

A MANAGEMENT PLAN FOR POTOMAC CREEK HERONRY

By

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Abstract

The Great Blue Heron (*Ardea herodias*) is a colonial breeder exhibiting a moderate to high vulnerability to human disturbance. Habitat destruction and the resulting loss of nesting and foraging sites potentially put this species at risk. Potomac Creek Heronry in Stafford County, Virginia, has been the subject of heightened concern as the pace of local development increases and threatens the sustainability of the resident Great Blue Heron colony. Northern Virginia Conservation Trust owns most of the land encompassing the heronry, and has initiated development of a management plan to assess the potential impacts of human encroachment and establish protection measures. The management plan incorporates a review of the literature regarding human disturbance and other impacts to Great Blue Heron colonies. It also focuses on land development potential in the vicinity of the heronry and provides general principles for implementation of conservation strategies that may help sustain the colony. This approach includes recommendations for minimizing human impact through buffers, site security, private property acquisitions, and enhanced local regulations. The plan provides a framework for future studies including identification of foraging areas, roosting areas, and wintering grounds, as well as colony expansion and nesting productivity.

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INTRODUCTION

In 1999, Northern Virginia Conservation Trust purchased a 70-acre parcel of land on Potomac Creek in Stafford County, Virginia, that contained a Great Blue Heron (*Ardea herodias*) colony. Purchase of the site was the result of mitigation for wetlands destroyed during construction of the nearby Stafford Regional Airport. Preparation of a management plan was required as part of the mitigation agreement. The goal of Northern Virginia Conservation Trust was to manage riparian and upland forest consistent with Great Blue Heron requirements. A management plan has not been implemented to date. Impending land development is near the heronry. Northern Virginia Conservation Trust desires to move forward with preparation of a management plan, due to the susceptibility of the Great Blue Heron to human disturbance and other factors. The goal of this plan is to identify conservation needs and management requirements for the colony to sustain the population and supporting habitat. Additionally, the plan will recommend actions for local government officials to consider regarding protection of the heronry site.

BACKGROUND

The Potomac Creek heronry is the only known Great Blue Heron colony in Stafford County, Virginia. According to the U.S. Fish and Wildlife Service (2000), as many as 600 breeding pairs have nested here, although very little documentation exists regarding this heronry. The Waterbird Monitoring Partnership recorded breeding pairs in 1984, 1993, and 2005 (U. S. Geological Survey 2006), but no further studies have been found. Because herons are vulnerable to human disturbance (Watts and Bradshaw 1994, Rodgers and Smith 1995), the heronry's remote location may have helped to protect it from human impact in previous years. As residential development begins to encroach toward the heronry, the need for management and stewardship of this unique County resource is becoming imperative.

The Potomac Creek heronry is located within the Chesapeake Bay watershed, a significant area for herons along the east coast of the United States. Late in the 1970s, more than half of the estimated population of Great Blue Herons along the East Coast was found in the Chesapeake Bay region of Maryland and Virginia (Spendelow and Patton 1988). The lower bay region supported approximately 200 colonies in 2003 (Watts 2004). However, the importance of the Potomac Creek heronry to the overall region is not known.

The heronry is located on the western end of a 4,000-acre peninsula of land, bounded on three sides by the Potomac and Accokeek Creeks, which flow into the Potomac River (Figure 1). The area lies approximately 65 miles upriver from Chesapeake Bay. This peninsula, commonly called Crow's Nest, is forested with a mature stand of mixed bottomland and riparian hardwoods, and contains > 700 acres of

freshwater tidal marsh (U. S. Fish and Wildlife Service 2000). The U. S. Fish and Wildlife Service (2000) considers the Crow's Nest peninsula and associated waterways ecologically unique habitat that supports numerous species of neotropical migratory birds, waterfowl, sport and commercial fishes, and numerous rare and threatened plant species. Crow's Nest supports three forest community types that are rare to the Coastal Plain ecosystem, including two that are classified broadly as Basic Mesic Forests, and one classified as Basic Oak-Hickory Forest (U. S. Fish and Wildlife Service 2000).

Property Ownership

Northern Virginia Conservation Trust owns the 70-acre tract of land that contains the majority of nest sites. The Trust, headquartered in Annandale, Virginia, is a 501(c)(3) nonprofit land trust dedicated to preserving land and enhancing the natural and historic resources of northern Virginia. Founded in 1994 as the Fairfax Land Preservation Trust, Northern Virginia Conservation Trust changed its name in 1999 to better reflect the regional scope of the growing organization. The Trust owns >1,800 acres of land in the northern Virginia area, including 483 acres in Stafford County.

In 1997, a mitigation agreement was made between the Stafford Regional Airport Commission and Fairfax Land Preservation Trust (Northern Virginia Conservation Trust) under a permit through the U. S. Department of Army Corps of Engineers, to compensate for the destruction of wetlands that occurred during construction of an airport. The permit required that 70 acres of wetlands be preserved elsewhere in the county. As a result, the 70 acres of land that contained the heronry was subdivided from the Crow's Nest tract, purchased by the Airport Commission, and deeded to Fairfax Land Preservation Trust (Northern Virginia Conservation Trust). The property also included

