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NEST SITE CHARACTERISTICS, BREEDING PHENOLOGY, AND NESTING SUCCESS OF AMERICAN OYSTERCATCHERS IN INDIAN RIVER COUNTY, FLORIDA

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The American Oystercatcher (*Haematopus palliatus*) inhabits coastal salt marshes, estuaries, and beaches along both coasts of Florida (Nol and Humphrey 1994). One of the few birds to specialize on saltwater bivalve mollusks, American Oystercatchers are entirely restricted to marine habitats (Nol and Humphrey 1994). This species was formerly common in all suitable habitats on both coasts of Florida (Howell 1932). However, intensive coastal development and human recreational activities in the State have precipitated a rapid population decline of breeding American Oystercatchers (Sprunt 1954, Ogden 1973, DeGange 1978, Below 1996). This shorebird, now rare and locally distributed especially on the Atlantic Coast of Florida, is listed as a Species of Special Concern by the Florida Game and Fresh Water Fish Commission (Wood 1996).

The American Oystercatcher requires extensive beaches, sandbars, mudflats, and mollusk beds for feeding, loafing, and roosting (Below 1996). Oystercatchers prefer large, sparsely vegetated sand areas for nesting, but will use wrack and marsh grass (Lauro and Burger 1989), and Australian pine (*Casuarina equisetifolia*) monocultures on spoil islands (Toland 1992) when sand nesting areas are lacking or regularly disturbed by humans.

I studied the nesting behavior of American Oystercatchers in Indian River County, Florida from 1 March through 15 August, 1986 through 1996. Using a boat, I performed systematic biweekly surveys of a 39-km section of the Indian River Lagoon for American Oystercatchers. The Indian River Lagoon is a linear estuarine system that comprises more than a third of Florida's east coast from Ponce de Leon Inlet near New Smyrna Beach to Jupiter Inlet in Palm Beach County (Anonymous 1996).

My study area includes 53 dredged material spoil islands designated as I.R.1-43 (Brown-Peterson and Eames 1989), a small, sand and shell island under the 17th Street Bridge in Vero Beach, and the natural 1.2-ha Pelican Island (the mixed-species water bird nesting colony island within the Pelican Island National Wildlife Refuge). The average size of all spoil islands in my study area is 2.9-ha (range = 0.1 to 29.6 ha). Indian River County spoil islands were created when the Atlantic Intracoastal Waterway was dredged by the U.S. Army Corps of Engineers to a depth of 3.7 m from 1957 through 1960 (Brown-Peterson and Eames 1989). The 17th Street Bridge island was created as part of the mitigation for the construction of the bridge (H. Kale pers. comm.).

Indian River County spoil islands have minimal topographical relief with maximum elevations ranging from about 1.0 m to 2.0 m above mean sea level. Vegetation on spoil islands consists of an upland near monoculture of 10-15 m Australian pines with a scattered understory of Brazilian pepper (*Schinus terebinthifolius*). The perimeter wetland transitional area and mangrove fringe average 15 m in width, dominated by red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove

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(*Laguncularia racemosa*), and buttonwood (*Conocarpus erecta*). Rocky oyster reefs occur in varying amounts adjacent to many of these islands. Most (77%) of the spoil islands have deep water accesses of 1.0 to 2.5 m in depth that accommodate landing by small to medium-sized power boats. Sand or sand/shell beaches or spits occur to some extent on 64% of the islands in my study area.

I used a pair of 10× binoculars to search each island for signs of paired oystercatchers. Invariably, only one pair of oystercatchers nested per spoil island. However, on Pelican Island two pairs of oystercatchers sometimes nested concurrently. When I located an oystercatcher nest scrape, I recorded the stage of nesting, nesting substrate, distance to the nearest upland vegetation, and distance to the mean high water line. Subsequent visits were made to each nest site to document the fate of each nesting attempt. I defined a nesting attempt as the laying of at least one egg in the nest scrape. An initial nest attempt was described as the first scrape with at least one egg laid by a breeding pair. A renesting attempt was defined as a breeding pair whose first attempt was known to have failed, subsequently laying at least one egg in an alternate scrape, usually on the same island or an adjacent island.

