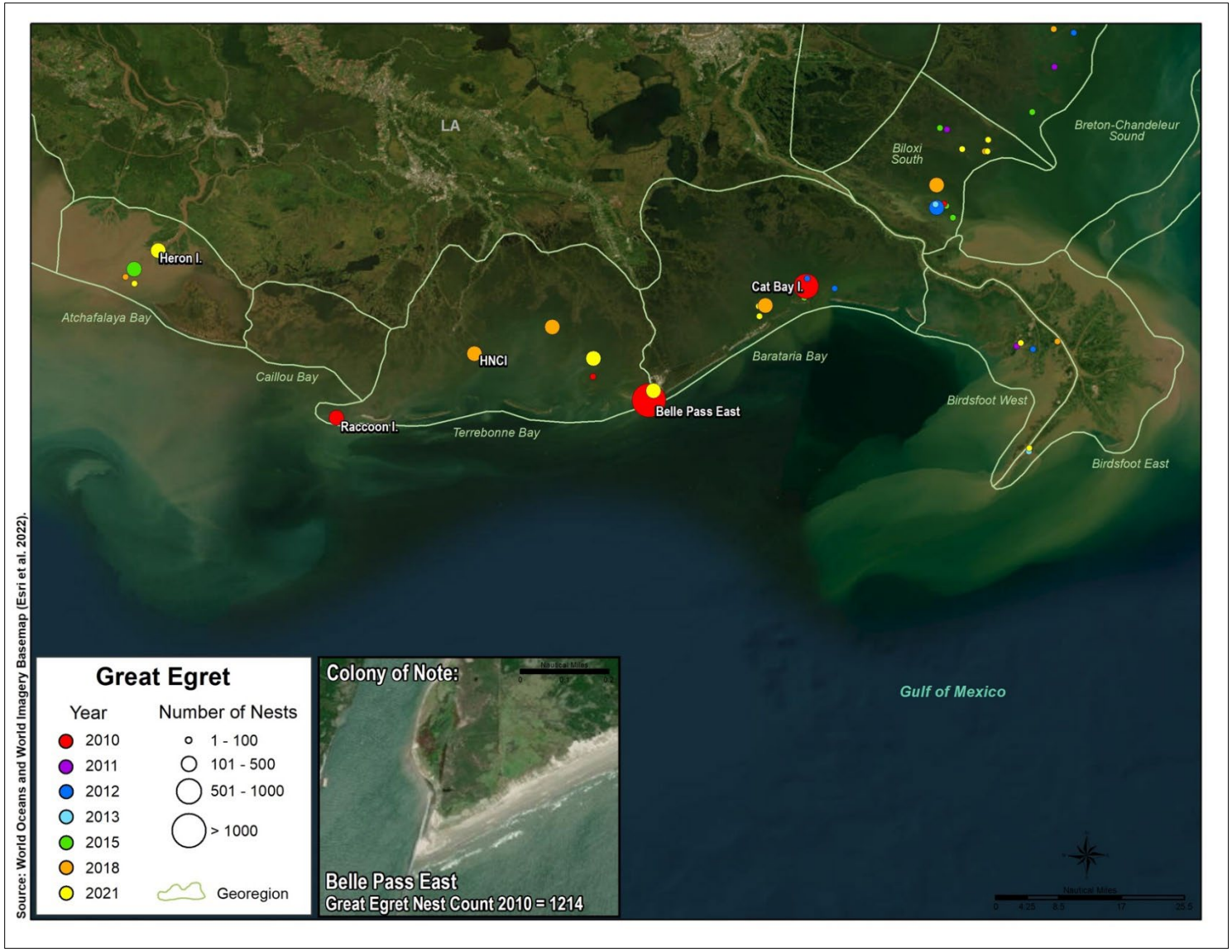
Table 2. Great Egret nest counts for all colonies with at least one count of 250 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Lower Laguna Madre	Green Island	-	-	-	-	-	-	470
	Corpus Christi-Aransas Bay	Second Chain of Islands G	107	-	-	-	-	-	454
	Matagorda Bay	Chester Island	233	-	-	-	-	-	***721***
	Matagorda Bay	Lavaca Bay Spoils E	0[1]	-	-	-	-	-	284
	East Matagorda Bay	Dressing Point	89	-	-	-	-	-	560
	Galveston	North Deer Island	168	-	-	-	-	-	353
	Galveston	West Bay Bird Island	125	-	-	-	-	-	857
	Salt Bayou	High Island	367	-	-	-	-	-	352
Louisiana	Sabine-Calcasieu	Rabbit Island	71	-	-	-	-	426	135
	Vermilion Bay	Southwest Pass Islands 1	ND	ND	ND	ND	ND	259	23
	Atchafalaya Bay	Heron Island	195	115	131	139	97	53	289
	Atchafalaya Bay	Skimmer Island	0	3	1	22	296	78	0
	Terrebonne Bay	Felicity Island	15	83	21	34	77	275	55
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	99	202	465	183
	Terrebonne Bay	Philo Brice Islands	0	0	0	0	0	183	440
	Terrebonne Bay	Raccoon Island	430	287	372	311	233	428	***316***
	Barataria Bay	Belle Pass East	1214	629	854	690	832	372	111
	Barataria Bay	Cat Bay Island	790	528	252	0	0	S	S
	Barataria Bay	Queen Bess Island	47	183	268	195	273	490	188
	Biloxi South	Biloxi South 11	79	301	428	270	22	0	0

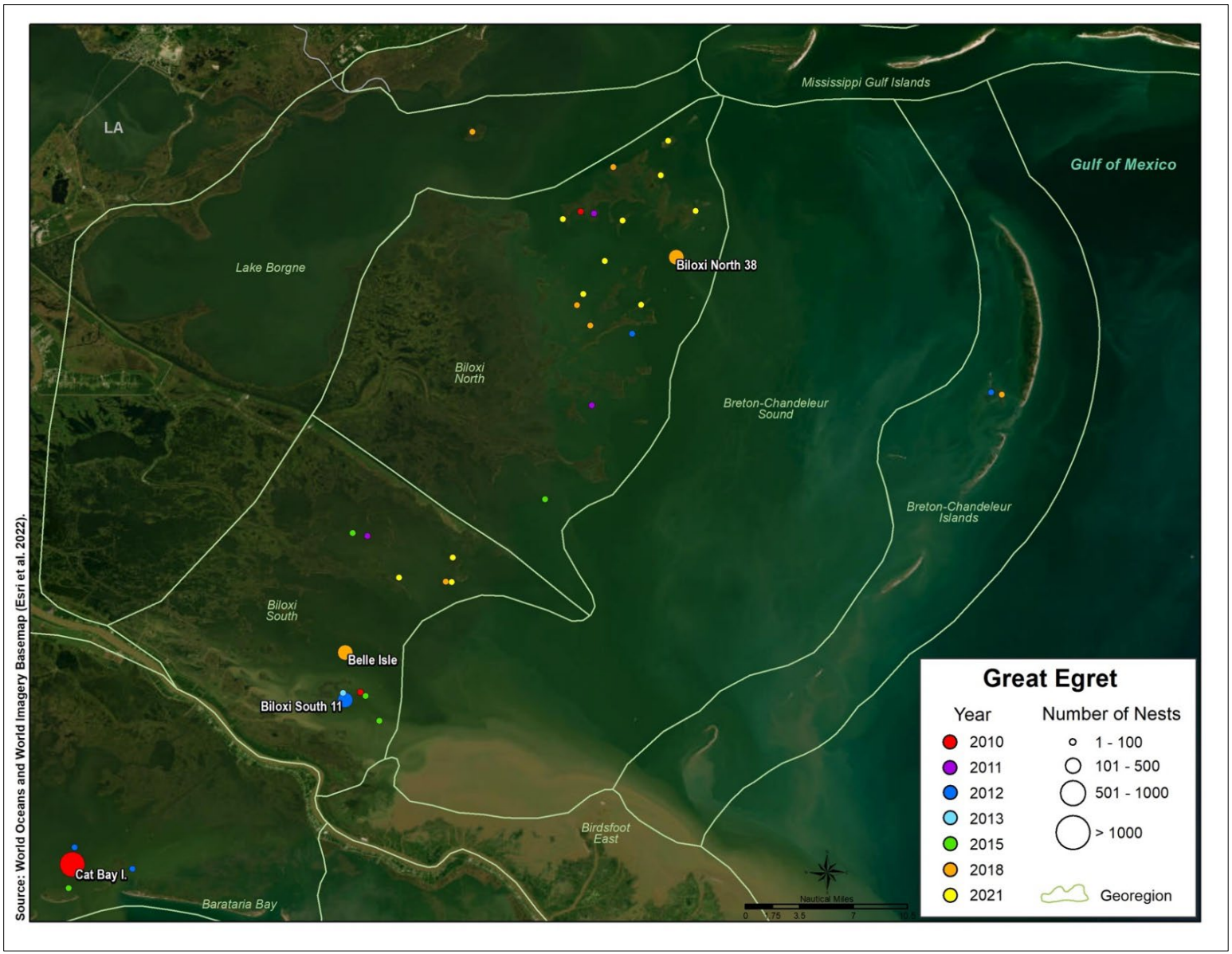
- = Outside intended survey area. ND = No Data. S = Submerged. **Bold italics** indicate a sum of counts from May and June surveys.
[1]Note that 360 unidentified egret nests (WHEG) were counted.



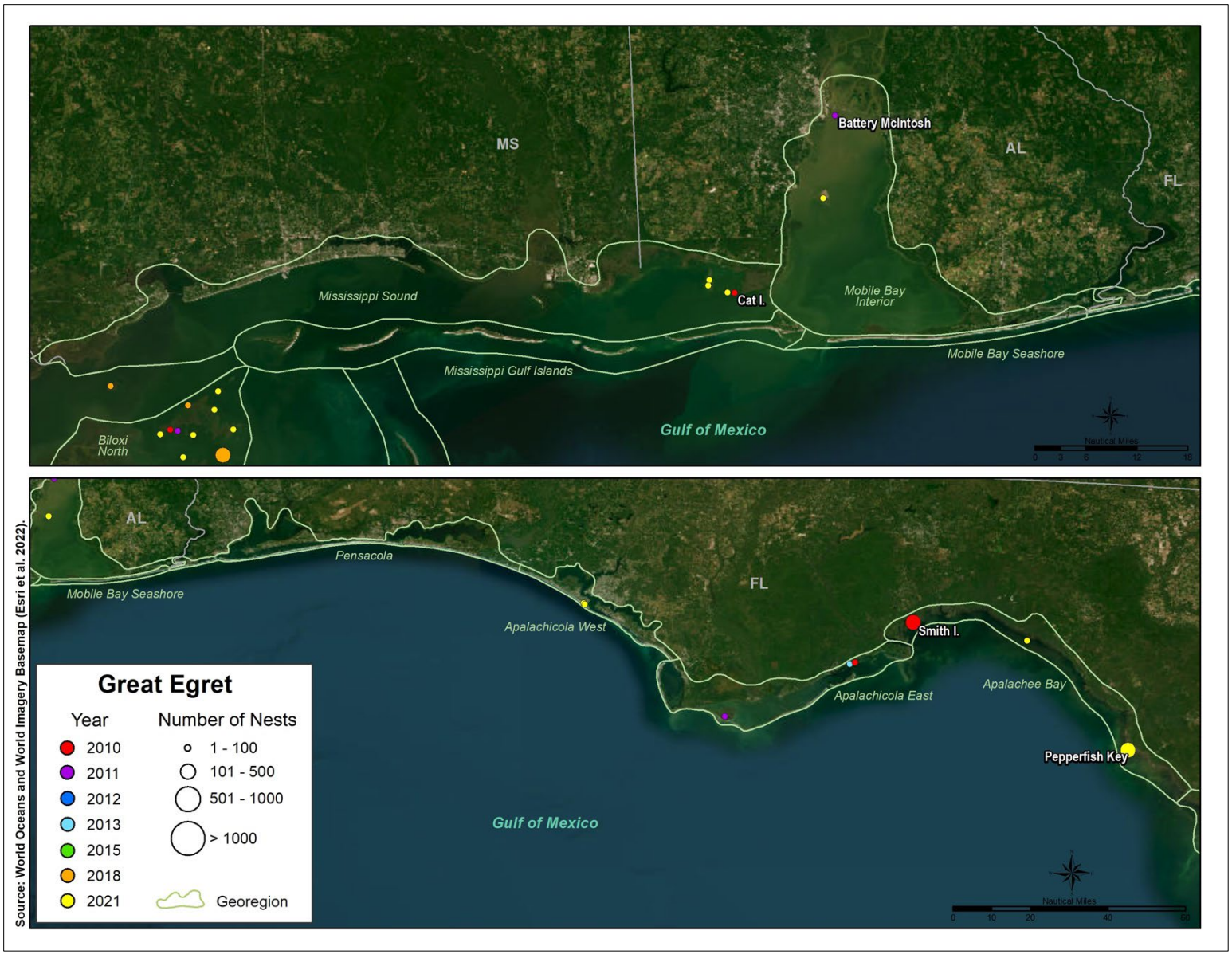
Map 1. Great Egret colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Great Egret colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 3. Great Egret colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Great Egret colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Snowy Egret

Snowy Egret nested at 123 colonies—64 in Louisiana, 49 in Texas, seven in Florida, and three in Alabama (Maps 1–4). In aerial photographs, Snowy Egrets are usually readily distinguishable from Great Egrets and white morph Reddish Egrets by their smaller size. The black bill is often visible in photographs as well. In Louisiana, Snowy Egrets often nested in herbaceous vegetation while Great Egrets typically nested in woody vegetation. In Biloxi Marsh, such as at Hell Pass Coast, Snowy Egrets usually co-occurred with Tricolored Herons in the same habitat and with similarly widely spaced nests. White Ibis is larger and nests in denser colonies.

In Texas, Snowy Egrets often nested in cacti, even where tall grass or low-lying shrubs were present. Cacti, if present, were used as nest substrates by all wader species, and Snowy Egrets nested in all levels of the cacti. The tops of the cacti, however, were typically occupied by larger species such as Great Blue Heron and Great Egret, while smaller egrets and herons occupied the mid and lower portions of the cacti. Nest and chick concealment was evident, as the vertical aerial photographs did not provide oblique views of the cacti. When views of the birds were obstructed by cacti, distinguishing Snowy Egrets from white morph Reddish Egrets was more difficult and based on relative body size.

In 2021, a total of 7014 Snowy Egret nests were counted among 69 colonies (Table 1). Of those nests, 65% were among 35 Texas colonies and 33% were among 27 Louisiana colonies. In Alabama and Florida, just 95 nests were among seven colonies. In Louisiana, colony totals were derived mostly from June surveys. In Texas, May surveys were preferred for analysis, because in June obstructed views of Snowy Egret chicks and the presence of white chicks of other species made species identification problematic. The largest colonies were at West Bay Bird Island in Texas (1531 nests), Rabbit Island (781 nests) in Louisiana, and Nolan Ryan Marsh in Texas (691 nests; Table 2). Another 30 colonies had more than 50 nests—18 in Texas and 12 in Louisiana.

Table 1. Numbers of Snowy Egret nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	1196 (21)	-	-	-	-	-	4579 (35)
LA	2392 (18)	2914 (34)	2291 (25)	2844 (34)	1756 (30)	3975 (24)	2340 (27)
AL	48 (1)	157 (3)	46 (3)	139 (3)	53 (3)	-	1 (1)
FL	4 (2)	0	0	171 (2)	49 (2)	-	94 (6)
Total	**3640 (42)**	**3071 (37)**	**2337 (28)**	**3154 (39)**	**1858 (35)**	**3975 (24)**	**7014 (69)**

() = number of colonies; - = state not included in survey area that year.

In Texas, the combined nest total for the six colonies that were active and surveyed in both 2010 and 2021 was more than 380% higher in 2021, driven by the 705% increase at West Bay Bird Island. The 2021 total at that colony was by far the largest colony size documented in any state in any survey year (Table 2, Map 1). In 2021, the colony was counted from 17 May photographs. In 2010, however, the single survey was conducted 25 June, when much nesting had already been completed. Although 2010 counts may be underestimates, the magnitude of percent change of

2021 counts may in fact indicate higher breeding population sizes in Texas. At West Bay Mooring Facility, the 2010 survey trackline was within 500 meters of potential breeding habitat, suggesting no active colony was present (Table 2).

In Louisiana, the highest nest total was in 2018 (3975 nests) and was nearly 40% higher than the 2021 total, when survey coverage was the same (Table 1, Figure 1). At Rabbit Island, after a 2018 peak, the nest total in 2021 was lower but nearly identical to the 2010 total (Table 2). Notably, no nests with visible chicks were evident in June 2021 photographs, following completion of restoration at Rabbit Island that spring. In 2010, a total of 169 chicks were counted from May photographs. Other patterns were like those observed for Tricolored Heron, including an increase at Philo Brice Islands in Terrebonne Bay in 2021 as Felicity Island shrank. Lack of recent nesting at Biloxi South 3 and 11 seemed related to changes in vegetation rather than land loss. At Biloxi South 11 in 2010, oblique photography on 8 May prevented confident identification of most egrets; aside from 79 Great Egret nests, most nests (218) were assigned a WHEG (white egret) code (Table 2).

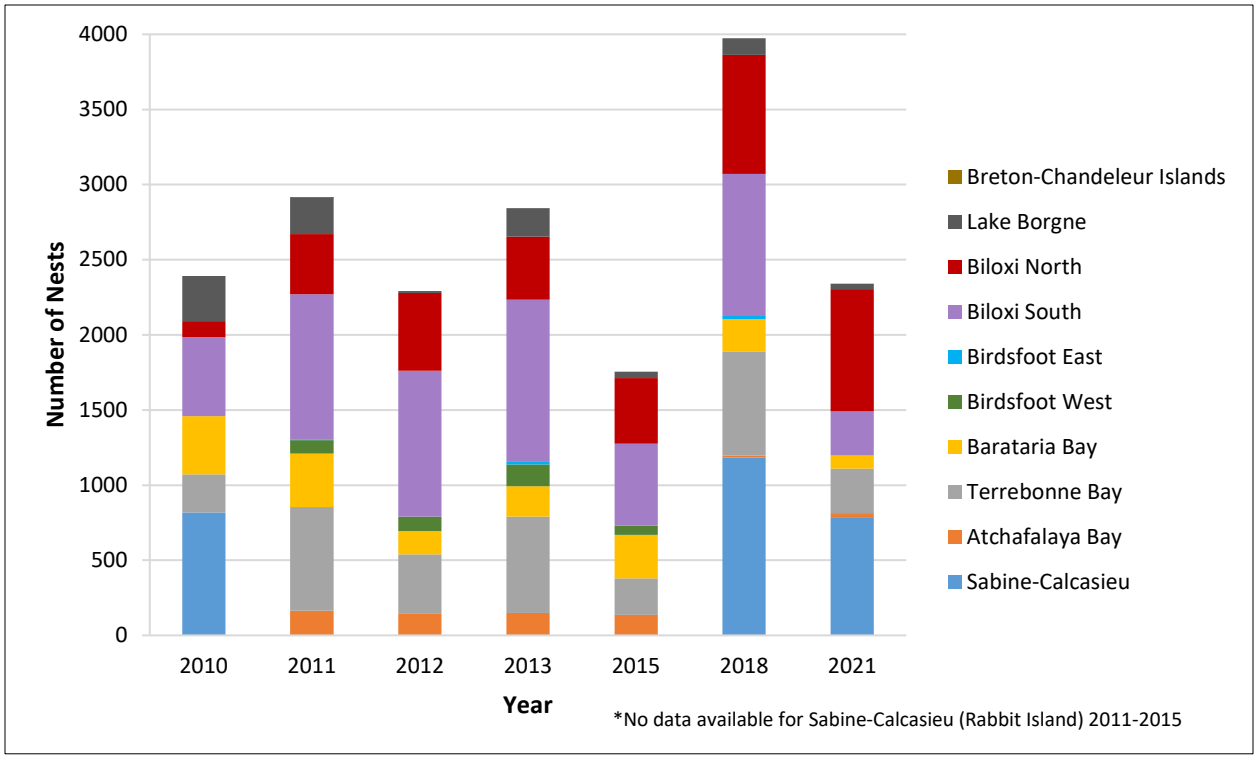


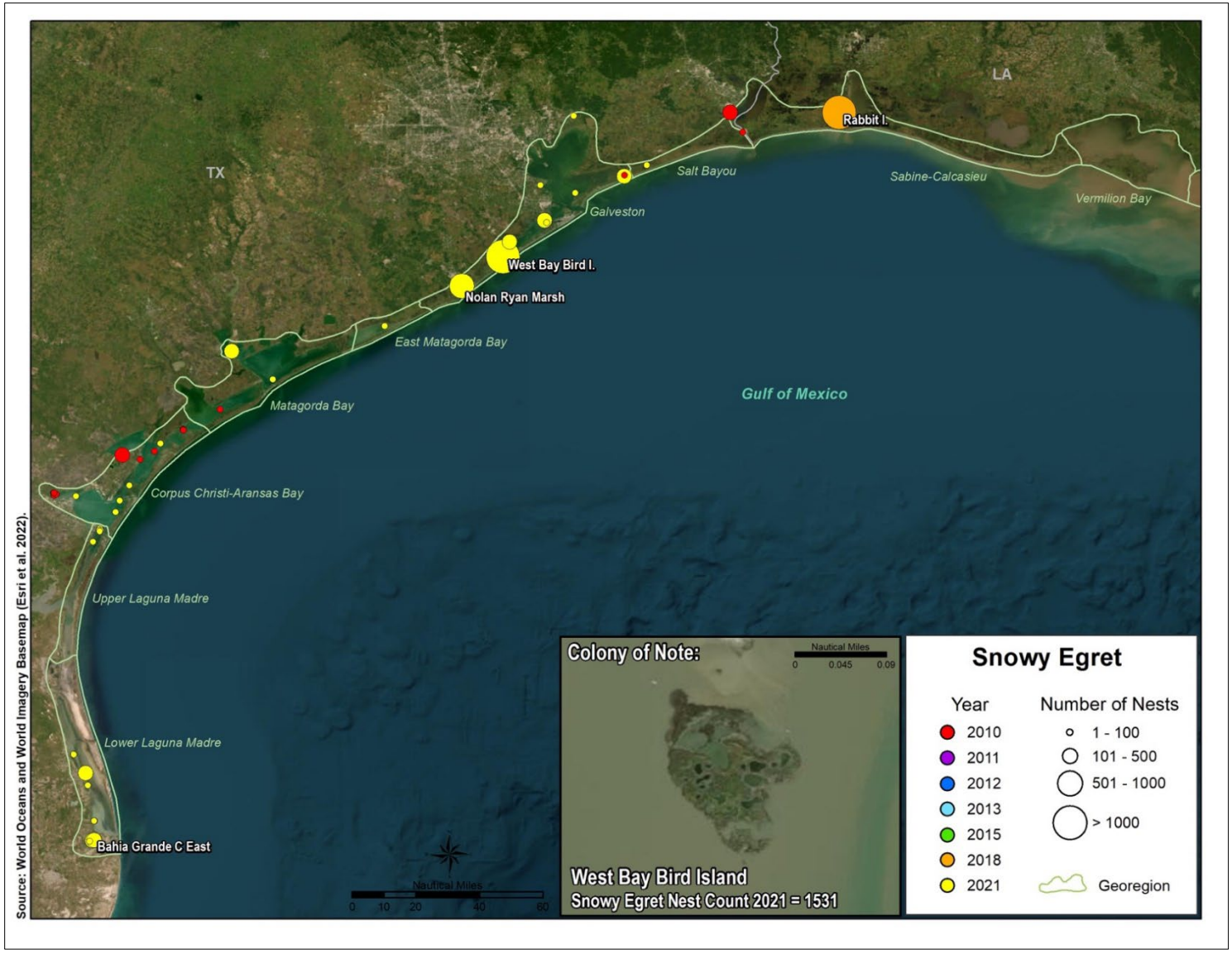
Figure 1. Numbers of Snowy Egret nests in Louisiana by GeoRegion from, 2010–2021.

In Alabama, the highest total was 157 nests in 2011, and Cat Island was the largest individual colony, with 77 nests that year. After 2011, parts of Cat Island became submerged, and vegetative cover decreased over time. By 2021, only terns and skimmers nested at Cat Island. In Florida, the highest total was 171 nests in 2013, with Lake Number Five at Saint Vincent National Wildlife Refuge as the largest individual colony, with 146 nests that year.

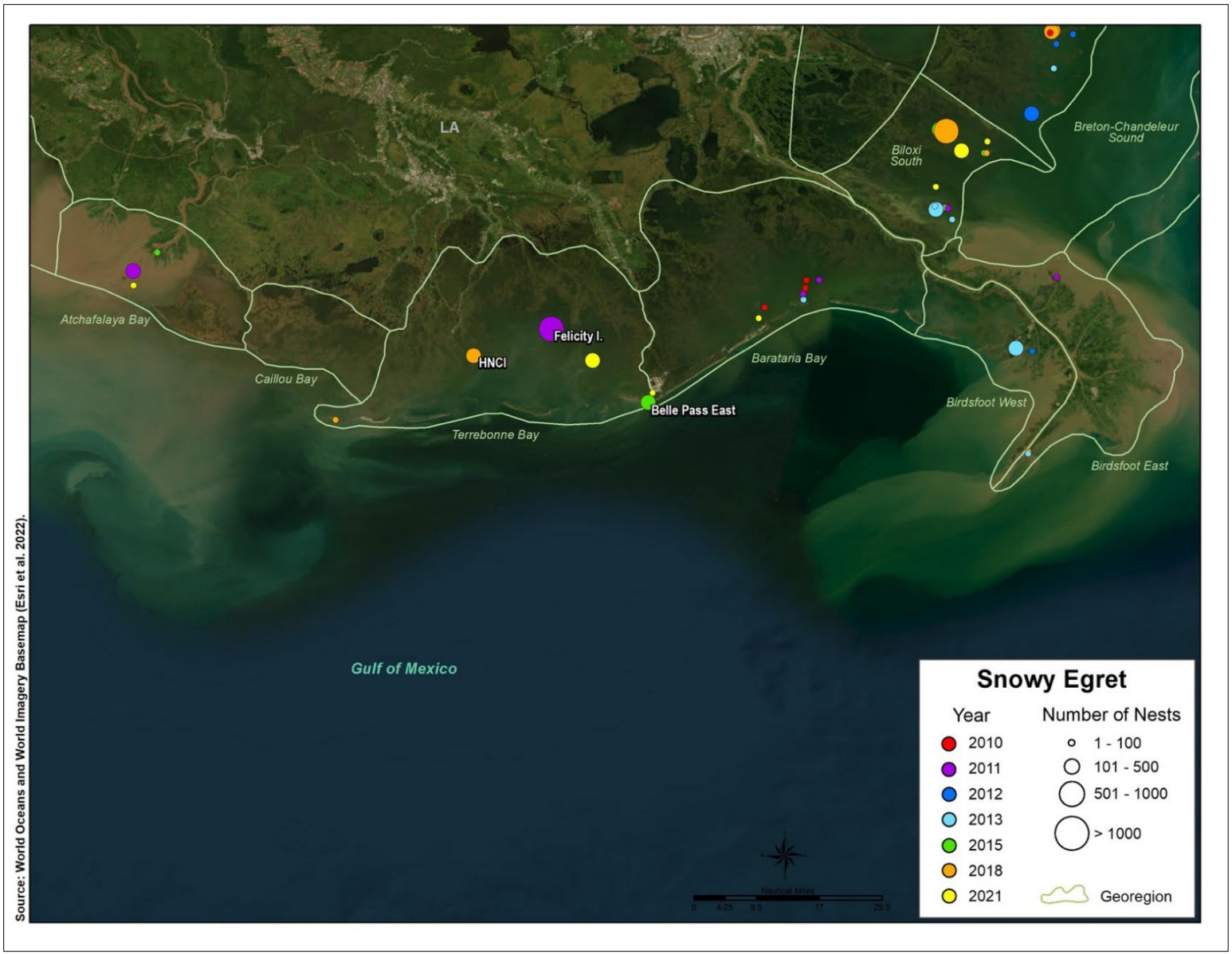
Table 2. Snowy Egret nest counts for all colonies with at least one count of 150 nests or more, 2010–2021.

