

Management of Feral Horses at the North Carolina National Estuarine Research Reserve

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ABSTRACT: Feral horse (*Equus caballus* L.) populations are found on properties managed by governmental agencies in western states, the Missouri Ozarks, and on several Atlantic coast barrier and estuarine islands. These animals are descendants of free-roaming horses introduced decades to centuries earlier. Public sentiment has influenced development of policies that have allowed the herds to remain. The North Carolina National Estuarine Research Reserve is a state program with federal support and oversight that manages four properties; two (Rachel Carson in Beaufort, NC, and Currituck Banks near Corolla, NC) include feral horse populations. Current reserve policies include maintenance of these herds; however, impacts on salt marshes and other ecosystems represent a conflict with federal regulations. Among the Atlantic Coast herds, conditions at the Rachel Carson site are least accommodating for the animals. With a combination of pertinent research results plus 20 years of site-specific management experience as a basis, I argue that feral horses of the Rachel Carson site should be removed for programmatic, ecologic, and humane reasons. To maintain estuarine reserve character, the Currituck Banks site should be protected from roaming horse impacts by creation of one or more delimited pastures outside reserve property.

Index terms: estuarine research reserves, feral horse management, introduced species, public sentiment

INTRODUCTION

North Carolina National Estuarine Research Reserve

The North Carolina National Estuarine Research Reserve (NCNERR) is a state-managed program within the North Carolina Department of Environment and Natural Resources, Division of Coastal Management (NCDCM). In addition to national guidance and technical assistance, the federal Estuarine Reserves Division of the National Oceanic and Atmospheric Administration (NOAA) within the U.S. Department of Commerce provides funding for operations, acquisition, research, and education. State support for reserve operations and personnel is provided by matching funds.

The NCNERR is one of 27 designated national estuarine research reserves located in 22 U.S. coastal states and the Commonwealth of Puerto Rico. Primary uses of these properties are research, education, and stewardship. Land ownership, management, and staffing for each reserve are responsibilities of the non-federal partner (e.g., NCDCM) with the Estuarine Reserves Division as primary liaison.

Between 1985 and 1991, the State of North Carolina and NOAA designated a four-component reserve to represent the diversity of habitats found within the state's 0.9 million-hectare estuarine area.

The four components or sites include: (1) Currituck Banks (near Corolla), (2) Rachel Carson (Beaufort), (3) Masonboro Island (between Wrightsville Beach and Carolina Beach), and (4) Zeke's Island (near Kure Beach). Two of the sites, Rachel Carson and Currituck Banks, have populations of feral horses (*Equus caballus* L.). Federal funds were used to purchase a majority of these sites for management according to NOAA guidelines (NCNERR 1998).

In this paper, I review published and unpublished information concerning management, ecological impacts, programmatic issues, and living conditions of feral horse populations at the NCNERR and at other Atlantic coast islands. I also draw on experience as the NCNERR manager during 1983–2004 to assess this information and to make recommendations concerning long-term management of horses at both reserve sites.

Feral horses management at the Rachel Carson and Currituck Banks sites

Rachel Carson Site

Most of the 1063-ha Rachel Carson site (125 upland hectares; 938 intertidal/subtidal hectares) is located across Taylor's Creek from the Town of Beaufort. Since 1954, feral horses have inhabited several estuarine islands and associated salt marshes,

intertidal flats, and tidal creeks surrounded by maintained navigation channels (Day 1997; NCNERR 1998). No regular herd management was performed prior to state acquisition during 1983-85, and the population eventually grew to 68 animals. Starvation problems during 1986-87 forced the state to remove 33 horses in 1988 as a remedial measure. The Secretary of the North Carolina Department of Environment and Natural Resources then decided that a representative herd of approximately 30 horses would be maintained (NCNERR 1998; Taggart 1998). Subsequent secretaries have not amended that policy.