I documented a total of 58 nesting attempts for oystercatchers during my study. Of the 55 available islands in the study area, 13 (24%) were used for nesting attempts by American Oystercatchers during the 11-year study. The islands selected for nesting by breeding oystercatchers ranged in size from 0.1 to 2.6 ha ($\bar{x}$ = 1.0 ha), substantially smaller than the spoil islands without nests ($\bar{x}$ = 3.5 ha). Only Pelican Island was used by at least one pair of oystercatchers every year during the study; although, I did not determine the fate of every nesting attempt on this National Wildlife Refuge because of the potential for disturbing the surrounding wading bird colony.

Prior to egg laying, each pair of oystercatchers excavated one or more shallow nest scrapes. In this study, nest scrapes were constructed an average distance of 5.9 m (range = 1.5 to 15 m) above the mean high water line. There was no significant difference in distances above mean high water line between successful nests (6.1 m) and unsuccessful nests (5.5 m) (X^2 = 0.03, P>0.05). Nest scrapes were located an average of 3.2 m below the vegetation pioneering edge, including 80% of the scrapes below the vegetation line and 20% above the vegetation line. Scrapes were dug in several types of substrate, including sand/shell beach (64%), sandy mudflat (19%), sand/rock beach (7%), Australian pine litter (7%), and mangrove/Brazilian pepper (3%).

Nest scrapes of American Oystercatchers averaged from 7.5 to 12.7 m above the water in New York and from 21.0 to 32.0 m above the water in North Carolina and Massachusetts (Lauro and Burger 1989). Vegetation around nest sites in those studies averaged from 23 to 50% (Lauro and Burger 1989).

The mean egg laying date was 10 April (range = 25 March to 25 May), the mean hatching date was 5 May (range = 20 April to 20 June), and the mean fledging date was 9 June (range = 24 May to 24 July). Renesting attempts occurred after an estimated 2-week recycling period (Baker and Cadman 1980, Nol 1989), resulting in hatching taking place as late as 30 June and fledging as late as 3 August.

Mean clutch size of initial nesting attempts was 2.73 (n = 44; 73% 3-egg clutches) while mean clutch size of renesting attempts was 2.21 (n = 14; 78.6% 2-egg clutches). American Oystercatchers were successful in fledging at least one young 57% (33 of 58) of the nesting attempts. Mean number of fledglings per nesting attempt was 1.1 for all oystercatcher nesting attempts and 2.0 for successful nesting attempts.

Mean initial clutch sizes of American Oystercatchers in other states included 2.81 (67% 3-egg clutches) and 2.78 (78% 3-egg clutches) for Massachusetts and Virginia, respectively (Nol et al. 1984, Nol and Humphrey 1994). In Virginia, replacement clutches averaged 2.3 (69% 2-egg clutches) (Nol et al. 1984). The percentage of nesting pairs to fledge at least one young in other studies ranged from 34% to 80% (Post and Raynor 1964, Zaradusky 1985, Nol and Humphrey 1994).

In this study, the most important causes of disturbance to roosting and nesting American Oystercatchers included powerboats, personal watercraft, picnickers, anglers, and domestic pets. Spoil islands with sandy beaches and/or spits and deep water accesses were regularly used by boaters, especially on weekends. These same habitat features attracted breeding pairs of oystercatchers to attempt nesting. During week days when few boats were on the water, a pair could successfully excavate a nest scrape and lay eggs, only to be exposed to continuous human interruptions on the weekend (B. Toland pers. obs.) Disturbances to oystercatchers usually resulted in repeated flushing, distraction displays, and defensive flight displays, all high energy activities. Many of the nest sites regularly disturbed by humans resulted in nest abandonment or depredation by domestic predators (mainly dogs). The only native predator observed to take oystercatcher eggs or chicks during this study was the Fish Crow (*Corvus ossifragus*), and humans invariably increased nest vulnerability by flushing adult oystercatchers, which otherwise were efficient at repelling crows from the nest site (B. Toland pers. obs.).