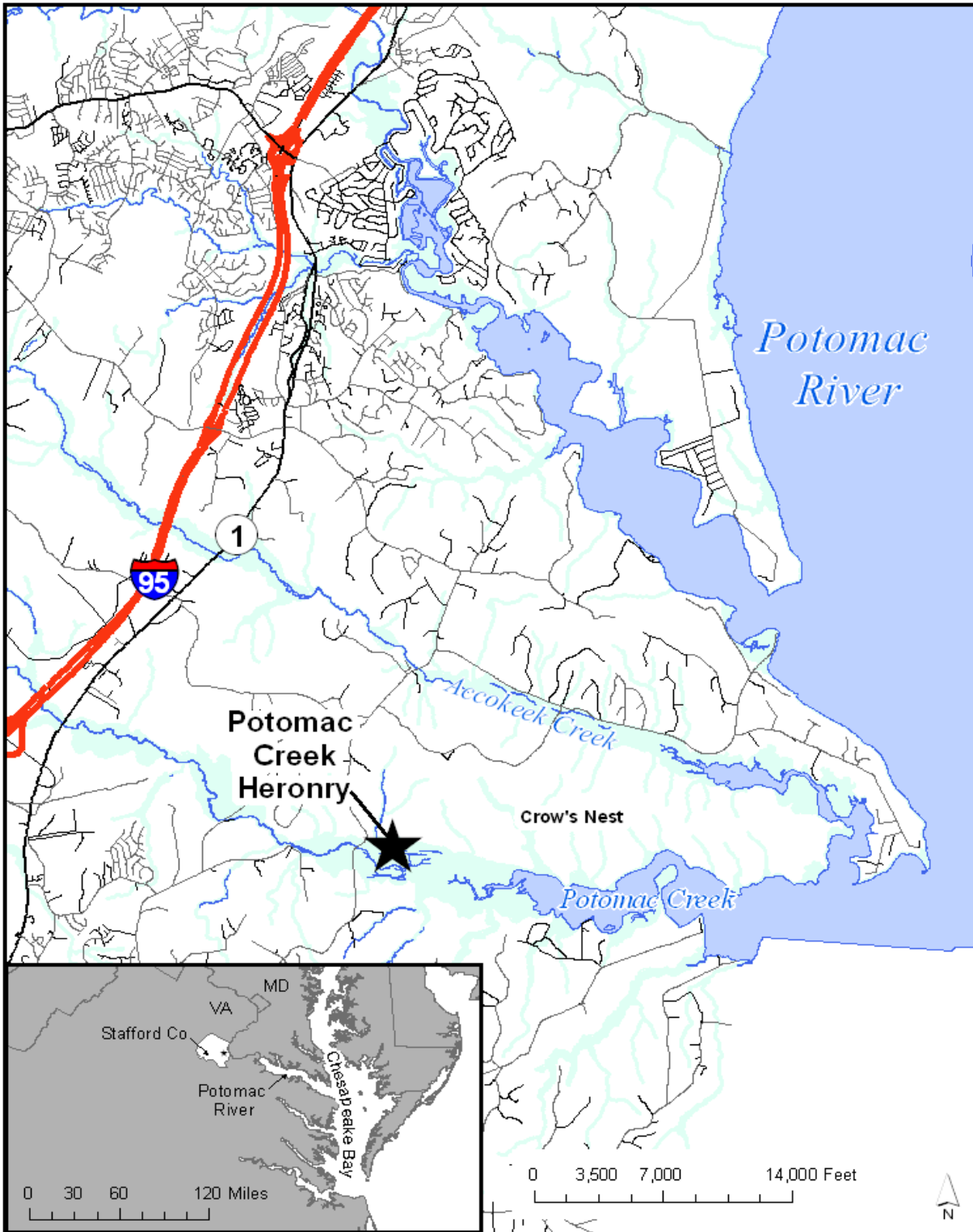
associated wetlands and riparian habitat. The location of the heronry was estimated at the time of purchase and may not have incorporated all of the nesting area. In 2006 and 2007, surveys by Stafford County Geographic Information System Department and Planning Department were conducted of the core nesting area utilizing Global Positioning System equipment. The surveys determined that some nest-bearing trees are located on adjacent parcels to the east and south. The property to the east is owned by Stafford Lakes Limited Partnership, a northern Virginia land development firm, and the property to the south is owned by a family trust.

County Demographics and Land Use

Stafford County, Virginia, is a rapidly urbanizing area located along the Interstate 95 corridor approximately 40 miles south of Washington, DC (Figure 1). The U. S. Bureau of the Census reported that Stafford County's population increased by 31,210 people from 1990 (61,236) to 2000 (92,446), a 51 % increase (Stafford County Comprehensive Plan 2003). Population projections for 2010 are 127,904 and 154,701 for 2020. This population growth has altered the once-rural character of the county to a bedroom community, and made it attractive to commuters who work in the nation's capital. Installation of a commuter rail system and construction of new commercial and office development to support the population has continued to fuel the local housing market.