Following partial herd removal, management was initiated by immunoconceptive darting, initially using anti-luteinizing hormone-releasing hormone vaccine administered by the Veterinary School at North Carolina State University. When several years of that treatment failed to produce desired results, darting of mares with Porcine Zona Pellucida (PZP) vaccine began in 1999 under the direction of the Humane Society of the United States and the Science and Conservation Center at ZooMontana. Testing for equine infectious anemia during 1990-96 revealed several disease carriers that were euthanized. Since then, the herd count has remained fairly stable, except for natural mortality, and currently consists of 42 animals managed by the reserve office located in Beaufort (P. Gillikin, Rachel Carson site manager, NCNERR, pers. comm.). Annual darting with PZP vaccine is performed according to a memorandum of understanding between the NCNERR and Cape Lookout National Seashore with assistance from the Humane Society of the United States (Taggart 1998; Kirkpatrick 2005).

Currituck Banks Site

Feral horses (aka Corolla wild horses) have inhabited the northern Currituck Banks for many decades and roam not only 135 ha of reserve property, but approximately 4889 ha of adjacent private and public lands. This area also includes properties owned and managed by The Nature Conservancy and U.S. Fish and Wildlife Service – Currituck National Wildlife Refuge (County

of Currituck 2007). Because of the large territory available to these animals, they spend relatively little time on the reserve site where less desirable grazing plants grow among the prevailing dune and shrub thicket habitats (Rheinhardt and Rheinhardt 1997).

Fencing erected on the Virginia side of the state line to limit vehicular access kept most horses from heading north onto False Cape State Park; however, there were problems to the south in the Village of Corolla. By 1989, 17 horses had been killed in road accidents and some local residents were beginning to tame and feed the animals. In 1994, a permit issued by the Division of Coastal Management to Currituck County allowed construction of an ocean-to-sound south fence that subsequently was built and maintained by the Corolla Wild Horse Fund. Feral horses from the Corolla area were then moved north of that fence to avoid further problems (County of Currituck 2007).

The most recent population census is 94 animals. This number will be reduced gradually by adoption, relocation, auction, and/or immunocontraception to a maximum of 60 animals, as prescribed by the herd management plan. Staff and members of the Corolla Wild Horse Fund perform census work and immunocontraception, maintain fences, retrieve horses that get through or around fences, and capture/remove horses as needed (County of Currituck 2007; S. Rogers, herd manager, Corolla Wild Horse Fund, pers. comm.).

The office of the Currituck Banks reserve site manager is located approximately 50 km south of Corolla because of additional stewardship responsibilities elsewhere on the Outer Banks. Primary duties concerning the feral horses involve monitoring site impacts and participation on the local management committee (NCNERR 1998; County of Currituck 2007).

Feral horse management at other locations in the United States

Management of feral horses elsewhere in the country is performed according to vari-

ous policies and techniques. Best known are wild mustangs of several western states managed by the federal Bureau of Land Management (BLM) according to the Wild Free-Roaming Horse and Burro Act of 1971. To avoid overpopulation problems, horses are captured and offered for adoption to the public, while immunocontraception has been used in some herds (Kirkpatrick 2005). BLM sanctuaries for unadopted mustangs are found in Oklahoma and Kansas (Ginsberg 2001). Controversies relative to these animals include: conflicts with cattle grazing and land management, genetic health, horse removal, treatment of removed horses, and whether or not feral horses should be part of western ecosystems (The Wild Horse Preservation Campaign 2007). A small population in the Missouri Ozarks has generated contentious management perspectives also, but the number of animals is now kept at a safe level by selective removal/adoption (Rikoon 2006; Missouri's Wild Horses 2007).

Other Atlantic coast feral horse populations are found on several federal properties: Assateague Island National Seashore (MD), Chincoteague National Wildlife Refuge (VA), Currituck National Wildlife Refuge (NC), Shackleford Banks within Cape Lookout National Seashore (NC), and Cumberland Island National Seashore (GA). Each of these sites has its own history, management policies (e.g., capture/adoption, immunocontraception, or no current population control), and public perceptions concerning these animals (National Park Service 1984; National Park Service 2006; Zimmerman et al. 2006; County of Currituck 2007; National Park Service 2007a, 2007c; U.S. Fish and Wildlife Service 2007; D. Hoffman, biologist, Cumberland Island National Seashore, pers. comm.). A summary of herd sizes and available roaming/grazing areas for the properties is given in Table 1. In addition, 25-30 horses descended from a once feral herd located on Ocracoke Island (NC) are maintained (i.e., provided food, water, and veterinary care) by the National Park Service in a 73-ha pen within the Cape Hatteras National Seashore (National Park Service 2007b).

