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REPRODUCTIVE SUCCESS OF AMERICAN OYSTERCATCHERS AT MANAGED SITES IN GEORGIA

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In recent decades, increasing development and recreation throughout the Georgia coastal region has generated new concern over the status of Georgia's beach-nesting birds (Georgia Coastal Management Program 1997). With a total U.S. population of American Oystercatchers (*Haematopus palliatus)* as low as 10,971 $\pm$ 258 individuals (Brown et al. 2004) and naturally low levels of annual productivity (Nol and Humphrey 1994; Davis 1999; Davis et al. 2001), American Oystercatchers could be especially vulnerable to habitat loss and other anthropogenetic pressures. American Oystercatchers currently are listed as a species of extremely high priority in the Southeastern Coastal Plain–Caribbean Regional Shorebird Plan (Hunter 2000) because of habitat loss along the southeastern coast and perceived population declines on the Atlantic coast of Florida and in the species' historical stronghold of Virginia, North Carolina, and South Carolina (Hunter 2000; Davis et al. 2001). The American Oystercatcher also is listed as a Georgia rare wildlife species (Ozier et al. 1999).

While originally considered common in Georgia, American Oystercatcher numbers were reduced during the early twentieth century because of unregulated hunting and egg collecting (Erichsen 1921; Bent 1929). The species began a slow recovery following passage of the Migratory Bird Treaty Act (1918) and as many as 35 pairs nested on the Georgia coast by mid-century (Burleigh 1958). The first coast-wide survey of American Oystercatchers conducted in 1980 produced an estimate of 70 nesting pairs (Rappole 1981) and aerial surveys in 1999 placed the state breeding population at 86 pairs (Winn 2000). Despite this apparent increase, oystercatchers have proliferated only in Georgia's remote areas (Winn 2000), not in areas that are easily accessed by people. Recent expansion of recreation into remote areas, combined with studies suggesting that human disturbance may affect Georgia's beach-nesting birds negatively (Rappole 1981; Corbat 1990), led the Georgia Department of Natural Resources (DNR) to establish recreation restrictions at five DNR-managed sites in 1998 (Board of Natural Resources Rule 391-4-7). Our study (George 2002) was initiated in 2000 with the goal of providing baseline breeding data for a subset of Georgia's American Oystercatchers, including those breeding at DNR-managed sites. The purpose of this paper is to present reproductive success, fledgling production, and recreational disturbance data for four DNR-managed sites used by DNR and used by breeding American Oystercatchers in 2000 and 2001.

Study Sites and Methods

Surveys of nesting American Oystercatchers were conducted from March to July, 2000 and 2001, at three DNR-managed sites: Egg Island Bar, St. Catherines Bar, and Williamson Island (Fig. 1). A fourth DNR-managed site, Pelican Spit, was surveyed from March to July, 2001. Each of these sites received recreation restrictions according to Board of Natural Resources Rule 391-4-7. All sites were accessible only by boat.

Although previously an important site for nesting shorebirds, Pelican Spit eroded away in 1999 and was unavailable to nesting birds in 2000. Accretion of sediments continued through 2000 and a small section of the spit (~1 ha) was available to nesting birds by March 2001. Recreation was prohibited on a portion of Pelican Spit, but signs were not posted during this study because of the spit's small size. No mammalian predators inhabited the site. Egg Island Bar's large size (25 ha), extensive topographic variation, and absence of mammalian predators provided high-quality nesting habitat for oystercatchers and other beach-nesting birds. Management at the site included prohibitive regulations against recreation, indicated by a large sign, and occasional use of fire to control woody vegetation, ants, and soft-bodies ticks. A portion of the site was

burned in March 2000. Although not measured quantitatively, density and coverage of vegetation at Egg Island Bar was visibly greater in 2001 than in 2000. St. Catherines Bar was influenced heavily by tides and storms in 2000 and 2001. The 5 ha consisted of a tidally-influenced interior mud flat, encircled by a perimeter of low-elevation, sparsely-vegetated dunes and sand flat. Management at the site included prohibitive restrictions on recreation, indicated by a large sign. Mammalian predators did not inhabit the site. Williamson Island (30 ha) was similar in size to Egg Island Bar and provided ample high-topography, sparsely-vegetated habitat. Unlike the other DNR-managed sites, Williamson Island was linked to an adjacent barrier island by tidal salt marsh and was readily accessible to mammalian predators, including raccoon (*Procyon lotor*), mink (*Mustela vison*), and river otter (*Lontra canadensis*). Management at the site included a prohibition on dogs and other domestic pets. Recreation was permitted along the island's beach and southwest tip, but was prohibited throughout the interior to protect beach-nesting bird habitat. These regulations were indicated by signs at numerous locations throughout the island.