Stafford County's Land Use Plan depicts an Urban Service Area, which includes land designated for medium- and high-density development, as well as commercial and

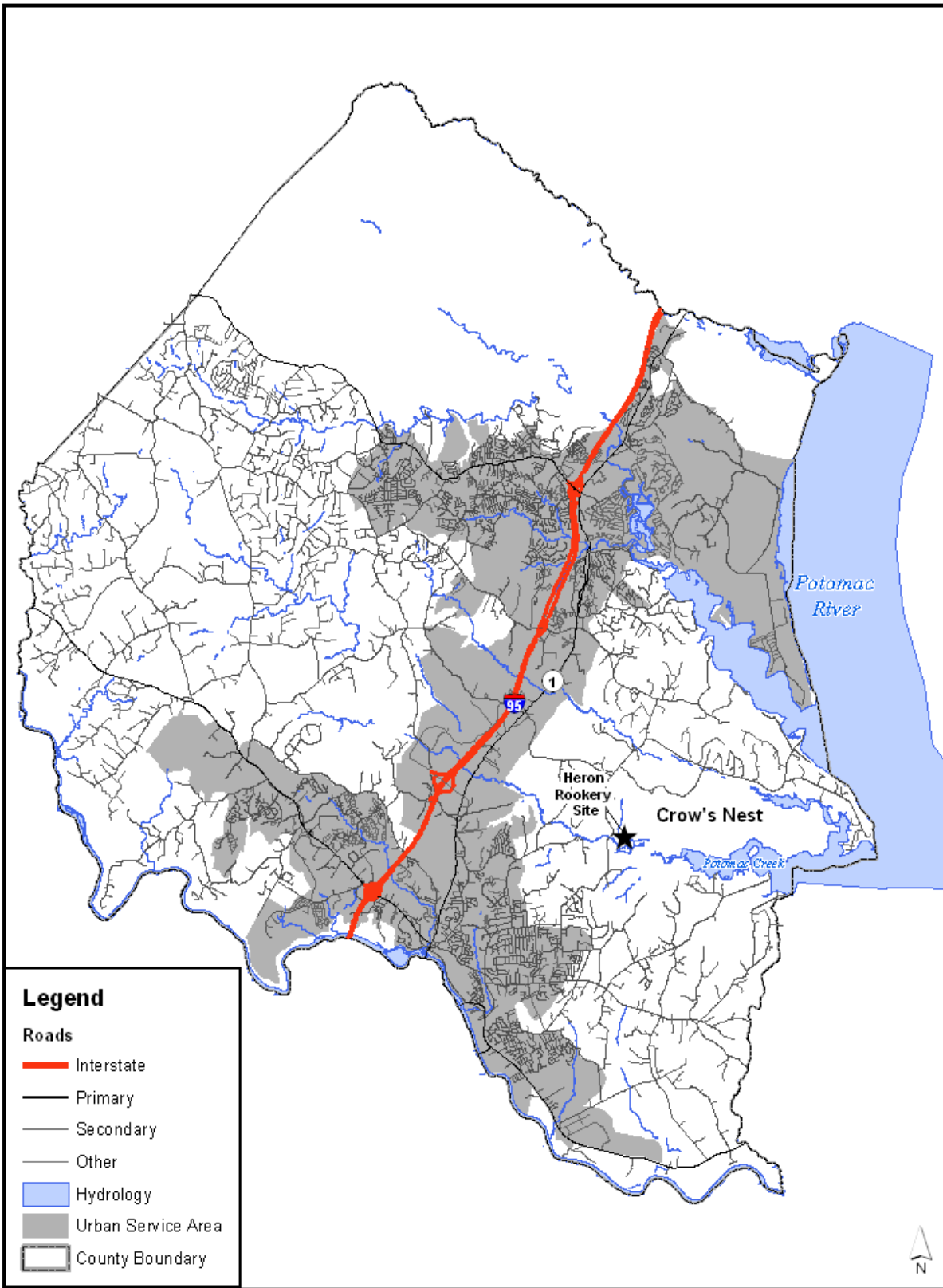
Figure 1. Location map of Potomac Creek heronry in Stafford County, Virginia.



Stafford County Planning Department
COUNTY LOCATION MAP: CROW'S NEST 2/11/11

industrial development (Figure 2). Land within the Urban Service Area is accessible to high capacity roads, public water and sewer, public services such as fire and rescue facilities, and public schools. Development generally has followed the I-95/US Route 1 corridor (that runs north/south) and the major collector roads in the northern and southern portions of the county. In 2000, the county's Board of Supervisors reduced the allowable density within the Urban Service Area by 50 % to slow the rate of residential development. The unforeseen impact was a surge of development outside the Urban Service Area. Land outside the Urban Service Area generally is agricultural and low density residential development, and previously was considered undesirable for development. A lack of public utilities and adequate roads, as well as rough terrain and environmentally sensitive land, precluded much development east of I-95 within Virginia's Coastal Plain. New subdivisions with large lots have begun to change the once-rural landscape. As the county continues to develop, sensitive resources, including waterways and wildlife habitat are at risk. The Potomac Creek heronry potentially is at risk as the path of development moves eastward.

Figure 2. Stafford County Urban Service Area boundary.



Stafford County, Maryland, OpenStreetMap
County Growth Area, Copyright © 2017

REGULATORY REVIEW

Federal

The Great Blue Heron is protected under the Migratory Bird Treaty Act, which prohibits the taking, killing or possession of any migratory bird (Appendix A). The U. S. Fish and Wildlife Service administers and enforces the Act. A federal permit is required if there is intent to destroy nests or eggs, or capture, disturb, relocate, or kill for damage control.

The Clean Water Act, administered by the Environmental Protection Agency, regulates discharge of pollutants into waters of the United States. Under Section 404 of the Act, filling and disturbance of wetlands is prohibited without a permit (Appendix A). This is significant because wetlands provide important foraging habitat for Great Blue Herons. The Environmental Protection Agency and the U. S. Army Corps of Engineers enforce the regulations.

