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MANAGEMENT, MONITORING, AND PROTECTION PROTOCOLS FOR AMERICAN OYSTERCATCHERS AT CAPE HATTERAS NATIONAL SEASHORE, NORTH CAROLINA

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Introduction

The Outer Banks region of North Carolina supports approximately 90 breeding pairs of American Oystercatchers (Simon et al. 2004), along 160 km of beach, of an estimated 327 pairs surveyed in the state (Cameron and Allen 2004). Since the 1990s, this population has sustained declines in breeding pairs at Cape Hatteras National Seashore (CAHA), e.g., on Hatteras Island nesting pairs declined from 24 to 15 from 1999 to 2004 (Simon et al. 2004). Reproductive success for CAHA has been very low (<0.1 fledged per breeding pair) and sporadic depending on years and locations; however, some signs of successful reproduction have been noted at Cape Lookout National Seashore (just south of Cape Hatteras) on North Core and Middle Core Banks in 2004 (Simon et al. 2004). On Cape Hatteras, overall trends indicate that American Oystercatcher nesting attempts could decline to a scattered few per island per year (<5) in less than a decade.

Threats to nesting oystercatchers on CAHA are numerous and inter-related, but more than 51% of nest losses are from undetermined causes, which does not allow managers to correct the problem (Simons et al. 2004). Major causes of known nest failures (<49% of nesting attempts) are mammalian predation (60%), overwash (25%), avian predation (5%), abandonment (5%, possibly another cause), and humans (3%), vehicles (<2%), and

ghost crabs (<2%) (Simon et al. 2004). Sabine (2005) found strong associations with significantly reduced oystercatcher reproductive success/high predation and high levels of human disturbances on Cumberland Island National Seashore. Others have found reduced foraging for European oystercatchers in areas disturbed by humans (Verhulst et al. 2001). In other counties similar relationships have been found (to quote Sabine, 2005): "Human activities reduced reproductive success and influenced geographical distribution of African Black Oystercatchers (*H. moquini*) in South Africa (Jeffery 1987, Leseberg et al. 2000). Human disturbance and use of coastal areas have been implicated as primary causes of the extinction of the Canarian Black Oystercatcher (*H. meadewaldoi*) (Hockey 1987)."

The USGS Patuxent Wildlife Research Center developed this protocol, based on the best available scientific information, to guide management, monitoring and research activity at CAHA that would result in the protection and recovery of each species. These protocols do not attempt to balance the need for protection of these species with other activities that occur at CAHA, nor was NPS management policy considered in detail. A draft of the protocols was sent to species experts for scientific review; the final draft of protocols were reviewed by NPS personnel to ensure that description of recent management at CAHA was accurately represented and that the approach was consistent with our work agreement.

I. Species Description – Distribution and Biology

American Oystercatcher

The American Oystercatcher (*Haematopus palliates*) is easily identified by its large size (40–44 cm long, 400–700 g) and relatively long, bright reddish-orange bill. Its bill and body colors make it very conspicuous for a shorebird. The upper, dark body feathers contrast with its bright yellow iris and white feathers on the flank and breast (Nol and Humphrey 1994). Sexes are similar in appearance with females slightly larger than males.

Oystercatchers build nests near or on the beach by scraping many shallow depressions in the sand (4–6 cm deep and 20 cm in dia.) in close proximity, but choose only one scrape to build a nest. Oystercatchers also build nests on sand and shell flats, marsh islands, and dredge spoil islands (Nol and Humphrey 1994, McGowan et al. 2005). The nest may contain shell fragments, dead plants, small stones, and other debris (Baicich and Harrison 1997). In North Carolina, nests are rarely more than 21–32 m from water (Lauro and Burger 1989 in Nol and Humphrey 1994) and are often on a mound, which serves as a lookout for the birds (Baicich and Harrison 1997). Colonial waterbirds (e.g., Common Tern, *Sterna hirundo*; Least Tern, *S. antillarum*; and Black Skimmer, *Rynchops niger*) often nest in American Oystercatcher territories after oystercatchers begin nesting. Primarily monogamous, American Oystercatchers may mate for life although few long term records exist (Palmer 1967 in Nol and Humphrey 1994).