Table 1. Herd sizes and use areas of Atlantic Coast feral horse populations.

Site	Herd Size	Roaming/Grazing Area Estimate
Assateague National Seashore	144 ^a	2267 ha upland + 1296 ha of high/low marsh ^a
Chincoteague National Wildlife Refuge	150 ^b	two pens totaling 1619 ha ^b
Currituck National Wildlife Refuge and Currituck Banks Estuarine Reserve	94 ^c	5024 ha ^d
Shackleford Banks (Cape Lookout National Seashore)	110-130 ^e	923 ha ^f
Rachel Carson Estuarine Reserve	42 ^g	125 ha upland + 109 ha of low marsh ^h
Cumberland Island National Seashore	135-140 ⁱ	14,575 ha ^j

^a C. Zimmerman, chief – Division of Resource Management – Assateague Island National Seashore, pers. comm.

^b W. Haglan, supervisory wildlife biologist, Chincoteague National Wildlife Refuge, pers. comm.

^c S. Rogers, Corolla, NC, pers. comm.

^d County of Currituck, 2007

^e NPS, 2006

^f Levin et al., 2002

^g P. Gillikin, Beaufort, NC, pers. comm.

^h J. Ott, GIS specialist, NCNEER, pers. comm.

ⁱ D. Hoffman, St. Marys, GA, pers. comm.

^j P. Wentworth, visitor use assistant, Cumberland Island National Seashore, pers. comm.

SITE AND PROGRAMMIC ISSUES RELATIVE TO ESTUARINE RESERVE FERAL HORSES

Estuarine impacts

Feral horse populations found on Atlantic coast islands consist of an introduced species that affects both upland and estuarine habitats to varying degrees. While it is true that prehistoric ancestors of horses and other megaherbivores grazed Pleistocene marshes (Koch et al. 1998), these species became extinct approximately 10,000 years ago (Levin et al. 2002; Prioli 2007). Thus horses brought from Europe did not co-evolve with the estuarine ecosystem.

The following is a review of previous research concerning Atlantic coast feral horses. Although not exhaustive, it is representative of investigations within habitats found at the two reserve sites and, therefore, provides valuable input concerning long-term management considerations.

Direct Effects

Feral horse impacts on salt marshes have been investigated at several of the aforementioned properties including the Rachel Carson reserve site. Buerger et al. (2005) began studying horse-generated changes to that property in 1997. Evidence of equine grazing and trampling was apparent within the western two-thirds of the uplands and in saltmarsh borders or ecotones associated with dredge material areas. The authors found that some areas (e.g., lightly grazed interior uplands) were able to mitigate horse impacts while others (e.g., frequently trampled ecotones) may need to be fenced to reduce or eliminate impacts.

Furbish and Albano (1994) studied factors influencing distributions of smooth cordgrass (*Spartina alterniflora* Loisel.) and salt grass (*Distichlis spicata* [L.] E. Greene) in salt marshes at Assateague Island National Seashore. They found that *Spartina alterniflora* responded negatively to selective grazing by feral horses while *Distichlis*

spicata responded positively, suggesting a plausible effect on the competitive relationship between the two grasses that favors a change in salt marsh community structure within the grazed area.

Rachel Carson site research by Hay and Wells (1991) compared patterns in vegetation structure between exclosures and grazed control areas to assess how horse density changes affected local marshes. They found that areas protected from grazing had significant increases in *S. alterniflora* biomass, percent cover, blade length, lateral expansion of isolated clones, culm density, and seed production. This vegetation increase among non-grazed plots was positively correlated with higher sedimentation rates and changes in sediment height. The authors concluded that “a reduction in horse grazing may accelerate seaward growth of the reserve and perhaps provide the increase in sediment elevation needed to offset any future increases in rate of subsidence or sea level rise due to the greenhouse effect.”