State

There is limited legislation in Virginia that pertains directly to conservation of wildlife and wildlife habitat. Water quality protection includes some overarching regulations that correlate to habitat protection. For instance, the Chesapeake Bay Act was established in 1983 to ensure protection of water quality in the Bay. The Commonwealths of Virginia and Pennsylvania, the State of Maryland, and the District of Columbia participate in meeting the standards of the Act. Each state has adopted its own regulations. The Virginia General Assembly enacted the Chesapeake Bay Preservation Act in 1988 and mandated Tidewater localities to adopt their own standards (Appendix A). The Act requires 100-foot undisturbed buffers around sensitive water bodies. This

limits development to some extent near wetlands and other important wildlife habitat. The program is overseen by Virginia Department of Conservation and Recreation.

The Virginia Marine Resources Commission Habitat Management Division reviews environmental permits for subaqueous beds or bottomlands, tidal wetlands, and coastal primary sand dunes. Title 28.2 of the Code of Virginia restricts encroachment into these areas. Joint Permit Applications consider local, state, and federal statutes and are reviewed concurrently by the Virginia Marine Resources Commission, the Virginia Department of Environmental Quality, the U. S. Army Corps of Engineers, and local wetlands boards.

Virginia Department of Game and Inland Fisheries primarily oversees regulation of game and non-game species and maintains a database of species documented from a variety of collections and surveys. These include Biota of Virginia Records, Virginia Breeding Bird Survey, Virginia Breeding Bird Atlas, Anadromous Fish Reaches, Threatened and Endangered Species, and Colonial Waterbird records. Virginia Department of Conservation and Recreation also maintains a database of species, including threatened and endangered species, and species of concern. Virginia Department of Conservation and Recreation does not regulate land use activity, but will make recommendations for mitigation if requested by a locality or a property owner. The Great Blue Heron colony at Potomac Creek is listed as a Natural Heritage Resource, and is listed as “vulnerable” due to potential impacts.

Local

Stafford County’s environmental regulations generally address water quality protection. The county adopted the Chesapeake Bay Preservation Area Overlay District

by ordinance in 1991. The intent of the Overlay District is to prevent any net increase in non-point source pollution. The ordinance requires a 100-foot natural buffer to be maintained along all streams with perennial flow, as well as associated wetlands. This buffer can incorporate prime shoreline habitat. It should be noted that some uses are allowed within the buffer area, including placement of roads, utilities, and lots, although residential structures are prohibited. Other requirements, such as 100 % reserve area for residential septic drainfields and regular septic pump-outs, help protect water quality.

Other county ordinances pertaining to water quality include the Wetlands Ordinance, which requires a permit for activity within tidal wetlands, and the Erosion and Sediment Control Ordinance, which also requires a permit for any land-disturbing activity over 2,500 square feet.

Stafford County reviews plans of development to ensure the Chesapeake Bay Preservation Act regulations are enforced. In addition, plans are reviewed for potential impacts to habitat of threatened and endangered species, and species of concern, utilizing Geographic Information System databases from Virginia Department of Conservation and Recreation and Virginia Department of Game and Inland Fisheries. If potential impact is suspected in areas planned for development, staff notifies applicants to contact the appropriate agency for further review and appropriate permits, where necessary. Development plans are not approved locally until proof of permits are presented. The county also coordinates with the U. S. Army Corps of Engineers regarding permits for wetland impacts before approving any land disturbance proposals.

County Comprehensive Plan

Stafford County's Comprehensive Plan is a guide to future development within the county. The plan identifies goals and objectives to ensure orderly development and determines appropriate land uses based on opportunities and constraints. Among the primary goals of the Comprehensive Plan is Goal 7: Preserve and enhance the county's natural resources. Strategies recommend directing more dense residential and intense commercial and industrial uses on land suitable for development to minimize impact on sensitive environmental resources. In addition, it recommends that habitat assessment and mitigation measures be employed during the development process. The challenge of the Comprehensive Plan has been to protect and enhance the existing natural environment without unduly restricting growth and impacting property rights.

The Wildlife Habitat Protection Plan, adopted in 2000, is a component of the county's Comprehensive Plan. It contains more specific objectives and strategies to protect the county's natural resources. Some of these objectives include developing wildlife habitat corridors; identifying sensitive plant and animal species and developing protective measures; identifying forest areas with special value as wildlife habitat; and establishing conservation practices for forest and wildlife habitat protection.

Several initiatives have been proposed to comply with recommendations of both the Comprehensive Plan and the Wildlife Habitat Protection Plan; however, most have failed to receive approval through the local governing body for fear of infringement on property rights. These initiatives included lowering the allowable density outside the Urban Service Area; requiring developers to meet performance regulation standards for projects including tree preservation and vegetation buffers; limiting development near

sensitive resources such as wetlands, steep slopes, and habitats for species of concern; and allowing cluster development for large-lot subdivisions. Although both the Comprehensive Plan and the Wildlife Habitat Protection Plan are intended to guide development, additional legislative action is necessary to ensure compliance with specific goals.

LITERATURE REVIEW

Life History of the Great Blue Heron

The Great Blue Heron is the largest and most abundant heron in North America (U. S. Fish and Wildlife Service 2006). Seven subspecies are found throughout the United States, southern Canada, and Central America (Butler 1992). Herons are rare in winter in the northern parts of its range. In much of its range, including the Chesapeake Bay region, the Great Blue Heron is a year-round resident.