Both sexes incubate 3-egg (rarely 2 and 4) clutches for 24-28 days. Incubation may begin after laying the second egg (Nol and Humphrey 1994) or invariably after the last egg (Baicich and Harrison 1997). Pairs will re-nest if the eggs or nestlings are lost early in the season, but clutch sizes are rarely more than two eggs. Precocial and downy nestlings remain in the nest for 1−2 days and then move with adults within the nesting territory or into adjacent feeding areas, which can be 50 to 200 m away, depending on the local landscape, e.g., birds may move off nesting territory to marsh area inland from beach to feed young. Both adults brood nestlings <7 days old. Nestlings will crouch motionless when alarmed, which makes them difficult to see. They fledge in about 35 days. Fledglings depend on adults almost entirely until 60 days old (Palmer 1967, Nol and Humphrey 1994). Recent color-banding studies in North Carolina indicate that oystercatchers may return to the general vicinity to nest in later years (T. Simons, personal communication), which can only be corroborated with additional return color-banded bird data and studies in other states.

In September, oystercatchers in northeastern United States migrate south to Virginia and other winter ranges further south along the Atlantic and Gulf coasts. Many breeding oystercatchers in the southern states are non-migratory. During winter, northern and southern birds form large flocks with up to 869 birds seen in one flock in December in Virginia (Kain 1987) and South Carolina (Post and Gauthreaux 1989).

II. Habitat Descriptions

American Oystercatcher

Breeding habitat - Oystercatchers inhabit marine environments because of their special adaptation – a knife-like bill (laterally compressed) – for feeding on bivalve mollusks from saltwater. During breeding from March to August, pairs can be located along the Atlantic coast from Boston south to Indian River County, Florida. In late February and early March, pair formation and nesting begins in dunes near the beach wrack, but also occurs on dredge spoils and oyster bars in salt marshes in more human-disturbed beach areas. Beach nesting habitats are flat, nearly open sand areas with sparse to no vegetation. In North Carolina, oystercatchers rarely nest on marsh islands and commonly prefer nesting on high sandy sites (Lauro and Berger 1989 in Nol and Humphrey 1994). Marsh islands may become more common nesting habitat because of disturbances on beaches, but more research is needed (McGowan et al. 2005).

Foraging habitat - Oystercatcher foraging habitats vary from oyster and mussel reefs/shoals to intertidal sand/mud flats. Preferred foods found in these habitats are shellfish (bivalves and mollusks) and marine worms. In the southern habitats, from Virginia south, the major food items include oysters (*Crassostrea virginica*), soft-shell clams (*Mya arenaria*), razor clams (*Ensis directus*), stout razor clams (*Tagelus plebeis*), ribbed mussels (*Geukensia demissa*), mole crabs (*Emerita talpoida*), sandworms (*Nereis pelagica*), limpets (*Aemaeu* sp.), jellyfish (Colenterata), sea urchins (*Strongylocentratus* sp.), starfish (*Asteria* spp.), and crabs (Bent 1929, Tomkins 1947, Cadman 1979,

Johnsgard 1981, Nol 1989). Winter and summer foraging habitats are similar because of the non-migratory behavior of oystercatchers in North Carolina although migration is not well documented (Nol and Humphrey 1994). Current and future color-banding studies of American Oystercatchers should provide information on the migratory status of the species in CAHA.

Breeding pairs roost on the edge of intertidal feeding areas. Oystercatchers are more common in areas with few predators, especially areas without domestic dogs and cats (Nol and Humphrey 1994). In North Carolina, winter and migratory roosting habitats should be similar to breeding and roosting habitats, i.e., predator-free islands (e.g., dredge spoil islands) and other isolated habitats near foraging habitat. We have inadequate information in North Carolina on preferred roosting habitat during winter and especially during migration. Limited observations indicate that winter birds roost in open ground without vegetation in areas near foraging habitat (Tomkins 1954). This information is critical because peak wintering oystercatcher populations occur in Virginia, North Carolina, and South Carolina (Nol and Humphrey 1994).

III. Threats to reproduction and survival

Direct and Indirect Effects on Populations

Historical status of the American Oystercatcher during the 19th Century is not clear for eastern United States. It's possible that the species may have nested on the entire coast,

north to Labrador. By 1900, the oystercatcher was considered rare or accidental north of Virginia and scarce south of the state. By the 1950s, American Oystercatchers began re-nesting in northeastern United States. In 1984, 42 breeding pairs nested in Massachusetts and similar increases occurred in other states. Earlier declines may have been related to lack of protection, egg collecting, and market hunting, both threats that no longer exist today (Richards 1888 in Nol and Humphrey 1994).