Surveys for nesting American Oystercatchers were conducted by boat and on foot by one or two observers using binoculars or spotting scopes during high or rising tides, from March through July. When a pair was observed, its location was charted on a map and its behavior was recorded. If incubating, the nest was marked at a distance (2-3m) with a numbered stake, and nest number, clutch size, and nest coordinates (determined by a handheld Trimble Geoexplorer Global Positioning System unit) were recorded. Time at each nest was less than five minutes, thus adults were flushed off the nest; however, they returned within seconds of our departure. Sites were revisited approximately every 5 to 6 days to document clutch status. Nests were not monitored more frequently due to the extensive study area and difficult boat access to nesting sites; both factors increased time between site visits. Cause of failure during the egg stage was surmised when possible from predator tracks, broken eggshells, or evidence of flooding. Hatching success and fledging success were defined as hatching or fledging one egg or chick, respectively, and were calculated as a percentage of total nesting attempts. Following Davis et al. (2001), production of fledglings at each site was calculated as the ratio of fledglings produced to total number of nesting oystercatcher pairs estimated at each site. To assess levels of recreation at each site, instantaneous point counts of all people within an estimated one km radius of the observer were conducted from March to July 2001. Point counts were conducted during each nest survey, were limited to daylight hours, and were conducted by the same observer to limit observer variability. Counts were randomized with respect to daylight hours by pulling potential point count times in ten minute intervals (e.g., 12:20, 12:40,

12:50...) from a hat before each nest survey. Because point counts were conducted randomly with respect to time, and movement throughout sites was relatively constant and thorough, location of point counts was essentially random relative to location. Relatively flat topography at each site ensured that all recreationists present were counted.

Results

Two American Oystercatcher clutches were documented at Pelican Spit on 19 June 2001. These clutches were apparently initiated by two oystercatcher pairs that nested unsuccessfully on the south tip of nearby Little St. Simon's Island earlier in 2001. One clutch was washed out during a high tide and the other hatched one of three eggs. The chick disappeared before fledging during an unusually high tide that submerged the entire spit. No other avian species nested at Pelican Spit in 2001. Recreational use was frequent at this accessible sand spit; point counts conducted in 2001 averaged 1.4 $\pm$ 1.7 (95% CI) people per count (N = 13).

Egg Island Bar provided nesting habitat for numerous avian species in 2000 and 2001, including American Oystercatchers, Brown Pelicans (*Pelecanus occidentalis*), Royal Terns (*Sterna maxima*), Sandwich Terns (*S. sandvicensis*), Gull-billed Terns (*S. nilotica*), Laughing Gulls (*Larus atricilla*), Black Skimmers (*Rynchops niger*), Willets (*Catoptrophorus semipalmatus*), Wilson's Plovers (*Charadrius wilsonia*), Mottled Ducks (*Anas fulvigula*), Clapper Rails (*Rallus longirostris*), and Marsh Wrens (*Cistothorus palustris*). An estimated 17 pairs of American Oystercatchers defended territories at Egg Island Bar in 2000 (Table 1). Eighteen clutches were documented and 44% of clutches (N = 8) hatched at least one chick. Fledging success was calculated as 33% (N = 6) and 0.35 fledglings were produced per pair (N = 6 fledglings). Cause of clutch failure during the egg stage was undetermined in 90% (N = 9) of cases and one nest failed because of flooding. An estimated 25 pairs of oystercatchers defended territories in 2001, representing a 47% increase in oystercatcher pairs from 2000. More clutches were documented in 2001 (N = 42) than in 2000 because of an increase in nesting pairs and an apparent increase in the number of replacement clutches. Hatching and fledging success in 2001 were 14% (N = 6) and 5% (N = 2), respectively, and fledgling production was estimated as 0.12 fledglings per pair (N = 3 fledglings). Cause of clutch failure during the egg stage was undetermined in 39% (N = 14) of cases and 31% (N = 11) of failures were attributed to predators (presumably avian). At least one clutch failure resulted from interspecific, antagonistic interactions between neighboring pairs of nesting oystercatchers. Nine nests flooded in 2001 (25%) and two nests were apparently abandoned for unknown reasons.

