A Comparison of American Oystercatcher Reproductive Success on Barrier Beach and River Island Habitats in Coastal North Carolina

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Abstract.—American Oystercatcher (*Haematopus palliatus*) numbers along the east coast of the United States are declining in some areas and expanding in others. Researchers have suggested that movement from traditional barrier beach habitats to novel inland habitats and coastal marshes may explain some of these changes, but few studies have documented oystercatcher reproductive success in non-traditional habitats. This study compares the reproductive success of the American Oystercatcher on three river islands in the lower Cape Fear River of North Carolina with that of birds nesting on barrier island beach habitat of Cape Lookout National Seashore. There were 17.6 times more oystercatcher breeding pairs per kilometer on the river island habitat than barrier beach habitat. The Mayfield estimate of daily nest content survival was 0.97 (S.E. ± 0.0039) on river islands, significantly higher than 0.92 (S.E. ± 0.0059) on barrier islands. The primary identifiable cause of nest failure on the river islands was flooding while the main cause of nest failure on the barrier islands was mammalian predation. Fledging success was equally low at both study sites. Only 0.19 chicks fledged per pair in 2002, and 0.21 chicks fledged per pair in 2003 on the river islands and 0.14 chicks fledged per pair in 2002 and 0.20 chicks fledged per pair in 2003 on the barrier islands. Many questions are still unanswered and more research is needed to fully understand the causes of chick mortality and the functional significance of non-traditional nesting habitats for the American Oystercatcher in the eastern United States. *Received 26 June 2004, accepted 8 January 2005.*

Key words.—American Oystercatcher, *Haematopus palliatus*, ecological trap, habitat selection, non-traditional habitat, range expansion, reproductive success.

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The American Oystercatcher (*Haematopus palliatus*) nests on beaches from Nova Scotia to Texas (Nol and Humphreys 1994). Numbers in the Mid-Atlantic States are in decline (Mawhinney and Bennedict 1999; Nol *et al.* 2000; Davis *et al.* 2001). The number of breeding pairs in Virginia, a state that has long been a stronghold for oystercatchers, fell from 619 breeding pairs in 1979 to 255 breeding pairs in 1998 (Davis *et al.* 2001). The U.S. Shorebird Conservation Plan currently lists the American Oystercatcher as a "Species of High Concern" (Brown *et al.* 2001). At the same, time the species is expanding its breeding range to both the north and south (Mawhinney and Bennedict 1999; Nol *et al.* 2000; Davis *et al.* 2001). Historically, American Oystercatcher nesting habitat was restricted to ocean beaches (Bent 1929; Nol and Humphrey 1994). However, concurrent with the recent range expansion, birds have begun nesting on dredge spoil islands (Humphrey 1990; Shields and Parnell 1990), marsh islands (Frohling 1965; Lauro and Burger 1989; Shields and Parnell 1990), forested areas (Toland 1992) and even on an abandoned river barge (McNair 1988). It has been suggested that use of non-traditional nesting habitats may have facilitated the recent range expansion (Humphrey 1990), but few studies have monitored oystercatcher reproductive success in such habitats.

The European Oystercatcher (*Haematopus ostregalus*) has also recently expanded its breeding range to inland agricultural sites (reviewed by Goss-Custard *et al.* 1996). Hepleston (1972) suggested several reasons to explain the inland range expansion, including a rapid increase of the number of coastal nesting birds which forced birds inland to find breeding territories, habitat degradation in coastal regions which made it advantageous for birds to breed at inland sites, and alleviation of limiting factors that prevented birds from previously nesting in inland habitats, or a behavioral change that allowed oystercatchers to exploit inland food resources. These same explanations might apply to American Oystercatcher.

This study compares the reproductive success of the American Oystercatchers in 2002 and 2003 on non-traditional river island habitats in the lower Cape Fear River of North Carolina with the reproductive success of birds nesting on traditional barrier island beach habitats of Cape Lookout National Seashore.