Similarly, Turner (1987) found that horse grazing at Cumberland Island National Seashore had a substantial impact on net aboveground primary production and standing stocks of *S. alterniflora*, but grazing was not uniform and varied from intense in high marshes to relatively less in low marshes. Results suggested that trampling of muddy marsh substrates may be the more destructive aspect of grazing. The author also felt that heavily grazed marshes may be more susceptible to erosion and storm damage.

Wood et al. (1987) observed that feral ungulates (i.e., horses, cattle, sheep, and goats) lowered aboveground annual growth in Shackleford Island salt marshes. Approximately 50% of horse diets consisted of *S. alterniflora* and saltmeadow cordgrass (*Spartina patens* [Aiton] Muhl.). The authors concluded that if the population remained stable “major deterioration in site potential to support vegetative growth is unlikely.”

At the Chincoteague National Wildlife Refuge, Keiper (1981) found that approximately 11% of available vegetation had been grazed by feral horses and that such light grazing actually may stimulate additional plant growth leading to shorter, denser vegetation. The animals spent approximately 60% of their annual time in the salt marsh. The author recommended a herd size of no more than 141 animals.

Indirect Effects

Levin et al. (2002) concluded that feral horse grazing altered saltmarsh and adjacent subtidal communities at Shackleford Banks, making them more or less suitable for occurrences of certain species. Horse-grazed marshes had less vegetation, a higher diversity of foraging birds, higher densities of crabs, and a lower density and species richness of fishes compared to ungrazed marshes. The authors also noted that “Conservation of the native marsh community of Shackleford Banks will require resolution of the conflicting goals of maintaining feral horses and a functioning marsh.”

Impacts on other habitats and associated biodiversity

Feral horse grazing has been sampled in sandy uplands of these public lands. De Stoppelarie et al. (2004) used remote sensing and field sampling to investigate grazing impacts on sand flats and small dunes at Assateague Island National Seashore. Paired plots of grazed and ungrazed/fenced plots with similar elevations indicated that grazing had a significant impact on dune formation and contributed to dune erosion.

Wood et al. (1987) found that feral ungulate (i.e., horses, cattle, sheep, and goats) impacts at Shackleford Banks lowered aboveground annual growth and slowed succession in grass-shrub areas plus prevented significant coverage of broomsedge species (*Andropogon* spp. [L.] and *Schizachyrium* spp. [Nees]) on grassy dunes. Approximately 37% of annual horse diets consisted of upland grasses. Results also suggested that ungulate grazing interfered with spatial increase in maritime forest, but horse impacts on this ecosystem were minimal.

Within the uplands and interior wetlands of Currituck Banks, Rheinhardt and Rheinhardt (1997) concluded that horse grazing shifted among habitats and plant species according to season: winter–maritime dry grasslands and developed areas; spring–tidal freshwater marshes and grassy dunes; and summer through fall–maritime wet grasslands and tidal freshwater marshes. Horse density appeared to be low at the time of sampling, but trampling may have been detrimental to local forbs. However, rooting by feral pigs likely caused more damage than either grazing or trampling by horses. Fresh water was not a limiting factor because of abundant swales and man-made canals.

The North Carolina Natural Heritage Program within the North Carolina Department of Environment and Natural Resources maintains a database of federal and state-listed species plus significant natural features (e.g., plant communities, geological formations, etc.) throughout the state. Each verified observation is known

as an element occurrence. Records for the Currituck Banks component consist of two plant communities while the portion of the Rachel Carson site used by the horses includes 14 element occurrences: plant/animal species, a bird colony, and plant communities as summarized in Table 2.

No studies have been completed at the Rachel Carson site to document impacts of feral horses on the species listed; however, Zimmerman et al. (2006) mentioned that *Amaranthus pumilus* is affected negatively by horse grazing. Investigations mentioned above encompass effects on the salt marsh community.