No signs or sightings of mammalian or reptilian predators were observed at Egg Island Bar during the study. Laughing Gulls frequently nested in close proximity to oystercatchers at the site and were observed depredating eggs and chicks on numerous occasions. Other potential avian predators frequently observed at the site included Bald Eagles (*Haliaeetus leucocephalus*), Boat-tailed Grackles (*Quiscalus major*), Fish Crows (*Corvus ossifragus*), Great Black-backed Gulls (*Larus marinus*), and Turkey Vultures (*Cathartes aura*). Potenial non-avian predators of chicks included fire ants (*Solenopsis* sp.) and ghost crabs (*Ocypode quadrata*). Recreationists were only observed at the site on one time in 2000 and had no known effect on beach-nesting birds. Accordingly, point counts of recreationists in 2001 averaged 0.0 $\pm$ 0.0 (95% CI) recreationists per count (N = 42).

Four pairs of American Oystercatchers defended territories at St. Catherines Bar in 2000. Of the six clutches documented in 2000, all failed before hatching. Five clutches flooded and one clutch failed for unknown reasons. Three pairs nested at the bar in 2001, but all seven clutches failed before hatching. One clutch washed out during floods, one clutch was apparently lost to an avian predator, four clutches failed for unknown reasons, and one clutch was apparently abandoned. The abandoned clutch and two clutches of unknown fate were incubated for the full 26-day incubation period, yet failed to hatch. Bird tracks and droppings observed on higher points following spring tides in 2000 and 2001 indicated that the bar was used as a roost by Brown Pelicans, gulls, and other birds during spring tide events. During such events, the area of land above water was reduced considerably. No signs or sightings of mammalian or reptilian predators occurred during 2000 or 2001, but ghost crabs were observed frequently. Despite the bar's close proximity (~250 m) to the north beach of St. Catherines Island (which is frequented by recreationists), no people were observed on the bar during the study. Human footprints were observed on one occasion in 2001. Point counts of recreationists in 2001 averaged 0.0 $\pm$ 0.0 (95% CI) people per count (N = 17). Wilson's Plovers were the only other beach-nesting birds that nested on St. Catherines Bar during the study. A single Wilson's Plover chick was observed in 2000.

Three pairs of oystercatchers nested at Williamson Island in 2000. One of four clutches hatched two eggs, but the chicks were lost prior to fledging for unknown reasons. Of the three failed clutches, one clutch flooded, one clutch was depredated (apparently by raccoons), and the last clutch was lost for unknown reasons. Three pairs were again documented in 2001, but ten clutches were located, suggesting the possibility of a fourth, undocumented oystercatcher pair. All ten clutches failed before hatching. Six clutches were apparently depredated by raccoons and the other four clutches disappeared for unknown reasons. Based on the

abundance of tracks, sightings, and scat raccoons were suspected in most uncertain clutch failures in 2000 and 2001. No avian predators nested at the site, but potential avian predators (e.g., Fish Crows, Boat-tailed Grackles), mink tracks, and ghost crabs were observed frequently. Human-related factors were not implicated directly in any clutch failures at Williamson, but human and dog footprints were frequently observed within the protected area. Dogs were observed on the island on 31% (N = 5) of visits in 2000 and 37% (N = 7) of visits in 2001. Forty-nine boats and over 200 recreationists were observed on the southwest tip on one occasion in 2000. Randomly conducted point counts in 2001 averaged 4.1 $\pm$ 4.6 (95% CI) people per count (N = 22) and ranged as high as 46 people. Wilson's Plovers nested at the northeast tip of the island in 2000 and 2001. Willets used the marsh on the leeward side of the island in 2000 and 2001, but nests were not confirmed.

Discussion

The small size and low topography of Pelican Spit likely were responsible for the low number of American Oystercatcher pairs, failure of one nest, and loss of one chick at that site. However, the arrival of two breeding pairs midway through the breeding season indicated greater plasticity in oystercatcher nest site selection than is generally cited in the literature (Nol and Humphrey 1994). Since 2001, the area and topography of the spit have fluctuated, presumably in response to natural accretion and erosion. During periods of accretion when nesting habitat is naturally enhanced (i.e., high topography, greater area), it may be beneficial to reinstate recreation regulations before onset of the nesting season. In addition to benefiting nesting oystercatchers, such actions would likely benefit Least Terns (*Sterna antillarum*), which have nested at Pelican Spit in the past.