Oystercatcher breeding success in North Carolina has been extremely low — one egg in 32 hatches (Davis et al. 2001). Current and future threats to the American Oystercatcher are human use, i.e., human disturbance within important breeding, wintering, and migratory habitat; increasing predators, especially associated with human use; and development of coastal areas (Bent 1929, Tomkins 1954, Nol and Humphrey 1994). Predators include red fox (*Vulpes vulpes*), mink (*Mustela vision*), skunk (*Mephitis mephitis*), dogs, cats, rats (*Rattus rattus, R. norvegicus*), American Crow (*Corvus brachyrynnchos*), and gulls (Nol and Humphrey 1994). More recently, video nest recordings have documented raccoon (*Procyon lotor*), bobcat (*Lynx rufus*), and ghost crab (*Ocypode quadratus*) predation of oystercatcher eggs and nestlings (Sabine et al. 2005). Oystercatchers may lay another clutch if predators depredate their nests early in the season (Nol and Humphrey 1994). Storms and high tides also reduce nesting success; sea level rise of 0.3–0.6 m in the next 50 to 100 years will reduce nesting success of shorebirds because of human development on suitable habitat created further inland (Titus 1990, Pilkey 2004).

Protection of oystercatcher feeding habitats requires an overall healthy environment, free from pollution, especially in coastal waters. Nesting areas require exclusion of humans in varying levels as well as management of Off Road Vehicles (ORVs) on the beach and occasionally predator management. Eight oystercatcher chicks (some with radios) have been documented in the last two years as mortality caused by ORVs crushing them on the beach (Simon et al 2004, and T. R. Simons, personal communications). In the future, habitat of national seashores, wildlife refuges, and state-owned wildlife management areas and parks will become increasingly more important to maintaining the population of American Oystercatchers in the eastern United States as private land is developed along Atlantic beaches.

Currently, there are few studies of the effects of humans and vehicles on the reproductive (nesting) success of American Oystercatchers (McGowan 2004, Sabine 2005) or colonial waterbirds. Studies of colonial nesting waterbirds indicate that set-back distances, in general, should be at least 180 m from nesting areas (Rogers and Smith 1995). Other investigators found similar data (flushed at 142 and 130 m respectively with human approach) for Common Terns (*Sterna hirundo*) and Black Skimmers (*Rynchops niger*) in Virginia and North Carolina (Erwin 1989). In general, more emphasis is needed on the effects of wildlife studies and viewing, recreational activities, and the intensity of these activities on behavior of nesting and foraging waterbirds (Burger and Gochfeld 1998).

For nesting American Oystercatchers on Cumberland Island National Seashore, Georgia, recent studies indicate that human disturbance free zones should be a minimum of 137 m

from the nest (upper 95% C. I. of mean flush distance from nest) and preferably 180 to 200 m (Sabine, J. B., personal communication). Eurasian Oystercatchers (*Haematopus ostralegus*) spent more time away and at greater distances from their nests when disturbed by researchers within 150 m of their nest (Verboven et al. 2001). In experiments on Eurasian Oystercatchers, investigators determined that human disturbance reduced incubation time as well as foraging time on nearby mudflats. When disturbed during chick rearing, these same oystercatchers delivered less food to their chicks, which presumably would reduce reproductive success (Verhulst et al. 2001). Although the number of papers published on this subject increased from the early 1970s to the late 1980s they have declined in recent times (Hill et al. 1997). More research is needed on disturbance of nesting American Oystercatchers if we want to protect and manage the population at current or increased levels in the Eastern United States.

Protection and Current Management at CAHA

Management for colonial waterbirds at CAHA has focused on reducing threats to nesting oystercatchers. Beginning in 2004, the approach to protect all beach-nesting birds and sea turtles has been to create a 150 ft transportation corridor for ORVs and pedestrian traffic from the high tide line landward. Vehicles may drive or park within the corridor. Pedestrians, but not pets, may cross the corridor boundary (inland), except where designated as specific natural resource closures. Park staff post and close traditional areas of nesting oystercatchers using signs and symbolic fencing, beginning in April, although March is the time for oystercatcher territorial establishment in North Carolina.

Park staff post additional sites with solitary-nesting birds when territories are established (dates unknown). When young hatch, sections of the entire beach from the water line to the dunes are closed to prevent direct mortality of chicks. In addition to management of ORVs and beach recreationists, mammalian predator control is also an ongoing management tool. Control of foxes, feral cats, raccoons, opossums, and skunks has been applied at Bodie, Hatteras, and Ocracoke islands.