An undescribed butterfly (*Atrytonopsis* sp. 1) that occurs only in Carteret and Onslow counties, North Carolina, is listed as a federal species of concern and has significantly rare status in North Carolina (LeGrand et al. 2006). While it has been recorded from islands adjacent to the Rachel Carson site, the butterfly never was observed by biologists during repeated visits to the reserve. Hall (2004) hypothesized this absence may be caused by horse grazing of seaside little bluestem (*Schizachyrium littorale* [Nash] Bickn.), the food plant used by larvae of this butterfly. Only a few plants were observed despite the presence of suitable habitat. In one area where the grass managed to persist, horse grazing of caterpillar shelters constructed near blade tips of the host plant may have been responsible for preventing development of a butterfly population. This site was located across a channel from another island with a large, vigorous butterfly colony that was inaccessible to horses (S. Hall, invertebrate zoologist, Natural Heritage Program, pers. comm.).

Conflicts with the estuarine research reserve program

The aforementioned impacts of feral horses on estuarine and associated habitats present a problem for a program that is intended to manage such areas for research and educational activities. In contrast to U.S. Department of the Interior properties, there is a more specific mission of estuarine habitat protection to serve as a baseline

Table 2. Element occurrences^a within portions of the Currituck Banks (CB) and Rachel Carson (RC) NERR Sites where feral horses are also present.

Site	Element Occurrence	Status ^b	
		Federal	NC
CB	<i>Plant Communities</i>		
	Maritime Shrub	–	–
	Maritime Shrub Swamp	–	–
RC	<i>Plants</i>		
	Seabeach Amaranth (<i>Amaranthus pumilus</i> Raf.)	T ^c	T
	Seabeach Knotweed (<i>Polygonum glaucum</i> Nutt.)	–	SR-T ^d
	Shoreline Sea-purslane (<i>Sesuvium portulacastrum</i> L.)	–	SR-P ^e
	Moundlily Yucca (<i>Yucca gloriosa</i> L.)	–	SR-P
	<i>Animals</i>		
	Piping Plover (<i>Charadrius melodus</i> Ord)	T	T
	Wilson's Plover (<i>Charadrius wilsonia</i> Ord)	–	SR ^f
	Eastern Painted Bunting (<i>Passerina ciris ciris</i> L.)	–	SR
	Black Skimmer (<i>Rhynchops niger</i> L.)	–	SC ^g
	Least Tern (<i>Sterna antillarum</i> Lesson)	–	SC
	Gull-billed Tern (<i>Sterna nilotica</i> J.F. Gmelin)	–	T
	Gull-Tern-Skimmer Colony	–	–
	<i>Plant Communities</i>		
	Maritime Shrub	–	–
	Salt Marsh	–	–
	Upper Beach	–	–

^a records from NC Natural Heritage Program files (unpubl. data)

^b plant status: Franklin and Finnegan 2006; animal status: LeGrand et al. 2006

^c threatened status

^d significantly rare – threatened status

^e significantly rare – peripheral status

^f significantly rare status

^g special concern status

or control for comparison to local/regional sites affected by various changes (e.g., development, invasive species, etc.). A brief summary of pertinent federal regulations and state guidelines will illustrate this management conflict.

Federal regulations for the National Estuarine Research Reserve System (NOAA 2006) have the following mission:

establishment and management, through Federal-state cooperation, of a national system of estuarine research reserves representative of the various regions and estuarine types in the United States. National Estuarine Research Reserves are established to provide opportunities for long-term research, education and interpretation.

National program goals include:

(1) Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources; and (5e) ... Many estuarine areas have undergone some ecological change as a result of human activities (e.g., hydrological changes, intentional/unintentional species composition changes – introduced and exotic species). In those areas proposed or designated as National Estuarine Research Reserves, such changes may have diminished the representative character and integrity of the site. Although restoration of degraded areas is not a primary purpose of the System, such activities may be permitted to improve the representative character of the Reserve.