State	GeoRegion	ColonyName	2010	2011	2012	2013	2015	2018	2021
Texas	Lower Laguna Madre	Bahia Grande C East	-	-	-	-	-	-	***229***
	Matagorda Bay	Lavaca Bay Spoils E	0[1]	-	-	-	-	-	152
	Galveston	Nolan Ryan Marsh	ND	-	-	-	-	-	691
	Galveston	North Deer Island	64	-	-	-	-	-	228
	Galveston	West Bay Bird Island	190	-	-	-	-	-	1531
	Galveston	West Bay Mooring Facility	0/ND	-	-	-	-	-	396
	Sabine-Calcasieu	Texas Coast 1	368	-	-	-	-	-	ND
Louisiana	Sabine-Calcasieu	Rabbit Island	776	-	-	-	-	1184	781
	Atchafalaya Bay	Skimmer Island	0[2]	163	147	126	85	0	0
	Terrebonne Bay	Felicity Island	244	671	378	304	149	258	22
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	319	89	368	62
	Terrebonne Bay	Philo Brice Islands	0	0	0	0	0	39	204
	Barataria Bay	Belle Pass East	270	275	101	183	282	198	0
	Biloxi South	Biloxi South 2	0	0	0	0	304	1	0
	Biloxi South	Biloxi South 3	518	786	753	608	163	900	0
	Biloxi South	Biloxi South 11	0[3]	148	152	293	0	0	0
	Biloxi North	Hell Pass Coast A-E	6	133	90	152	257	577	445
	Lake Borgne	Half Moon Island	301	242	12	***190***	44	112	36

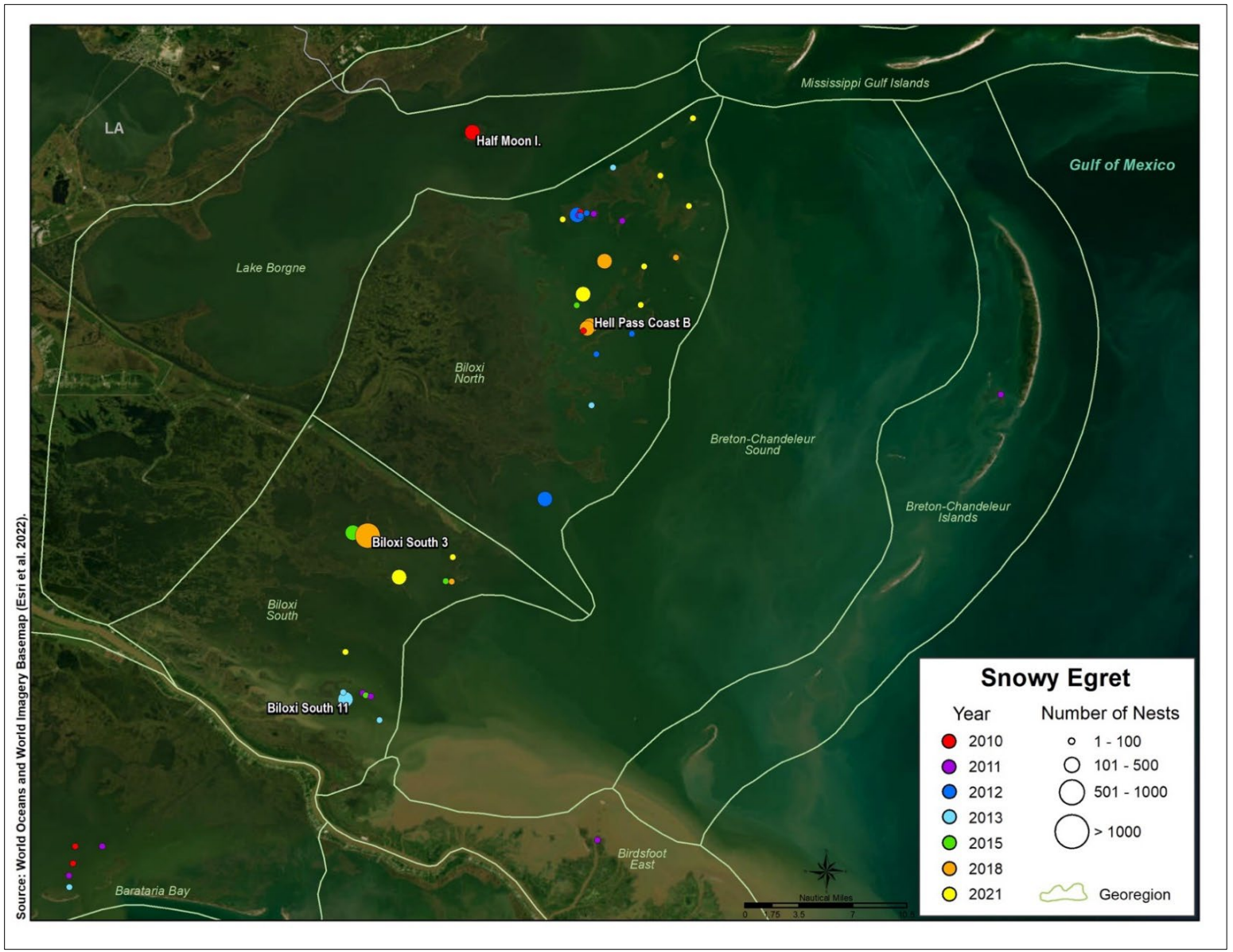
- = Outside intended survey area. Bold italics indicate a sum of counts from May and June surveys.
[1]Note that 360 unidentified egret nests (WHEG) were counted; [2]Note that 3 WHEG were counted; [3]Note that 218 WHEG were counted.



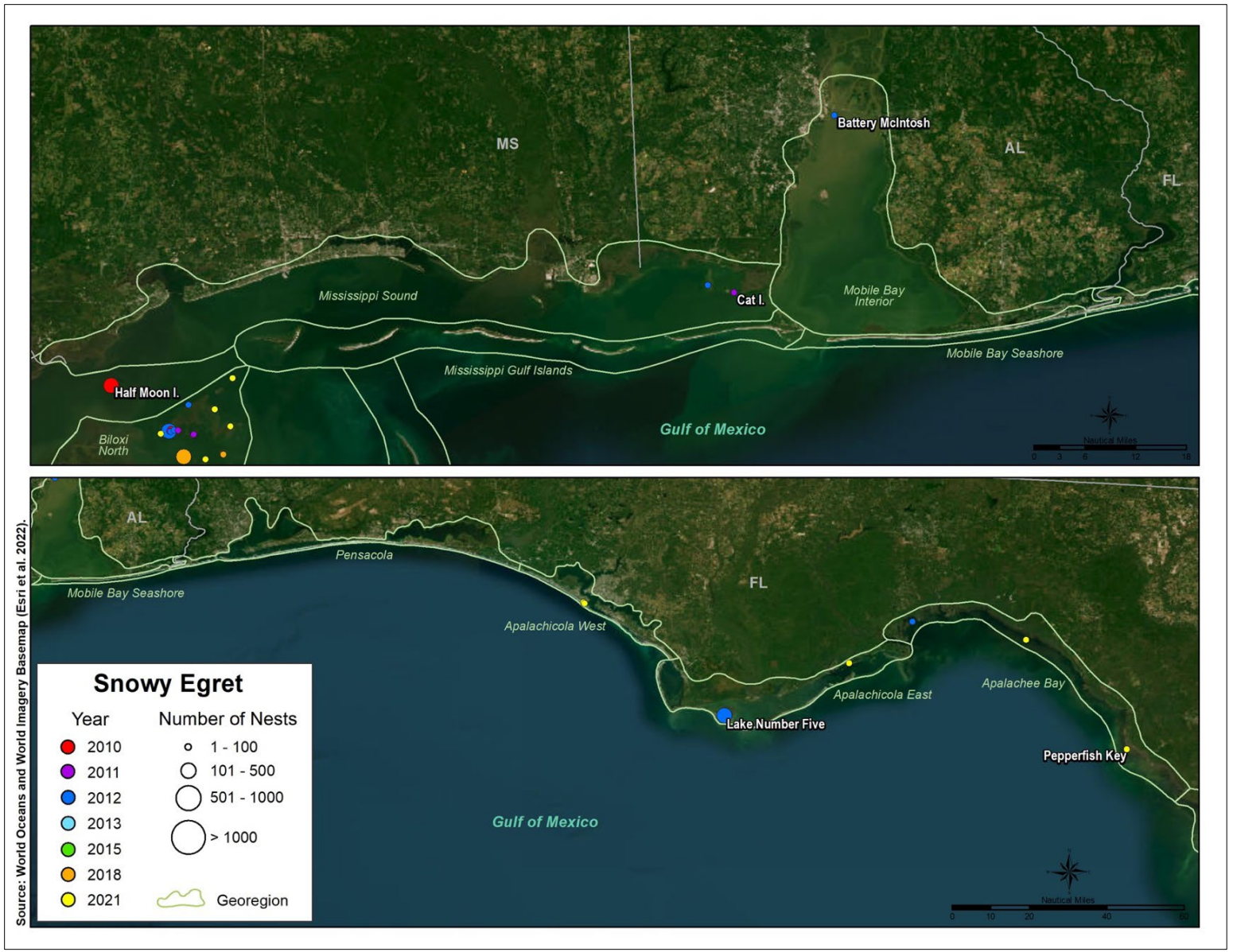
Map 1. Snowy Egret colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Snowy Egret colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Snowy Egret colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Snowy Egret colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Little Blue Heron

Little Blue Heron nesting was documented at 44 colonies—19 in Louisiana, 18 in Texas, five in Florida, and two in Alabama. Little Blue Heron is identified in aerial photographs by its purple-maroon head and neck, dark slate-blue body, and pale blue bill. Juveniles are entirely white, while molting immatures have patchy white and blue plumage; neither age group was detected in aerial photographs. Little Blue Heron is about the size of Snowy Egret.

Little Blue Heron builds platform nests in low shrubs and small trees in a variety of freshwater and marine habitats. It commonly nests on natural and dredge-spoil islands but mainly nests inland, usually selecting freshwater areas like ponds, lakes, swamps, marshes, and impoundments. Because of concealed nest placement in protected areas below the canopy, nest counts are easily underestimated when surveying from the air.

In 2021, a total of 160 nests were counted among 15 colonies (Table 1). Of those nests, 74% were among 11 Texas colonies, and the remaining 26% were among four Florida colonies. The Florida colonies were all counted from May photographs, whereas six of the 11 Texas colonies were counted from June photographs. The largest colonies were at Shamrock Island in Texas (41 nests), Saint Andrews State Park Buttonwood Marsh in Florida (18 nests), and Mayes Lake North in Texas (17 nests). Another four colonies had more than 10 nests—two in Texas and two in Florida.

Table 1. Numbers of Little Blue Heron nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	107 (8)	-	-	-	-	-	118 (11)
LA	14 (3)	167 (10)	18 (6)	69 (7)	107 (3)	0	0
AL	0	4 (2)	14 (2)	10 (2)	34 (2)	-	0
FL	1 (1)	0	0	22 (1)	1 (1)	-	42 (4)
Total	**122 (12)**	**171 (12)**	**32 (8)**	**101 (10)**	**142 (6)**	**0 (0)**	**160 (15)**

() = number of colonies; - = state not included in survey area that year.

In Texas, Little Blue Heron nest totals were similar in 2010 and 2021 (Table 1, Map 1), whereas many other species showed a dramatic increase in 2021 due to greater survey coverage and effort in the state. Comparisons in Texas are still problematic for Little Blue Heron, however, as most colonies where nesting was documented were not surveyed both years. The largest colony was at Kamey Island in 2010 (45 nests), but it was not surveyed in 2021. The largest colony in 2021 was at Shamrock Island (41 nests), but it was not surveyed in 2010.

In Louisiana, Birdsfoot West 3 was the largest colony in 2011, 2013, and in 2015, when it reached 104 nests, the largest colony size documented among all states and years (Figure 1, Table 2, Map 2). Vegetation on the island was dominated by Common Reed (*Phragmites australis*). But in 2018 and 2021, no nests of any CWB species were documented at Birdsfoot West 3. Belle Pass East, in the Barataria Bay GeoRegion, was the most prominent other colony, with nest counts

ranging from seven to 22 from 2010 to 2013. Little Blue Heron chicks were rarely detected; Biloxi South 3 had the highest count at nine chicks in 2011. The lack of nesting activity at Biloxi South 3 in 2021 for Little Blue Heron and all other CWB species was not obviously associated with land loss, but may reflect habitat changes, as was the case with Felicity Island. In 2018 and 2021, no Little Blue Heron nests were documented in Louisiana.

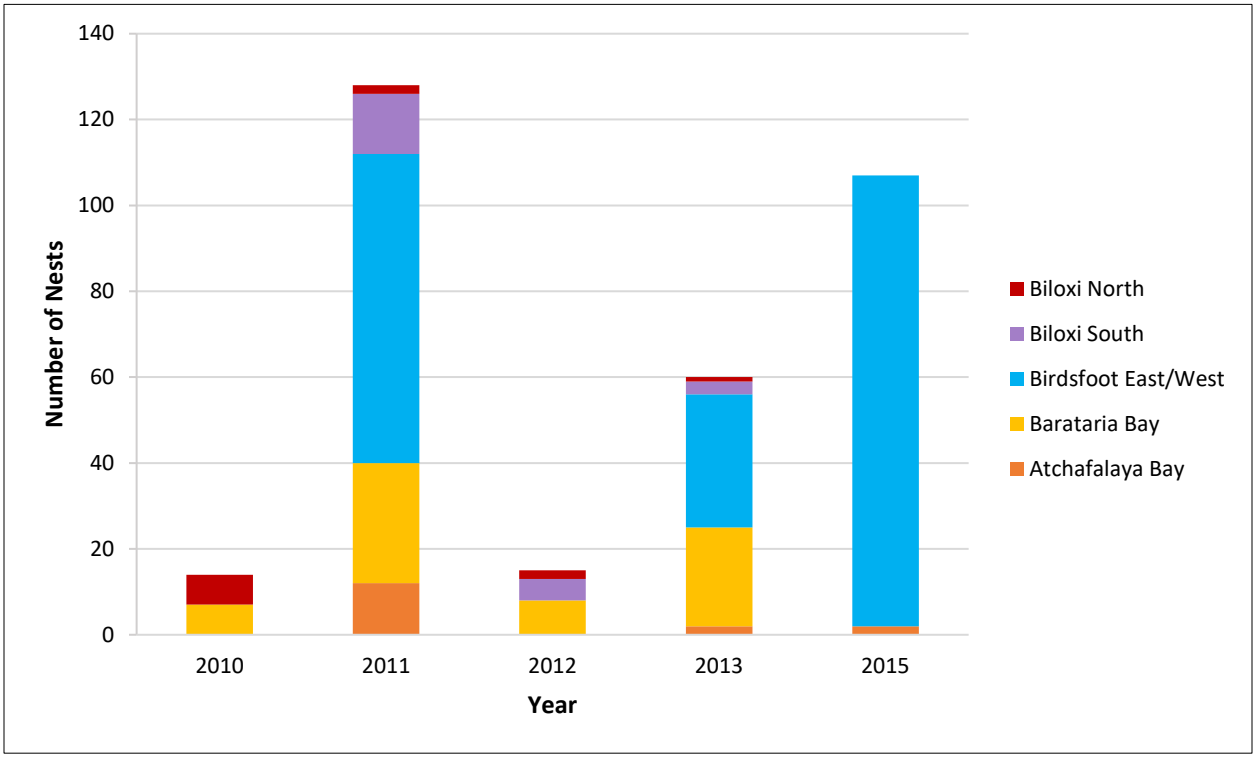


Figure 1. Numbers of Little Blue Heron nests in Louisiana by GeoRegion, 2010–2021.

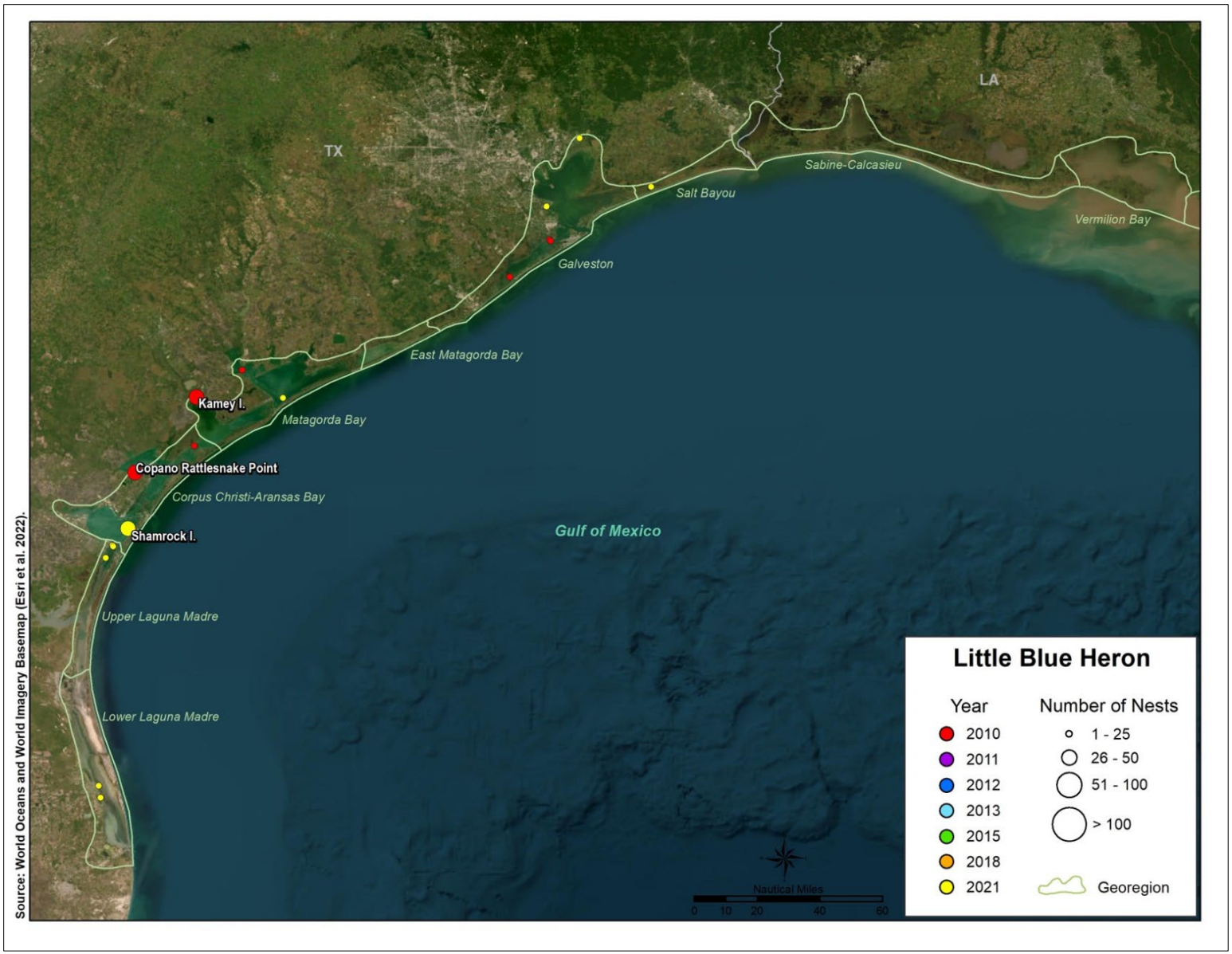
Alabama's largest colony was at Gaillard Island with 21 nests in 2015 (Map 4). Nest count increased with the growth of shrubs and herbaceous vegetation after 2013. Terrapin Island increased from three nests in 2011 to 13 nests in 2015 but dropped to zero by 2021. Tricolored Heron experienced a similar rise then fall at Terrapin Island.

Habitat in Florida was densely vegetated, and Little Blue Herons nested in close association with other egret and heron species. Lake Number Five at Saint Vincent National Wildlife Refuge was the largest colony in Florida with 22 nests in 2013 (Table 2, Map 4), as seen with Snowy Egret and Tricolored Heron as well. Florida's higher nest total in 2021 can be attributed to colonies at Saint Andrews State Park's Buttonwood Marsh and Gator Lake, which were not surveyed in other years. Buttonwood Marsh was the second largest colony in 2021 among all states. In addition to Little Blue Herons, Buttonwood Marsh and Gator Lake both hosted nesting Snowy Egrets, Cattle Egrets, Great Egrets, Tricolored Herons, and Anhingas, plus Great Blue Herons at Gator Lake. Due to the dense vegetation, it was difficult to determine the identification of species on either island. In particular, juvenile Tricolored Herons could be misidentified as adult Little Blue Herons.

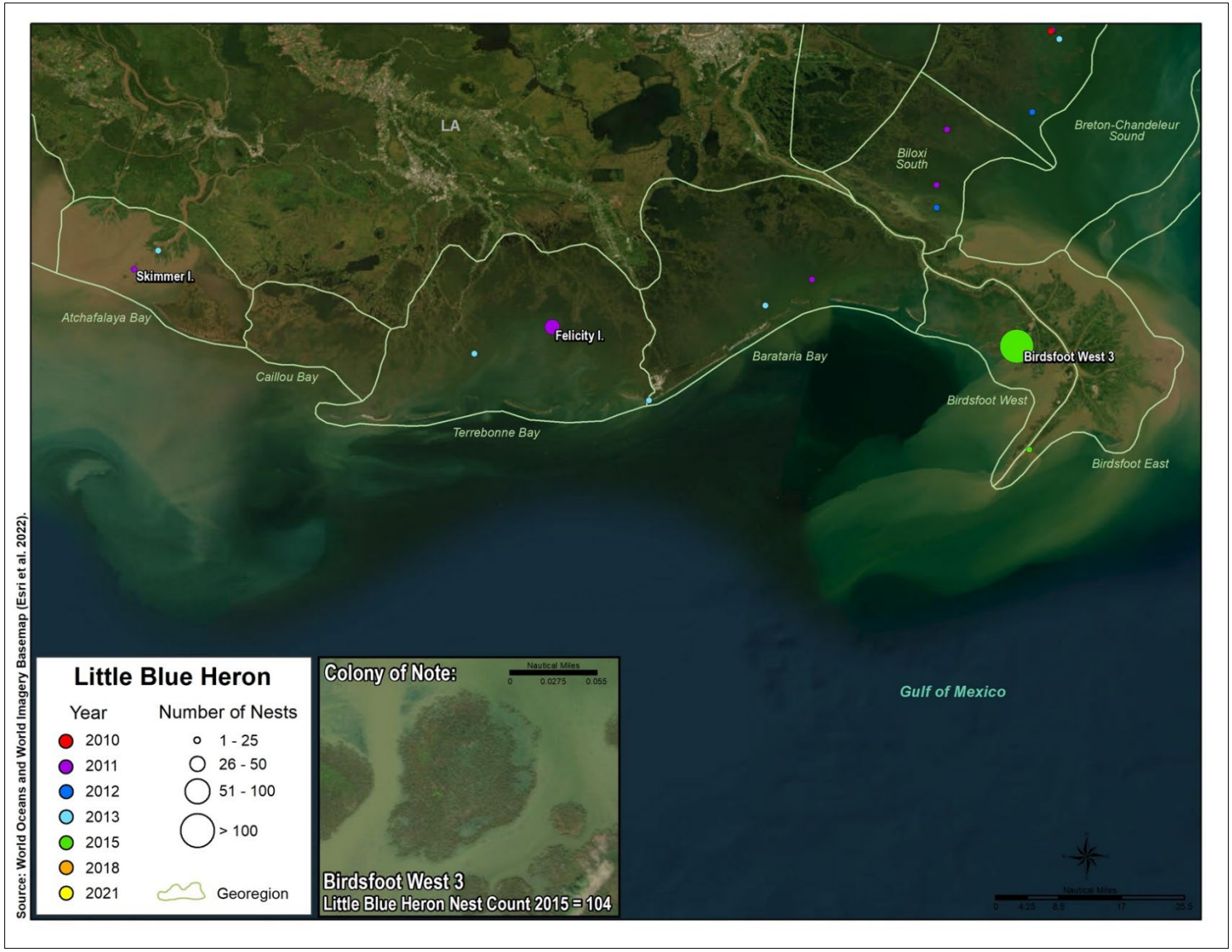
Table 2. Little Blue Heron nest counts for all colonies with at least one count of 10 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Upper Laguna Madre	Pita Island	-	-	-	-	-	-	15
	Corpus Christi-Aransas Bay	Copano Rattlesnake Point	30	-	-	-	-	-	-
	Corpus Christi-Aransas Bay	Shamrock Island	-	-	-	-	-	-	41
	Matagorda Bay	Kamey Island	45	-	-	-	-	-	-
	Matagorda Bay	Lavaca Bay Spoils E	12	-	-	-	-	-	0
	Galveston	Dickinson Bay Spoil Island	-	-	-	-	-	-	13
	Galveston	Mayes Lake North		-	-	-	-	-	17
Louisiana	Atchafalaya Bay	Skimmer Island	0	12	0	0	0	0	0
	Terrebonne Bay	Felicity Island	0	39	3	0	0	0	0
	Barataria Bay	Belle Pass East	7	20	8	22	0	0	0
	Birdsfoot West	Birdsfoot West 3	ND	72	ND	31	104	0	0
	Biloxi South	Biloxi South 3	0	12	3	3	0	0	0
Alabama	Mississippi Sound	Terrapin Island	0	3	3	6	13	-	0
	Mobile Bay Interior	Gaillard Island	0	1	11	4	21	-	0
Florida	Apalachicola West	Saint Andrews State Park Buttonwood Marsh	-	0	-	-	-	-	18
	Apalachicola West	Saint Andrews State Park Gator Lake	-	-	-	-	-	-	12
	Apalachicola East	Lake Number Five	0	0	0	22	1	-	11

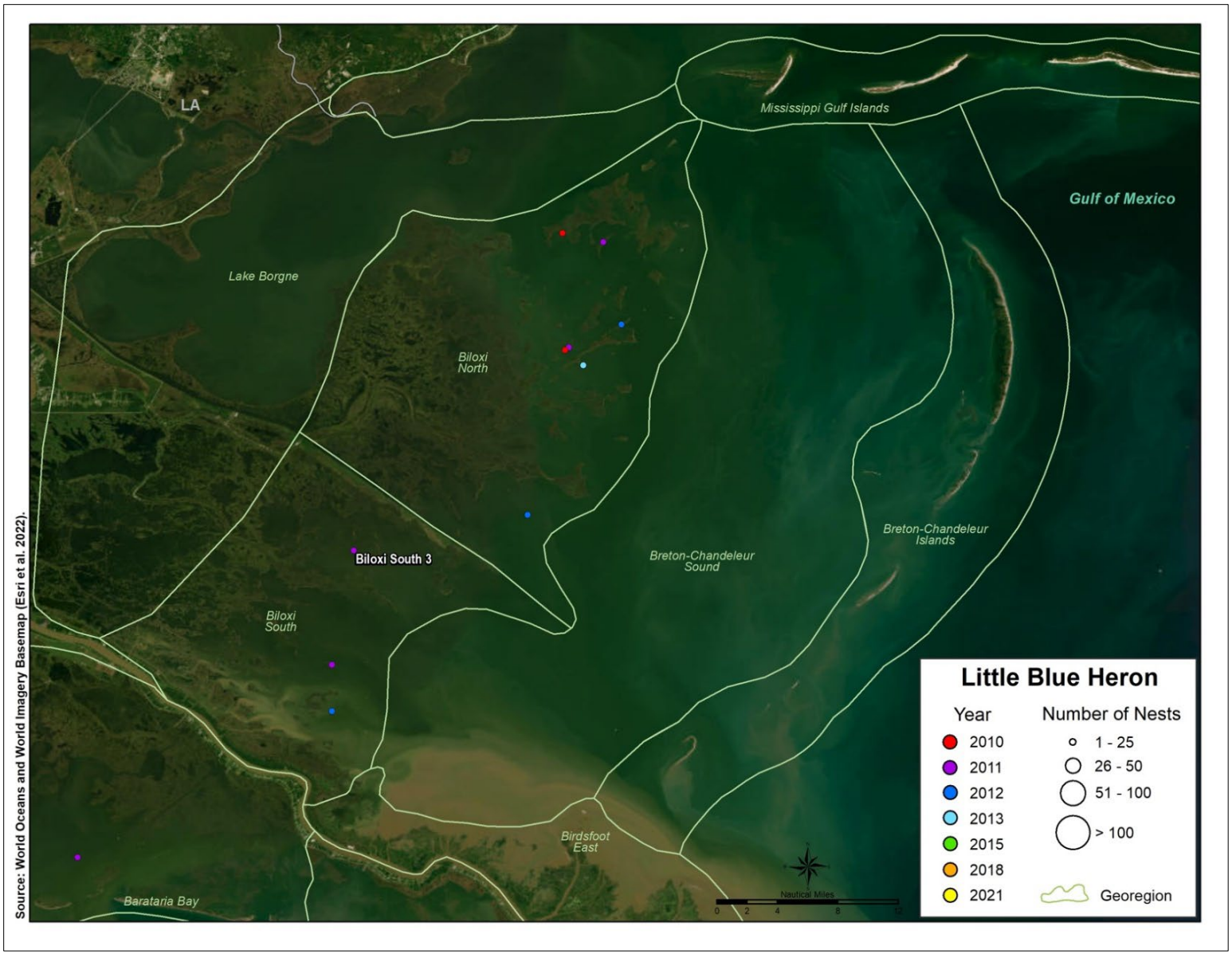
- = Outside intended survey area; ND = No Data; S = Submerged.