Great Blue Herons are considered a top predator in the food web (Vermont Fish and Wildlife Department 1995). They primarily eat fish, but also feed on amphibians, invertebrates, reptiles, mammals, birds, crustaceans and insects (Butler 1992). Typically, herons are solitary feeders, but are known to forage with conspecifics (Custer et al. 2004). They prefer to forage in slow moving or calm freshwater (Butler 1992). Herons hunt by sight as they wade in shallow water and catch prey with a rapid forward thrust of their neck and head. The prey is held between mandibles and swallowed whole.

Custer et al. (2004) noted that quality feeding habitat can be defined by physical, biological, and anthropogenic factors such as water depth, turbidity, vegetation characteristics, topography, abundance and size of food, distance from breeding site, and distance from human disturbance. Custer et al. (2004) tracked herons in the upper Mississippi River by fixed-winged aircraft and found that most foraged within 3 miles of the colony. They rarely travel distances > 6 miles. The median distance from colony to feeding site ranged from 0.62 miles to 4.6 miles. However, adults flew farther during the brooding period than during incubation. In South Dakota, Dowd and Flake (1985) determined that mean distance from colony to feeding site ranged from 1.4 miles to 4

miles. Foraging distances of 10 miles and 13.6 miles have been noted in various studies where nearby foraging habitat was limited (Taylor et al. 1982).

Hérons nest in colonies, which consist of ≥ 2 pairs at the same site (Vermont Fish and Wildlife Department 1995). Colonies are considered independent if separated from other groups by at least 1,320 feet, or are separated by a distinctive barrier or habitat discontinuity (Watts and Byrd 1998). In the Chesapeake Bay region, heron colonies are located primarily in forested wetlands and mature pine stands near water (Watts and Bradshaw 1994). Many colonies form near headwaters of small streams (Watts and Byrd 1998). Colonies can be mixed with other species, including great egrets (*Ardea alba*). Great Blue Herons nest near water in trees and bushes, on artificial structures, and on the ground (Butler 1992). Nests may be reused year after year. Tree stands may be damaged by bird feces after years of continual use, so a colony may move circularly outward in succeeding years (U. S. Fish and Wildlife Service 2006). Butler (1992) noted that a colony in British Columbia had been used for 71 years. Herons typically nest in colonies that are isolated from human disturbance (Watts and Bradshaw 1994, Vermont Fish and Wildlife Department 1995). Bowman and Siderius (1984) found that herons continued to nest near human disturbance where the colony was close to quality feeding habitat.

Great Blue Herons gather in staging areas prior to courtship and nesting (Butler 1992). These staging areas often lie in open fields, forest stands, or marshland associated with the colony. Limited studies are available regarding the location of staging areas, as well as the importance and vulnerability of the staging areas. Upon leaving the staging area, adults return to former colony sites to begin rebuilding old nests or build new ones. Breeding pairs form and both the male and female participate in nest construction.

Females lay between 2 and 6 eggs over a 2-3-day interval (Vermeer 1969, Pratt 1970, McAloney 1973). Herons in Virginia begin nesting in early March (Virginia Department of Game and Inland Fisheries 2005). Nest-building activity has been observed at Potomac Creek heronry as early as February 15. Both parents participate in incubation (Butler 1992), which lasts about 30 days. After chicks hatch, both parents take turns feeding until the chicks are fledged at 81 days (mean).

After fledging, adults and young disperse and usually vacate colonies for the non-breeding season (Virginia Department of Game and Inland Fisheries 2005). Many, however, continue to forage the same areas used during the breeding season. Studies have not been conducted to determine dispersal in Potomac Creek herons.

Threats to Great Blue Herons

Disturbance factors

Reproductive success may be impacted by several factors, including the presence of humans and predators, weather, food availability, and the size of a colony (Vennesland and Butler 2004). Disturbance can cause adults to abandon nests prior to eggs hatching, as well as after chicks are hatched. Abandonment is most prevalent early in the breeding season (Butler 1992) during pair formation, nest construction and egg laying, before the adults have formed an attachment to the nest (Buckley and Buckley 1978). Disturbance also may cause premature fledging, reduce body mass, or slow growth of nestlings (Rodgers and Smith 1995).

An Oregon study showed the mean number of nests was greater in undisturbed areas than in areas subject to silvicultural activities (107.2, 36.3 respectively: Werschkul et al. 1977). Nest occupancy rate was greater (93 %) in undisturbed areas than in logged

areas (67 %). Mean distance from disturbance to active nests was 720 feet versus 495 feet to inactive nests.

Human impact is derived from various means such as pedestrian activities, motorized vehicles, watercraft and aircraft. Visual intrusion appears to be more significant than noise impact (Taylor et al. 1982). Rodgers and Smith (1995) indicated that the mean flushing distance for on-foot human approach is 105 ± 39 feet. The mean flushing distance for motor boat approaches is 86.2 ± 12.9 feet. Vos et al. (1985) also noted that herons habituate better to boat traffic than pedestrian traffic. Leaf canopy development cuts down on disturbance from adjacent activity, but activity directly below nest sites creates distraction. Great Blue Herons tolerate limited recreational use beyond 575 feet of the heronry during the nesting period. Farming activities are tolerated within 275 feet. Bratton (1990) noted that Great Blue Herons are more sensitive than other waterbirds. According to Rodgers and Smith (1995), the recommended setback distance from pedestrian traffic to nesting areas is 330 feet, and from boat traffic is 270 feet. Buckley and Buckley (1978) recommend buffer zones of 1000 feet for any pedestrian or boating activity.