The NCNERR management plan (NCNERR 1998) contains the following policy concerning feral horses:

Scientific studies of population structure, feeding habits, and impacts on reserve habitats plus information from analogous management programs of feral horses shall be used to manage the horses at the Rachel Carson component. Such information will also be used to consult with key parties concerning feral horse management on the Currituck Banks.

Explanatory text also includes the following passage:

Though the horses are very popular with local residents, the animals represent a management conflict because they are an introduced species that consumes marsh vegetation vital to estuarine productivity and other natural processes. Any decision on horse management will be reviewed by the Department of Environment and Natural Resources, the Sanctuaries and Reserves Division (now the Estuarine Reserves Division) and the local advisory committee.

In 1993, NOAA denied a request by the North Carolina Division of Coastal Management to confine feral horses within a portion of the Currituck Banks reserve site because: "confining or penning these horses on the Currituck Banks Component of the Reserve is not consistent with the goals and objectives of the National Estuarine Research Reserve Program." In addition, it was stated that NOAA would not consider a "buy back" of the land because it would involve de-designation of that property and possibly all four reserve sites. Feral horses, however, are not restricted from the site as part of their overall roaming/grazing range (NCDRCM 1993).

Living conditions

Another important aspect of NCNERR horse management involves local living conditions, particularly at the Rachel Carson reserve. This property has the smallest upland/intertidal area of the Atlantic coast sites with feral horses (see Table 1).

During warm months, Rachel Carson horses spend the majority of their time on intertidal marshes where they graze *Spartina alterniflora*. Other preferred salt marsh species of adjacent high marsh and salt flat areas include *Spartina patens* and glasswort (*Salicornia virginica* L.), respectively. Upland areas composed of dredge material and dune communities are home to scattered populations of ruderal species, such as Bermuda grass (*Cynodon dactylon* [L.] Persoon) and clover (*Trifolium camp-*

estre Schreber), that are consumed more frequently during winter months when salt marsh productivity is low (Stevens 1986, 1987).

Currituck Banks horses roam a large area (5024 ha) with an array of freshwater wetland and dune habitats adjacent to a low-salinity estuarine system (Rheinhardt and Rheinhardt 1997). These conditions give the animals choices among grazing areas and plant species throughout the year.

Currituck Banks has numerous perennial freshwater sources, but this is not true for the Rachel Carson site where fresh water is in limited supply most of the year, especially during low rainfall periods of hot summer months when mares are lactating. Temporary pools may form following heavy rainfalls, but no permanent ponds are found on the islands and horses must dig to water tables at several locations. These water holes are small and typically allow only one horse to drink at a time. Horse groups or harems often take turns when water is especially scarce and competition can result in some animals having little or no access (Stevens 1986, 1987).

On rare occasions, feral horses have been killed by drowning in storm surges. This occurred in September 2003 during Hurricane Isabel, a category two storm. Bodies of five Rachel Carson horses were found 4.8 km east on Harkers Island. Three other horses survived the same storm after being carried 1.6 km south to Shackleford Banks (none were lost from that herd). These animals were returned to the reserve following testing for equine infectious anemia (Prioli 2007). A total of 12 horses were lost to storms on Assateague Island during 1989-1993 (Zimmerman et al. 2006).

Small, isolated populations are susceptible to genetic drift and inbreeding. E.G. Cothran (unpubl. data) found that among Atlantic coast herds, blood samples from horses of the Currituck Banks and Rachel Carson sites exhibited low levels of heterozygosity. This raises a concern relative to future genetic health and population viability. The issue of genetics combined with other herd sustainability issues (i.e., behavior, nutrition, reproduction) was a

primary motivation for long-term management planning at Assateague Island National Seashore (Zimmerman et al. 2006).

Finally, management can be limited by local geography. While herds found at Currituck Banks and east coast federally-managed properties inhabit large barrier islands, the Rachel Carson reserve site is composed of relatively small estuarine islands separated by tidal creeks and intertidal mud flats that make capture/removal and testing/treatment of animals difficult. For example, repeated attempts during 1990-96 by the North Carolina Department of Agriculture to test all horses for equine infectious anemia within the same week proved unsuccessful.