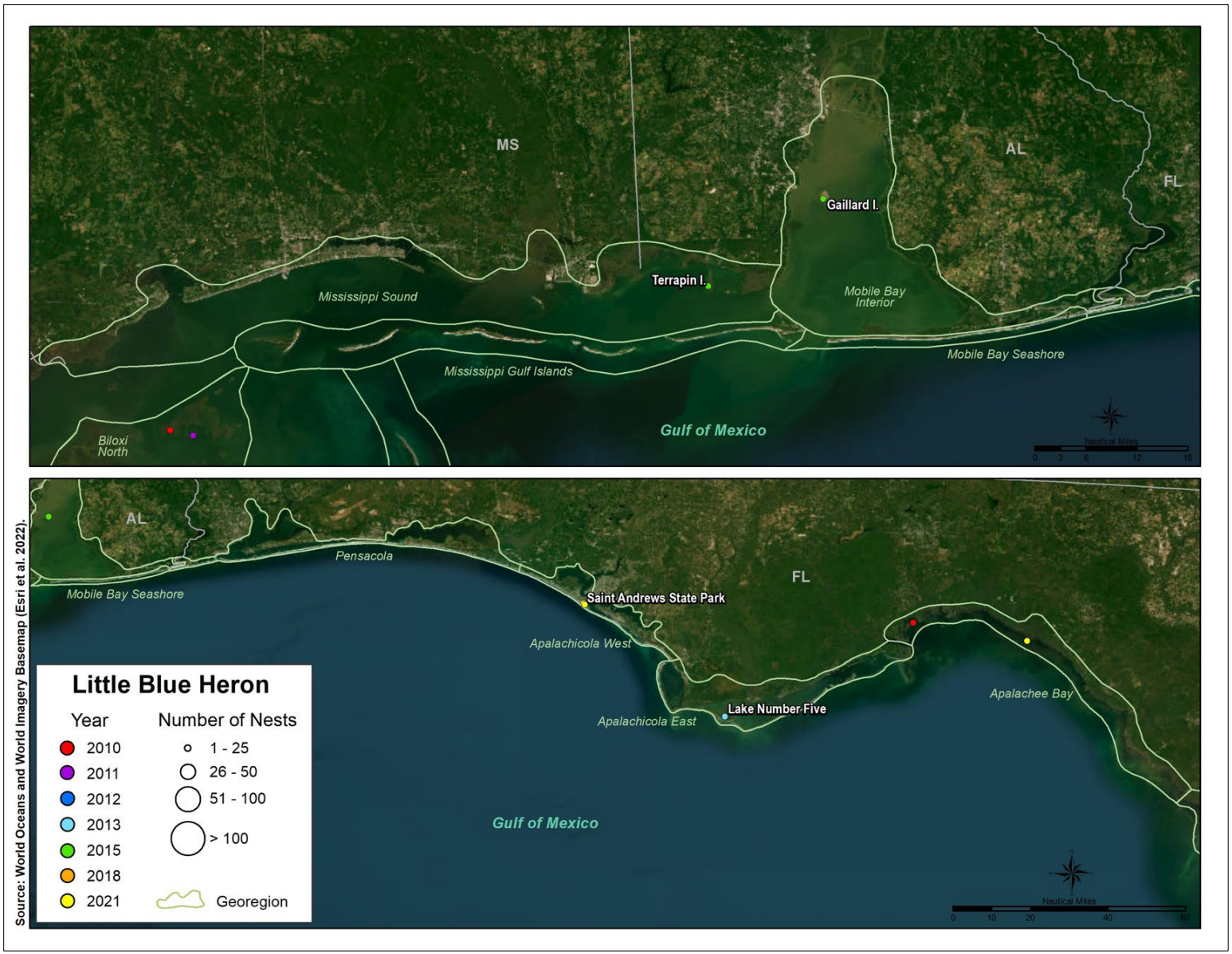
Map 1. Little Blue Heron colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Little Blue Heron colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 3. Little Blue Heron colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Little Blue Heron colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Tricolored Heron

Tricolored Heron was a widespread, conspicuous breeder, documented nesting at 156 colonies—83 in Louisiana, 60 in Texas, seven in Florida, and six in Alabama (Maps 1–4). In the aerial photographs, even those taken at shorter focal lengths, the buff color of the plumes on the upperparts of adults was usually obvious, even if birds were partly concealed. The buff color especially stood out on birds in incubation posture. However, visual detection of Tricolored Heron during surveys is not straightforward (Rodgers et al. 2005, Green et al. 2008), given that their otherwise dark plumage does not contrast with the vegetation present at a colony. Surveys are also flown at higher altitudes than typical visual-estimate aerial surveys (e.g., Michot et al. 2003). On the other hand, that higher altitude, combined with the vertical perspective through the belly port and constant searching for Laughing Gulls (the most abundant CWB species), usually resulted in excellent search effort for Tricolored Heron. Routine inspection of photographs immediately after a pass over a colony also aided in detecting Tricolored Heron. Furthermore, 103 nests were counted from aerial photographic surveys in 2010 at Raccoon Island in Louisiana from 17 May photographs, whereas Raynor et al. (2013) counted 17 pairs during late June ground surveys.

In 2021, a total of 14,471 Tricolored Heron nests were counted among 88 colonies (Table 1). Of those nests, 58% were among 39 Texas colonies and 40% were among 39 Louisiana colonies. In Alabama and Florida, just 251 nests were counted among 10 colonies. In Texas, colony totals were derived from May or June surveys roughly evenly, whereas 33 of the 39 Louisiana colonies were counted solely from June photographs because the herons were obviously more abundant than in May and were largely still in the incubation stage. The largest colonies were at Rabbit Island in Louisiana (1840 nests) and West Bay Mooring Facility (1806 nests) and West Bay Bird Island (1472 nests) in the Galveston GeoRegion in Texas. Another 21 colonies had more than 100 nests—11 in Texas, nine in Louisiana, and one in Alabama.

Table 1. Numbers of Tricolored Heron nests counted by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	2824 (34)	-	-	-	-	-	8427 (39)
LA	5476 (33)	8373 (43)	5742 (41)	7559 (40)	5363 (34)	11,566 (32)	5793 (39)
AL	57 (2)	100 (4)	43 (3)	83 (3)	80 (4)	-	157 (4)
FL	31 (1)	2 (1)	5 (1)	108 (2)	13 (1)	-	94 (6)
Total	**8410 (70)**	**8475 (48)**	**5790 (45)**	**7750 (45)**	**5456 (39)**	**11,566 (32)**	**14,471 (88)**

() = number of colonies; - = state not included in survey area that year.

In Texas, only 13 colonies were surveyed in both 2010 and 2021. The combined total among those 13 colonies was 91% higher in 2021. However, late June survey dates in 2010 may have led to underestimates of colony sizes that year, as many fledglings were noted. The large colony at Hog Island Complex East Islands in 2021 is an example of possible variable survey coverage among the two years. The location was not on the provided survey list for 2021, and the colony was not detected during May surveys that transited north about 800 meters to its east. In June,

the survey flight path was closer to the colony, and the colony was detected and surveyed. Many Chick Nests and Broods were dotted from June photographs, so the colony must have been active in May. In June 2010, survey flight paths also got no closer than about 800 meters to the islands, and therefore it is unknown if an active colony was present that year. At West Bay Mooring Facility, the 2010 trackline was within 500 meters of potential breeding habitat, providing slightly more confidence that no active colony was present (Table 2). Statewide, Remsen et al. (2019) reported a 2011–2014 average of 13,712 breeding birds (or 6856 nests) from the Texas Colonial Waterbird Society database. The 2021 aerial photographic survey nest total was 23% higher than that reported average.

Annual variation in nest totals was evident by colony and statewide in Louisiana (Tables 1 and 2). The highest statewide nest total (11,566 nests) was in 2018 and was nearly twice as high as the total in 2021 (when survey coverage was the same), likely indicating excellent breeding conditions in 2018. The Rabbit Island total in 2018 (2438 nests) was the largest colony size documented in any state in any year (Map 1) and was 33% higher than the 2021 total. Several other colonies also had much higher nest counts in 2018, compared with 2021. Large fluctuations in nest counts were observed at Houma Navigation Canal Island and Queen Bess Island (Table 2).

Tricolored Heron occurred in all Louisiana GeoRegions but in low numbers in Birdsfoot West and East (Figure 1). The apparent decline in numbers in Barataria Bay reflects the lack of nesting at Queen Bess Island in 2021 following restoration, along with submersion of Bay Ronquille Northwest Island by 2018. In Terrebonne Bay, land loss was conspicuous at Felicity Island by 2021. In contrast, the lack of nesting at Biloxi South 3 in 2021 (Table 2) was not obviously associated with land loss.

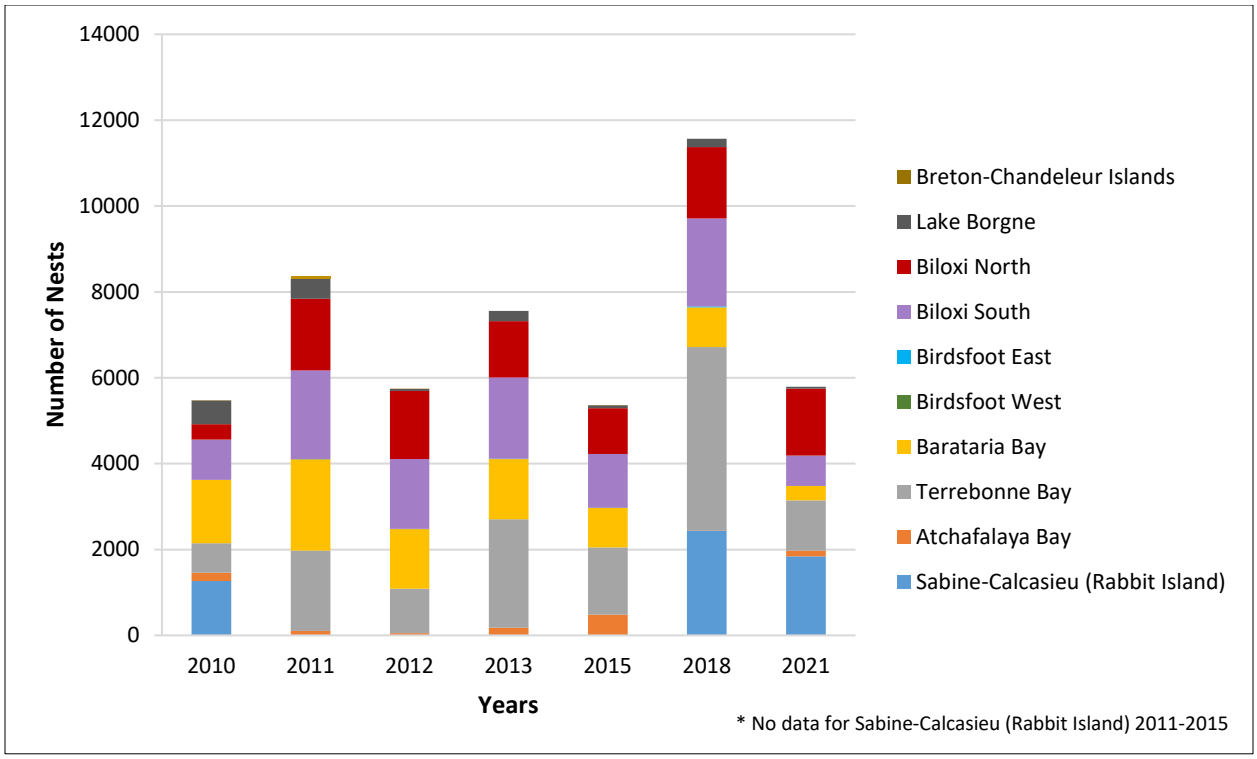


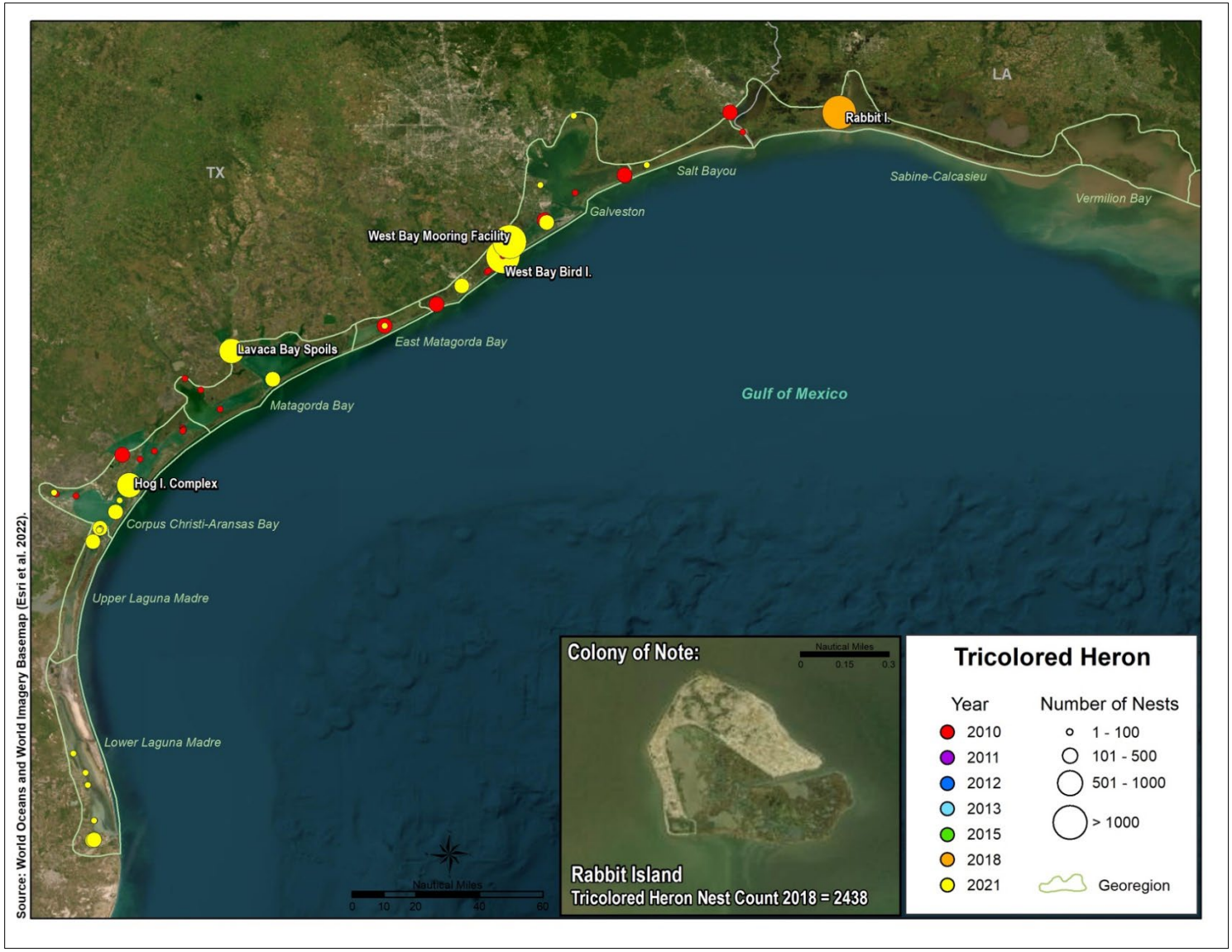
Figure 1. Numbers of Tricolored Heron nests in Louisiana by GeoRegion, 2010–2021.

In Alabama and Florida, colony habitat included more trees and tall shrubs compared with Louisiana and Texas, so nest concealment may have been greater where Tricolored Herons nested under the canopy. Still, survey data are likely representative of relative colony size. In Alabama, the highest total was 157 nests in 2021, and Marsh Island was the largest colony, with 130 nests that year. Restoration of Marsh Island was completed in 2017, and some birds that had nested at nearby Cat Island and Terrapin Island in previous years likely shifted nesting to Marsh Island. In Florida, the highest total observed across the state was 108 nests in 2013, with Lake Number Five at Saint Vincent National Wildlife Refuge as the largest colony, with 69 nests that year.

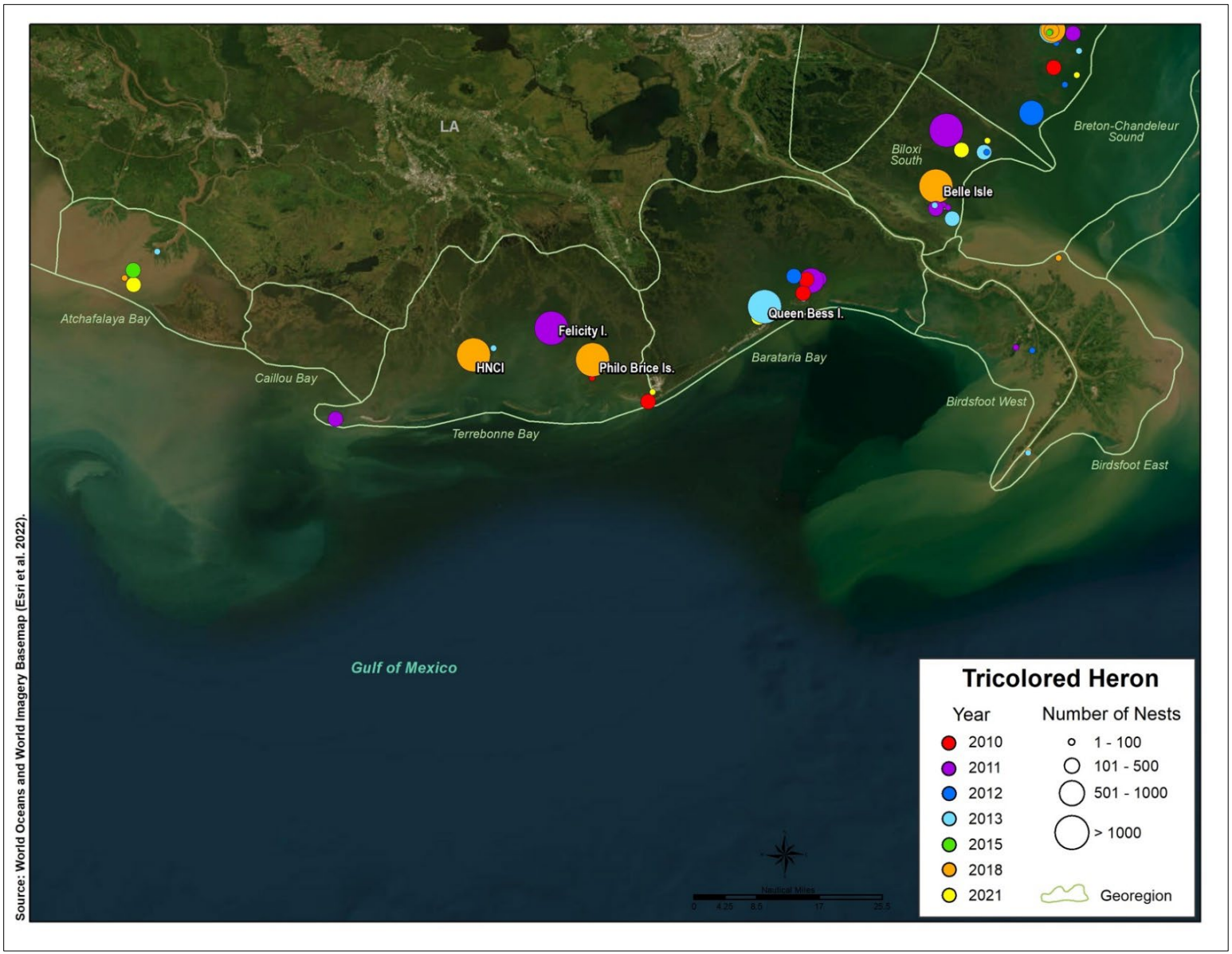
Table 2. Tricolored Heron nest counts for all colonies with at least one count of 500 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Corpus Christi-Aransas Bay	Hog Island Complex East Islands	ND	-	-	-	-	-	902
	Matagorda Bay	Lavaca Bay Spoils E	56	-	-	-	-	-	844
	Galveston	West Bay Bird Island	543	-	-	-	-	-	1472
	Galveston	West Bay Mooring Facility	0/ND	-	-	-	-	-	1806
	Matagorda Bay	Lavaca Bay Spoils E	56	-	-	-	-	-	844
Louisiana	Sabine-Calcasieu	Rabbit Island	1263	-	-	-	-	2438	1840
	Terrebonne Bay	Felicity Island	576	1551	1033	1212	1164	1447	28
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	1312	401	1548	559
	Terrebonne Bay	Philo Brice Islands	0	0	0	0	0	1276	549
	Barataria Bay	Bay Ronquille Northwest Island	397	506	336	3	0	S	S
	Barataria Bay	Queen Bess Island	421	1111	***660***	1136	638	904	0
	Biloxi South	Belle Isle	19	44	183	195	159	1042	569
	Biloxi South	Biloxi South 3	798	1625	1264	871	681	887	0
	Biloxi North	Hell Pass Coast A-E	3	234	133	596	709	1328	561
	Biloxi North	Deadman Point	20	387	625	161	157	19	27
	Lake Borgne	Half Moon Island	551	480	43	239	71	195	48

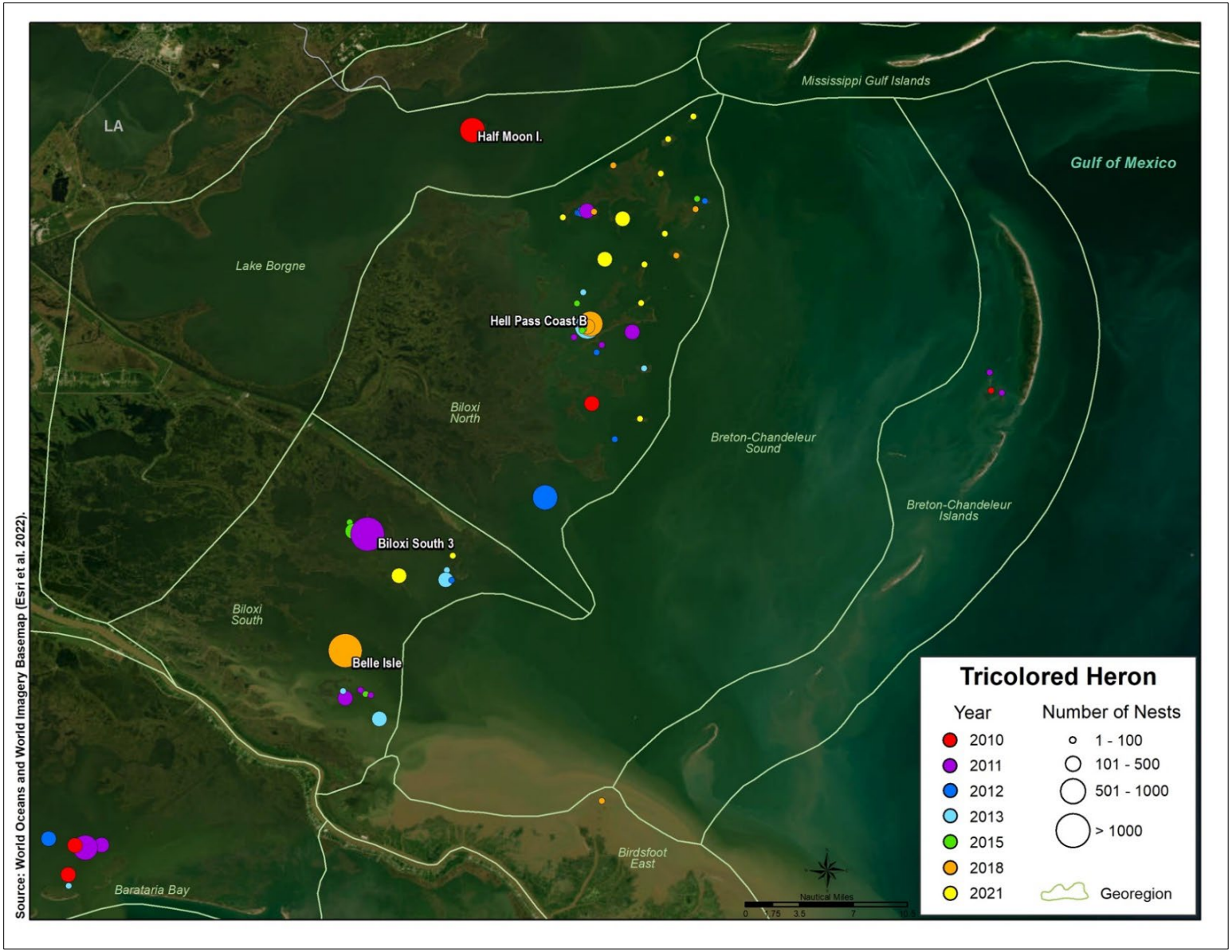
- = Outside intended survey area. ND = No Data. S = Submerged. Bold italics indicate a sum of counts from May and June surveys.



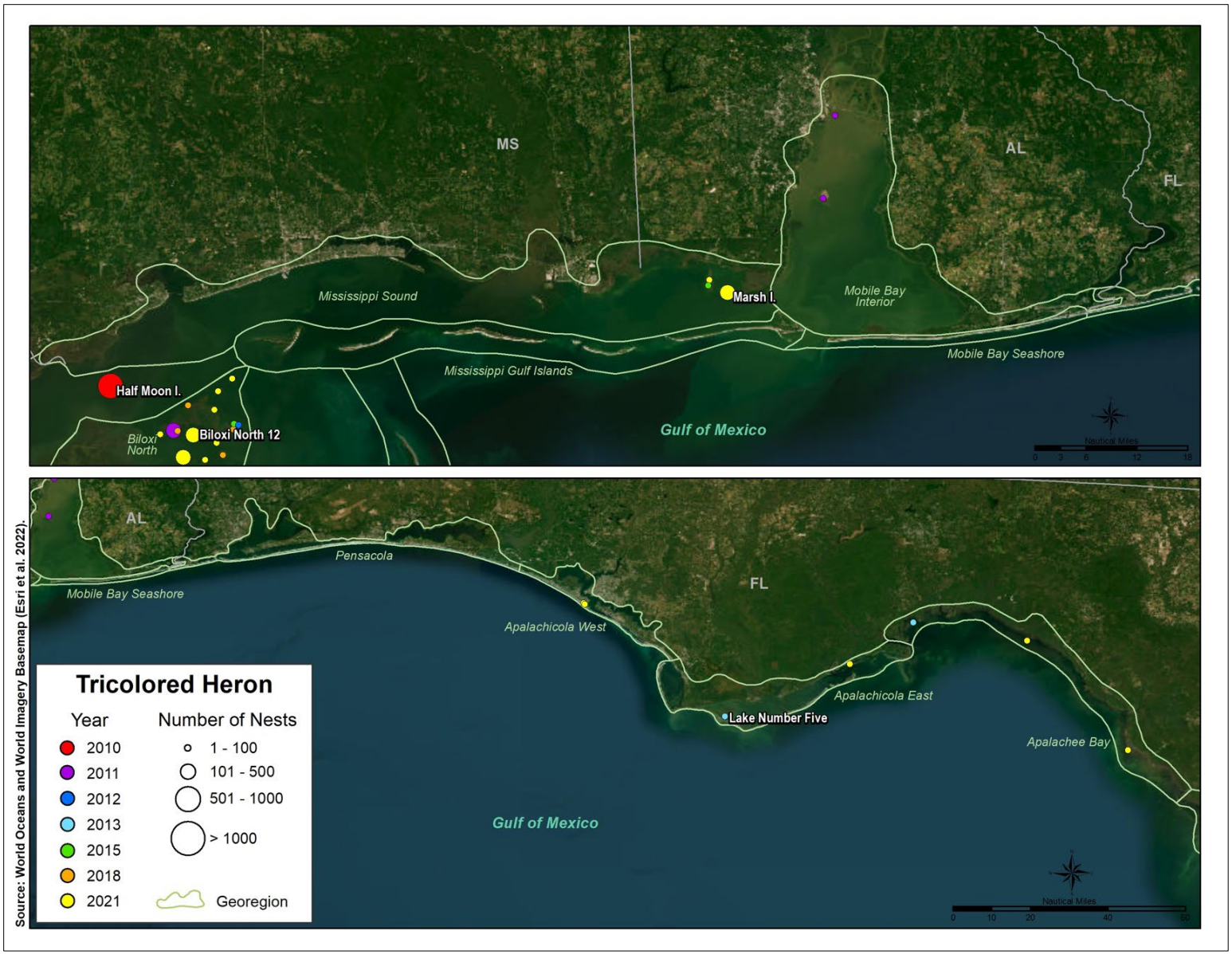
Map 1. Tricolored Heron colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Tricolored Heron colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Tricolored Heron colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Tricolored Heron colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

Reddish Egret

Reddish Egret nesting was documented at 75 colonies—44 in Texas, 28 in Louisiana, and three in Alabama (Maps 1–4). Reddish Egrets occur in dark morphs and white morphs, but only with improved camera resolution in 2021, and with survey coverage including Texas again, were white morph Reddish Egrets identified. In the aerial photographs, several characteristics such as bill color, body size, nest spacing, and plumage were used in combination to confirm identification (Figures 1–4). Dark morphs in incubation posture were obviously larger than Tricolored Herons, and the reddish head and neck were usually conspicuous. However, juvenile Tricolored Herons elsewhere in a colony could on occasion have been misidentified as Reddish Egrets. White morphs in incubation posture were obviously larger than Snowy Egrets and smaller than Great Egrets. Their bills were noticeably lighter and pinker than the orange or black bills of Great Egrets and Snowy Egrets, respectively, with a black tip visible in some images.

Figure 1. Dark morph adult Reddish Egret in incubation posture.

Figure 2. White morph adult Reddish Egret in incubation posture.

Figure 3. Dark morph adult Reddish Egret attending a mixed morph chick nest.

Figure 4. Dark morph and white morph breeding pair of Reddish Egrets at a nest site.