In 2005, more restrictive measures were attempted in a number of areas of CAHA. At Green Island, with cooperation from the NCWRC, closure signs were posted early in the season around the perimeter to protect the island for colonial waterbirds and American Oystercatchers. Oystercatchers nested on Green Island in 2005. At Hatteras Island, an area of about 3 acres (2 ha) was closed around ephemeral ponds at Cape Point where terns, Black Skimmers, and one oystercatcher nested. Along South Beach on Hatteras, the upper beach was closed for about 1.5 km to protect nesting American Oystercatchers (3 nested), which could also indirectly benefit least terns. At Hatteras Spit, an experimental escort program with bird monitors was attempted, resulting in employing additional law enforcement personnel. This was enacted largely to protect Piping Plovers and oystercatchers nesting on the Spit. From 0700 to 1900 h, ORVs were allowed in the ORV corridor once per hour in convoys escorted by monitors. The area was closed during the night. At North Ocracoke, there was little sign of bird activity, therefore no additional closure was needed. At South Ocracoke, the 150-ft vehicle corridor was narrowed in one area to protect an intertidal zone where Piping Plovers had been observed feeding. Three oystercatchers nested at South Ocracoke this year within an

existing closure area. ORVs were permitted to drive past the protected area in the backshore, but were restricted from the shore of Pamlico Sound.

The effects of the current management are that vehicles and recreationists may still gain access to more than 90% of the open beach habitats. People management and public education is needed during the critical stages of territorial establishment, nesting, and rearing of chicks for oystercatchers, which is a sensitive period for the birds.

IV. Adaptive Resource Management Approach (ARM)

1. Framework for ARM

1. Research and management questions to be addressed

Monitoring of American Oystercatcher reproductive success on CAHA should address the following questions:

A. What are the number of nesting attempts and breeding pairs annually and what are their locations?

B. What is the daily egg and nestling survival (Mayfield Method) for a representative sample of oystercatchers nests (at least 30 monitored nests, if available, in each management area)?

C. Is predation high (>50% of nests depredated) and what are the major predators?

D. Is disturbance by pedestrians and ORVs causing loss of nests (destruction or abandonment) and nestlings?

E. Is high predation associated with highly disturbed areas? And are oystercatchers being forced to nest in areas too low (< 1 m asl), making nests susceptible to spring tide overwashes?

2. *ARM Experiments*

Adaptive Resource Management (ARM) is an efficient method for using monitoring information for testing hypotheses, modifying management procedures, and determining causality for natural resource problems (Walters 1986). With the vast amount of oystercatcher data already collected (Simon et al. 2004), additional experimental designs and sampling will permit evaluations for associations of explanatory variables (ORVs, visitors, and predators) on the reproductive success and survival of oystercatchers at CAHA (personal communication, S. Schulte, NCSU). Experiments that reduce the amount of disturbance, e.g., random seasonal closure of sections of beach to pedestrians and ORVS or regulated use (driving only at low tide, monitored , or permitted), will provide information on effects of these relatively undisturbed areas on oystercatcher survival or reproductive success when compared to disturbed treatments (controls). Experiments should include monitoring of amount of disturbances by pedestrians and ORVs in addition to information on oystercatcher reproductive success and survival. This could be done by remote means for vehicles (counters) or by direct counting of pedestrian use and disturbance. A video monitoring system may be useful. Video of

people could be controversial (persons may need to be told that video monitoring is occurring). Experimental areas should have replicated treatments (preferably 3, for disturbed and undisturbed) and should contain at least 10 oystercatcher territories or nests, but 20 would be preferred. These experimental areas should be selected for treatment randomly (disturbed or undisturbed = closed or regulated). If predator over abundance is suspected in the experimental areas, then predator removal should be undertaken before the disturbed and undisturbed experiments begin (see *Research Needs* for predator controls). Exclosures for nests (for predators and human disturbance) will not work well in protecting American Oystercatchers because they would have to be very large (137-200 m away and surrounding the nests) to prevent disturbance to most nesting pairs and are not practical in the dynamic beach forefront and back area.