Eissinger (2003) noted that disturbance by aircraft includes variables such as size, speed, color, proximity, noise and direction of flight of the craft. Frequent flights over time may reduce response by herons. A vertical buffer of 1,970 feet is recommended over heronries to prevent harassment by low-flying aircraft.

Another potential human impact is the location of roads and structures, such as buildings. Watts and Bradshaw (1994) found that heron colonies located a mean distance of 700 ± 49 feet from secondary roads, and 788 ± 86 feet from buildings.

Based on the literature, U. S. Fish and Wildlife Service (Kim Marbain, pers. comm.) recommends that no disturbance occur between March 15 and July 30 within 1,320 feet of a heronry, and if a high density activity, such as, a residential subdivision is planned, there should be no disturbance within 2,640 feet.

Predation

Bald Eagles (*Haliaeetus leucocephalus*) prey on heron eggs, nestlings, and fledglings (Vennesland and Butler 2004). In Wisconsin, gray wolves (*Canis lupus*) preyed on heron chicks (Robinson et al. 1991). Fledglings and young herons are vulnerable to predation from raccoons, hawks, snakes, owls, vultures, ravens, and crows (National Park Service 2006).

Weather

Weather can affect the foraging behavior and success of Great Blue Herons (Bovino and Burt 1979). Wind and rain that cause rippling of the water surface indirectly impacts foraging. Rippled water reduces the visibility of fish below. Also, sunny skies create glare that reduces the visibility of fish, and may also cause herons to be more conspicuous to prey.

Weather also may have a direct impact on productivity (Witt 2005). Eggs and nestlings are susceptible to high winds, forcing them out of nests. Heavy rains and the resulting flooding reduce available foraging habitat and cause adults to expend more energy searching for food. This also can reduce body weights for nestlings. Wind and rain may reduce the ability of nestlings to thermoregulate body temperature, thus increasing mortality (Witt 2005).

Habitat loss

Great Blue Herons are indicators of ecosystem health because they return to the same site each year (Vermont Fish and Wildlife Department 1995). They are linked with and dependent upon habitat quality. Wetland and shoreline habitat loss are factors that contribute to declines in some Great Blue Heron populations (Short and Cooper 1985). Foraging habitat reduction will cause adults to fly farther to find available food, expend more energy, and keep them from the nest site longer.

Contaminants

Environmental contaminants and pollution create a risk to colonial waterbirds and their supporting habitat (Rattner 2000). Contaminants include pesticides, industrial chemicals, and manufacturing by-products. Organochlorides and polychlorinated biphenyls (PCB's) can result in behavioral problems and other toxicological impacts in Great Blue Herons (Cobb et al. 1994).

Increased amounts of sediment from soil erosion enables freshwater systems to trap non-point source pollutants and retain higher residual levels of contaminants (Parsons and McColpin 1995). Suspended sediment also depletes oxygen levels and degrades water quality and submerged aquatic vegetation (U. S. Fish and Wildlife Service 2000), potentially decreasing fish and shellfish populations on which herons prey.

Current Great Blue Heron status

Nationwide

In the early 20th century, herons were hunted for plumage and population levels declined dramatically (National Audubon Society 2006). Passage of the Lacey Act (1900) and the Migratory Bird Treaty Act of 1918 are attributed to stabilizing heron populations. According to the draft 2005 North American Breeding Bird Survey, Great Blue Heron have been increasing in population since studies were first conducted in 1966 and continue to show positive trends (Sauer et al. 2005). The National Audubon Society (2006) estimates the continental North American population at 124,500. Virginia Department of Conservation and Recreation (2006) reports that heron populations are secure globally, but vulnerable due to restricted habitat requirements and disturbance factors.

Custer et al. (2004) noted that Great Blue Heron populations have declined in certain states, including Wisconsin and Illinois, and the upper Midwest region of the United States in general. These declines often are attributed to habitat loss and degradation.

Regional

A 2003 survey of the lower Chesapeake Bay region recognized 202 Great Blue Heron colonies (Watts 2004). The heron was the most widely distributed of 24 species of colonial waterbirds¹ found in the coastal area of this region. The 2003 survey covered the entire Virginia coastal plain, divided into five geographic regions. Although the Eastern Shore of Virginia was most important for all species of colonial waterbirds, the

¹ Colonial waterbirds are defined as: “nesting marine birds and wading birds that share the characteristics of typically nesting in colonies and obtaining all or most of their food from the water” (U. S. Fish and Wildlife Service 2007).

Western Shore region was the dominant region for Great Blue Herons. Ranging from the south shoreline of the Potomac River to the south shoreline of the James River, and west to the fall line, > 78 % of the coastal plain Great Blue Heron colonies fell within this region, which includes Potomac Creek heronry. Within the 202 colonies in the lower Chesapeake Bay region, Watts estimated 9,136 breeding pairs of Great Blue Herons, whereas 7,112 pairs in 158 colonies occurred in the Western Shore region.

Watts and Byrd (1998) previously conducted a 1993 colonial waterbird survey with the intention of surveying every ten years. From 1993 to 2003, the overall waterbird community in coastal Virginia declined >16 %. Seventeen of 24 species declined in population; however, seven species increased in population. The Great Blue Heron showed an increase from 156 colonies and 9,112 breeding pairs in 1993 to 202 colonies and 9,136 pairs in 2003.