Plumes appeared shorter on the head and body compared with Snowy Egrets and Great Egrets, respectively. Reddish Egret nests were widely spaced but often occurred near nests of other species.

In 2021, a total of 1406 Reddish Egret nests were counted among 43 colonies (Table 1). Of those nests, 98% were among 35 Texas colonies. In Texas, colony totals were derived from May or June surveys roughly evenly. Color morph has not shown to significantly affect nest initiation dates in this species, including in mixed-morph nests (Holderby et al. 2012). The largest colonies were at Shamrock Island (209 nests), Green Island (143 nests), West Bay Bird Island (135 nests), and Bahia Grande C East (103 nests). The Reddish Egret count at Shamrock Island was likely an underestimate due to dark morphs blending in with the substrate in marshes and some white morphs perhaps being included in the unknown white wader (UNWW) category. Comparisons of 2021 and 2010 Texas data are of limited value, given differences in survey coverage, survey timing, and white morph recognition.

Table 1. Numbers of Reddish Egret nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
Texas	71 (14)	-	-	-	-	-	1379 (35)
Louisiana	12 (7)	24 (7)	6 (4)	44 (11)	46 (10)	10 (5)	26 (7)
Alabama	0	0	0	6 (2)	0	-	1 (1)
Total	**83 (21)**	**24 (7)**	**6(4)**	**50 (13)**	**46 (10)**	**10 (5)**	**1406 (43)**

() = number of colonies; - = state not included in survey area that year.

In Louisiana, the highest count was 13 nests at Rabbit Island in 2021. In 2018, only two nests were counted at Rabbit Island from aerial photographs, whereas Collins et al. (2021) reported 25–30 pairs from 2016 to 2018 from ground monitoring. Although Reddish Egrets were clearly less abundant in Louisiana than in Texas, possible concealment by vegetation of small numbers of nests should be considered in interpreting all Louisiana nest counts.

In Alabama, in addition to a single nest counted at Terrapin Island in 2021, one nest was counted at Gaillard Island and five nests were counted at Cat Island in 2013. Cat Island is where nesting by the species in Alabama was first documented (Dindo and Marion 1986). After 2011, parts of Cat Island became submerged, and vegetative cover decreased over time. By 2021, only terns and skimmers nested at Cat Island.

Dark morph Reddish Egret nests only slightly outnumbered white morph egret nests throughout Texas, with 54% of nests categorized as dark morph nests and 46% white morph nests in 2021. However, at lower latitudes, within the Lower and Upper Laguna GeoRegions, white morph nests outnumbered dark morph nests (Figure 5). Evidence of mixed dark morph and white morph breeding pairs was evident on a few occasions (Figures 3 and 4, Table 2).

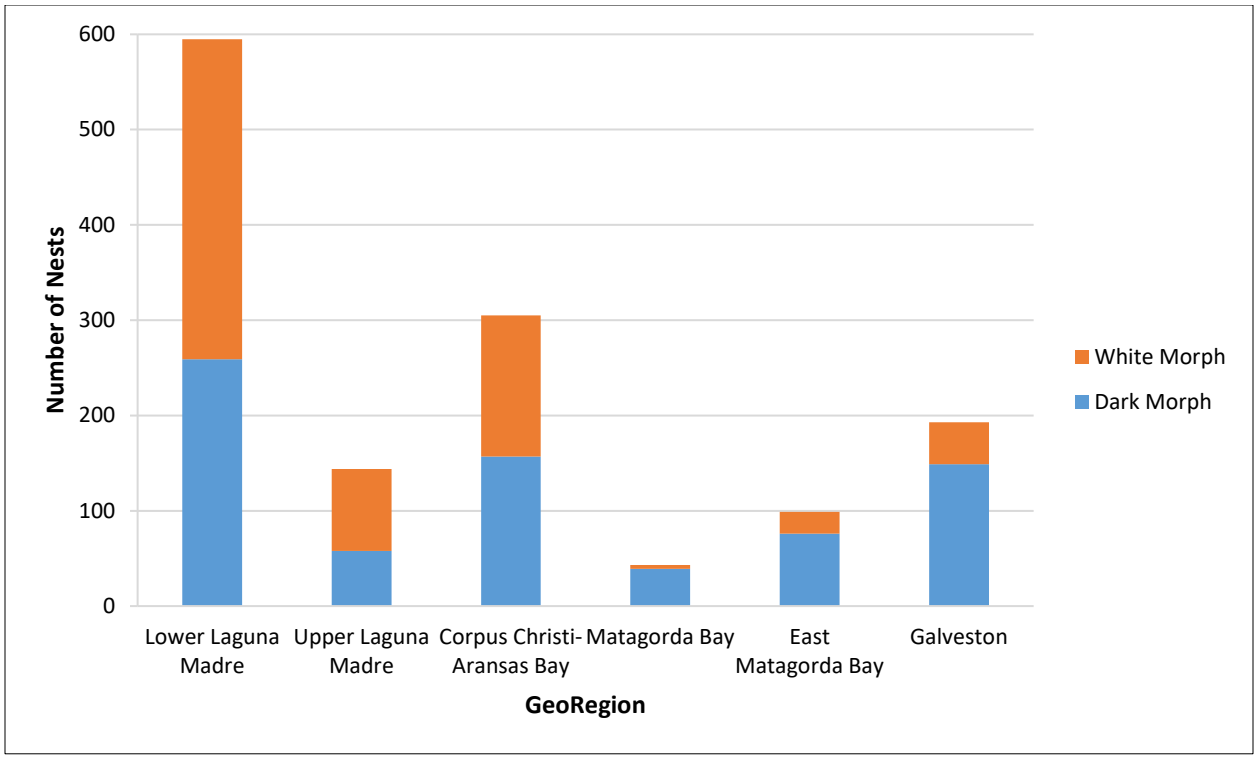
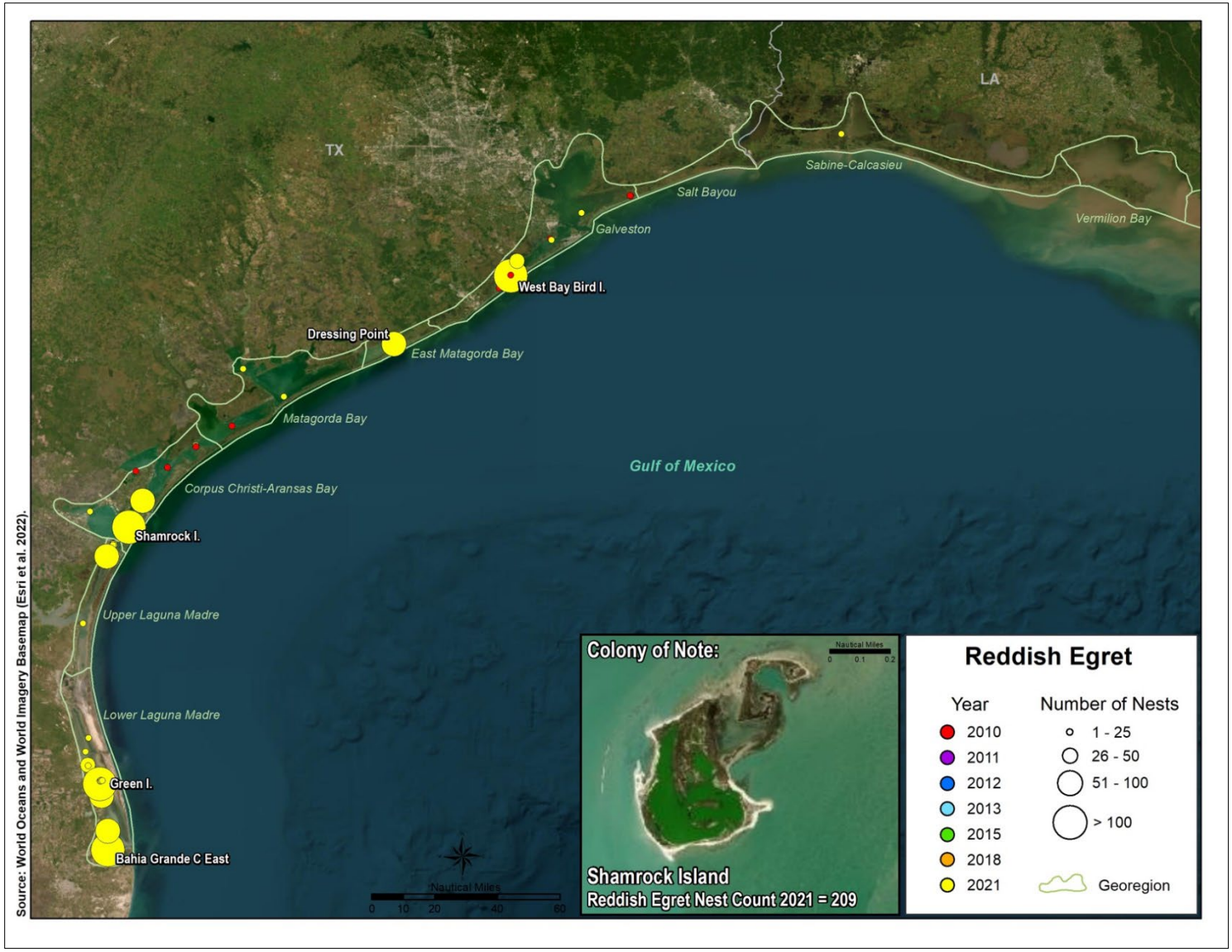


Figure 5. Numbers of Reddish Egret nests in Texas by GeoRegion and color morph in 2021.

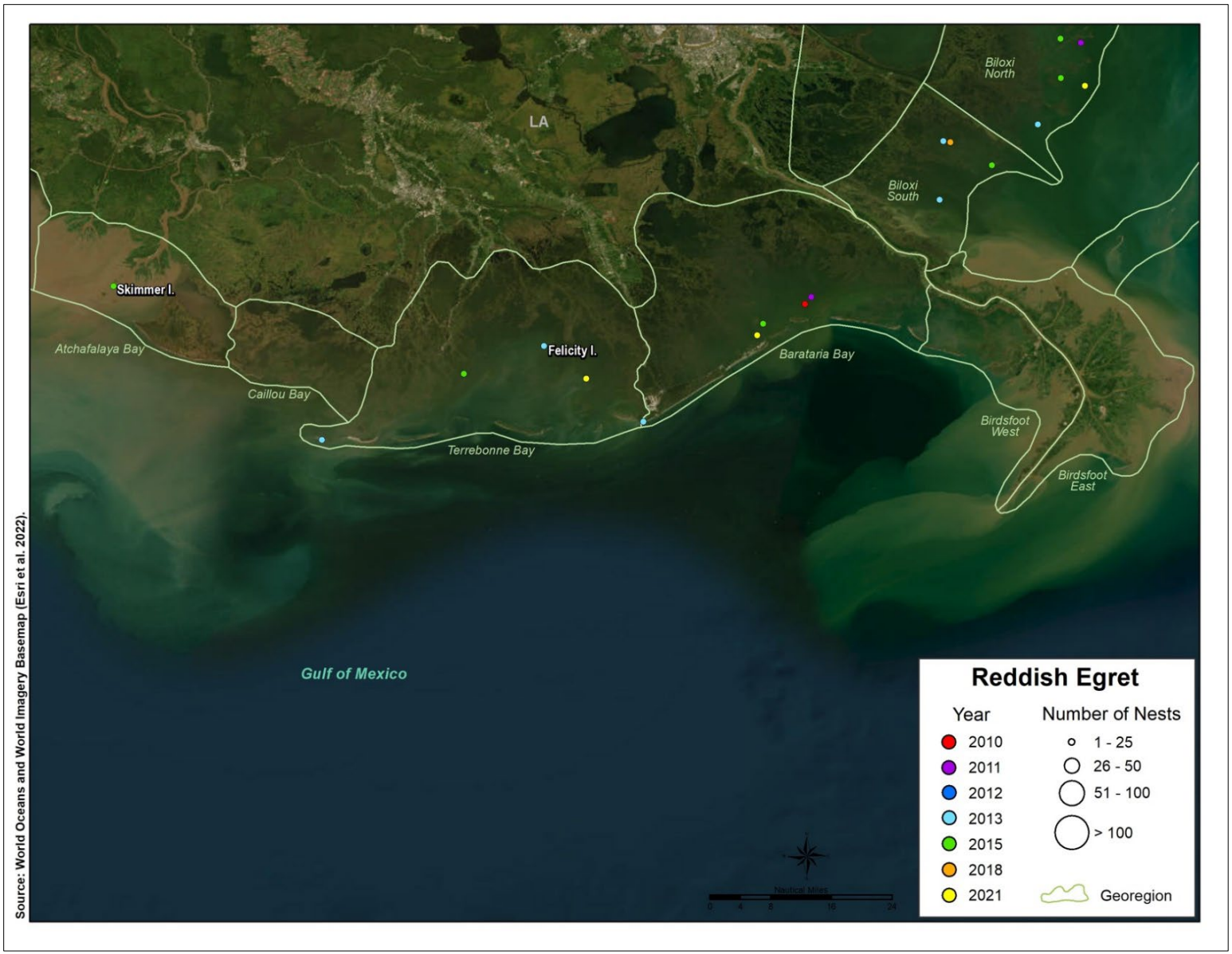
Table 2. Reddish Egret dark morph (DM) and white morph (WM) nest counts for all colonies with at least one count of 10 nests or more in 2021.

State	GeoRegion	Colony Name	DM	WM
TX	Lower Laguna Madre	Arroyo Colorado Spoils B1	13	53
	Lower Laguna Madre	Bahia Grande C Central	31	45
	Lower Laguna Madre	Bahia Grande C East	***44***	***59***
	Lower Laguna Madre	East Marker Spoil	***2***	***17***
	Lower Laguna Madre	Green Hill Spoils A	18	31
	Lower Laguna Madre	Green Hill Spoils B	3	12
	Lower Laguna Madre	Green Island	98	45
	Lower Laguna Madre	Green Island Spoils D	***12***	***13***
	Lower Laguna Madre	Laguna Vista Spoils A	6	20
	Lower Laguna Madre	Laguna Vista Spoils B	18	33
	Upper Laguna Madre	Naval Air Station Islands E	4	17
	Upper Laguna Madre	Naval Air Station Islands H	3	11
	Upper Laguna Madre	Pita Island	13	16
	Upper Laguna Madre	Rabbit Island Laguna Madre	***14***	***11***
	Corpus Christi-Aransas Bay	Hog Island Complex East Islands	46	24
	Corpus Christi-Aransas Bay	Second Chain of Islands G	22	7
	Corpus Christi-Aransas Bay	Shamrock Island	96[1]	113
	Matagorda Bay	Chester Island	***18***	***1***
	Matagorda Bay	Lavaca Bay Spoils E	21	3
	East Matagorda Bay	Dressing Point	76	23[2]
	Galveston	North Deer Island	10	1
	Galveston	West Bay Bird Island	117	18
	Galveston	West Bay Mooring Facility	20	20
LA	Sabine-Calcasieu	Rabbit Island	13	0

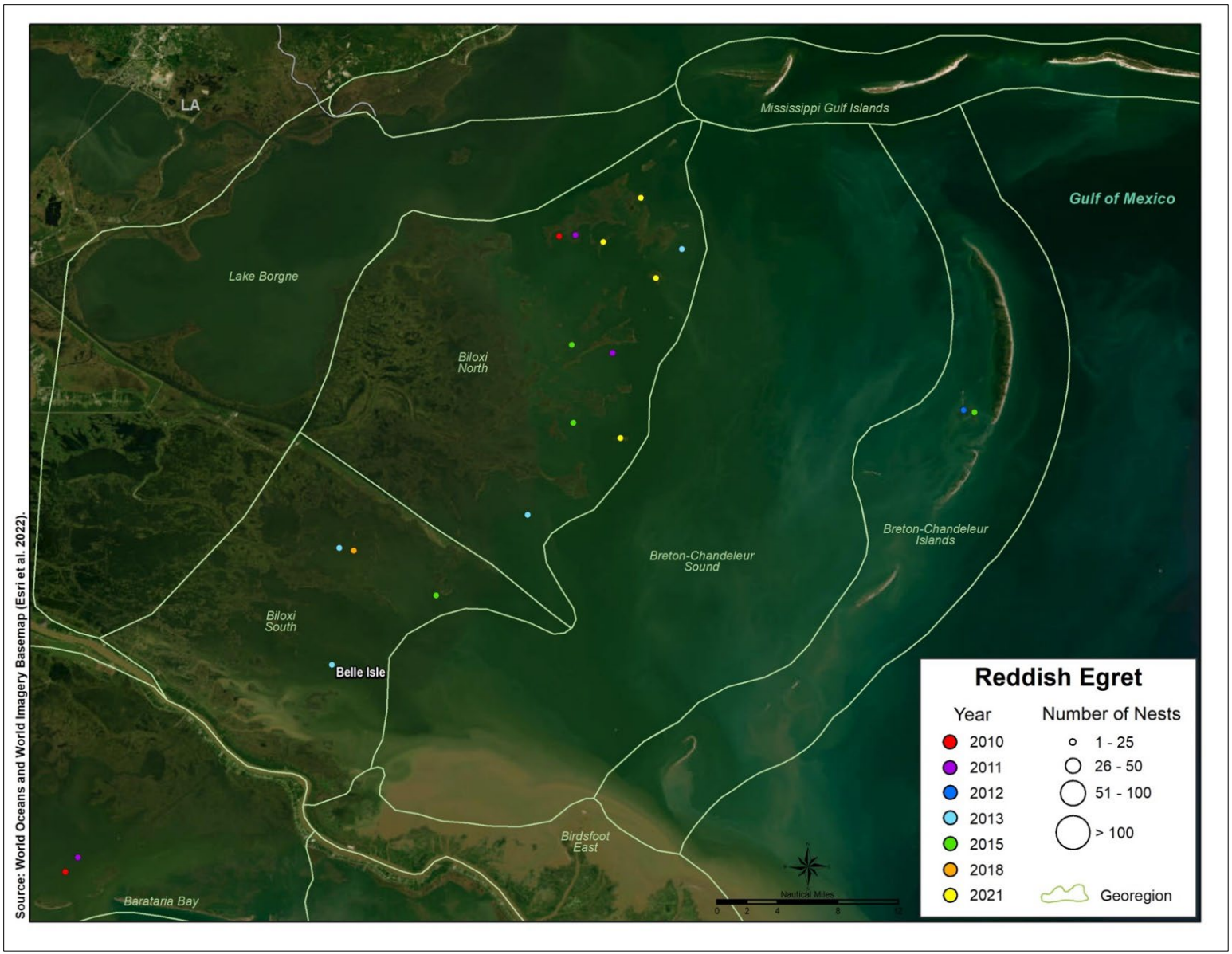
- = Outside intended survey area; Bold italics indicate a sum of counts from May and June surveys.
[1]Note that one dark morph adult attended a mixed morph chick nest; [2]Note that one mixed morph breeding pair observed, with the white morph on the nest site.



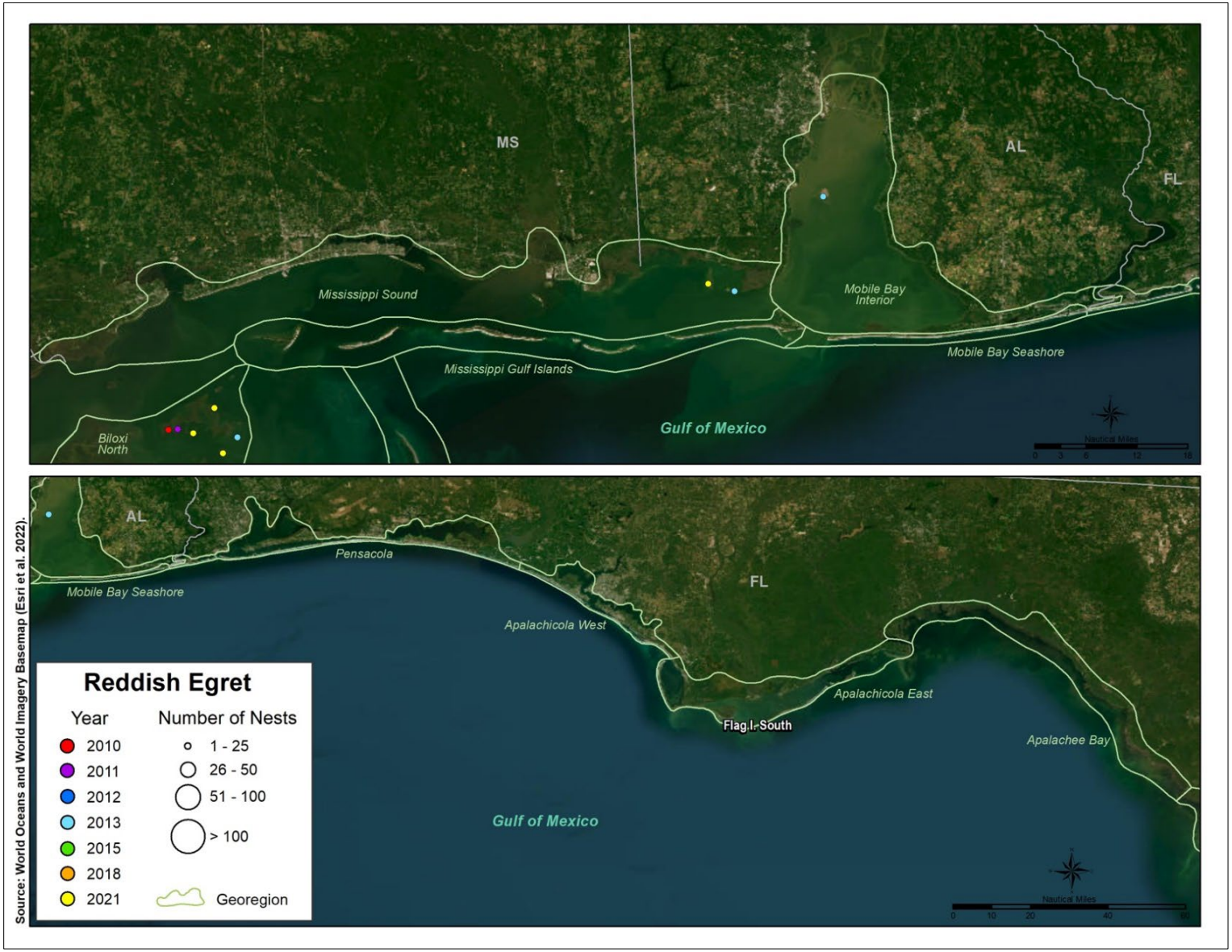
Map 1. Reddish Egret colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Reddish Egret colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Reddish Egret colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Reddish Egret colonies counted from Mississippi to Florida, 2010–2021 with year and range of maximum count indicated.

Cattle Egret

Cattle Egret nesting was documented at 31 colonies—17 in Texas, five in Alabama, five in Louisiana, and four in Florida (Maps 1–4). Cattle Egret can form large, conspicuous colonies. It is smaller than Great Egret and can be distinguished during breeding season by orange-buff plumage on the head, breast, and back. East of Texas, the low number of Cattle Egret colonies may be attributed to its tendency to nest inland rather than along the coast (Telfair 2006). Proximity to water is not a requirement for nest site selection in Cattle Egret (Krebs et al. 1994). Cattle Egrets typically do not establish their own heronry, but nest in heronries already established by other species (Telfair 2006). Among the surveys, Cattle Egret always nested in colonies with at least one other heron species. Of 47 Cattle Egret colony counts, Tricolored Heron co-occurred 39 times, and Snowy and Great Egret co-occurred 36 times.

In 2021, a total of 4212 Cattle Egret nests were counted among 18 colonies (Table 1). Of those nests, 51% were among 13 colonies in Texas, 46% were among three colonies in Alabama, and 3% were among two colonies in Florida. The two largest nest totals of any year throughout the survey area were recorded in 2021 at Gaillard Island (1605 nests) in Alabama and Nolan Ryan Marsh (1032 nests) in Texas. Another six colonies had more than 100 nests—three in Texas, two in Alabama, and one in Florida (Saint Andrews State Park Gator Lake; Table 2). Half of the colonies in 2021 had nests with visible chicks, and two colonies had broods of chicks away from nests. Nearly all colonies were counted from May photographs, with the exception of Mayes Lake North in Texas and five nests counted among four other Texas CWB colonies.

Table 1. Numbers of Cattle Egret nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	122 (5)	-	-	-	-	-	2148 (13)
LA	5 (1)	0	8 (1)	4 (2)	29 (2)	0	0
AL	169 (2)	382 (3)	503 (3)	287 (3)	790 (4)	-	1920 (3)
FL	19 (1)	20 (1)	0	12 (1)	0	-	144 (2)
Total	**315 (9)**	**402 (4)**	**511 (4)**	**303 (6)**	**819 (6)**	**0**	**4212 (18)**

() = colonies counted; - = state not included in survey area that year.

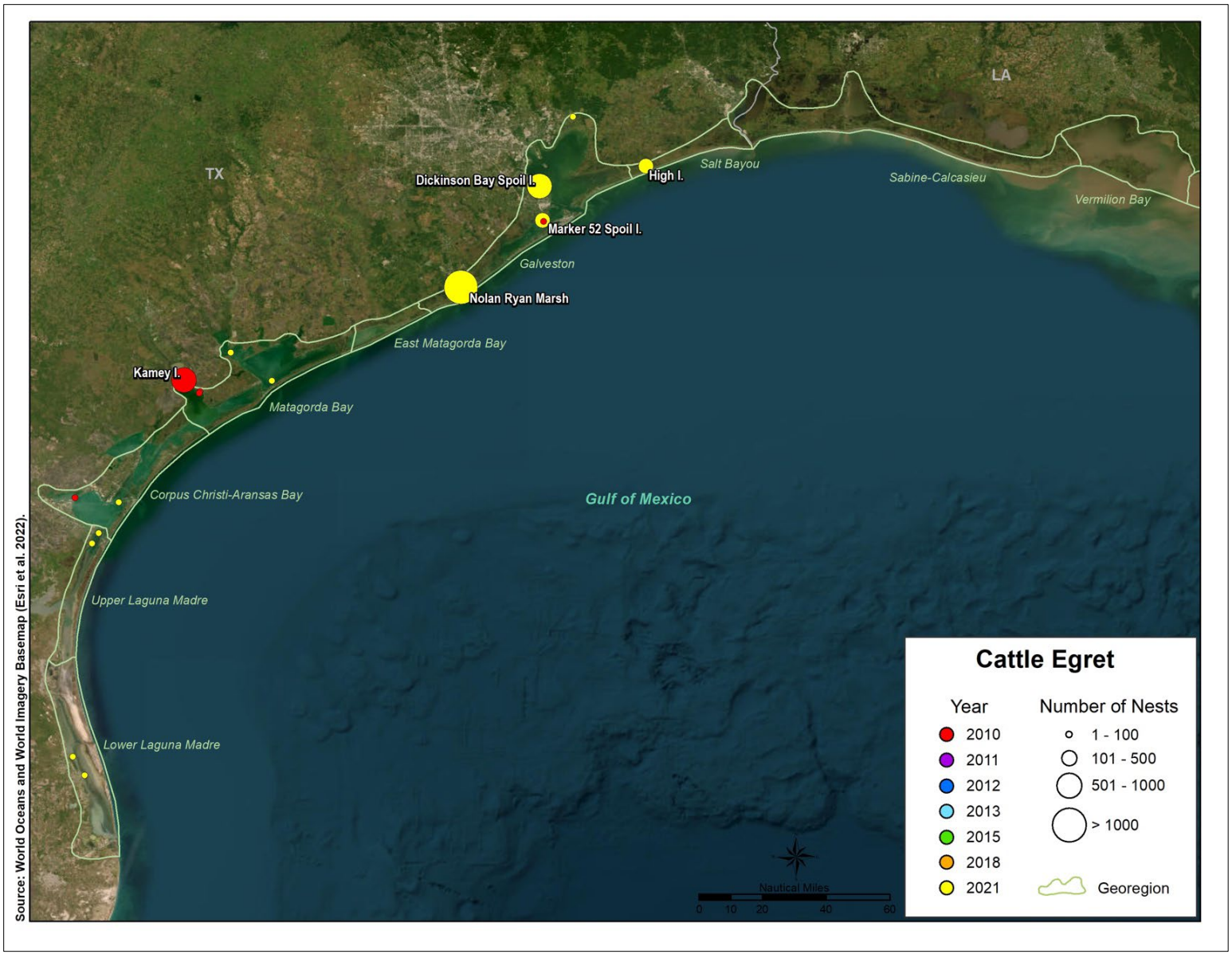
In Alabama, nest totals at Cat Island declined after 2011 due to land loss, and the species had apparently shifted nesting to Marsh Island by 2021 following its restoration (Table 2). No apparent cause for a sharp increase in nest totals at Gaillard Island in 2021 could be determined, especially without survey data for 2018. However, the influx of Cattle Egrets in 2021 may be a result of reduced competition for nesting space with White Ibis, as Cattle Egret can compete with other wader species (Burger 1978). In 2021, the White Ibis nest total at Gaillard Island was much lower than in earlier years, and the species nested later. Cattle Egrets were counted from May photographs and chicks were noted, while White Ibis were counted from June photographs and just three nests had visible chicks. In contrast, in 2015, White Ibis were counted from May photographs and some larger chicks already moving away from nests were noted.

