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Jeff S. Liechty
Audubon Florida

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SITE CHARACTERISTICS AND REPRODUCTIVE SUCCESS OF ROOF-NESTING AMERICAN OYSTERCATCHERS (*Haematopus palliatus*) IN FLORIDA

Jeff S. Liechty

Audubon Florida, Florida Coastal Islands Sanctuaries, Tampa, Florida, USA

Email: Jeff.Liechty@audubon.org

Abstract.—American Oystercatchers (*Haematopus palliatus*) have adapted to urbanization of barrier islands in Florida by nesting on gravel-roofed buildings. This novel nesting habitat may offer an opportunity to conserve oystercatchers by providing refuge from human disturbance and sea-level rise, or it may provide low-quality habitat that serves as a population sink. This study aimed to describe site characteristics and determine hatching and brood success of roof-nesting American Oystercatchers in Pinellas County, Florida. We monitored roofs with a known history of nesting from 2017–2020, and documented nesting on 18 roofs. Nesting roofs varied in area and height but were located within 108 m of water, mostly the Gulf of Mexico or the Intracoastal Waterway. Hatching success (0.76) was higher than published ground-nesting estimates, whereas brood success (0.53) was comparable. Elevated hatching success in roof-nesting American Oystercatchers demonstrates a benefit to roof-nesting; however, this may be offset by high chick mortality after leaving the roof. Eight of 16 fledglings died or vanished upon leaving the roof, likely because of their lack of experience navigating the urban environment. Conservation of populations in developed areas may be possible through creation of nesting habitat on roofs immediately adjacent to beaches, but monitoring fledgling survival is imperative.

Key words: alternative habitat, behavioral plasticity, human disturbance, nesting success, rooftop, urban adaptation

Anthropogenic habitat loss is a major driver of declining biodiversity around the world, and many bird populations have been negatively affected (Dirzo et al. 2014). Habitat loss can be a result of direct conversion of land use (e.g., deforestation), or deterioration of habitat suitability by other anthropogenic pressures such as invasion by exotic species, altered ecosystem processes, or disrupted disturbance regimes. For beach-nesting birds, human development, recreation, and disturbance renders nesting habitat inhospitable, a long-standing conservation concern (Burger 1995). Behavioral plasticity is an important mechanism enabling species to withstand such widespread anthropogenic changes (Wong and Candolin 2015).

In urbanized areas with high levels of human disturbance, gravel roofs offer alternative nesting habitat for beach-nesting birds. This behavioral adaptation has been documented in North America and Europe since the mid-1900s, primarily in Larids (Fisk 1978). Selection of roofs as nest sites in beach-nesting birds is believed to be a response to urban development, habitat degradation, and human disturbance in their traditional nesting habitat (Krogh and Schweitzer 1999, Douglass et al. 2001, Forys and Borboen-Abrams 2006). Roof nesters may gain relative solitude compared with beach nesters but also face unique challenges, such as chicks falling off unprotected roof edges, and flooding events during heavy rainfall on impervious flat roofs. In Florida, Least Terns (*Sternula antillarum*) have been nesting on roofs for over 60 years (Goodnight 1957), and American Oystercatchers (*Haematopus palliatus*) for at least 30 years (Paul 1988, Douglass et al. 2001). More recently, American Oystercatchers have been discovered nesting on roofs in urban areas of New Jersey (McConnell 2018) and South Carolina (F. Sanders, South Carolina Department of Natural Resources, pers. comm.), possibly indicating increased pressure on ground habitat along the Atlantic Coast of the United States. Eurasian Oystercatchers (*H. ostralegus*), which are more generalist in nesting habitat, also commonly nest on roofs in Europe (Bourne 1975, Munro 1984, Duncan et al. 2001).

Across their range, American Oystercatchers have demonstrated flexibility in habitat selection; sites such as dredge spoil islands and shell rakes are now vital nesting habitat (Toland 1992, Virzi 2008, Jodice et al. 2014). Reproductive success in these alternative habitats has been found to be higher than at traditional barrier island sites (McGowan et al. 2005, Virzi et al. 2016), where human activity and associated mammalian populations are abundant. Given the continued human population growth along the Atlantic Coast of the United States, alternative nesting sites are likely to become more important to American Oystercatchers, but these habitats are also declining because of sea-level rise, loss of oyster reefs, and erosion (Vitale et al. 2020).