Watts (2004) demonstrated that the Great Blue Heron population, in coastal Virginia, has continued to increase since 1964, when five colonies were known to exist. Custer and Osborn (1977) documented 15 colonies and 2,400 breeding pairs in 1975, and Watts (2004) noted 31 colonies with 3,600 pairs in 1984.

Disturbance and harassment of wildlife may reduce species diversity and density at the landscape or regional scale (Vermont Fish and Wildlife Department 1995). Regarding Great Blue Herons, abandonment of colonies may contribute to regional population loss. Colony concentrations are important and fledgling success is greater in larger colonies (Butler et al. 1995). Influx and dispersal of young contribute to genetic diversity and health of regional populations (DesGranges 1989).

Two other heron colonies exist within a 20-mile radius of Potomac Creek heronry. Mason Neck heronry is located approximately 20 miles north of Stafford County in Fairfax County, Virginia, within the Mason Neck National Wildlife Refuge. The site, located along the Potomac River, has contained as many as 1,600 heron nests (Witt 2005). Nest count data and reproductive success at this site have been tracked since 1988.

Nanjemoy Creek heronry is located in Charles County, Maryland, approximately 15 miles east of Potomac Creek heronry and across the Potomac River. The heronry was first documented in 1945 and has been used for nesting by herons on a continual basis (The Nature Conservancy 2006). Nest count data has been collected annually since 1989. The highest number of nests counted was 1,362 in 1994. Most recent figures show 338 nests, during the 2005 count.

Local

Documentation of nest counts at Potomac Creek heronry is limited. The Mid-Atlantic/New England/Maritimes Region (MANEM) Waterbird Working Group estimated 410 breeding pairs in 1984, 650 breeding pairs in 1993, and 300 breeding pairs in 2005 (U.S. Geological Survey 2006). The 1998 database records of Virginia Department of Conservation and Recreation estimated 600 breeding pairs, but an official count was not conducted (Steve Roble, pers. comm.). In January 2006, representatives from Northern Virginia Conservation Trust, the U. S. Army Corps of Engineers, and Stafford County Planning staff counted 296 nests within the core concentration of Potomac Creek heronry. An additional 20 nests were found on property to the south, which staff were not authorized to enter. In January 2007, Stafford County Planning staff

and Geographic Information Systems staff counted 343 nests, including the off-site nests.

No fledgling counts are known to have been conducted at this site.

PHYSICAL ENVIRONMENT - POTOMAC CREEK HERONRY AND VICINITY

No specific environmental site studies have been conducted within the 70-acre boundary of Potomac Creek heronry. However, the Final Environmental Assessment, Proposed Accokeek Creek National Wildlife Refuge (U. S. Fish and Wildlife Service 2000) gives an overview of the 4,000-acre Crow's Nest peninsula that incorporates the heronry.

Climate

Stafford County has a humid, temperate climate with warm summers and mild winters (U. S. Fish and Wildlife Service 2000). The annual mean temperature is 57° F, and the mean annual precipitation is 40 inches. Prevailing winds are from the northwest, but southerly summer winds are common.

Geology and Physiography

Stafford County is divided into two major geologic zones (Stafford County Comprehensive Plan 2003). Areas west of I-95 fall within the Piedmont Plateau, whereas areas east of I-95 are within the Coastal Plain. The Crow's Nest peninsula, including the heronry, is located in the Coastal Plain zone. The area is characterized by Tertiary Marine deposits with a range of formations from green sands to silt and clay. The peninsula was formed through deposition and erosion of substrates, which gouged steep ravines (U. S. Fish and Wildlife Service 2000). Later, marshes formed along the edges of the peninsula, where deposits of sand and mud accretions had accumulated.

Topography and Soils

The Crow's Nest peninsula is approximately 5 miles long and 2 miles wide. A high, narrow ridge runs along the center of the peninsula, approximately 160-170 feet above mean sea level. Deep ravines have cut perpendicularly into the ridge, leaving behind slopes of up to 35 % (Williamsburg Environmental Group, Inc. 1999). The banks of the peninsula are characterized by tidal marsh wetlands that extend from 0-10 feet above mean sea level. The Potomac Creek heronry sits between 5 and 15 feet above mean sea level. Steep slopes just north of the heronry rise abruptly.

Soils on the peninsula are classified in the Sassafras and Caroline series, which are acidic sandy, loamy or clay, and low in organic matter (U. S. Fish and Wildlife Service 2000, National Resource Conservation Service 1974). However, soil samples taken by Gary Fleming of the Virginia Department of Conservation and Recreation indicated calcareous soils high in organic matter in certain areas. Soils at the heronry site are Sassafras, Caroline, Wehadkee, and submerged sediments underlying Fresh Water Swamp (National Resource Conservation Service 1974).

Hydrology

Potomac Creek is within the Potomac River watershed (Stafford County Comprehensive Plan 2003). The Potomac Creek sub-watershed basin drains approximately 40,706 acres. Potomac Creek flows into the river about 5 miles east of the heronry site.

The 700 acres of tidal marsh that surround the Crow's Nest peninsula account for 60 % of all marshes in the county (U. S. Fish and Wildlife Service 2000). The southern portion of the heronry property supports palustrine tidal and non-tidal wetlands and

estuarine wetlands (Williamsburg Environmental Group, Inc. 1999; Cowardin et al. 1979). The southern portion of the heronry site also lies within the 100-year floodplain, based on Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Number 5101540210E, revised February 4, 2005.