During this study, Egg Island Bar was the most important nesting site for American Oystercatchers and other beach-nesting birds in Georgia. The greater number of oystercatcher pairs and increased productivity at Egg Island Bar compared to the other DNR-managed sites were probably due to the bar's large size, apparent absence of mammalian predators, relatively high-topography habitat, and minimal human disturbance to nesting birds. Previous studies in New York (Zarudsky 1985) and Florida (Toland 1999) have also documented increased productivity of oystercatchers at isolated islands with low levels of disturbance and no mammalian predators. Greater productivity at the site in 2000 as compared to 2001 was notable. A previous study (Davis et al. 2001) found that oystercatcher productivity fluctuates yearly in response to changing environmental variables (e.g., habitat quality, predation rate, storms,

extremely high tides). As such, greater productivity in 2000 may have resulted from natural factors. However, the controlled burn in March 2000 may have benefited oystercatchers by reducing vegetation, thereby reducing inter- and intraspecific competition for nest sites. Conversely, the increase in oystercatcher pairs in 2001, coupled with perceived increase in vegetative cover, probably increased competition for nest sites, which may have reduced productivity (Nol and Humphrey 1994). Evidence of greater inter- and intraspecific competition in 2001 than 2000 was provided by: 1) documentation of clutch failure due to interactions among neighboring oystercatchers, 2) increased rates of predation, and 3) increased rates of flooding (i.e., selection of low-elevation, low-quality habitat) despite lower tidal extremes (National Ocean Service, *unpublished data*).

Future management at Egg Island Bar should strive to prevent encroachment of woody vegetation, as oystercatcher numbers will likely decrease if vegetative cover increases substantially (Soots and Parnell 1975; Nol and Humphrey 1994). Maintenance of sparsely-vegetated habitat could also benefit other Georgia state-listed beach-nesting birds, such as Gull-billed Terns, Least Terns, and Wilson's Plovers (Ozier et al. 1999) that prefer sparsely-vegetated nesting habitat (Soots and Parnell 1975; Parnell et al. 1995; Thompson et al. 1997; Corbat and Bergstrom 2000). Additionally, expansion of Egg Island Bar's area, topography, and vegetation could create refugia for mammalian predators. Surveys should be conducted for predators before the onset of each nesting season and contingency plans should be developed to control mammalian predators if they become established at the site. Natural factors (e.g., erosion, tidal overwash) may control encroachment of woody vegetation. If natural factors prove ineffective, more aggressive use of fire and herbicides may be warranted. The effectiveness of herbicides in maintaining shorebird nesting habitat is well documented (Evans 1986; Linz et al. 1994; Root 1996; Linz and Blixt 1997). Although recreational disturbance at Egg Island Bar was insignificant during this study, future increases in recreation could affect beach-nesting birds negatively (Toland 1999). If recreational use increases in the region, better placement of more visible regulatory signs at Egg Island Bar would be warranted.

Despite an absence of recreation and mammalian predators, the small size and low topography of St. Catherines Bar resulted in frequent flooding of oystercatcher nests. Use of the bar as a roost site by gulls, terns, and pelicans also may have contributed to clutch failures indirectly through abandonment of nests or directly through increased depredation of eggs and chicks. Nonetheless, the relatively large number of clutches that failed despite being incubated the full 26-day term is disconcerting and warrants future monitoring. Since 2001, St. Catherines Bar has fluctuated in size

much like Pelican Spit. Although the site remains closed to the public year-round because it is an important roosting and foraging site for wintering and migratory birds, special care should be taken to enforce regulations during years when nesting habitat is naturally enhanced.

The abundance of mammalian predators at Williamson Island was the primary cause of low reproductive success at that site. Other studies of oystercatchers have found that, when raccoons and other mammals are present, depradation is the most frequent cause of clutch failure (Nol 1989; Davis et al. 2001). Recreational disturbance may have contributed to low reproductive success at Williamson Island indirectly by increasing predation rates. Davis (1999) found that recreational use was correlated with increased raccoon density on North Carolina beaches. High raccoon densities likely increase predation rates, thereby reducing reproductive success of beach-nesting birds. Although not documented in this study, recreation can also directly reduce reproductive success in oystercatchers and other shorebirds through trampling of nests, increased nest abandonment, slowed chick growth, and increased exposure of eggs and chicks to natural or domestic predators (Erwin 1980; Safina and Burger 1983; Rodgers and Smith 1995; Toland 1999).

Williamson Island provided poor-quality habitat for nesting oystercatchers during this study, primarily because the site was accessible to mammalian predators. Any protection provided by recreational restrictions was probably outweighed by predation rates and the fact that recreationists were permitted on the beach. Recreational restrictions would be beneficial in the future if habitat quality improves. Barring natural reductions in predator populations or physical changes in landscape (i.e., erosion) that reduce accessibility to predators, Williamson Island will likely remain poor habitat for nesting oystercatchers. Control of predators has been shown to benefit shorebirds (Witmer et al. 1996) and would probably benefit oystercatchers and other beach-nesting birds at Williamson Island. Unfortunately, predator removal can be prohibitively expensive, logistically difficult, politically controversial, and can have unintended ecological effects (Garretson et al. 1996; Witmer et al. 1996; Hecht and Nickerson 1999). Consequently, costs and benefits of such management should be considered before initiating such measures.

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