American Oystercatchers are a species of conservation concern throughout much of their range, including Florida where they are listed as Threatened (Florida Fish and Wildlife Conservation Commission [FWC] 2013). Human disturbance and development of nesting habitat resulting in low productivity is a major threat (McGowan and Simons

2006, Sabine et al. 2008, Virzi 2010, Borneman et al. 2016), as is erosion of nesting habitat (Vitale et al. 2020), and much of the management of this species has focused on increasing productivity (American Oystercatcher Working Group et al. 2012, Felton et al. 2017). Although the plight of ground-nesting American Oystercatchers has been well documented, little is known about roof nesting in this species, most notably habitat selection and reproductive success.

The purpose of this study was to better understand roof-nesting in American Oystercatchers and to evaluate roofs as an opportunity to conserve American Oystercatchers within urban environments. Specific objectives were to describe characteristics of roof nest sites, and to determine hatching and brood success of roof-nesting American Oystercatchers in Florida.

METHODS

Pinellas County is the only place in Florida where American Oystercatchers have been documented nesting on roofs in recent years. Pinellas County, the most densely populated county in Florida, is located in west-central Florida between Tampa Bay and the Gulf of Mexico (Fig. 1). Nearly uninterrupted development spans 39 km along its barrier islands.

The author and trained volunteers monitored 92 gravel roof sites in Pinellas County with a known history of roof-nesting by beach-nesting birds (American Oystercatchers, Least Terns, or Black Skimmers [*Rynchops niger*]) from 2017–2020 for nesting activity by American Oystercatchers. At roofs with nesting oystercatchers, I documented the following site characteristics: roof height (stories), roof area, presence of a parapet (wall around the perimeter of roof), building type (residential or commercial), distance to nearest water, and shoreline type (seawall, beach, mangrove, or riprap). I also obtained data on 9 other roofs with a previous history of American Oystercatcher nesting in Florida from 2011–2016 to describe site characteristics (E. Forys, Eckerd College, unpublished data). I used Google Earth Pro 7.3.2.5776 software to measure roof area and distance to water at each roof-nesting site.

The author and volunteers conducted 15-minute observations at each site approximately every two weeks from March through July to identify the presence of American Oystercatchers following FWC protocol (FWC 2020). Once we identified American Oystercatcher activity, we visited roofs at least weekly to monitor nesting through completion ($n = 943$). To avoid disturbing birds, we monitored nesting from the ground or an adjacent structure that offered a vantage onto the roof when available. For analysis of hatching and brood success, I included only sites with a suitable vantage where we could observe incubation and chick-rearing activities with the aid of 10×42 binoculars or 22–48×65 spotting scopes.

I calculated hatching and brood success using the Mayfield method (Mayfield 1975), with an assumed 27-day incubation period and 35-day fledging period. I calculated 95% confidence intervals (CI) following Johnson (1979). I defined hatching success as ≥1 chick hatching from a clutch, and brood success as ≥1 individual of a brood reaching 35 days old (hereafter fledge-age). When nesting attempts failed near the time of hatching and we never observed chicks, I assumed failure occurred during the egg stage. American Oystercatchers are single-brooded renesters, and renesting attempts were included in the analysis. We closely monitored the fate of fledge-age chicks (approximately four times per week) to the extent possible by searching adjacent roofs, beaches, and foraging areas