Table 2. Cattle Egret nest counts for all colonies with at least one count of 100 nests or more, 2010–2021.

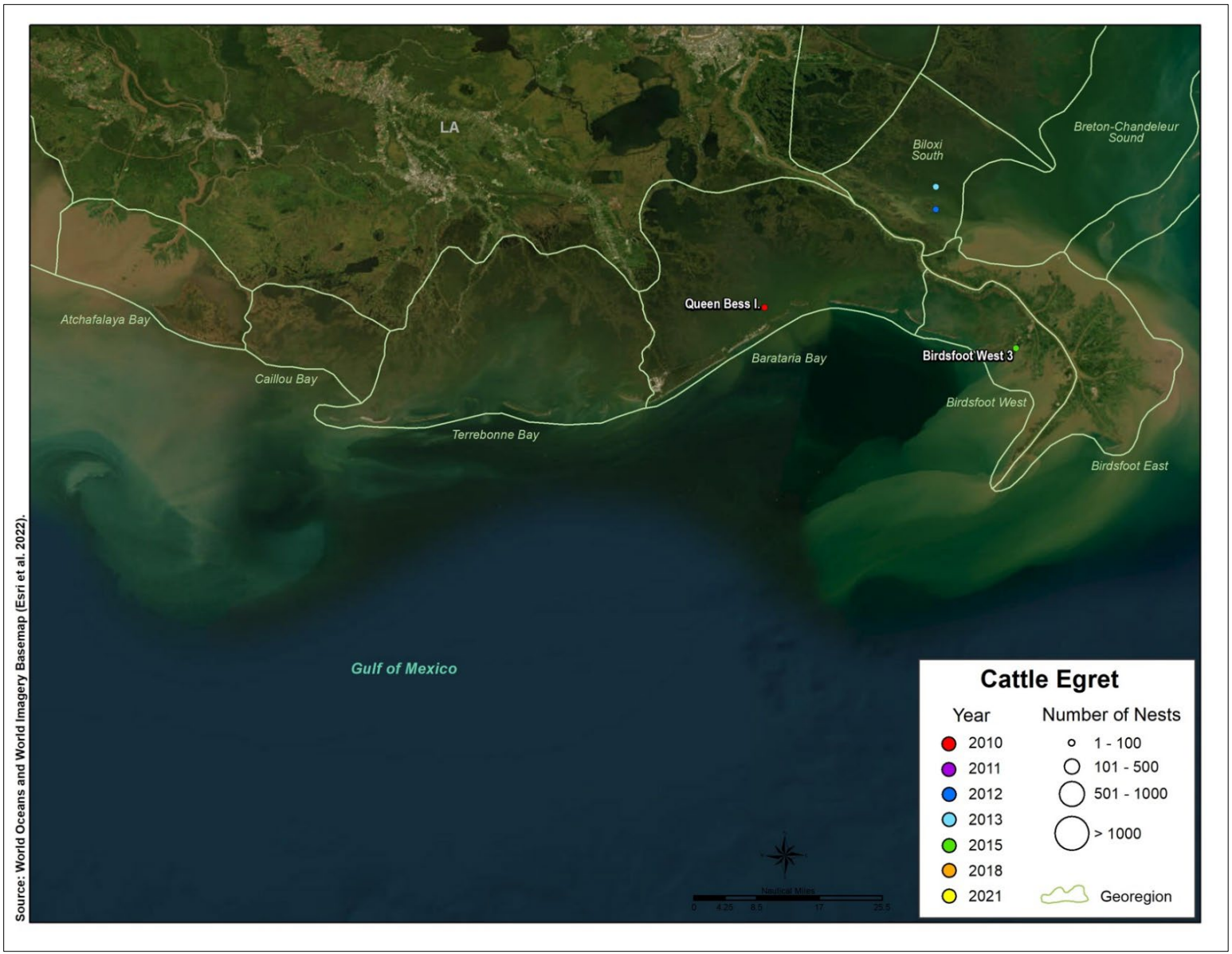
State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Matagorda Bay	Kamey Island	>700[1]	-	-	-	-	-	ND
	Galveston	Dickinson Bay Spoil Island	ND	-	-	-	-	-	548
	Galveston	Nolan Ryan Marsh	ND	-	-	-	-	-	1032
	Salt Bayou	High Island	0	-	-	-	-	-	161
Alabama	Mississippi Sound	Cat Island	105	199	84	79	59	-	0
	Mississippi Sound	Marsh Island	0	0	0	0	0	-	149
	Mississippi Sound	Terrapin Island	64	149	334	136	364	-	166
	Mobile Bay Interior	Battery McIntosh	0	34	85	72	188	-	0
	Mobile Bay Interior	Gaillard Island	0	0	0	0	179	-	1605
Florida	Apalachicola West	Saint Andrews State Park Gator Lake	ND	ND	ND	ND	ND	-	119

ND = No Data; S= submerged; - = Outside intended survey area.

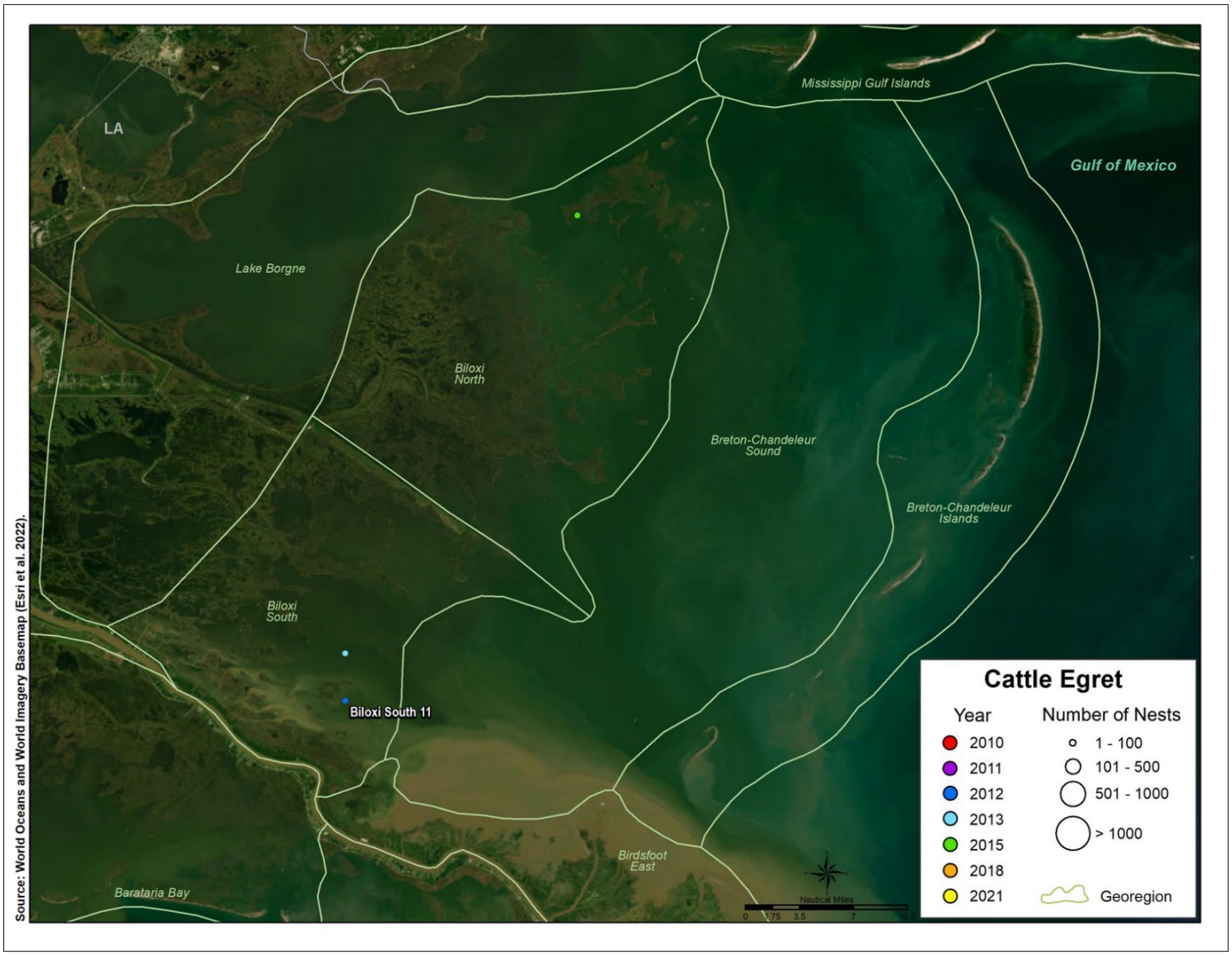
[1]Note that 841 counted nests were categorized as WHEG due to time constraints but were roughly estimated to be 90% Cattle Egret and 10% Snowy Egret.



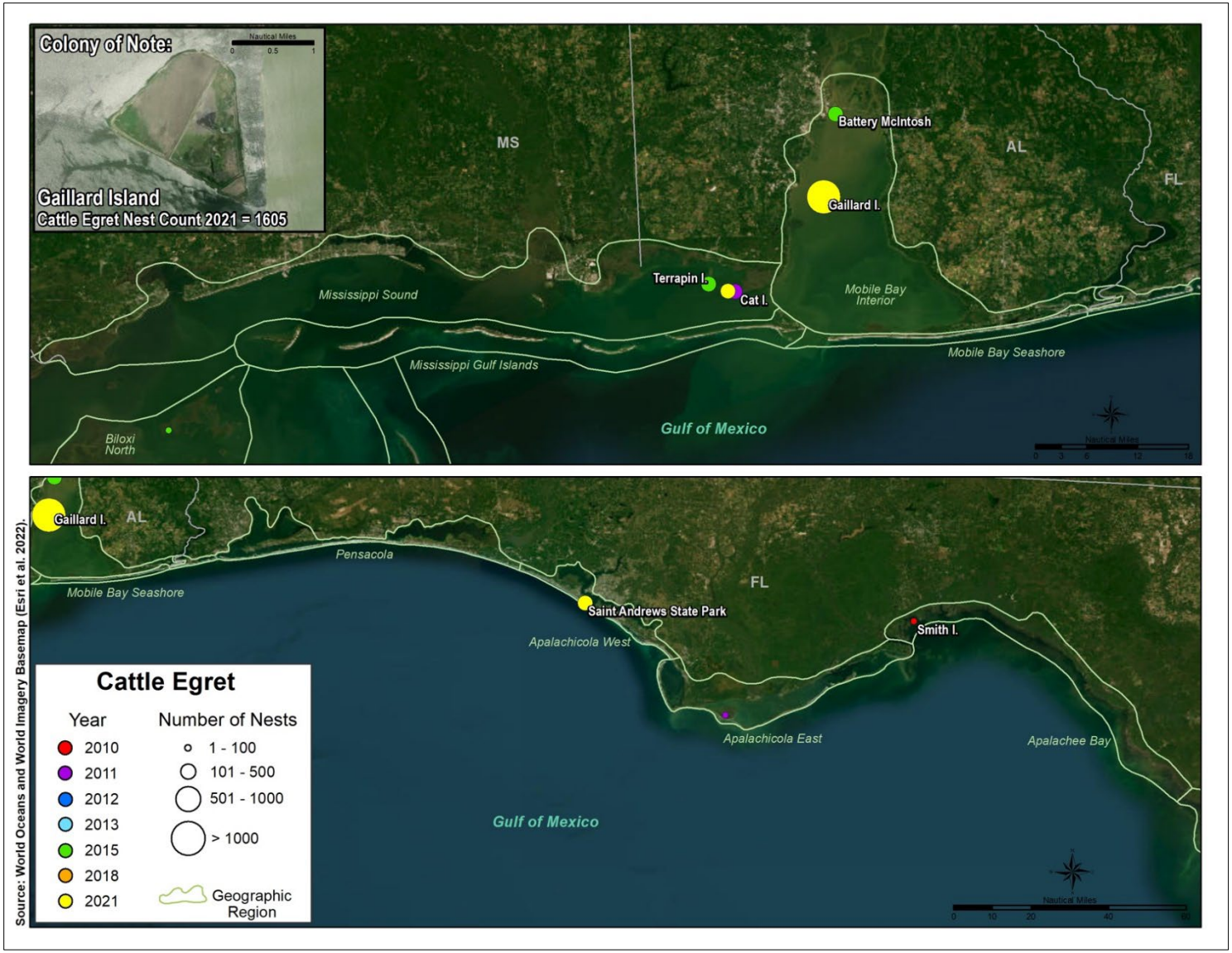
Map 1. Cattle Egret colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. Cattle Egret colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Cattle Egret colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Cattle Egret colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.

Black-crowned Night-Heron

Black-crowned Night-Heron nesting was documented at 83 colonies—45 in Louisiana, 32 in Texas, four in Alabama, and two in Florida (Maps 1–4). Nests are typically scattered among mixed species colonies (Chapman et al. 1981, Hothem et al. 2020). Black-crowned Night-Heron can be distinguished from other heron species by its small size and a black cap and back that contrast with a pale neck and breast. Its dark coloration, small size, and tendency to nest in shrubs and tall grass can make it difficult to spot. Yellow-crowned Night-Heron were rarely detected in aerial photographs, but it is possible some could have been misidentified as Black-crowned Night-Herons, and vice versa.

In 2021, a total of 1085 Black-crowned Night-Heron nests were counted among 44 colonies (Table 1). Of those nests, 50% were among 23 Texas colonies, 44% were among 19 Louisiana colonies, and 6% were at two colonies in Alabama. The Nolan Ryan Marsh colony in Texas (225 nests in 2021) was the largest across the Study Area and all years (Table 2, Map 1). Another six colonies had more than 50 nests—three in Louisiana, two in Texas, and one in Alabama (Gaillard Island).

Table 1. Numbers of Black-crowned Night-Heron nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	48 (11)	-	-	-	-	-	543 (23)
AL	0	23 (2)	10 (2)	5 (1)	6 (2)	-	67 (2)
LA	49 (9)	258 (13)	227 (10)	390 (12)	539 (16)	617 (14)	475 (19)
FL	0	0	0	16 (2)	0	-	0
Total	**97 (20)**	**281 (15)**	**237 (12)**	**411 (15)**	**545 (18)**	**617 (14)**	**1085 (44)**

() = colonies counted; - = state not included in survey area that year.

In Louisiana, nest counts fluctuated by colony and year (Figure 1). Although the overall trend of nest counts in Louisiana appears to be increasing, lack of data for Rabbit Island from 2011 to 2015 prevents a complete understanding of statewide trends. Louisiana hosted over 90% of all Black-crowned Night-Heron nests from 2011 to 2018. Four GeoRegions had nests in every survey year: Barataria Bay, Biloxi North and South, and Terrebonne Bay. Barataria Bay, Biloxi South, and Terrebonne Bay made up over half of all nests in Louisiana in any given year and over 90% of nests in 2011 through 2013. Decreases in nest totals at Felicity Island and Bay Ronquille Northwest Island coincided with land loss and mirror decreasing nest totals there for other species such as Tricolored Heron (Table 2).

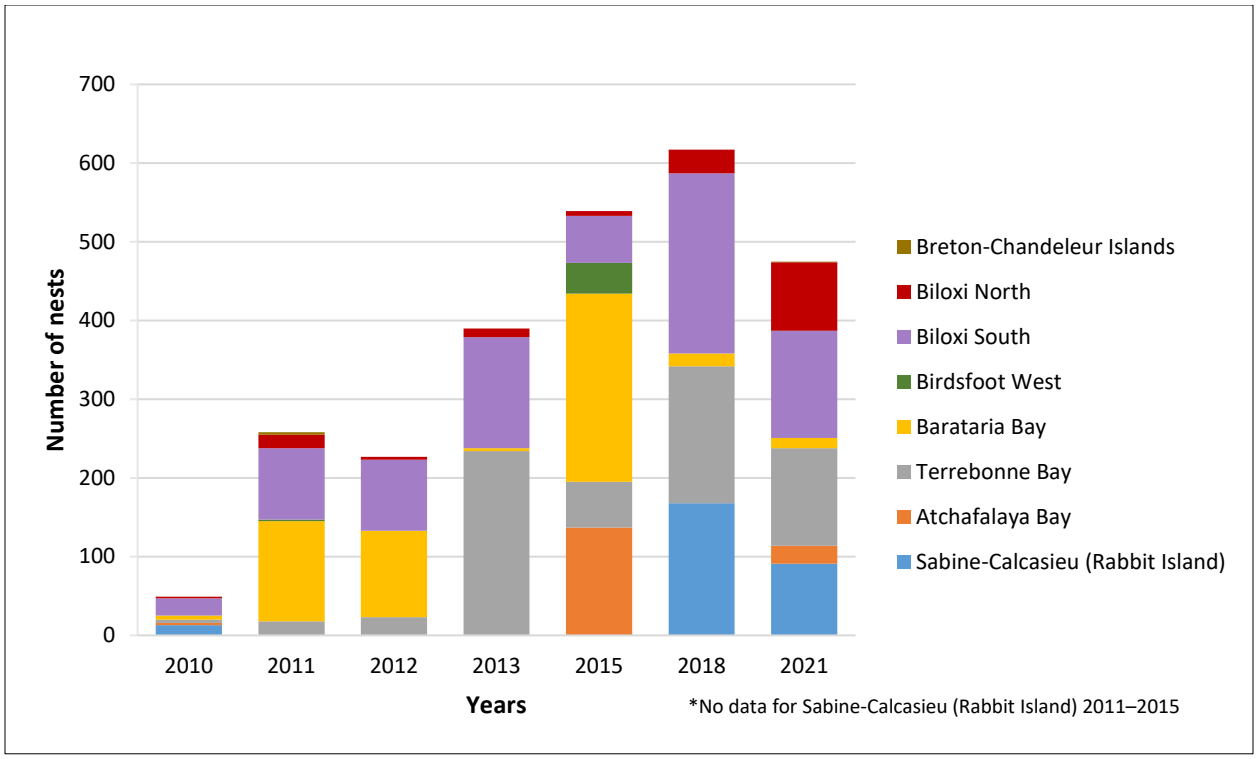


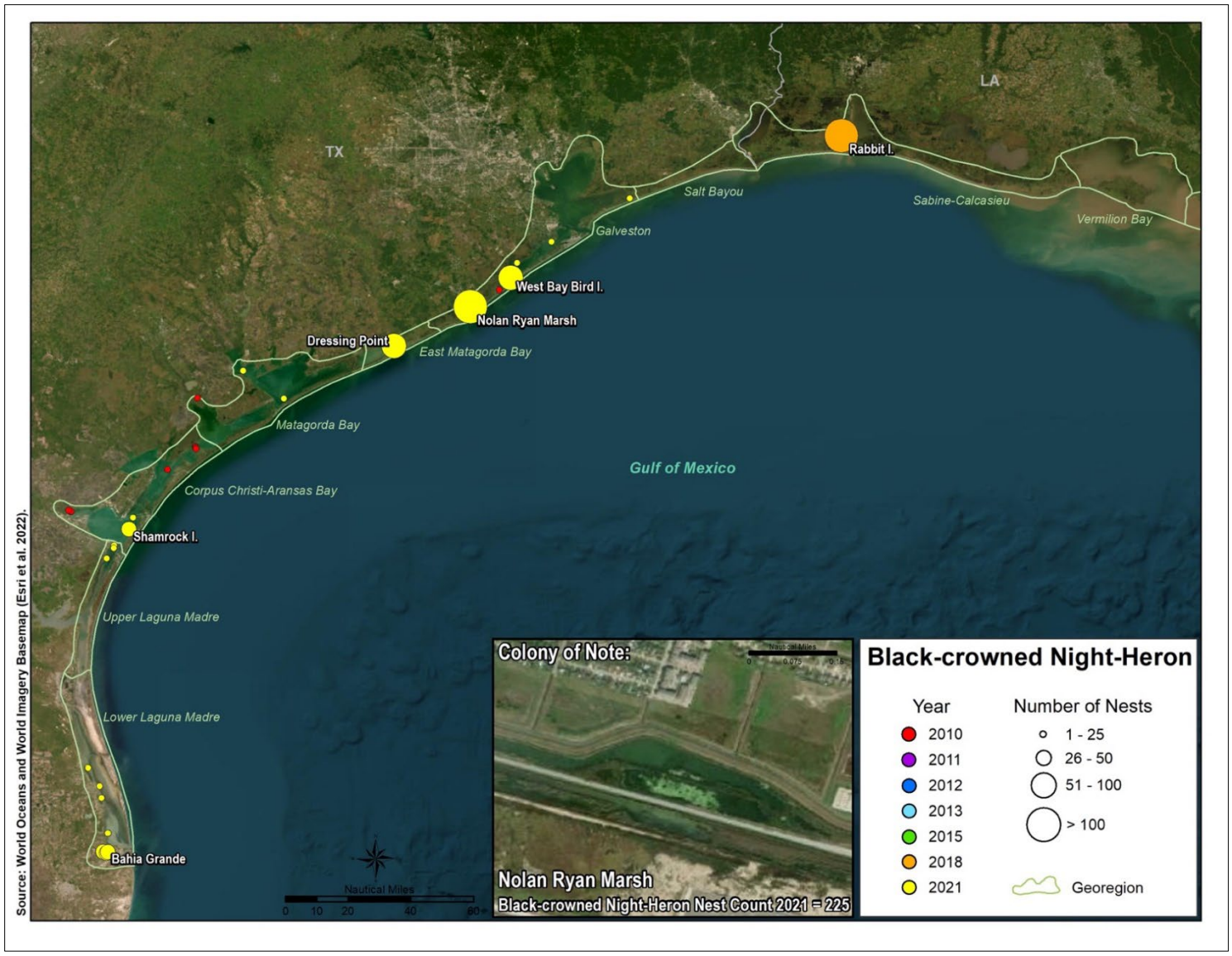
Figure 1. Numbers of Black-crowned Night Heron nests in Louisiana by GeoRegion, 2010–2021.

Black-crowned Night-Heron rarely had nests with visible chicks. Just four of the 44 colonies counted in 2021, for example, had nests with visible chicks, two in Texas and two in Louisiana. In 2011, however, seven of the 13 colonies counted in Louisiana had visible chicks. Six of those counts were from May, with chicks noted as half-grown to full-grown. The initiation of Black-crowned Night-Heron breeding is variable throughout its range (Hothem et al. 2020), but the species is generally an early nester with nest building starting as early as February in Corpus Christi, Texas (Chapman et al. 1981).

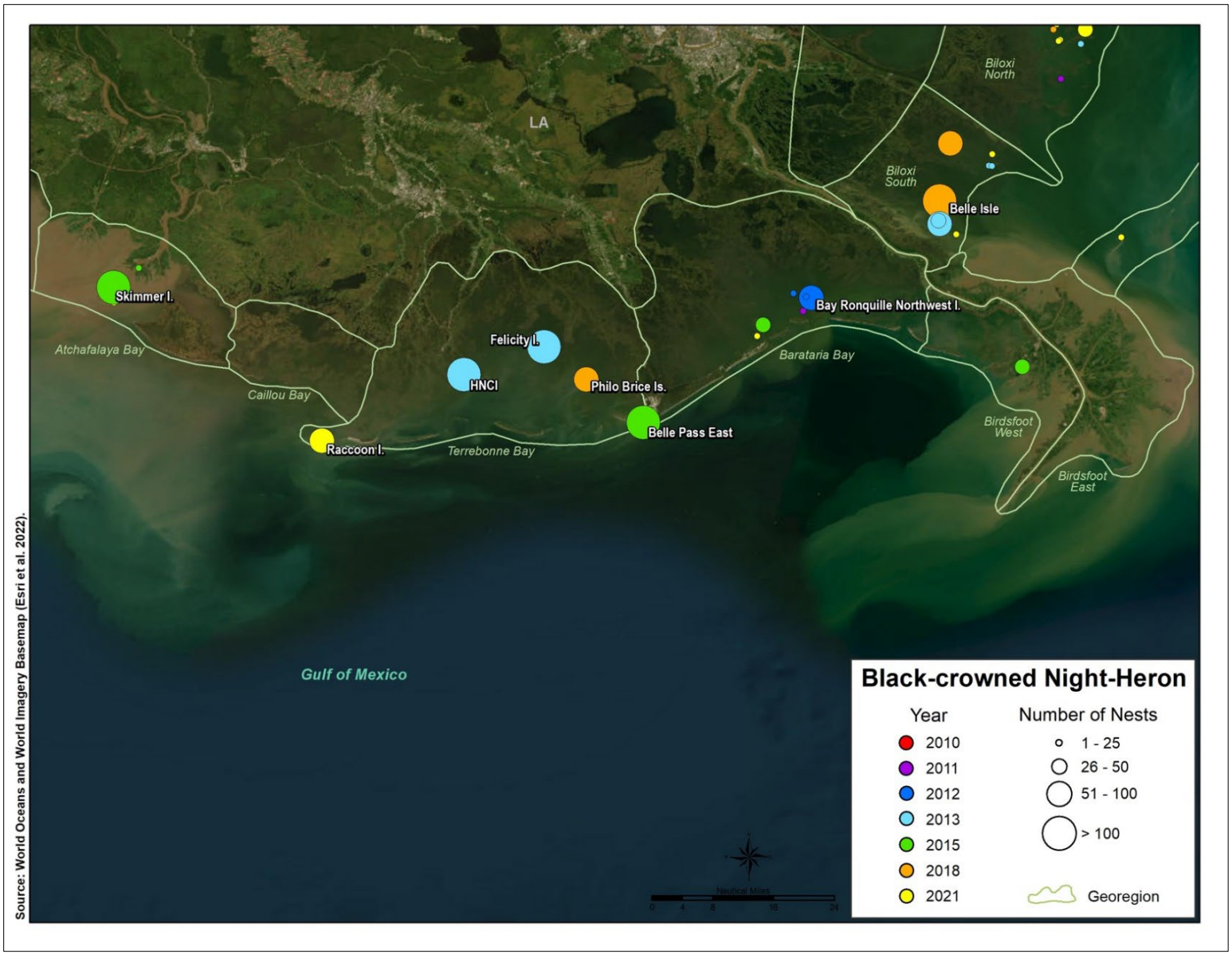
Table 2. Black-crowned Night-Heron nest counts for all colonies with at least one count of 50 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	East Matagorda Bay	Dressing Point	16	-	-	-	-	-	67
	Galveston	Nolan Ryan Marsh	ND	-	-	-	-	-	225
	Galveston	West Bay Bird Island	0	-	-	-	-	-	76
Alabama	Mobile Bay Interior	Gaillard Island	0	12	9	5	1	-	63
Louisiana	Sabine-Calcasieu	Rabbit Island	13	-	-	-	-	168	91
	Atchafalaya Bay	Skimmer Island	3	0	0	0	135	0	0
	Terrebonne Bay	Felicity Island	4	1	23	116	27	70	6
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	115	31	18	19
	Terrebonne Bay	Philo Brice Islands	0	0	0	0	0	84	43
	Terrebonne Bay	Raccoon Island	0	***17***	0	3	0	2	56
	Barataria Bay	Bay Ronquille Northwest Island	0	85	100	0	0	0	S
	Barataria Bay	Belle Pass East	4	0	0	0	197	2	0
	Biloxi South	Belle Isle	0	0	16	2	25	154	115
	Biloxi South	Biloxi South 11	4	43	7	59	0	0	0
	Biloxi South	Biloxi South 3	17	46	59	37	24	69	0

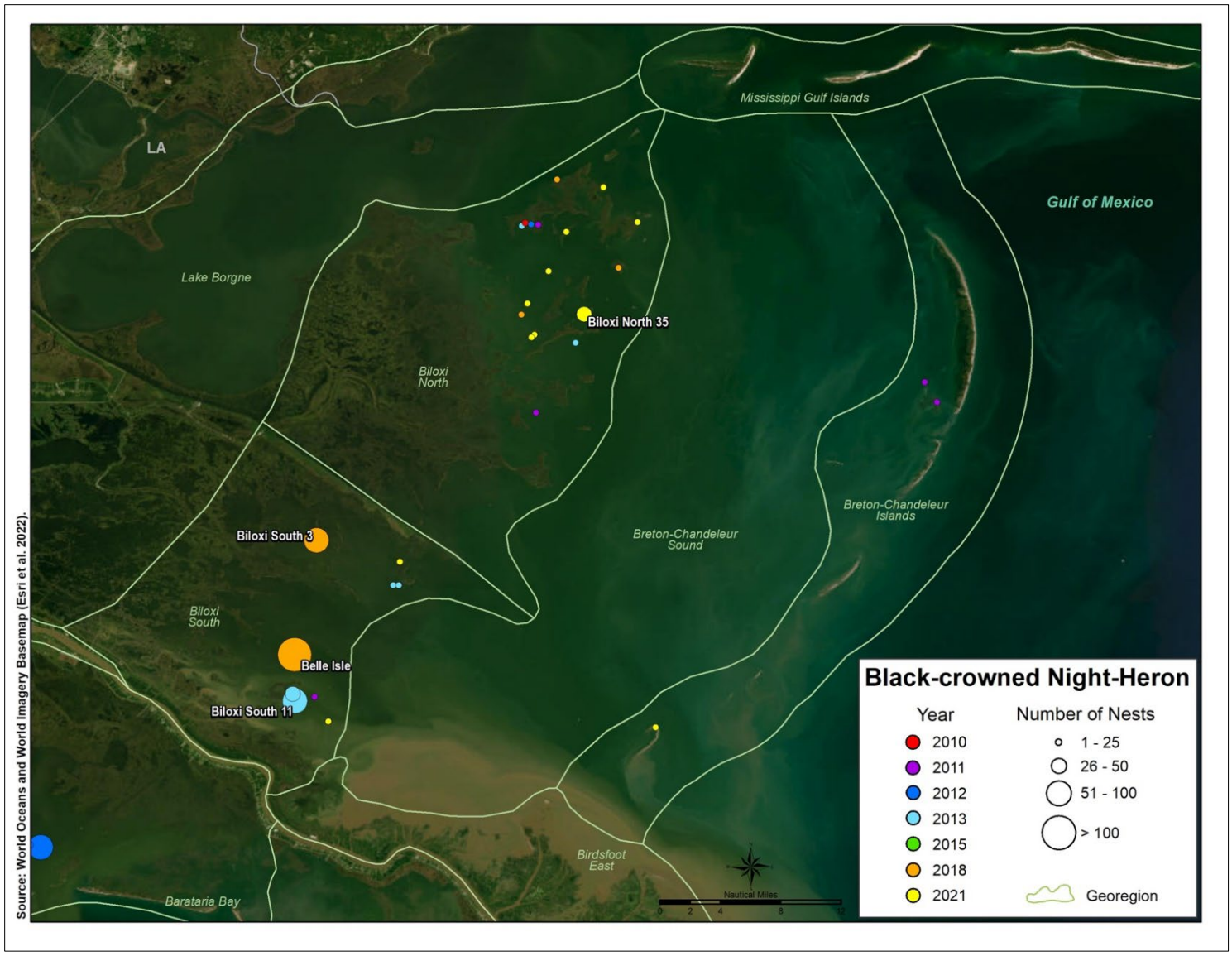
ND = No Data; S= submerged; - = Outside intended survey area; **Bold italics** indicate a sum of counts from May and June surveys.