THE ROLE OF PUBLIC SENTIMENT

The appeal and emotions associated with feral horses are well known and undeniable. These animals are strongly associated with beauty and freedom plus, in some instances, are considered to be historic or cultural resources (Henry 1947; Rikoon 2006; County of Currituck 2007; National Park Service 2007a). Although this perspective is not universal (Dobbie et al. 1993), public support tends to favor extant populations in the United States, particularly wild mustangs of western states (Klingburg 1994).

Atlantic coast feral horse herds have experienced high profile public attention that benefits local tourist economies (e.g., National Park Service 2007a; Prioli 2007). Perhaps the best known example involves horses that graze a portion of the Chincoteague National Wildlife Refuge. The annual July pony penning and sale by local firemen receives national press coverage and is attended by thousands of visitors (The Ponies of Chincoteague and Pony Penning 2007).

Such attention has made feral horse management at some sites the object of political action. The number of horses maintained on the Shackleford Banks portion of Cape Lookout National Seashore is mandated by federal legislation (i.e., P.L. 105-202

and P.L. 105-229) (National Park Service 2006). Rikoon (2006) described political and philosophical clashes between local residents and staff of the National Park Service concerning proposed removal of a small (25-30) free-roaming herd in the Ozarks of south-central Missouri. Years of controversy ended when the local congressman successfully amended 1996 federal legislation that required the Park Service to protect horses within the Ozark National Scenic Riverways boundaries by providing adequate pastures.

Since 1983, NCNERR personnel have received numerous suggestions and concerns from individuals and groups relative to the Rachel Carson feral horses and their management. Examples include: requests to plant forage for horse consumption, an offer from local businesses to purchase and to place feed on the island if more horses were maintained, pleas for temporary removal and relocation prior to storms, and opposition to both disease testing and immunocontraception. Occasional articles in local newspapers, websites (e.g., Hurteau 2007; Insiders 2007) and books (e.g., Day 1997) also discuss some of these issues and support continued presence of feral horses at both reserve sites.

Public sentiment concerning the Currituck Banks horses was a primary factor that catalyzed development of two documents to address management options. The local state senator, Currituck County, and Corolla Wild Horse Fund proposed confinement of feral horses on reserve property (Corolla Wild Horse Fund, unpubl. data). This prompted the Division of Coastal Management to develop alternative management scenarios (NCDCM 1993) because the federal oversight agency prohibited horses from being penned within that site.

DISCUSSION

Feral horse populations are found on various public properties where each governmental agency has specific management policies concerning these animals. The Rachel Carson and Currituck Banks reserves have unique site conditions and programmatic mandates that must be

evaluated when considering long-term management options.

Management of introduced species populations that graze and trample portions of the target ecosystem to be protected begs an obvious question: why were the tracts acquired given this issue? Aside from being well-known regional examples of North Carolina estuaries, both properties were purchased to preclude potential development (Day 1997; NCNERR 1998). As a consequence, these feral horse populations received little to no consideration at the time of site selection (1982) because state and federal staffs were focused on and primarily familiar with acquisition, protection, and planning aspects of the young program rather than resource management.

According to federal regulations, estuarine research reserves are intended for long-term estuarine research, education, and interpretation (NOAA 2006). However, feral horse populations at both the Rachel Carson and Currituck Banks sites have been maintained with the acknowledgment that they represent a conflict with programmatic goals and objectives (NCDCM 1993; NCNERR 1998).

While it is apparent from previously cited literature that feral horses have caused negative impacts to estuaries and associated habitats (e.g., Turner 1987; Hay and Wells 1991; Levin et al. 2002; De Stoppelarie et al. 2004), prevailing public sentiment has strongly influenced policies to retain the animals on both reserve properties (Corolla Wild Horse Fund 1993; NCNERR 1998). This is understandable because of the relatively short terms of elected and appointed public officials who are ultimate decision-makers for the NCNERR. However, this politically-motivated process does not address long-term ecological, programmatic, and humane issues concerning these horses.