STUDY SITES

The National Audubon Society manages several islands near Wilmington, North Carolina (77.97 W, 33.92 N) that provide habitat for breeding oystercatchers (Fig. 1). Ferry Slip Island and South Pelican Island are small, circular dredge-spoil islands near the mouth of the Cape Fear River (Fig. 1) that support large nesting colonies of Royal Tern (*Sterna maxima*), Sandwich Tern (*Sterna sandvicensis*), and Laughing Gull (*Larus atricilla*). Ferry Slip Island has a circumference of 0.55 km, and South Pelican Island has a circumference of 0.67 km. Both islands are ringed by narrow, sandy beaches. Battery Island, is a natural island with 1.72 km of sandy shoreline armored with large sand bags to prevent erosion and over-wash (Fig. 1). Battery Island is the site of a large wading bird colony comprised of White Ibis (*Eudocimus albus*), Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*) and Great Blue Heron (*Ardea herodius*). It also supports a substantial number of breeding Fish Crow (*Corvus ossifragus*). All river islands are free of mammalian predators and are closed to the public.

North and South Core Banks of Cape Lookout National Seashore (76.54 W, 34.61 N) (Fig. 1) comprise approximately 70.2 km of barrier island habitat. These long, narrow islands have wide sandy beaches on the ocean side, and extensive salt marshes on the sound side (Godfrey and Godfrey 1973). American Oystercatchers nest on the ocean beaches, dunes, and sand flats. The islands are open to the public (approximately 642,000 visitors per year in 2002 and 2003) and they support significant numbers of Raccoons (*Procyon lotor*) and feral Cats (*Felis catus*).

METHODS AND STATISTICAL ANALYSES

In 2002 and 2003, the number of breeding pairs was counted at each study site during the first week of May. The number of breeding pairs was divided by the number of kilometers of beachfront habitat to estimate an index of nesting density. We assumed no immigration or emigration between river habitat and barrier beach habitat occurred within seasons.

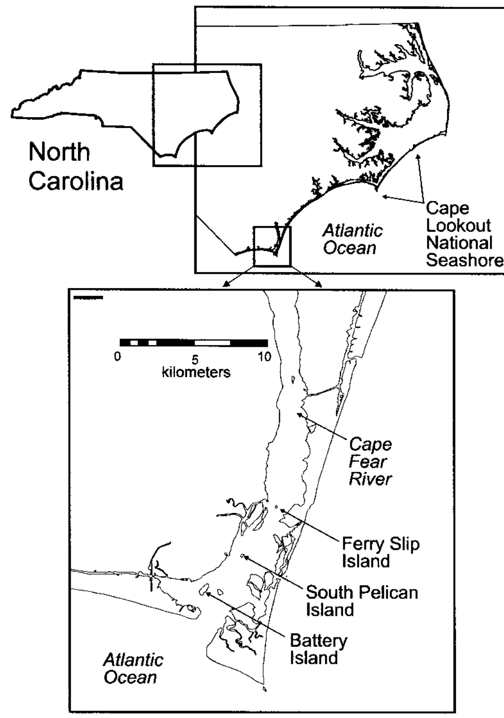

Figure 1. Map of eastern North Carolina with the study sites labeled and the lower Cape Fear River in detail.

Researchers located nests by observing incubating adults from a boat just off shore, and by walking or driving along the shoreline. Most nests were found during the egg-laying stage or during the first few days of incubation, however the researchers continued searching for and finding nests throughout the breeding season. Nests were usually checked every three to four days or as frequently as weather conditions permitted. If a nest failed before hatching, researchers tried to determine the cause of failure, and if a nest hatched, they monitored chick survival until fledging. Partial failure of clutches was not considered in this study. All nests were monitored until all eggs were lost or at least one egg hatched.

The Mayfield method (1961, 1975) was used to estimate daily survival of nest contents and hatching success. The Mayfield estimate was applied to whole clutches, and individual egg survival was not considered. A 27-day incubation period (Nol and Humphrey 1994) was used to estimate hatching success using the daily survival rate (Mayfield 1961, 1975). Heterogeneity in survival probabilities during the incubation stage was not considered, and the midpoint rule was used to designate the time of failure and time of hatching for nests that failed or hatched between visits. A Z-test and 95% confidence intervals were used to compare daily survival rates and hatching probabilities for birds nesting on river island and barrier island habitats (Johnson 1979). The 95% confidence intervals for Mayfield estimate of hatching success were derived by raising both the upper and lower bound of the daily survival 95% confidence interval to the 27th power (Johnson 1979; Hensler and Nichols 1981). Productivity is reported as the number of chicks fledged per breeding pair per year. The standard error of productivity was calculated by averaging the number of chicks fledged by each pair that attempted to nest, and then calculating the variance of that average. This estimate of productivity assumed the local breeding numbers did not change during the breeding season, and that breeding pairs retained their territories during a breeding season. Although many birds in this study were unmarked, observations of marked birds, and other studies of this species, supported these assumptions (Nol and Humphrey 1994).