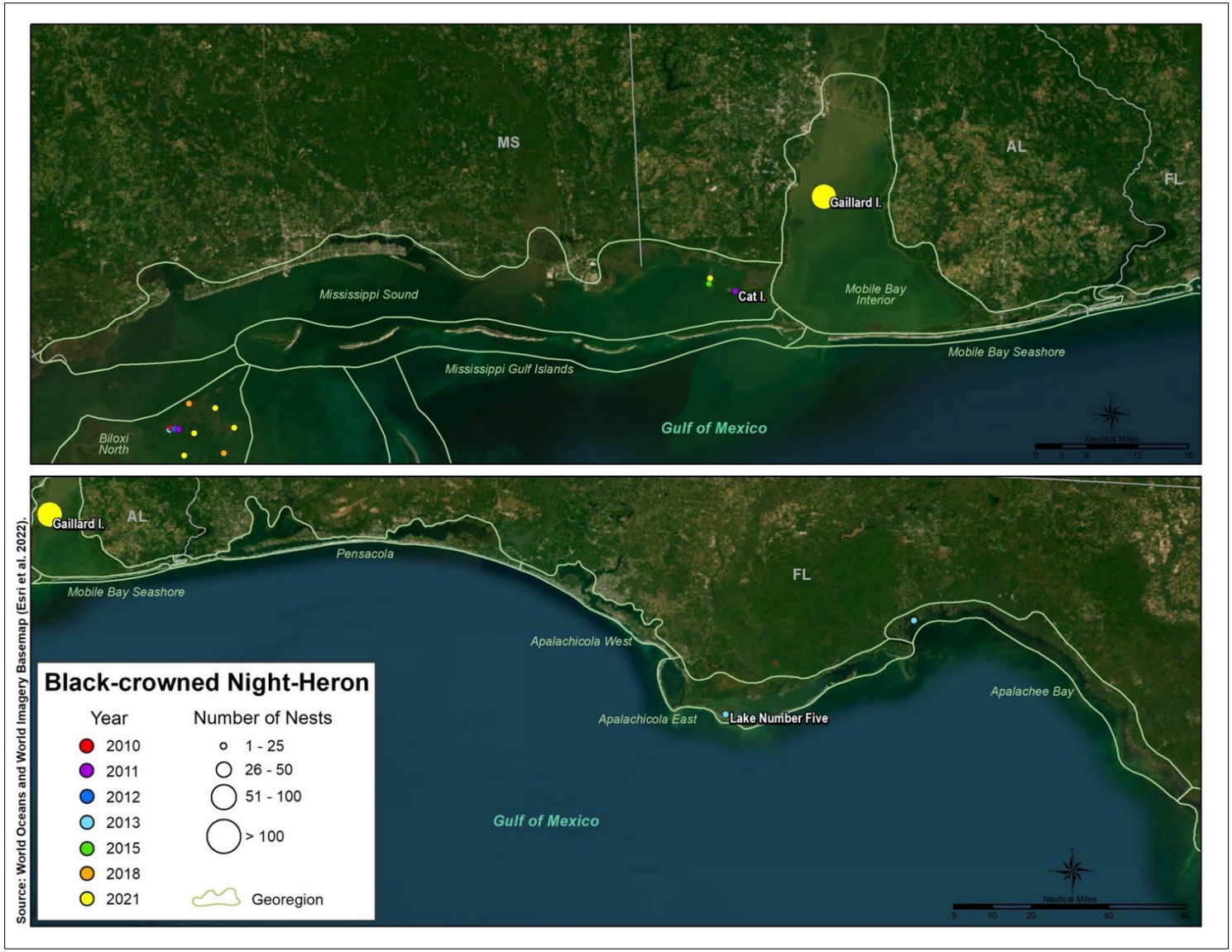
Map 1. Black-crowned Night-Heron colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Black-crowned Night-Heron colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Black-crowned Night-Heron colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Black-crowned Night-Heron colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

White Ibis

White Ibis nesting was documented at 81 colonies—49 in Louisiana, 26 in Texas, five in Alabama, and one in Florida (Maps 1–4). During aerial surveys and when analyzing aerial photographs, White Ibis is readily distinguishable from other wader species with white plumage due to its larger and denser colonies. For smaller groups or groups of mixed species, a White Ibis on a nest generally appears rounder and glossier, and the red, decurved bill is often visible in photographs. Although breeding colonies are conspicuous, colony locations can move from year to year.

In 2021, a total of 19,118 White Ibis nests were counted among 30 colonies (Table 1). Of those nests, 59% were among 14 Louisiana colonies, 30% were among 13 Texas colonies, and 10% were among three Alabama colonies. The three largest colonies—Bird Island East in Louisiana (9843 nests), South Deer Island in Texas (3116 nests), and Gaillard Island in Alabama (1591 nests)—accounted for 76% of all nests. Another 14 colonies had more than 100 nests—nine in Texas, four in Louisiana, and one (Marsh Island) in Alabama.

Table 1. Numbers of White Ibis nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	2716 (15)	-	-	-	-	-	5768 (13)
LA	6827 (17)	5108 (29)	9229 (20)	6086 (17)	8686 (20)	10,749 (20)	11,350 (14)
AL	4106 (2)	13,438 (3)	4700 (4)	4140 (3)	5466 (2)	-	2000 (3)
FL	0	0	0	4 (1)	0	-	0
Total	**13,649 (34)**	**18,546 (32)**	**13,929 (24)**	**10,230 (21)**	**14,152 (22)**	**10,749 (20)**	**19,118 (30)**

() = colonies counted; - = state not included in survey area that year.

Gaillard Island and a colony that moved locations in Atchafalaya Bay in Louisiana consistently had the highest nest counts from 2010 to 2021 (Table 2, Figure 1). At Gaillard Island, nest totals fluctuated slightly, except for a dramatic influx in 2011 to 12,511 nests, the highest colony count across the Study Area and all years (Map 4). The White Ibis colony in Atchafalaya Bay occurred at Skimmer Island from 2010 to 2015. By 2018 it had moved to Bird Island West, and by 2021 it had moved to Bird Island East (Map 2). Construction activities were evident in satellite imagery at Bird Island East in 2012 and on Skimmer Island in 2019, as was the creation of other new islands (Google 2022). Furthermore, in 2022 (beyond the scope of this report), the colony had switched again slightly southeast to Point au Fer. From 2012 to 2021, Atchafalaya Bay accounted for at least 50% of nests in the survey area. However, lack of data for Rabbit Island from 2011 to 2015 prevents a more complete understanding of statewide trends in Louisiana. Among other Louisiana GeoRegions, Biloxi North and Biloxi South together hosted more than 1000 nests in all years except 2015 (Figure 1). The largest Biloxi Marsh colonies were at Belle Isle in Biloxi South in 2018 (890 nests) and at Biloxi North 16 in 2021 (839 nests; Map 3).

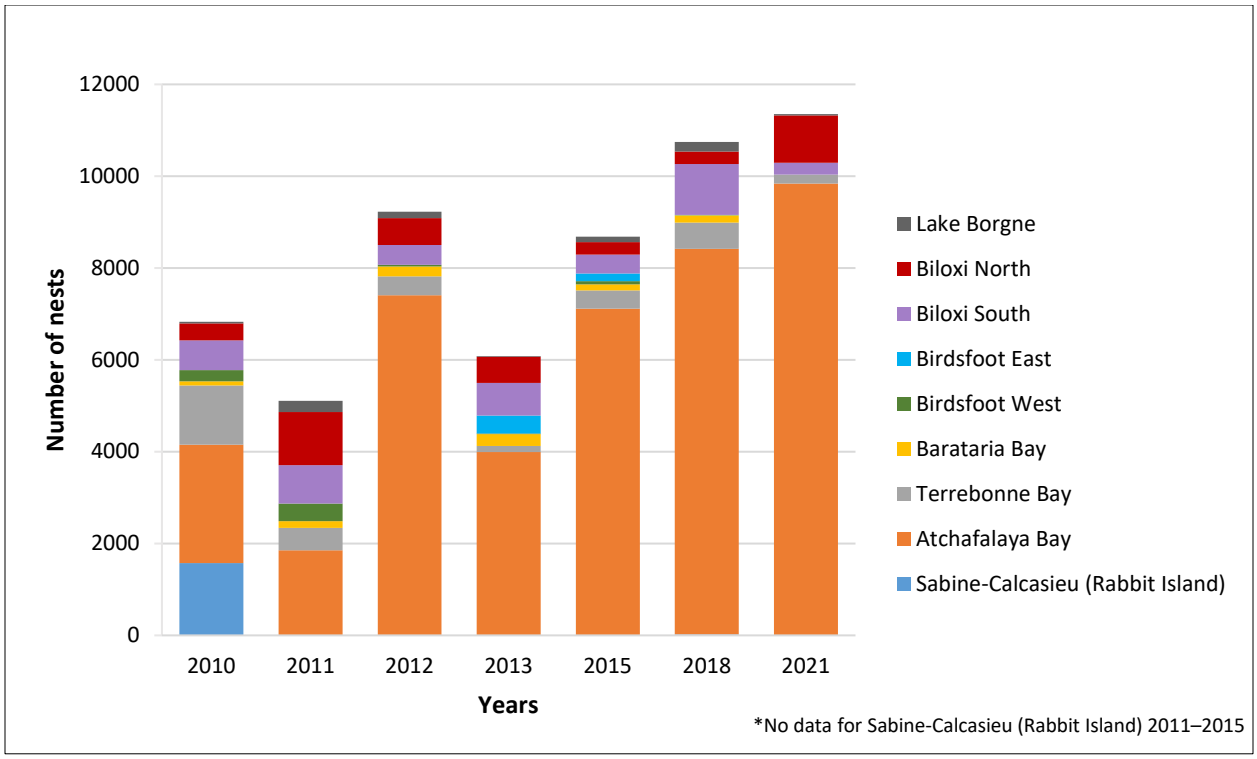


Figure 1. Numbers of White Ibis nests in Louisiana by GeoRegion, 2010–2021.

Breeding phenology appeared earlier and more protracted in Atchafalaya Bay compared with Gaillard Island. In May 2015, birds on Skimmer Island in Atchafalaya Bay showed a complete range of phenology, from fledged broods (45% of nests) to adults in early nest-building stages (nearly 1000 territories). The number of fledged broods may have been even higher, as young were observed in dense shrubs and grasses, and some broods might have been concealed. Conversely, birds were primarily in the incubation stage at the same time on Gaillard Island, though some chicks moving away from nests were noted. In 2021, the nest total at Bird Island East was derived roughly evenly from May (45% of nests) and June (55% of nests) photographs, whereas 99% of nests at Gaillard Island were counted from June photographs. At Bird Island East in June, 13% of the new nests had visible chicks, whereas < 1% of nests had chicks on Gaillard Island. Both 2015 and 2021 counts indicate that nesting began earlier and was more staggered in Atchafalaya Bay than at Gaillard Island.

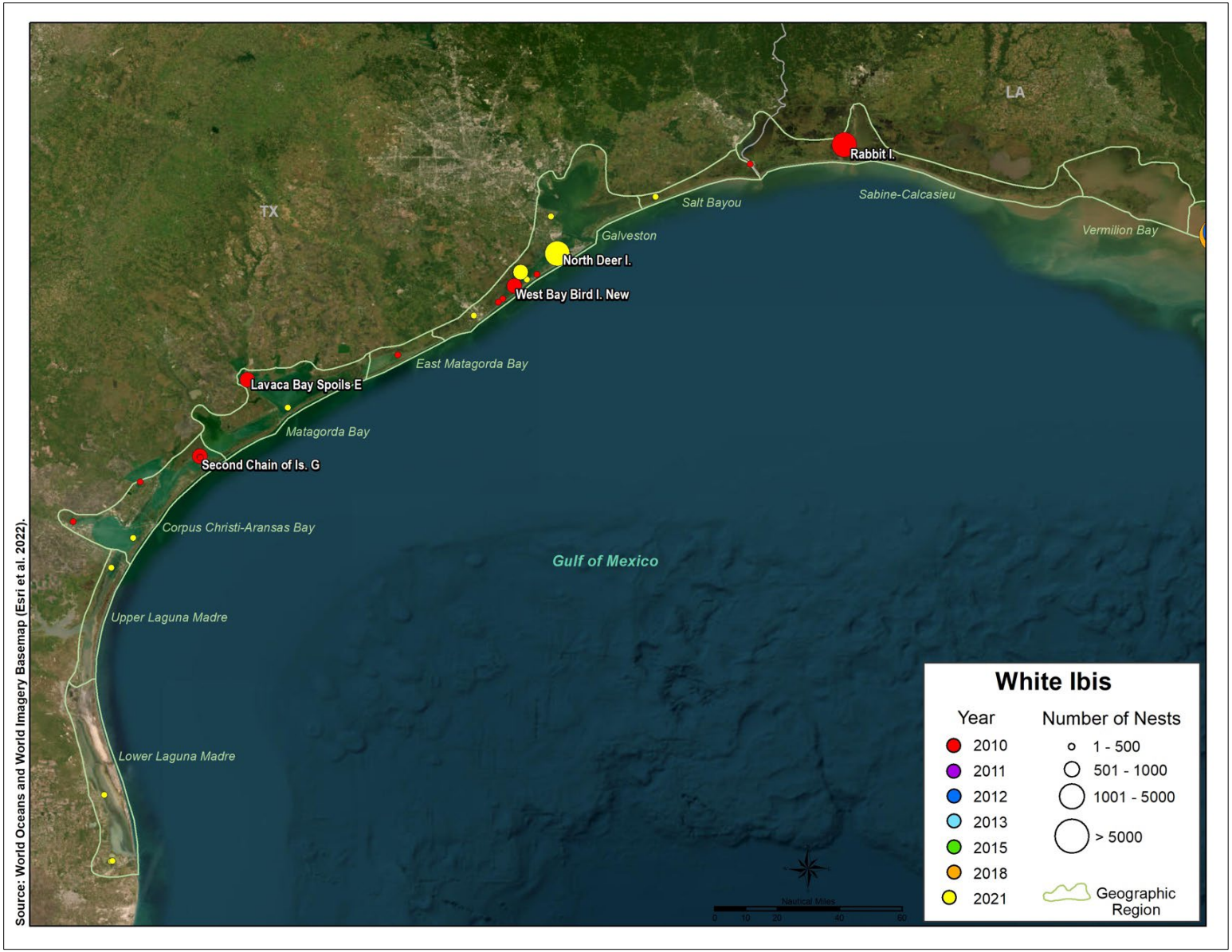
Among other large colonies (Table 2), declining nest numbers at Felicity Island, Louisiana, associated with land loss mirror the trend observed for Tricolored Heron. Low nest totals at Rabbit Island in Louisiana in 2018 and the large apparent increase at South Deer Island in Texas in 2021 are difficult to interpret without data from intervening years. Also of note is that no White Ibis nested at Rabbit Island in 2021, immediately following restoration.

Table 2. White Ibis nest counts for all colonies with at least one count of 1000 nests or more, 2010–2021.

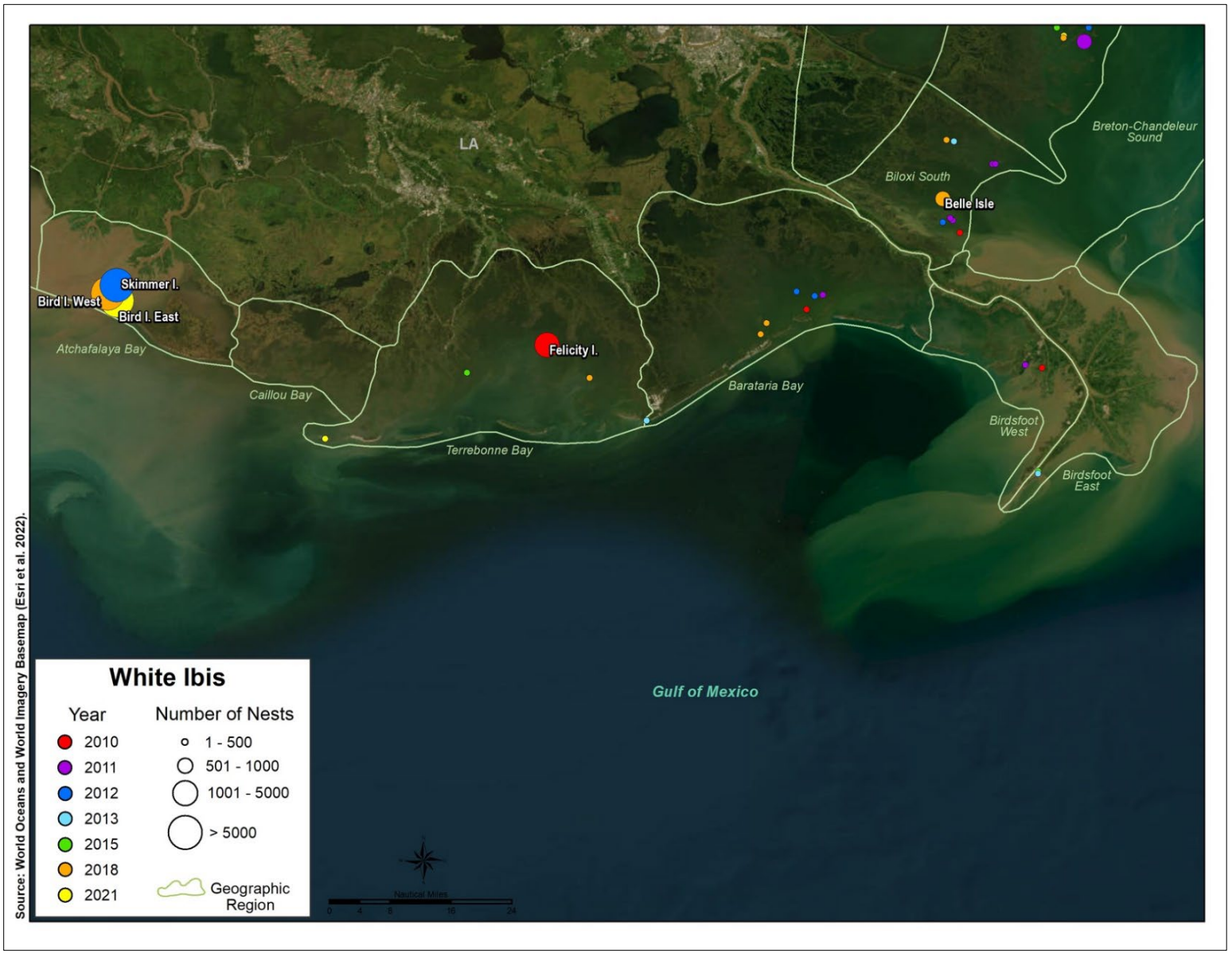
State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Galveston	South Deer Island	0[1]	-	-	-	-	-	3116
Alabama	Mobile Bay Interior	Gaillard Island	3880	12,511	4063	3552	5375	-	***1591***
Louisiana	Sabine-Calcasieu	Rabbit Island	1568	-	-	-	-	20	0
	Atchafalaya Bay	Bird Island East	0	0	0	0	0	0	***9843***
	Atchafalaya Bay	Bird Island West	0	0	0	0	0	8397	0
	Atchafalaya Bay	Skimmer Island	2581	1855	7407	3991	7113	0	0
	Terrebonne Bay	Felicity Island	1288	487	411	***134***	***329***	227	0

- = Outside intended survey area; Bold italics indicate a sum of counts from May and June surveys.

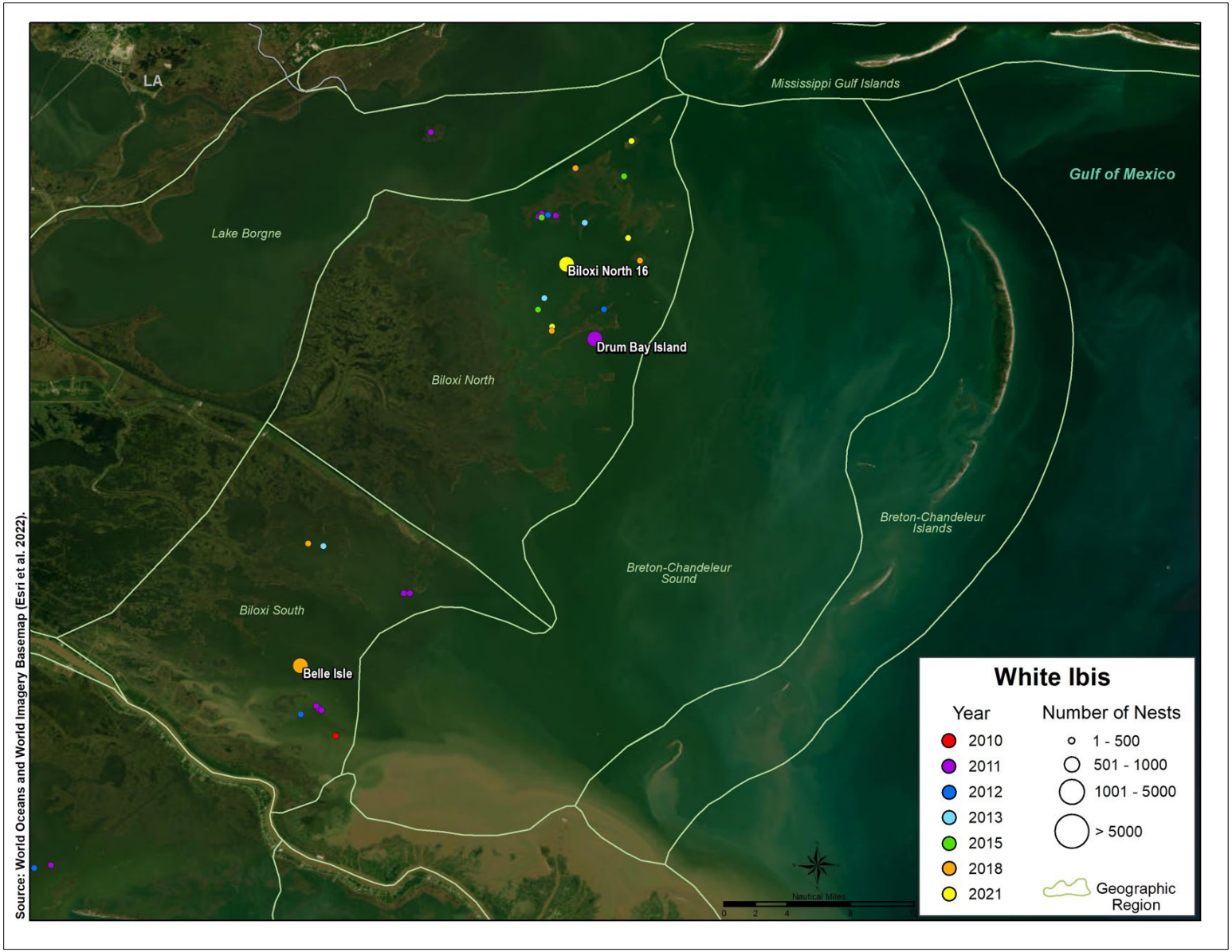
[1]On 25 June 2010, we flew directly over South Deer Island and did not take any photographs, indicating no nesting waterbirds were present.



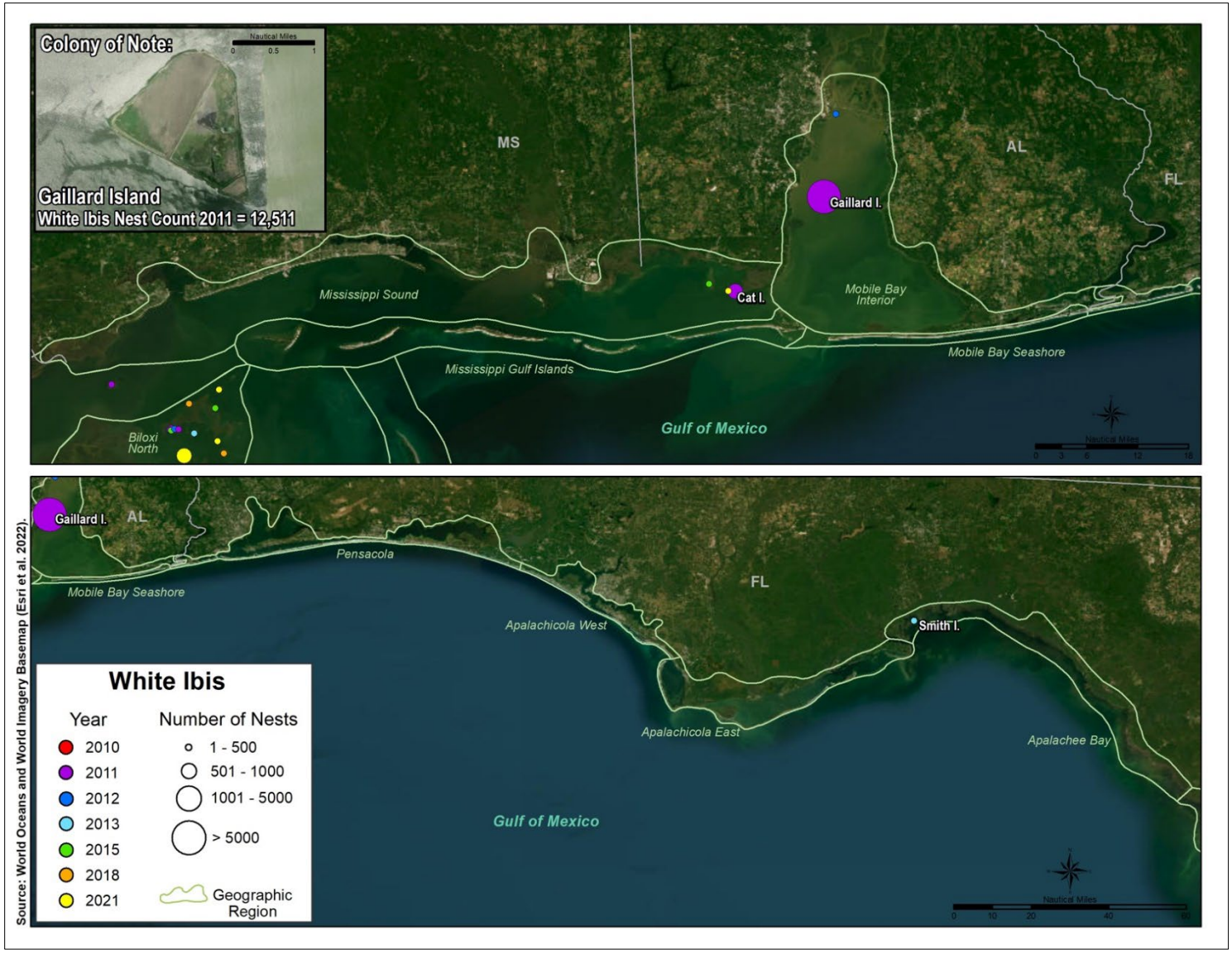
Map 1. White Ibis colonies in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 2. White Ibis colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. White Ibis colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. White Ibis colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.