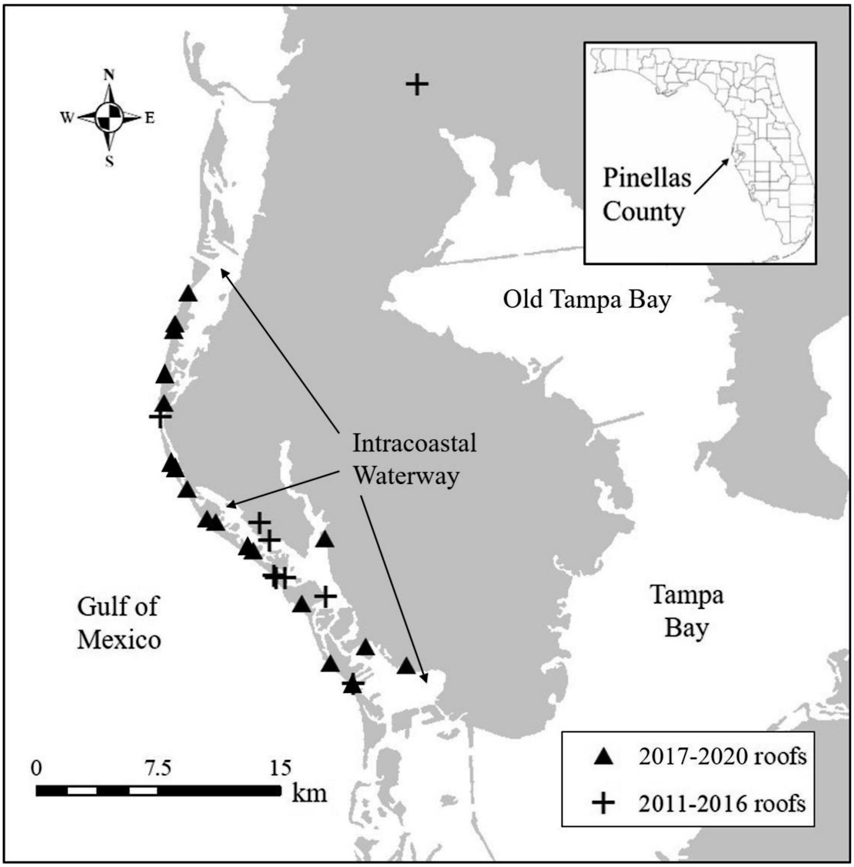

Figure 1. American Oystercatcher (*Haematopus palliatus*) roof nest sites in Pinellas County, Florida, USA.

in the seven days following departure from the roof. I used the FWC definition of productivity rate: the number of fledglings divided by the number of breeding pairs each year (FWC 2013).

Results

From 2017–2020, we identified American Oystercatcher nesting at 18 roof sites, including five opportunistically discovered roofs with no known history of nesting. We observed nesting activity between 9 March and 1 August, with a single pair of American Oystercatchers occupying each roof, although sometimes in association with Least Terns, Black Skimmers, and Killdeer (*Charadrius vociferous*).

Roofs with American Oystercatcher nesting from 2011–2020 (n = 27) had a mean area of 1,434 m^2 (± 318 SE), but nesting occurred on roofs as small as 77 m^2 (range = 77–7,284 m^2). Buildings ranged from 1–8 stories in height (median = 2), and the majority of the buildings were residential (18 apartments or condominiums, 3 single-family homes). Commercial buildings were retail (3), industrial (1), hotel (1), and school (1). Ten roofs (37%) were completely encompassed by parapets. Roofs ranged 2–108 m from water (mean = 36.7 ± 7.1 SE), and all but one were located along the Gulf of Mexico or Intracoastal Waterway (Fig. 1). Shoreline types for the nearest waterbody were seawall (15), beach (9), mangrove (2), and riprap (1).

Twelve different roofs had a suitable vantage for monitoring nest fate in 2017–2020, with 30 nesting attempts monitored. Across all years, daily nest survival and daily brood survival were 0.990 (n = 30) and 0.982 (n = 23), respectively. Overall hatching success was 0.76 (95% CI = 0.62–0.93), and brood success was 0.53 (95% CI = 0.45–0.82). Chicks remained on roofs until approximately 35–45 days of age. The 30 nesting attempts resulted in 16 fledge-age chicks on roofs, and a productivity rate of 0.76 chicks/pair (Table 1). Eight of the 16 fledge-age chicks were confirmed to have survived for at least one week after leaving the roof, one died after a collision with a sign, and three others died as determined by immediate re-nesting of the pair. In the remaining four cases, we never observed chicks off the roof, and believed they died shortly after leaving the roof because we observed a pair of adult American Oystercatchers in the vicinity of the roof without a chick. Additionally, roofs without a suitable vantage to monitor hatching success fledged six chicks during the four-year study period.

DISCUSSION

This study provides the first quantitative information on the productivity of roof-nesting American Oystercatchers, and demonstrates the potential for gravel roofs to be used as a tool for conserving American Oystercatchers in developed landscapes. Characteristics of roofs selected by American Oystercatcher pairs varied considerably in building height and roof area, from one-story single-family homes to high-rise condominiums and supermarkets. Site tenacity at roofs is high, with some sites occupied continuously for 13 years (E. Forys, unpublished data). All but one of the American Oystercatcher roofs were located close to the Gulf of Mexico or the Intracoastal Waterway, indicating close foraging areas as an important element of site selection. The exception was a roof adjacent to a canal that leads into Old Tampa Bay. Roof-nesting Least Terns also select buildings of various heights and roof areas but, unlike American Oystercatchers, sometimes select buildings at great distance from large bodies of water (Forys and Borboen-Abrams 2006).