3. *Research Needs*

Long-term research needs for American Oystercatcher include not only daily survival estimates of eggs and nestlings, but also survival estimates of sub-adults (prior to breeding) and adults. An expanding color-marking program to help determine oystercatcher survival should provide data necessary for constructing population models (see http://www4.ncsu.edu/unity/users/s/simons/www/AMOYworkinggroup_2004.htm for details and Simon et al. 2004). This program will also provide information on management goals for nesting success for national seashores in North Carolina and elsewhere in the southeastern United States. An excellent baseline of American Oystercatcher reproductive success data has be compiled by government and private

agencies and North Carolina State University, which should continue to provide information for managers (see Simon et al. 2004). Research and monitoring of suspected high predation levels will require real-time video recording of nests, which should provide excellent information for predator management (see Sabine 2005 and Sabine et al. 2005). This technique works well for monitoring nests until the nestlings leave the nest area. After that time, use of small radio transmitters on nestlings in two representative areas (disturbed and undisturbed – people and ORVs managed) may provide information on causes of chick mortality, especially prior to fledging (Simon et al. 2004). Data collected from video nest monitoring will provide definitive proof of suspected predator problems, which will allow specific management recommendations for reducing predators when necessary. Removal of all larger mammalian predators, e.g., foxes, raccoons, and cats, may be warranted based on data collected by video monitoring or reproductive success studies. Experiments could be setup to determine the success of predator removal (see colonial waterbird section for details), but usually are not needed if nesting failure is high from predation (50 to 100 %). In this case a substantial reduction in overabundant predators will most likely increase oystercatcher nesting success. After predators are controlled or eliminated, experiments on effects of disturbance from pedestrians, dogs, ORVs, and others will be more likely to produce results that managers can use effectively.

2. Management Recommendations

Three management options for American Oystercatchers and their habitat are presented from the most conservative (low adverse effects) to one that might be considered "take" under the migratory bird regulations. Management options for oystercatchers should be discussed in cooperation with the USFWS and North Carolina Wildlife Resources Commission.

Option A: Highest Degree of Protection

1. Completely close all areas used by nesting and foraging American Oystercatchers during the last 10 years to recreational activities from March 15 to August 15. This may increase reproductive success in combination with other management practices, e.g., elimination of overabundant mammalian predators. Close winter roosting areas to recreation during times to be determined from winter roosting surveys in the future.
2. Allow essential vehicles access to restricted areas within the guidelines for Essential Vehicles section of Appendix G of the Revised Recovery Plan for Piping Plover (USFWS 1996, see colonial waterbird section). Speed limits should be 10 mph.
3. Continue to conduct surveys for reproductive success and mammalian predators. Trap as needed to reduce predation levels when >50% of nests are loss to predators. Use USDA Wildlife Services or approved USDA trappers.

4. Erect signs 200 m from nests to warn personnel of the nesting pair and reduce disturbance in the area by other biologists, law enforcement, and managers. Move signs to boundaries of chick foraging areas after hatching so that the vast majority of foraging area is protected.

Predicted effect:

Only limited effects from recreational impacts on nesting and foraging oystercatchers should occur with little habitat impacts from limited use of essential vehicles. Reproductive success will be related to success management of overabundant predators and natural weather (storms) and tide conditions, which could eliminate nests occasionally. Nesting oystercatchers and productivity should gradually increase during four to five year periods.

Option B: Moderate protection

1. Close specific areas for nesting American Oystercatcher's in coordination with closure of beaches for nesting colonial waterbirds and Piping Plovers (*Charadrius melodus*). Important nesting areas and ones that have been closed in the past for oystercatchers are Hatteras Island: Cape Point, South Beach, Hatteras Inlet; Bodie Island: Bodie Island flats; and Ocracoke Island: areas from ramp 59 to ramp 72 in addition to sites mentioned in Option B for colonial waterbirds. See Figures 1-6 for locations in colonial waterbird sections. Place signs 200 m from nesting birds

to warn persons of the nesting areas. Signs should have some educational value as well as law enforcement information.

2. Allow pedestrians only in oystercatcher territories and limit walking corridors to 50 m from high tide line. Pets must be kept on a short lease in these areas. Discourage and warn pedestrians about walking above the beach wrack, which could cause destruction of eggs. Encourage pedestrians to quickly move through the area be placing warning signs, e.g., "migratory bird nesting area...," and directional signs, e.g., "do not stop in bird nesting areas, move quickly to reduce disturbance to nesting birds."

3. At the remaining corridors outside the ones mentioned above, follow procedures established for ORV corridors in the colonial waterbird section.