Glossy Ibis and White-faced Ibis

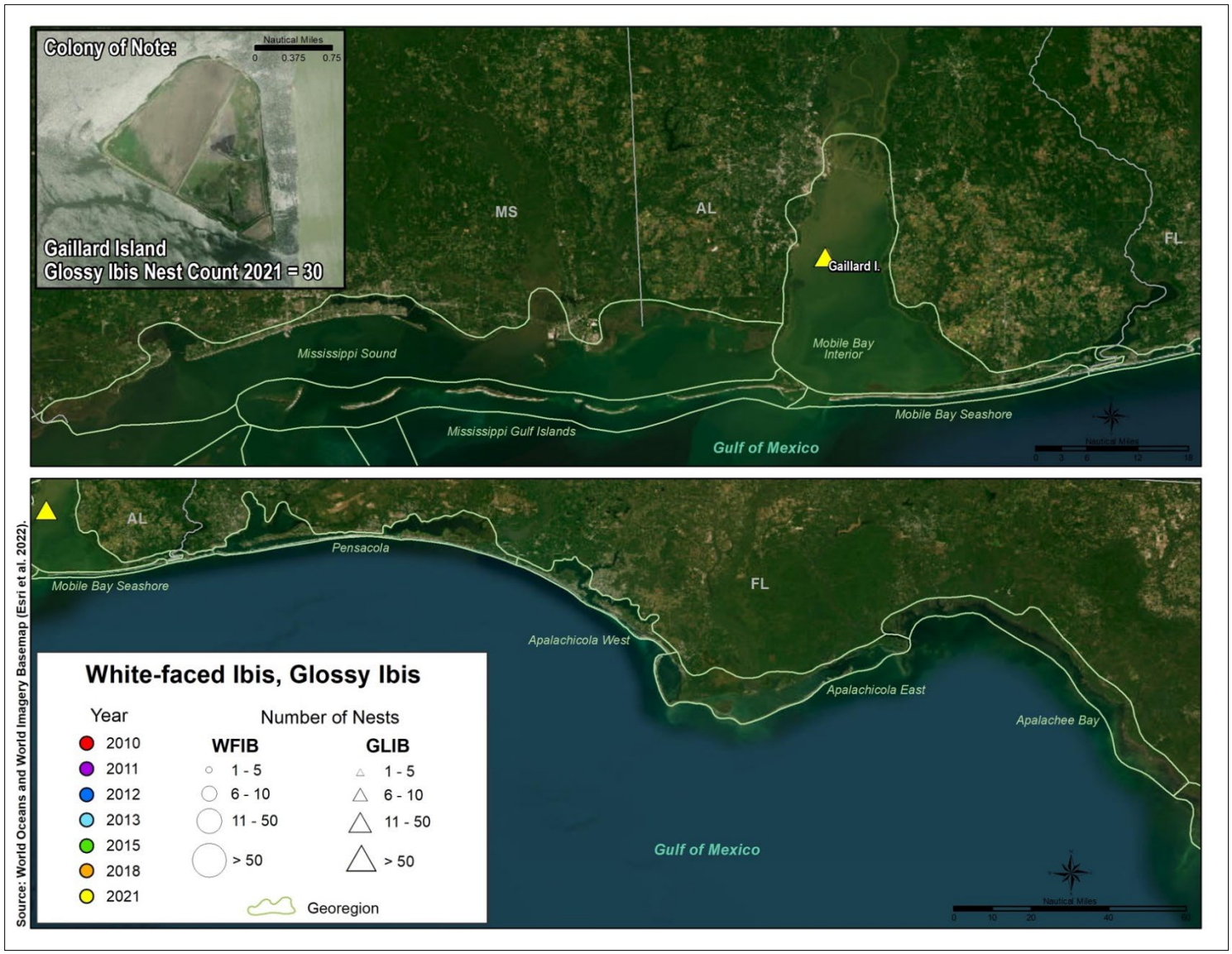
Glossy Ibis and White-faced Ibis were rarely encountered (Maps 1 and 2). Both species have maroon-metallic plumage and a long, curved bill, and both are larger than Cattle Egret and smaller than Great Egret. In aerial photographs, only the dark plumage and general size and shape of birds were evident. Therefore, identification was based mainly on local nesting records and differences in nesting habitat, with White-faced Ibis nesting mainly in low herbaceous vegetation and Glossy Ibis nesting mainly higher in more structured vegetation (Figure 1).

Figure 1. A: Two White-faced Ibis nests (indicated by red arrows) at North Deer Island, Texas in 2021. B: One Glossy Ibis nest (indicated by red arrow) at Nolan Ryan Marsh, Texas in 2021.

Glossy Ibis nesting was documented at just two colonies in 2021, with 30 nests at Gaillard Island in Alabama and six nests at Nolan Ryan Marsh in Texas.

White-faced Ibis nesting was documented at just five colonies in Texas, two colonies in 2010 and four colonies in 2021, with nests counted at North Deer Island both years. The largest colony was at South Deer Island (203 nests) in 2021, with another 158 nests at the adjacent North Deer Island. Burger and Miller (1977) described White-faced Ibis at a colony in Texas as nesting "on dry land…on the ground among low shrubs and in mixed forbs rather than in habitats containing grass and cactus".

Map 1. Glossy Ibis and White-faced Ibis colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest White-faced Ibis colony count across the Study Area and all years.



Map 2. Glossy Ibis and White-faced Ibis colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest Glossy Ibis colony count across the Study Area and all years.

Roseate Spoonbill

Roseate Spoonbill nesting was documented at 73 colonies—38 in Louisiana, 34 in Texas, and one in Alabama (Maps 1–4). Identifying Roseate Spoonbill in aerial photographs was effortless due to its large size, long flattened bill, and bright pink plumage. However, extra care must be taken with bird and nest categorizations when large chicks are present, to ensure nest counts are accurate. Some concealment by vegetation can also occur.

In 2021, a total of 1878 Roseate Spoonbill nests were counted among 43 colonies (Table 1). Of those nests, 78% were among 27 Texas colonies and 21% were among 15 Louisiana colonies. In Alabama, four nests were at Gaillard Island. Colony totals in Texas and Louisiana were derived roughly evenly from May and June surveys. The largest colonies were at Green Island (269 nests), West Bay Bird Island (268 nests), and Shamrock Island (241 nests) in Texas. Another two colonies had more than 100 nests—Philo Brice Islands in Louisiana and North Deer Island in Texas.

Table 1. Numbers of Roseate Spoonbill nests by state, 2010–2021.

State	2010	2011	2012	2013	2015	2018	2021
TX	249 (14)	-	-	-	-	-	1472 (27)
LA	649 (12)	551 (11)	360 (11)	524 (15)	407 (14)	595 (12)	402(15)
AL	0	0	0	0	0	-	4 (1)
Total	**898 (26)**	**551 (11)**	**360 (11)**	**524 (15)**	**407 (14)**	**595 (12)**	**1878 (43)**

() = number of colonies; - = state not included in survey area that year.

In Texas, of the 34 colonies documented, just seven were counted in both 2010 and 2021. The combined nest total for these seven colonies was 250% higher in 2021. This increase could indicate a larger breeding population in 2021 but may also reflect the lack of May surveys in 2010, which could have led to underestimates that year. Among the largest colonies in 2021, West Bay Bird Island was counted from May photographs and had 17% of nests with visible chicks. In June, more than half of the nests at Shamrock Island had visible chicks.

In Louisiana, statewide totals did not vary greatly among years, but variation across colonies was evident (Figure 1, Table 2). Submerged islands (Cat Bay Island and others) led to decreased nest numbers in Barataria Bay after 2015, while other habitat changes led to apparent colony shifting, such as from Biloxi South 11 to Belle Isle after 2013. Similarly, Roseate Spoonbills in Terrebonne Bay, as with other species, also appeared to have switched from the shrinking Felicity Island to Philo Brice Islands by 2021.

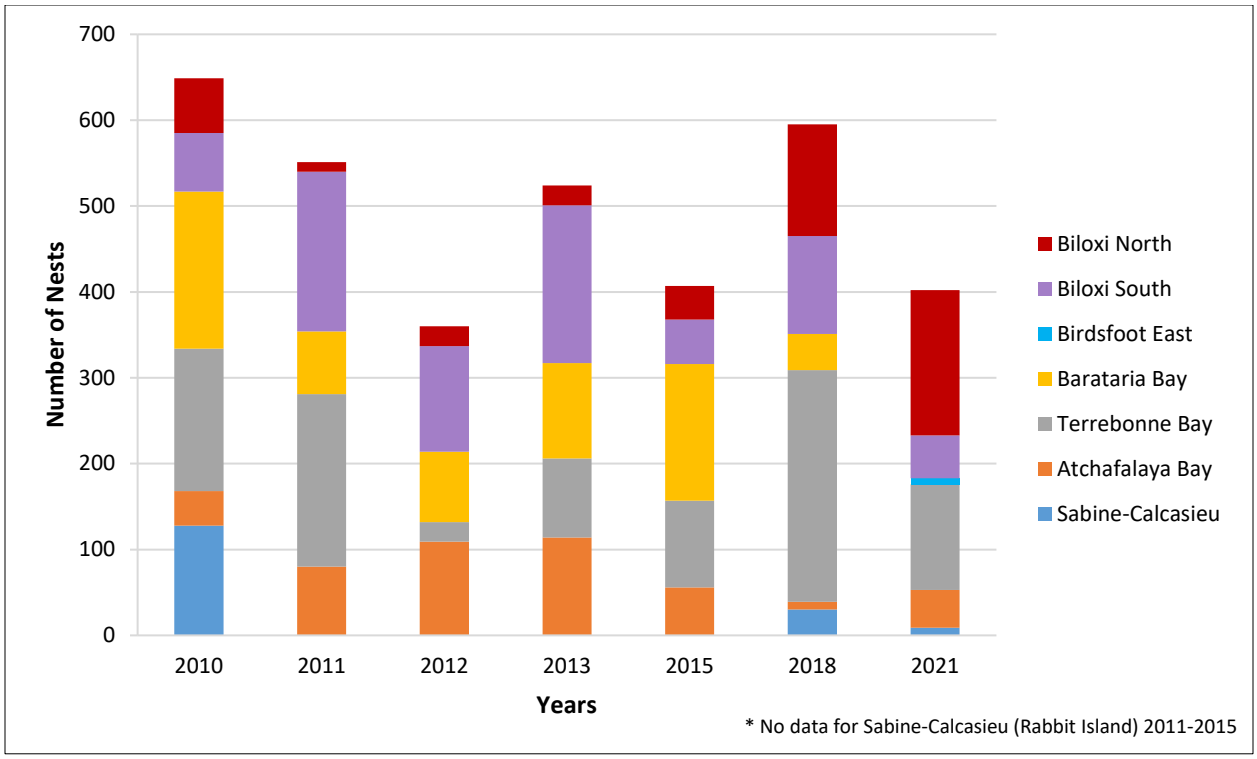
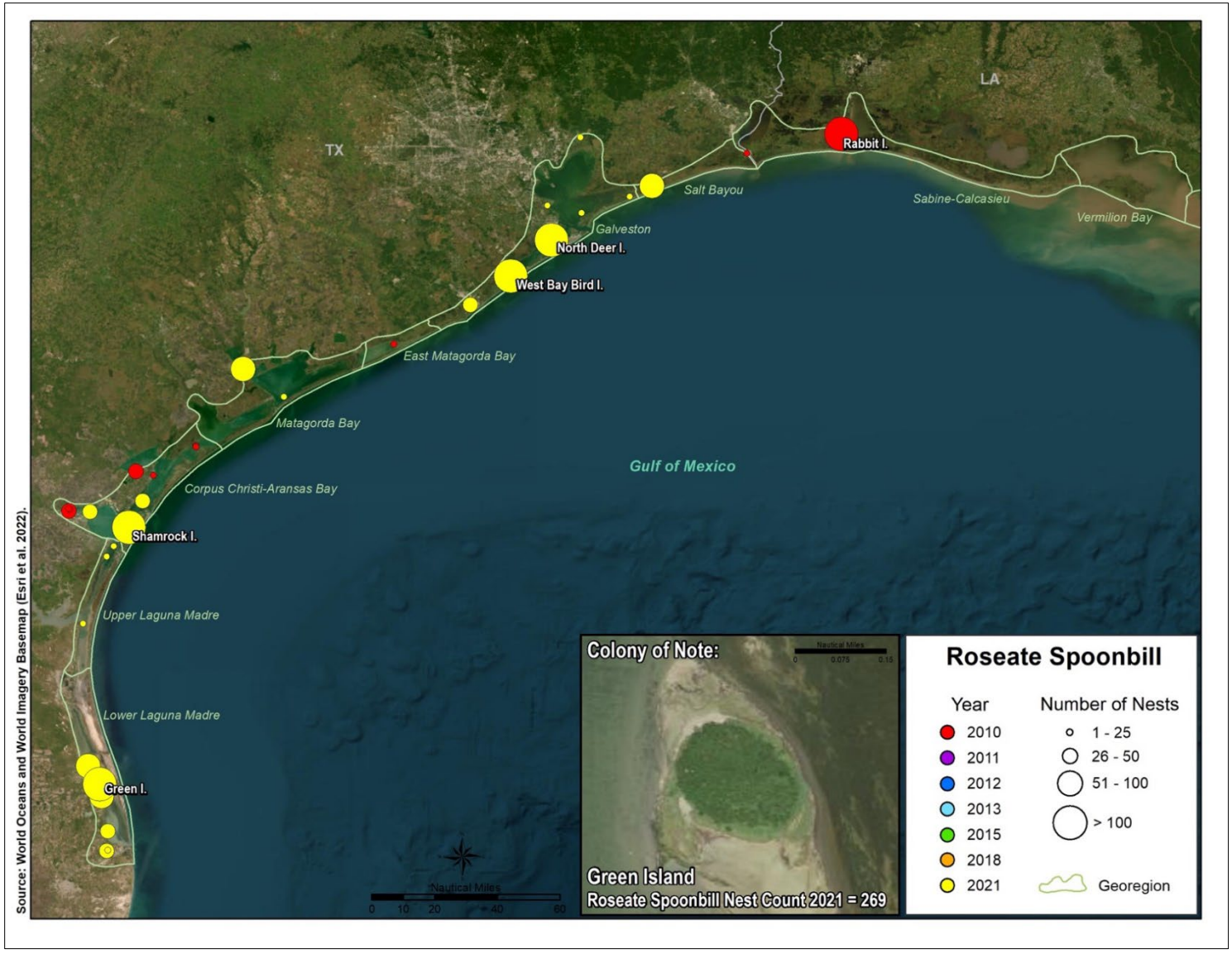


Figure 1. Numbers of Roseate Spoonbill nests in Louisiana by GeoRegion, 2010–2021.

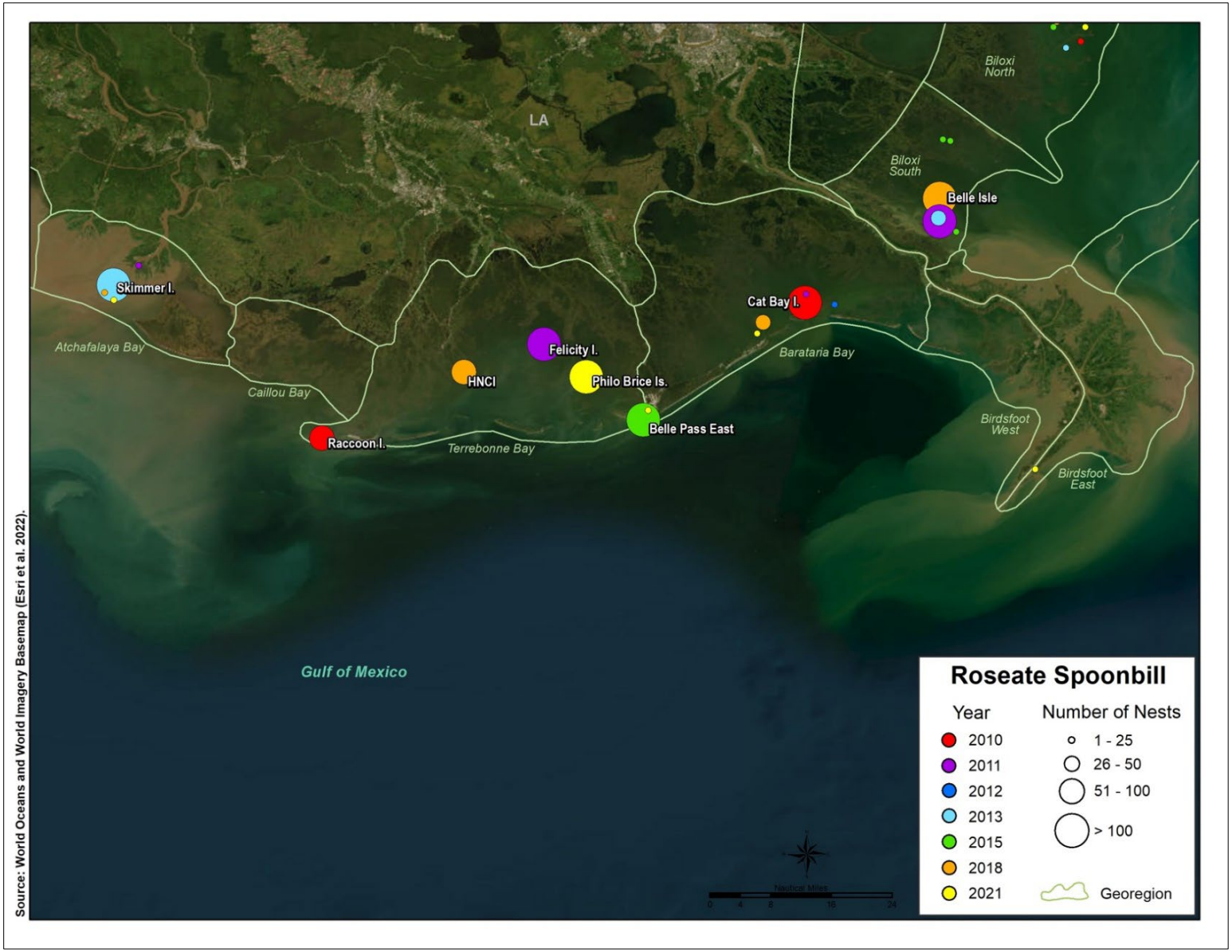
Table 2. Roseate Spoonbill nest counts for all colonies with at least one count of 50 nests or more, 2010–2021.

State	GeoRegion	Colony Name	2010	2011	2012	2013	2015	2018	2021
Texas	Lower Laguna Madre	Arroyo Colorado Spoils B1	-	-	-	-	-	-	84
	Lower Laguna Madre	Green Hill Spoils B	-	-	-	-	-	-	68
	Lower Laguna Madre	Green Island	-	-	-	-	-	-	269
	Corpus Christi-Aransas Bay	Shamrock Island	-	-	-	-	-	-	241
	Matagorda Bay	Lavaca Bay Spoils E	0	-	-	-	-	-	84
	Galveston	North Deer Island	54	-	-	-	-	-	101
	Galveston	West Bay Bird Island	9	-	-	-	-	-	268
	Salt Bayou	High Island	24	-	-	-	-	-	76
Louisiana	Sabine-Calcasieu	Rabbit Island	116	-	-	-	-	30	9
	Atchafalaya Bay	Skimmer Island	38	56	88	110	56	0	0
	Terrebonne Bay	Felicity Island	79	145	21	22	48	76	0
	Terrebonne Bay	Houma Navigation Canal Island	ND	ND	ND	69	53	81	0
	Terrebonne Bay	Philo Brice Islands	0	0	0	0	0	101	113
	Terrebonne Bay	Raccoon Island	87	***56***	2	1	0	12	4
	Barataria Bay	Belle Pass East	81	22	54	103	140	0	0
	Barataria Bay	Cat Bay Island	102	1	0	0	0	S	S
	Biloxi South	Belle Isle	0	0	0	0	26	114	50
	Biloxi South	Biloxi South 11	32	186	123	141	0	0	0
	Biloxi North	Biloxi North 12	0	0	0	0	0	0	***56***
	Biloxi North	Biloxi North 16	0	0	0	14	0	0	72
	Biloxi North	Biloxi North 38	0	0	0	0	14	89	0

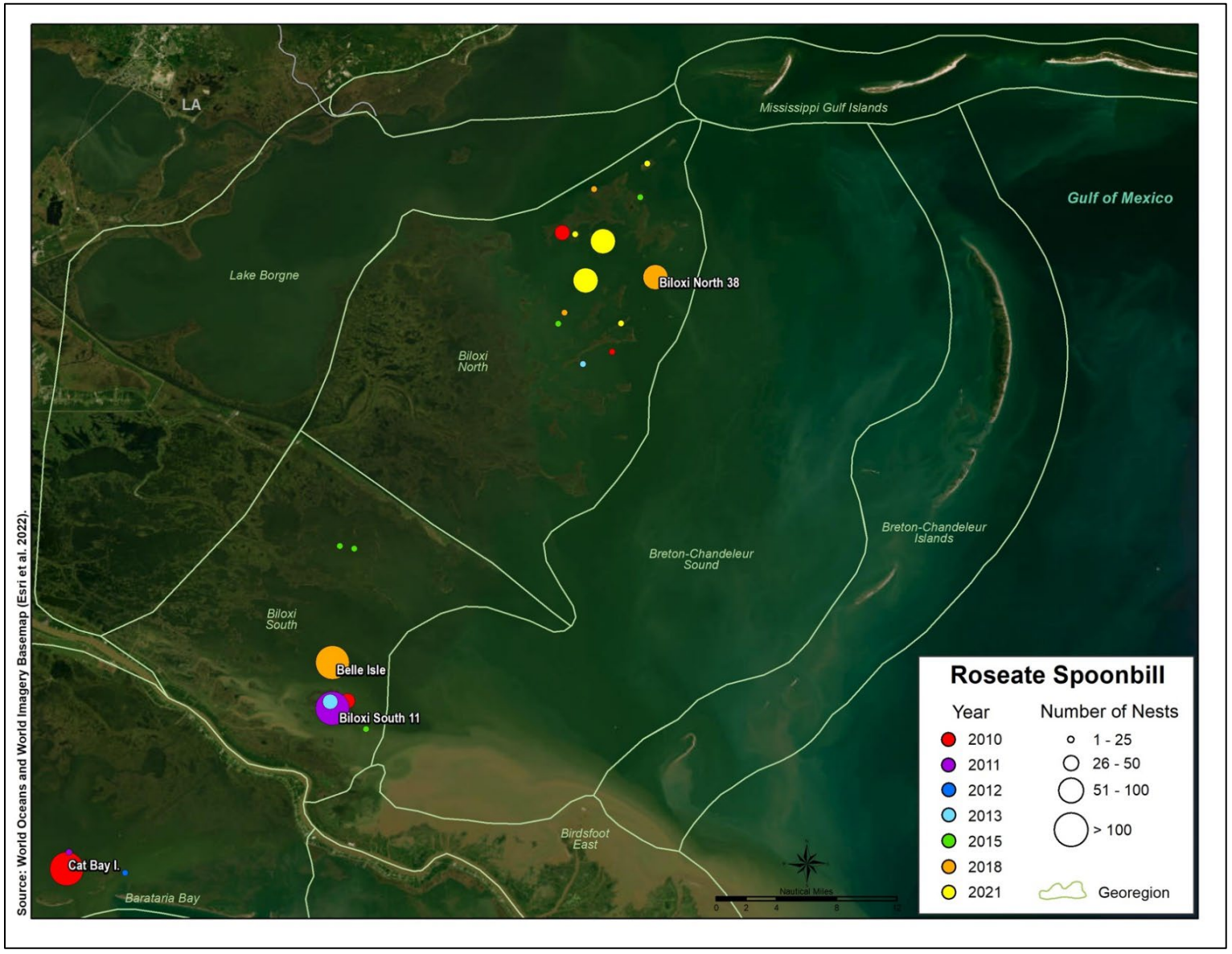
- = Outside intended survey area; ND = No Data; S = Submerged; **Bold italics** indicate a sum of counts from May and June surveys.



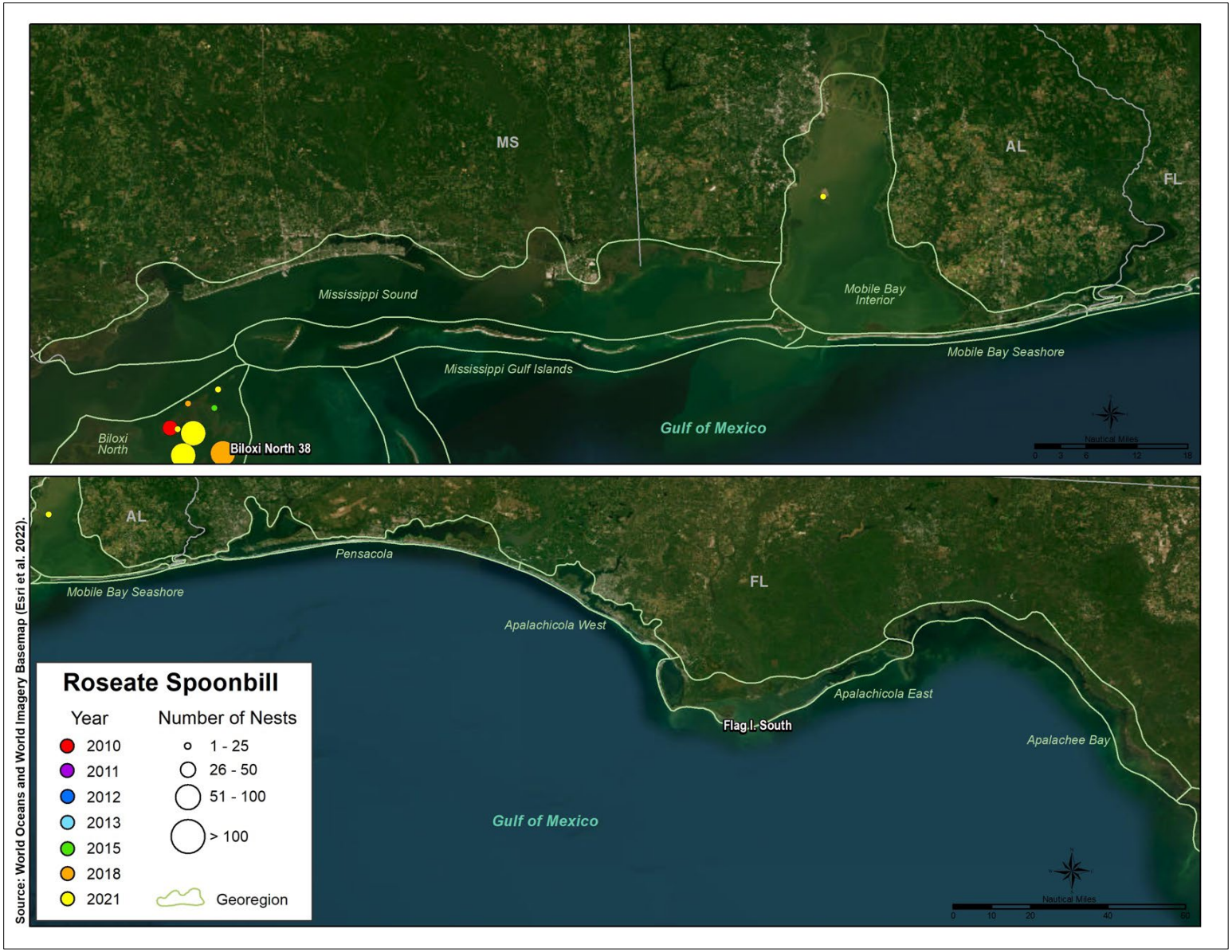
Map 1. Roseate Spoonbill colonies counted in Texas and western Louisiana, 2010–2021, with year and range of maximum count indicated. The inset highlights the largest colony count across the Study Area and all years.



Map 2. Roseate Spoonbill colonies counted in central Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 3. Roseate Spoonbill colonies counted in eastern Louisiana, 2010–2021, with year and range of maximum count indicated.



Map 4. Roseate Spoonbill colonies counted from Mississippi to Florida, 2010–2021, with year and range of maximum count indicated.