Table 1. Annual summary of American Oystercatcher (*Haematopus palliatus*) roof-nesting in Pinellas County, Florida, 2017–2020. Visible roofs had a suitable vantage for monitoring reproductive success without accessing the roof. I considered chicks to be fledge-age at 35 days. Productivity rate is fledglings per pair.

Year	Roofs with nesting	Visible roofs	Fledge-age chicks on visible roofs	Fledglings surviving ≥1 week after leaving roof (visible roofs)	Productivity rate (visible roofs)	Fledglings surviving ≥1 week after leaving roof (all roofs)	Productivity rate (all roofs)
2017	8	2	1	1	0.50	3	0.38
2018	8	7	6	3	0.42	3	0.38
2019	7	7	3	0	0.00	0	0.00
2020	11	5	6	4	0.80	8	0.73
Total	34	21	16	8	0.38	14	0.41

Although I did not directly access roofs to avoid disturbance, and did not formally assess microhabitat characteristics, nests appeared to be preferentially placed within 0.25 m of a roof vent or other small feature on the roof but far from larger objects like air conditioner condensers or tall parapets. This placement could help make exposed eggs less conspicuous to aerial predators while still allowing clear sightlines for incubating adults (Buckley and Buckley 1980, Lauro and Nol 1995).

Young chicks spent much of the time out of sight underneath air conditioner condensers or similar structures, venturing out only for a few moments to receive food provisions from a parent. In 2019 and 2020, I placed wooden A-frame and pallet-style chick shelters on six roofs to provide chicks protection from sun and predators. Chicks of all ages readily used shelters when I supplied them at sites with little cover available.

Hatching success of roof-nesting American Oystercatchers was higher during this study than reported hatching success of ground-nesters (usually 0.11–0.45; Davis et al. 2001, McGowan et al. 2005, Sabine et al. 2006, Koczur et al. 2014, Schulte and Simons 2015, Virzi et al. 2016). The most plausible explanation for increased hatching success on roofs is the lack of overwash and mammalian predation, the leading causes of nesting failure in ground-nesting American Oystercatchers (American Oystercatcher Working Group et al. 2012). Additionally, actual roof-nesting hatching success may be higher than the estimate in this study because of the assumption that failure occurred during the egg stage when we never observed chicks. My results are similar to those found for roof-nesting Eurasian Oystercatchers (Duncan et al. 2001), and Least Terns (Gore and Kinnison 1991, Krogh and Schweitzer 1999), indicating a benefit to roof nesting across species.

Brood success of American Oystercatchers nesting on roofs was comparable to most published estimates for ground-nesting American Oystercatchers (0.33–0.65; Thibault et al. 2010, American Oystercatcher Working Group et al. 2012, Schulte and Simons 2015, Virzi et al. 2016). The only confirmed cause of mortality during chick rearing was a case of human disturbance, but Fish Crow (*Corvus ossifragus*) predation was strongly suspected in other cases where adults were repeatedly fending off crows in the days prior to failure.

The high mortality rate experienced by fledge-age chicks leaving the roof is attributable to hazards posed by the urban environment. Chicks learning to fly struggled to safely navigate obstacles and we observed them crashing into posts and bushes shortly after leaving the roof. Additionally, residents of buildings with roof nesting reported chicks dying in previous years from drowning along seawalls and being hit by automobiles. The productivity rate of 0.76 fledge-age chicks per pair on visible rooftops exceeds the FWC's goal of 0.50 fledglings/pair for population growth (FWC 2013). The realized productivity rate accounting for the observed mortalities (productivity rate × survival rate of fledglings upon leaving the roof), however, was only 0.38 fledglings/pair among visible roofs.

Gravel roofs offer urban nesting habitat that opportunistic American Oystercatchers are taking advantage of; however, development of superior roofing materials has made gravel roofs obsolete. As gravel roofs are replaced, this nesting habitat will be lost (DeVries and Forys 2004), displacing nesting American Oystercatchers. Availability of American Oystercatcher nesting habitat is a major concern in Florida (Vitale et al. 2020), and roof nesting offers a potential refuge from the threats of human disturbance and rising sea levels. As American Oystercatchers have demonstrated nesting on roofs as small as 77 m^2, it may be possible to retain nesting American Oystercatchers in urbanized settings by providing gravel nest boxes on top of buildings. Placing nest boxes on buildings immediately adjacent to beaches may offer a safer environment for fledging chicks compared to roofs located along seawalls, but monitoring the fate of fledglings will be necessary to determine the conservation benefit of roof nesting.

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