4. Enact recommendations number 2 and 3 in Option A above.

Predicted effects:

Expected effects may be slightly reduced nesting success caused by minor disturbances by pedestrians. ORV Essential Use may have a limited effect on hatchling mortality although signs should provide the drivers enough warning to reduce mortality if they reduce speeds to 5 mph in nesting zones. Predators may be attracted to the area by refuse left by pedestrians; however, predator control may reduce this potential negative effect. Potential effect from Essential Vehicle Use is expected to be similar Option A.

Option C: Minimum Protection

1. Restrict all ORV, boat (recommend coordination with other agencies), and pedestrian recreation to a corridor within 50 m of the oceanside mean high time line from sunrise to sunset at all sites used in the last 10 years by nesting American Oystercatchers. This should be in effect from March 15 to August 15 for nesting birds. The corridor should be reduced or closed during the hatchling stage (assuming the pair were successful) to reduce chick mortality from ORVs. It should remain closed until August 15 (Sabine 2005) or until 60 days (independence from adults; Nol and Humphrey 1994) after last hatching date if nests were monitored in the area. Areas should be closed from sunset to sunrise for all recreation activities.
2. At the focal sites mentioned in Option B, prohibit kites, balls, frisbees, fireworks, pets, and trash disposal. Vehicle speed limits should be 10 mph.
3. Enact recommendations number 2 - 4 in Option A above.

Predicted effects:

American Oystercatchers may persist mainly as unsuccessful nesters (daily nesting survival of <0.92) for 5-10 years, but will eventually be extirpated from areas of high human use. Subsistence resources will provide foraging and other needs for the species, but low reproductive success will mean the population will only maintain itself with immigration from other areas (if surpluses are being produced in other nesting areas).

3. Monitoring protocols

A. Nesting and breeding success — All beaches should be searched for oystercatcher activity beginning in late March at least twice per week. Observers should record the locations (GPS), number (pair or single), behavior, courtship (piping display, see Nol and Humphrey 1994), and evidence of scrapes. Areas with oystercatcher activity should be checked 3 times per week in early April and if possible more often as nesting and laying season approaches in late April. Once a nest is located it should be marked in an unobtrusive manner (e.g., numbered wooden paint stirrer 10 m east of nest), given an identification number, and checked every 3 days or more if possible. When checked initially, we recommend that the following information be recorded for the nest description: nest number; distance to high tide line (m); GPS location (UTM in NAD83); habitat (see glossary); and description of scrape substrate (digital photograph at 10 m from nest may be helpful). Monitoring data collection should proceed the same day with recording the following: date and time of check, nest number, number of eggs (flushing adults 3 times per week); status of the nest (laying, incubating, lost, abandoned, hatching [eggs pipping], hatched); number of adults; presence of potential predator, human, or ORV tracks within 30 m of nest; evidence of potential predator trails within 10 m of the nest; and suspected causes; date and time of nest check of egg or nestling loss; and detailed description of area if nest is lost.

After nestlings leave their nest (1-2 days old), observers should record the location and habitat of adults and chicks at least twice a week. Habitat and GPS locations should be collected (use for mapping feeding areas) in addition to nest number, the number of nestlings, number of adults, brood age if known, behavior of nestlings and adults (see glossary), chick loss, cause of chick loss if carcass is found and mortality is apparent, and signs of potential predators or threats (e.g., deep vehicle tracks, which prevent chicks from accessing the beach).

B. Migration and wintering habitat — Surveys for oystercatchers should be coordinated with the winter Piping Plover survey. Locations (GPS as above), activities, habitat, and numbers of oystercatchers should be recorded and entered into a GIS database, if available, for each year. This will allow eventual detection of important use areas for oystercatchers during migration and winter.

4. Reporting procedures

During the breeding season from mid April to June, interns and technicians should provide weekly updates of nests to biologists and managers. Changes, if possible, can be made in management procedures (e.g., widening exclosure) for nests not part of an experimental study, which may produce higher reproductive success.

5. Data management

All data (hard copy) should be copied weekly and stored in a different location than the original. Data should be entered into computer files and verified by another person. Computer files must be backed up daily and in their entirety at least every week. Backup disks must be stored at a different location and preferably on the mainland in an area well protected from storm damage, which could eliminate all files in the area. Annual data backups should be sent to the regional office for archiving. Access or equivalent data management software is preferred for large data files and it will also reduce errors during entry. Excel or equivalent software is useful for management of smaller data sets. Please see the colonial waterbird section for addition information on data collection, training, and data management.

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