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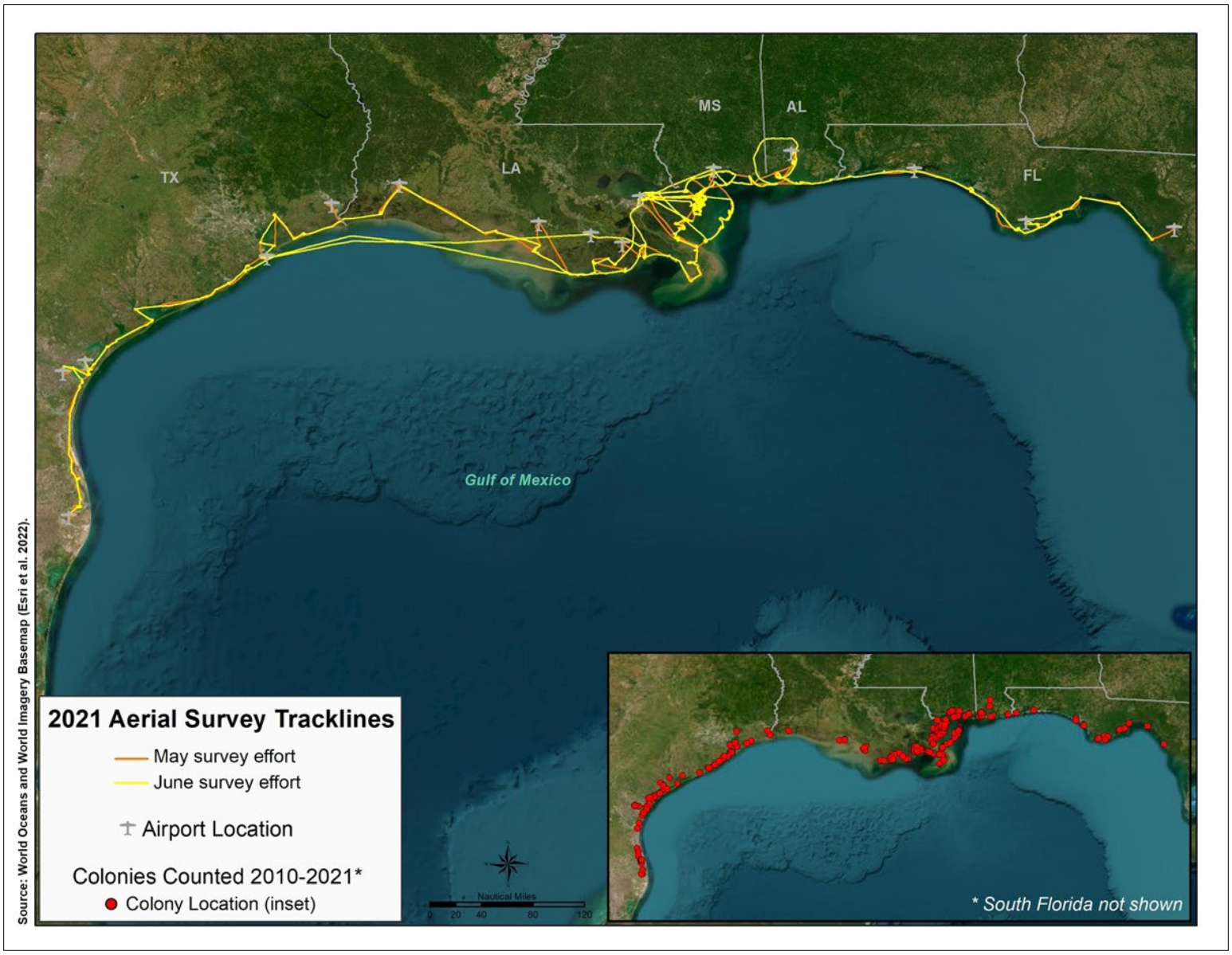

Figure 1. Aerial photographic survey tracklines, May and June 2021, from Texas to Florida.

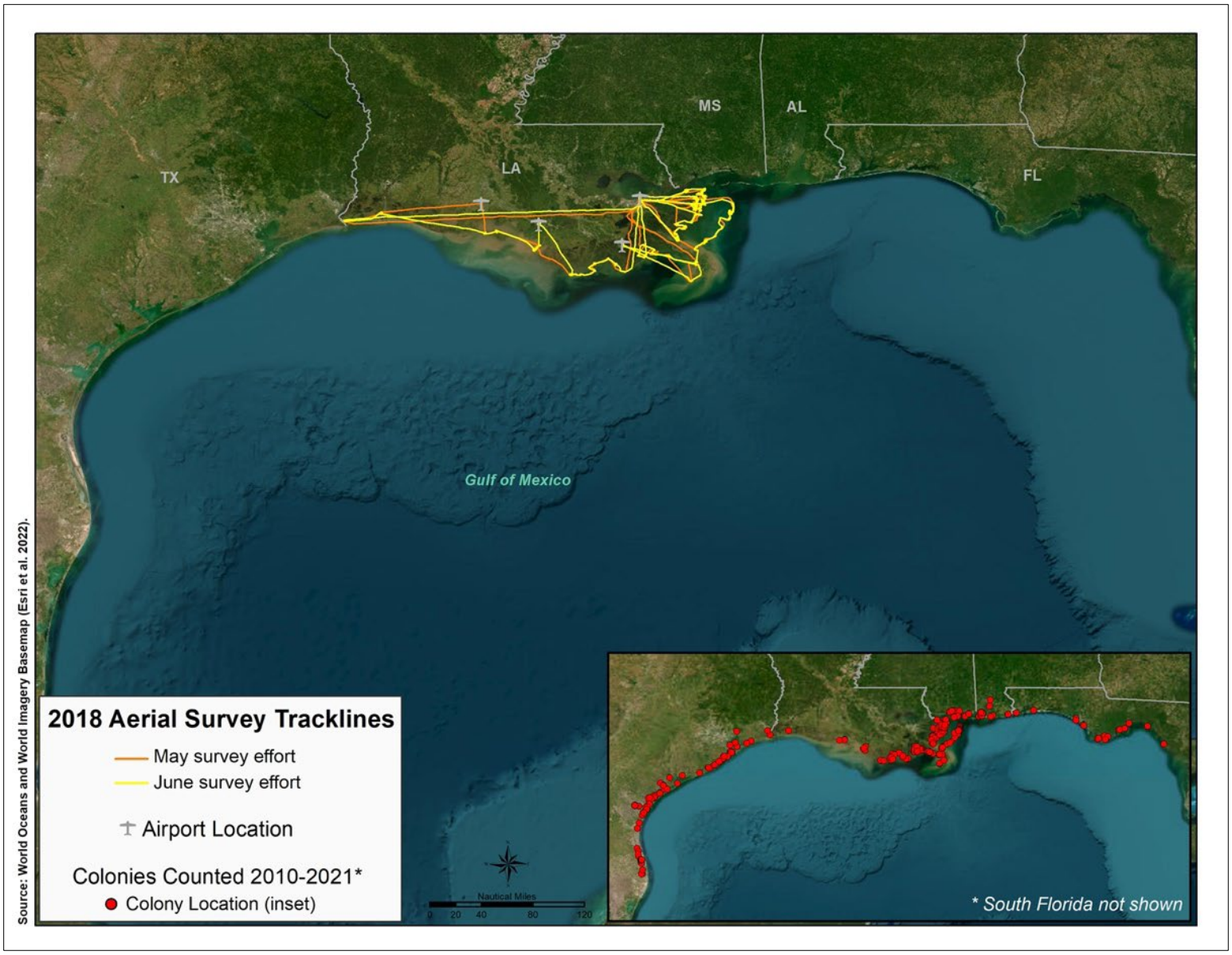

Figure 2. Aerial photographic survey tracklines, May and June 2018, in Louisiana.

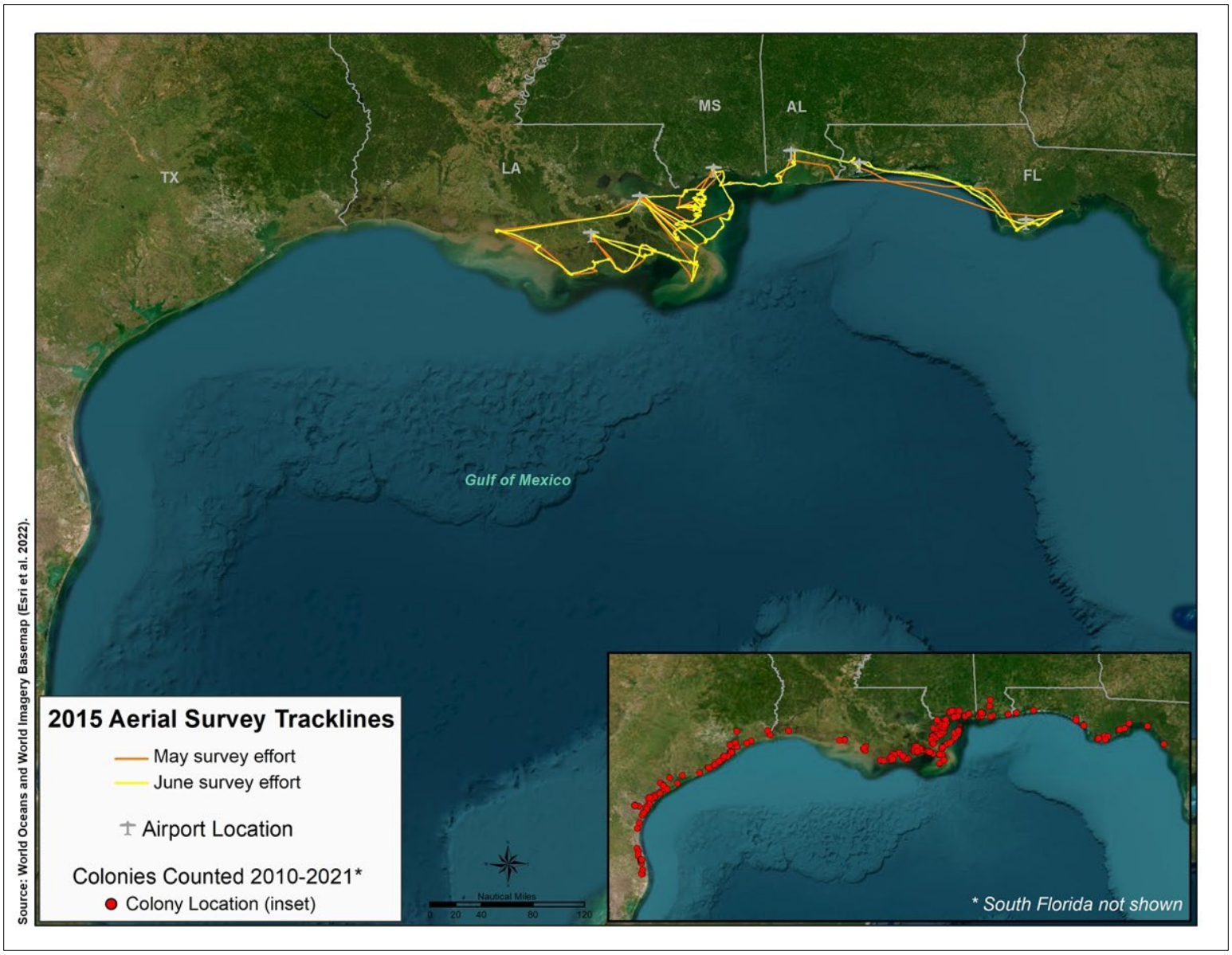

Figure 3. Aerial photographic survey tracklines, May and June 2015, Louisiana to Florida.

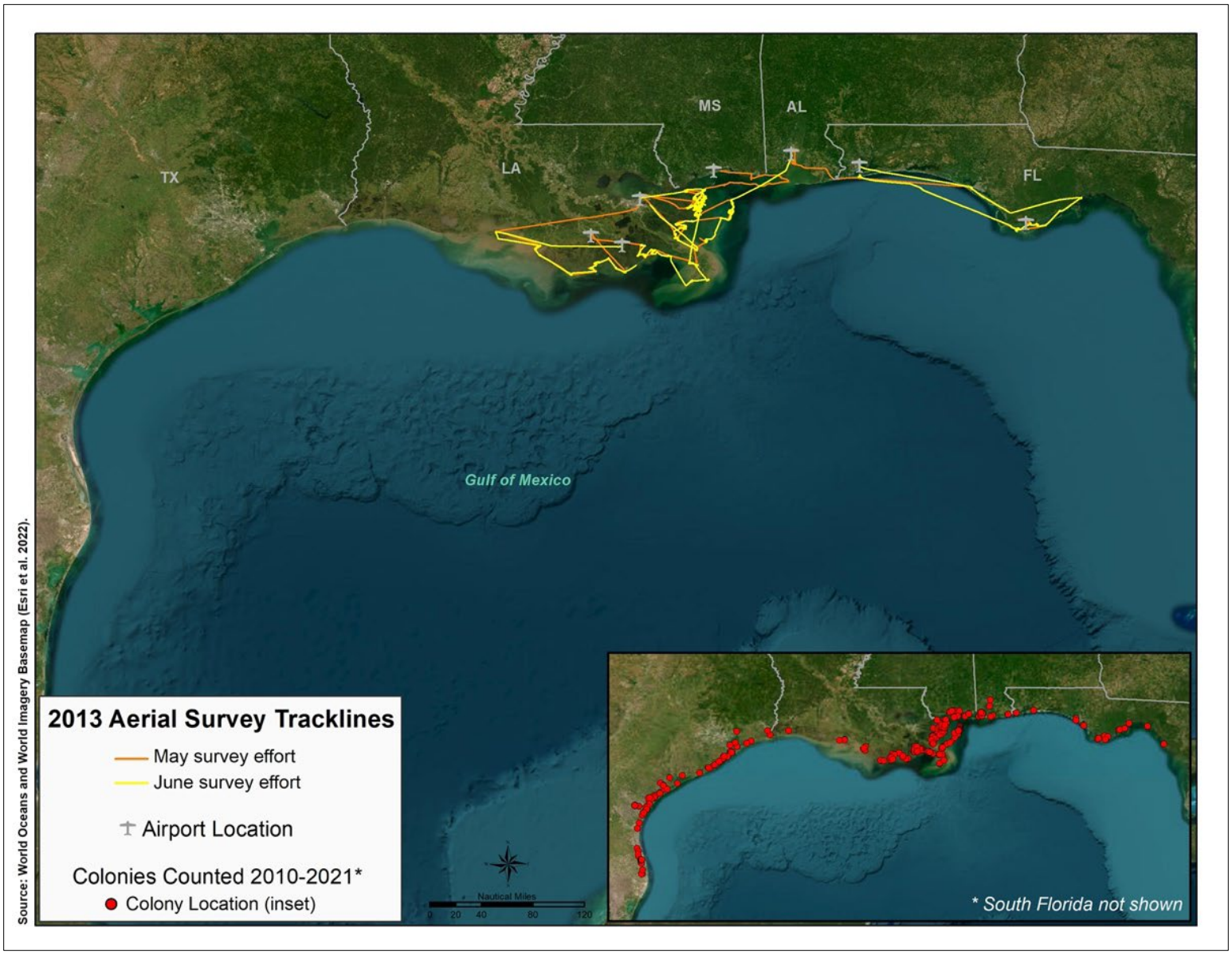

Figure 4. Aerial photographic survey tracklines, May and June 2013, Louisiana to Florida.

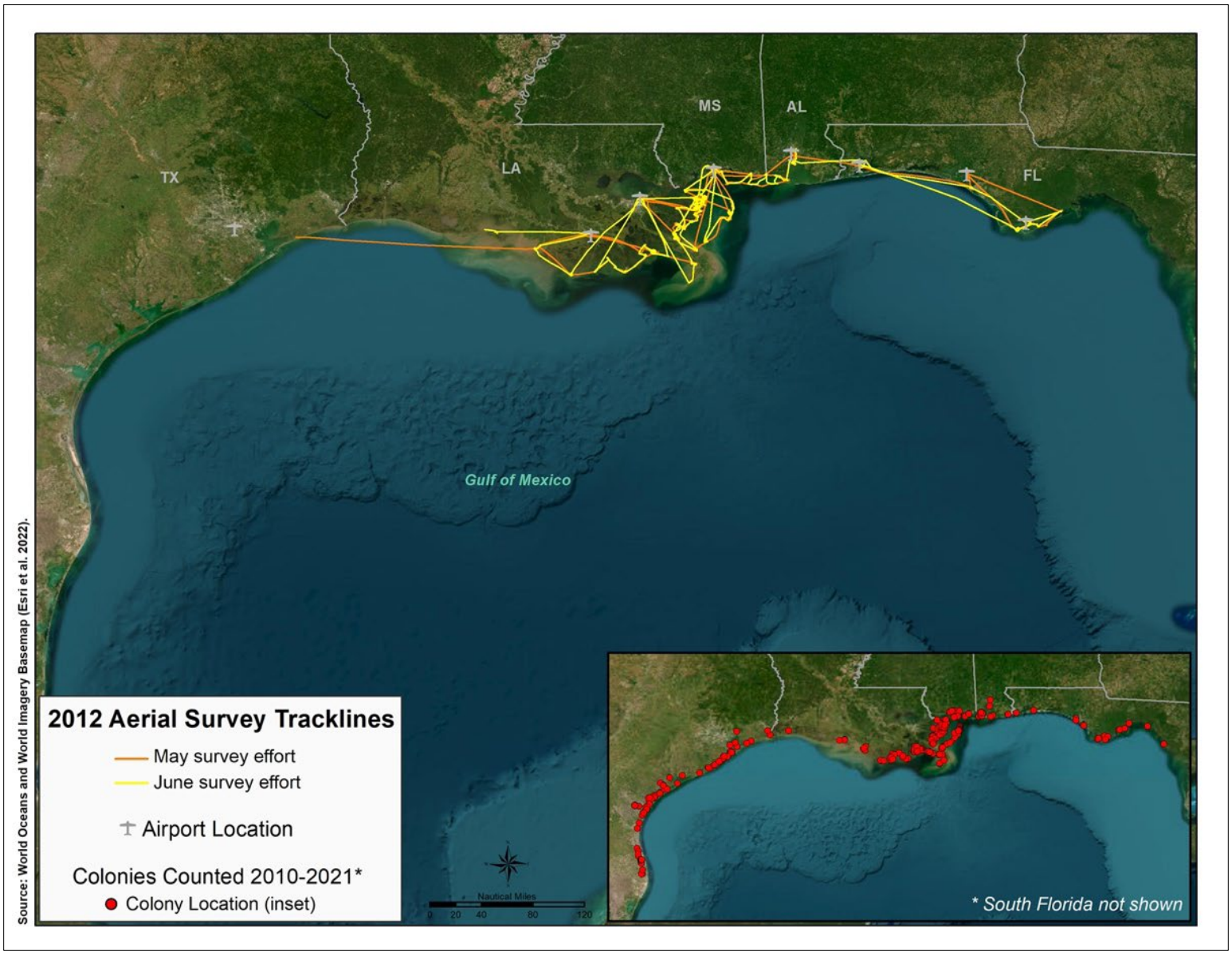

Figure 5. Aerial photographic survey tracklines, May and June 2012, Louisiana to Florida.

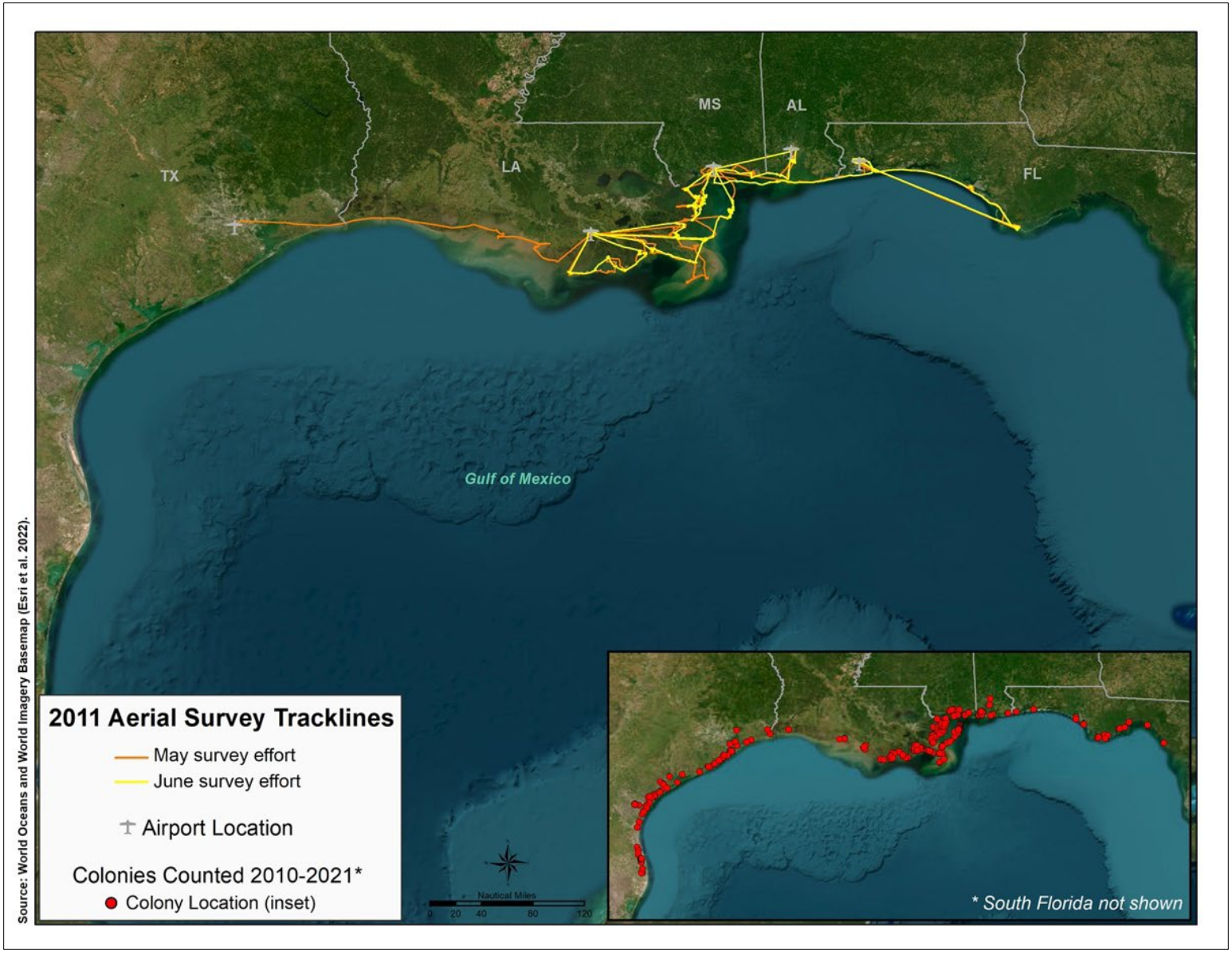

Figure 6. Aerial photographic survey tracklines, May and June 2011, Louisiana to Florida.

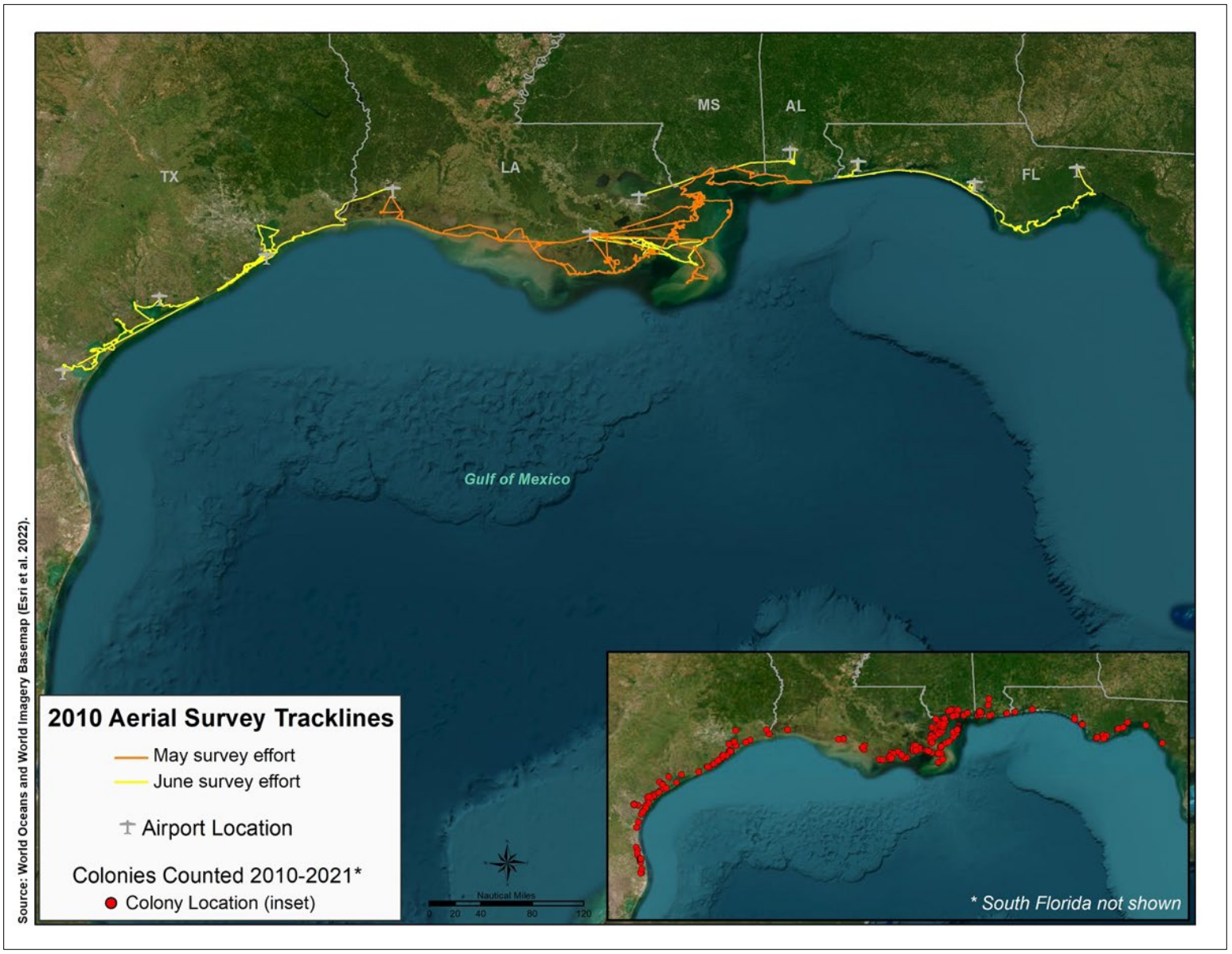

Figure 7. Aerial photographic survey tracklines, May and June 2010, from Texas to Florida.

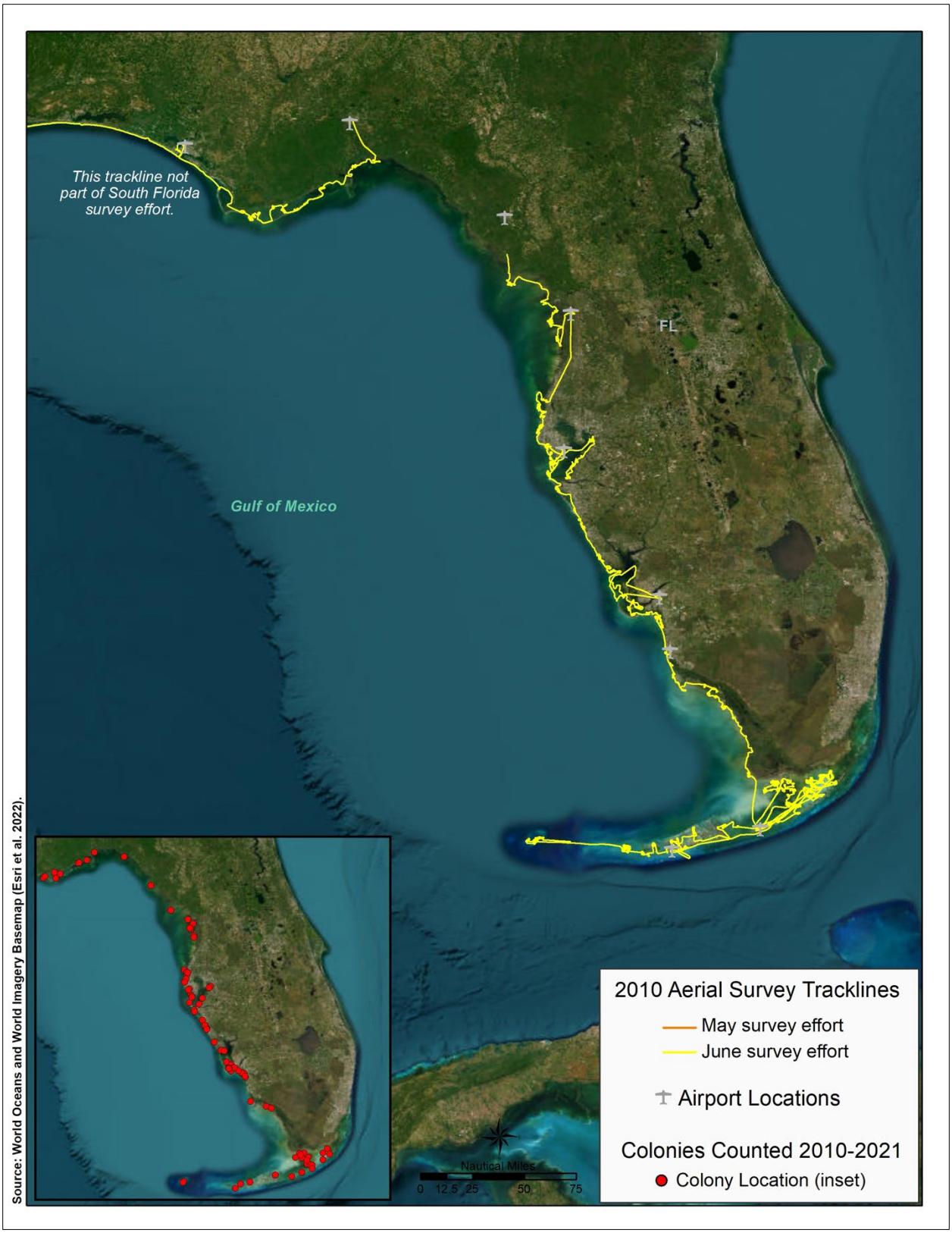

Figure 8. Aerial photographic survey tracklines, 2010, in southwestern Florida.