RESULTS

There were ten breeding pairs on Ferry Slip Island, ten breeding pairs on South Pelican Island, and twelve breeding pairs on Battery Island in 2002, and ten breeding pairs on Ferry Slip Island, eleven breeding pairs on South Pelican Island, and 13 breeding pairs on Battery Island in 2003. There were 22 breeding pairs on North Core Banks and 22 breeding pairs on South Core Banks in 2002, 19 breeding pairs on North Core Banks and 21 breeding pairs on South Core Banks in 2003, giving an average of 10.6 pairs per kilometer of beach shoreline on river island habitat. There was an average 0.60 breeding pairs per kilometer of beach shoreline on barrier beach habitat in 2002 and 2003, thus there were 17.6 times more pairs per kilometer of shore on the river island beaches than on the barrier island beaches.

A total of 48 river island nests in 2002 and 49 nests in 2003 were monitored (Table 1). The Mayfield estimate of the daily nest survival of river island nests was 0.97 (S.E. ± 0.0039) (Fig. 2), and the probability of hatching was 0.45 over both seasons, with 95% confidence intervals ranging from 0.36 to 0.55 (Hensler and Nichols 1981). The primary cause of nest failure of river island nests was weather-related erosion and flooding.

A total of 90 barrier island nests were monitored in 2002 and 96 nests in 2003 (Table 1). The Mayfield estimate of daily nest survival was 0.92 (S.E. ± 0.0059) (Fig. 2) and the probability of a clutch hatching on barrier island habitat was 0.11 over both seasons, with 95% confidence intervals ranging from 0.08 to 0.16. The primary cause of nest failure for barrier island nests was mammalian predation. The probability of survival of nest contents on river island habitat was significantly greater than nests on barrier beach habitat ($Z = 6.68$, $P < 0.0001$) (Fig. 2). The hatching probability was much greater for river island habitat than for barrier beach habitat.

Differences in productivity between habitats in 2002 and 2003 were not significant ($Z = 0.58$, and $Z = 0.09$ respectively). Forty-seven chicks hatched and six chicks fledged from 27 nests on river island habitat in 2002. Productivity was 0.19 chicks fledged per pair (Table 1). Twenty-one chicks hatched and seven chicks fledged from 15 nests on river island habitat in 2003. Productivity of was 0.21 chicks fledged per breeding pair (Table 1).

Seventeen chicks hatched and six chicks fledged from ten nests on barrier island beach habitat in 2002. Productivity was 0.14 chicks fledged per breeding pair (Table 1). Thirty-one chicks hatched and eight chicks fledged from 16 nests on barrier island beaches in 2003, giving a productivity of 0.20 chicks fledged per breeding pair (Table 1).

Table 1. American Oystercatcher reproductive success data for river island and barrier island habitats in 2002 and 2003.

	No. pairs	No. nests	Exposure days	No. of failures	No. chicks hatched	No. fledglings	Fledglings/ pair (S.E.)
River islands							
2002	32	48	837.5	21	47	6	0.19 (0.07)
2003	34	49	1029.0	34	21	7	0.21 (0.07)
Barrier islands							
2002	44	90	838.0	80	17	6	0.14 (0.07)
2003	40	96	1207.5	80	31	8	0.20 (0.07)

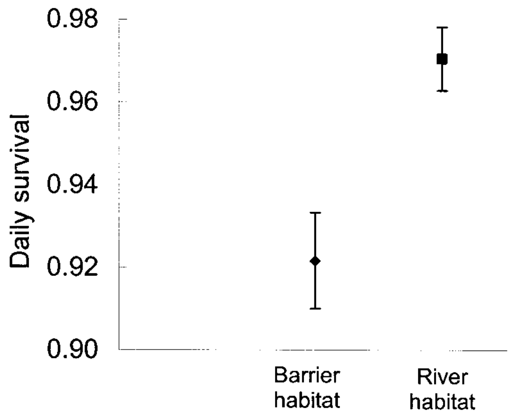

Figure 2. Comparison of 95% confidence intervals for the Mayfield estimates of daily nest content survival of American Oystercatchers on river island and barrier island habitats.