The public desire to see feral horses at the Rachel Carson site is a fact, but realities concerning long-term herd maintenance present problems. Upland and marsh grazing areas are much smaller and more fragmented than properties available to other Atlantic coast herds living on their

own (Table 1). This disparity creates harsh lives for these animals that include searching for limited fresh water (Stevens, 1986, 1987) and more exposure to weather extremes including rare, but potentially lethal, storm surges (Zimmerman et al. 2006; Prioli 2007). Any needed veterinary care or capture/removal has been difficult to provide given the arrangement of islands with intervening tidal and subtidal areas. While the number of animals must be kept below the overpopulation level experienced in 1987, extant low genic diversity (E.G. Cothran, unpubl. data) would have to be remedied by selective breeding with imported horses. Continued grazing/trampling of intertidal marshes may accelerate their erosion (Turner 1987; Hay and Wells 1991); plus the trend of sea level rise (Riggs and Ames 2003) could further limit food and water resources. Permanent placement of the herd in an on-site pen or corral would not be an option because such intensive animal management conflicts with previously cited NOAA (2006) regulations for estuarine reserves. If the herd is allowed to remain, these circumstances do not bode well for either the horses or the reserve in coming decades.

Aside from ecological/programmatic conflicts is the issue of humane treatment for these animals versus what the public wants to see or believe. Is the object of having feral horses at the Rachel Carson site just human-perceived beauty and freedom plus an enhancement to the local tourist economy, or does it include concern for the animals' long-term welfare given the problems mentioned above? These horses would be served best by removal from the site with adoption and care in a more protected environment. Also, this scenario would be consistent with the previous position taken by the federal Estuarine Reserves Division relative to proposed confinement of feral horses at the Currituck Banks reserve (NCDCM 1993).

Currituck Banks reserve employees do not actively manage local feral horses because the animals roam thousands of adjacent acres that include more desirable grazing areas (Rheinhardt and Rheinhardt 1997). However, continued development north of Corolla will decrease this open range and

increase the likelihood of horse impacts to the reserve plus other problems, such as feeding by tourists and conflicts with vehicles. This reality is acknowledged within the multi-party herd management plan: "The wild horses should be protected and preserved over public and private lands to the extent possible as the northern Currituck Banks grow and develop. However, it is recognized that ultimately confinement, relocation or other strategies may be necessary to maintain a viable herd" (County of Currituck 2007).

To date, there is no effort on the northern Currituck Banks to create a delimited feral horse pasture outside reserve property. Since it is clear that surrounding private lands will be developed and that fencing the entire reserve is not a practical option from human access and native wildlife management standpoints, appropriate long-term site stewardship for this herd must involve a proactive approach by all parties involved in the local feral horse management plan. Options concerning types of pastures (i.e., managed pasture and/or dry lot) plus the need for public education have been developed by the NCDCEM (1993).

The federal Estuarine Reserves Division has stated already that feral horses will not be confined to the reserve site without raising the possibility of de-designation. However, loss of reserve status is not likely to be a desirable scenario because it could force the State of North Carolina to either pay back the land value or to sell not only the Currituck Banks site but all four reserve sites. Seeking one or more fenced pasture areas outside the reserve is the most viable option that will maintain the local herd and avoid ecological and programmatic conflicts.

CONCLUSION

Estuarine research reserve regulations, ecological impacts, and humane considerations justify removal of feral horses from the Rachel Carson site to a location(s) with more suitable circumstances for permanent management. This would be in the best interest of both the reserve site and the ani-

mals. People who have a strong attachment to the horses and/or feel they are important to the local economy could adopt them and provide appropriate care.

Feral horses found on the northern Currituck Banks have a much larger area to roam with more conducive living conditions. Nevertheless, horse impacts are incompatible with estuarine reserve management, and it would be difficult to keep horses off the property without fencing the entire boundary—an impractical solution relative to public access and stewardship of other wildlife. Given ongoing development of adjacent private lands that provide roaming/grazing area for these animals, all parties of the local feral horse management plan need to look at ways to protect this population within one or more fenced pastures located outside the reserve site.

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