Pelican Island is the only island in my study area that restricts visitation by the public and is protected as part of the U.S. Fish and Wildlife Service Refuge System. Of the 54 remaining islands, 27 (50%) are regularly used by humans for fishing, camping, and picnicking. American Oystercatchers nesting on islands with a tradition of regular recreational use by humans had lower nesting success than those pairs nesting on islands that received little or no human disturbance (Table 1). Nesting success of oystercatchers on undisturbed islands was 77%, significantly higher than the nesting success rate of 33% on islands regularly used for human recreation ($\chi^2 = 20.2$, $P<0.01$).

Of the 42 spoil islands never selected for nesting by oystercatchers, 93% were either regularly used by humans or lacked sand or sand/shell beaches. Of the 27 spoil islands unexploited by people, 22 either lacked sand/shell beaches or were inaccessible to boaters because of rocky oyster reefs or shallow water (<1.0 m). The five remaining undisturbed islands featured both sand/shell spits or beaches and deep water access and were occupied by nesting oystercatchers and large, conspicuous colonies of mixed-species water birds. These colony sites were active every year at least since 1986 (B. Toland unpubl. data) and were typically avoided by boaters.

Two islands that oystercatchers successfully nested upon seven times lacked a sand/shell beach component but were inaccessible to boaters. On these islands nest scrapes were placed beneath Australian pines or mixed mangrove-Brazilian pepper thickets in close proximity to large mixed-species water bird colonies. Of the islands used by nesting American oystercatchers, eight (62%) were historical colony sites of mixed-species water birds.

During the past 20 years, Indian River County barrier island beaches have been impacted by intensive development and burgeoning recreational use, severely reducing the availability of undisturbed beach habitat (Fernald et al. 1982). Indian River Lagoon spoil islands with sand/shell beaches or spits have also experienced more and more recreational use (Fisk 1978, Schreiber and Schreiber 1978). The use of Australian pine forest (Toland 1992) and mixed mangrove/Brazilian pepper fringes for nesting by American Oystercatchers on islands lacking beaches but inaccessible to boaters, is probably an adaptive response to increased human activity on open, sandy beaches of the barrier islands and more recently on the Indian River Lagoon spoil islands (H. Kale pers. comm., B. Toland pers. obs.).

Management recommendations for American Oystercatchers in the Indian River Lagoon should include as a high priority the control of human recreational activities on or around the 13 islands that were documented as oystercatcher nest sites during this study. Oystercatchers nested in close proximity to eight of the ten active colonial water bird nesting rookeries in my study area. Therefore, protection measures for colonies of pelicaniformes and ciconiiformes should benefit nesting American Oystercatchers.

Table 1. Effect of human recreation on American Oystercatcher nesting success from 1986 through 1996 on islands in Indian River Lagoon.

Island Number or Name	Deep Water Access	Sand/Shell Beach	Regular Use by Humans	Total Nesting Attempts	Successful Nesting Attempts
Pelican Island	No	Yes	No	11	9
I.R. 8	Yes	Yes	No	2	2
I.R. 15	Yes	Yes	No	2	1
I.R. 16	Yes	Yes	No	2	1
I.R. 18	Yes	Yes	No	4	3
I.R. 19	Yes	Yes	No	2	1
17th Street Bridge	Yes	Yes	Yes	8	3
I.R. 37	No	No	No	4	3
I.R. 37a	Yes	Yes	Yes	9	3
I.R. 38	No	No	No	4	4
I.R. 39	Yes	Yes	Yes	3	1
I.R. 41	Yes	Yes	Yes	3	1
Harbor Branch	Yes	Yes	Yes	4	1

Implementation of artificial nest platforms (automobile tires tied together and filled with sand and shell) on islands lacking beaches that are not currently utilized for human recreation has proven successful in Virginia and could increase potential nest sites in southeastern Florida (Nol and Humphrey 1994). Three spoil islands with small sandy beaches that are inaccessible to people should be monitored for future use by oystercatchers. County comprehensive plans should include nest site protection, emphasizing buffer zones around nesting islands (Rodgers and Smith 1995). Recent studies to determine disturbance distances of approaching personal watercraft to nesting wading birds and shorebirds recommend a buffer zone radius of 180 m to adequately protect shorebirds (J. Rodgers pers. comm). Continued nest surveys are needed to locate additional American Oystercatcher nest sites, update oystercatcher population assessments, and initiate appropriate protective measures throughout the Indian River Lagoon.

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