DISCUSSION

Although overall reproductive success was low at both study sites, the American Oystercatcher is a long-lived species, and even low levels of annual productivity may be sufficient to maintain the population. The European Oystercatcher can live up to 40 years (Ens *et al.* 1996) and American Oystercatchers are known to live for at least 17 years (Nol and Humphrey 1994). Davis (1999) showed that if the American Oystercatcher exhibits the same annual adult survival as the European Oystercatcher, these low levels of fecundity are still adequate for population replacement. These low levels of reproductive success are paradoxical in light of the expansion of the species' breeding range observed over the last 60 years. Better population estimates and measures of adult and juvenile survival rates are necessary to determine if the American Oystercatcher population is growing, or if birds are simply being driven out of traditional breeding habitats.

Oystercatcher hatching success was over four times greater on river island habitats than on barrier island beach habitats of North Carolina. Differences between these two habitats are likely attributable to the presence of mammalian predators on the barrier islands of Cape Lookout National Seashore. Mammalian predators were the primary cause of nest failure in Cape Lookout (Davis *et al.* 2001; McGowan 2004). The high oystercatcher nesting densities on the Cape Fear River islands, suggests that these areas represent high quality habitat. Ens *et al.* (1992) showed that the European Oystercatcher nested at higher densities when their territories contained contiguous nesting and feeding habitats. The birds with contiguous territories had higher reproductive success than birds of "leap-frog" territories (territories where the nesting and feeding grounds are not contiguous). Isolated islands, free of mammalian predators (such as those in the Cape Fear River), may serve as population sources for oystercatchers if they have high nesting success. Hockey (1996) suggested that predator free islands often serve as population sources for oystercatcher species around the world. The use of new habitats along the east coast of the United States may also explain the apparent population declines in the southeast, because birds nesting in non-traditional inland habitats may not be detected by coastal breeding bird surveys.

Fledging success was low on both barrier island and river island habitats. The standard errors of the annual productivity were large because most pairs fledged zero chicks and a few pairs fledged one or two chicks. Despite a hatching success of 44%, many chicks disappeared before fledging on the river islands. It is possible that chick predation at the river island sites was higher due to the large gull colonies in the vicinity. Kelps Gulls (*Larus dominicanus*) are important predators of African Black Oystercatcher chicks in South Africa (Summers and Cooper 1977; Hockey 1996). Chick provisioning may also be a problem for birds nesting on small isolated islands because adults have to fly to distant salt marshes to find food for their chicks. Ens *et al.* (1992) found that European Oystercatcher parents with "leapfrog" territories had lower reproductive success than birds in contiguous territories because provisioning rates and parental effort declined as distance to the foraging grounds increased. Nol (1989) reported similar observations, but she attributed the differences to higher chick predation on territories where parents were not continuously present to defend their chicks. Furthermore, Khatchikian *et al.* (2002) showed that the American Oystercatcher suffered from kleptoparasitism by the Brown-hooded Gull (*Larus maculipennis*), which reduced chick-provisioning rates. Kleptoparasitism might be a factor for oystercatchers nesting near Laughing Gull colonies in the Cape Fear River.

Breeding bird density can be a misleading measure of habitat quality (Van Horne 1983; Vickery *et al.* 1992). It is possible that non-traditional river island habitats in North Carolina are acting as ecological traps for the American Oystercatcher (Gates and Gysel 1978; Schlaepfer *et al.* 2002). Oystercatchers may preferentially select nesting territories on isolated islands because they are free of mammalian predators. However, because of the increased effort of provisioning chicks or the higher density of avian predators, the quality of river island habitats might actually be lower than barrier island habitats. Breeding oystercatchers in North Carolina are apparently faced with a tradeoff between habitat quality during incubation and habitat quality during the chick rearing stage.

This study did not identify a specific source for oystercatcher range expansion, because reproductive success was equally low in both habitats. Despite much higher hatching success on river habitats, these birds failed to produce a large number of fledglings. Additional research is needed to identify the sources of chick mortality on traditional and non-traditional habitats. In particular, studies of radio-tagged chicks are needed to determine the relative importance of different nesting habitats, and to set conservation and management priorities for the American Oystercatcher breeding along the east coast of the United States. Determining the causes of chick mortality, especially on river island habitats may indicate if these habitats can be managed to increase oystercatcher productivity. Furthermore, better estimates of adult and immature annual survival rates are critical for determining the levels of productivity necessary to ensure population stability of the American Oystercatcher.

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