The heronry falls within the county's designated Critical Resource Protection Area buffer. This buffer also incorporates the boundaries of the peninsula and several perennial streams on the peninsula. In accordance with the Stafford County zoning ordinance, Critical Resource Protection Area buffers restrict development, except for roads, utilities, and water-dependent uses such as piers.

Potomac Creek is listed on the Virginia Department of Environmental Quality's 2006 Water Quality Assessment as an impaired water body. Water quality monitoring has identified high levels of dissolved oxygen, fecal coliform, and polychlorinated biphenyls (PCBs), which can impact aquatic life, recreation, and fish consumption. Six other water bodies in the Potomac River watershed are considered impaired, four of which also pose potential impacts to aquatic life.

Biota

Flora

The Crow's Nest peninsula is dominated by mature stands of mixed hardwood forests of several types (U. S. Fish and Wildlife Service 2000). The Coastal Plain Bottomland Hardwood community, associated with alluvial soils, is found along Potomac Creek within the floodplain area. Canopy vegetation includes green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), sycamore (*Platanus occidentalis*), tulip poplar (*Liriodendron tulipifera*), and hydrophilic oaks (*Quercus spp*). Williamsburg

Environmental Group, Inc. (1999) characterized the wetland vegetation in the vicinity of the heronry as forested bottomland and emergent/shrub-scrub. Vegetation found within the marshes, as identified by U. S. Fish and Wildlife Service (2000), included yellow pond lily (*Nuphar luteum*), American lotus (*Nelumbo lutea*), pickerelweed (*Pontederia cordata*), arrow arum (*Peltandra virginica*), spatterdock (*Nuphar advena*), wild rice (*Zizania aquatica*), marsh hibiscus (*Hibiscus moscheutos*), smartweed (*Polygonum spp.*), cardinal flower (*Lobelia cardinalis*), big cordgrass (*Spartina cynosuroides*), jewelweed (*Impatiens capensis*) and beggar-ticks (*Bidens spp.*). The distribution of vegetation within the wetland is dependent upon elevation relative to mean low water.

A list of plant species found on the entire Crow's Nest peninsula can be found in Appendix B. This list includes species that have been recorded through various surveys, but no plant inventory has been conducted; thus, the list is not comprehensive.

Fauna

Few official surveys have been conducted of the fauna endemic to Crow's Nest peninsula or the heronry site. U. S. Fish and Wildlife Service (2000) referenced an Audubon Society Christmas Bird Count, which identified 25 species of waterfowl in the vicinity of Crow's Nest, and a Breeding Bird Survey, which identified 54 species of neotropical migratory birds in the area. Eight species of mammals have been collected on Crow's Nest, and numerous species commonly found in Stafford County are likely to be found on the property. U. S. Fish and Wildlife Service (2000) noted 38 species of amphibians and reptiles that likely occur in the area. Numerous aquatic resources, including mussels and a variety of fishes, have been observed in Potomac and Accokeek Creeks. A more extensive species list is provided in Appendix B.

Threatened and Endangered Species

The Crow's Nest peninsula is home to several threatened and endangered species, or species of concern. Three bald eagle (a federal-listed threatened species) nests have been confirmed on site, two of which are active (U. S. Fish and Wildlife Service 2000). Five additional eagle pairs nest nearby. The area supports potential habitat for the federal-listed endangered small whorled pogonia (*Isotria medeoloides*) and threatened sensitive joint-vetch (*Aeschynomene virginica*). State-listed species on the peninsula include ginseng (*Panax quinquefolius*) and river bulrush (*Scirpus fluviatilis*). Rare plants include showy orchid (*Orchis spectabilis*), adam and eve (*Aplectrum hyemale*), black snake-root (*Cimicifuga racemosa*), cut-leaved toothwort (*Dentaria laciniata*), common alum-root (*Heuchera americana*), pubescent sedge (*Carex hirtifolia*), and silvery glade fern (*Athyrium thelypteroidides*) (U. S. Fish and Wildlife Service 2000).

POTOMAC CREEK HERONRY SITE FEATURES

The concentration of nest sites within the heronry covers an area approximately 7 acres in size. Most nest sites are located near a beaver (*Castor canadensis*) pond north of the main channel of Potomac Creek (Figure 3). The beaver dam is located at the eastern end of the pond. Based on aerial photographs, the pond dates back to 1983, but there is no indication whether beaver activity has been continuous at the site. Small streams and pockets of wetlands characterize the area. Great Blue Heron nests are located primarily in large sycamore and tulip poplar trees and are situated in the crowns of the trees approximately 80-100 feet from the ground. A nest count in January 2006 identified 296 nests in 38 trees; nests occurred singly or in clusters (up to 22 nests/tree). An additional 20 nests in 5 trees were detected off-site. A nest count in January 2007 documented 343 nests in 63 trees, including off-site nests. Ten nest trees were located off-site to the south, and have not been located by Global Positioning System coordinates on the map.

Existing Human-constructed Features

The Stafford County Geographic Information Systems office has located various human-constructed features near the heronry (Figure 4). The nearest road, Brooke Road, lies approximately 2,300 feet west of the core nest area; this 2-lane rural collector road carries about 1,600 vehicles per day. The nearest residential structure is about 2,030 feet to the west, and fronts on Brooke Road. A trail runs along the northern property boundary line, with evidence of all-terrain vehicle traffic. The trail is approximately 400 feet from the major concentration of heron nests.

Figure 3. 2002 aerial photograph of Great Blue Heron nest locations at Potomac Creek heronry.

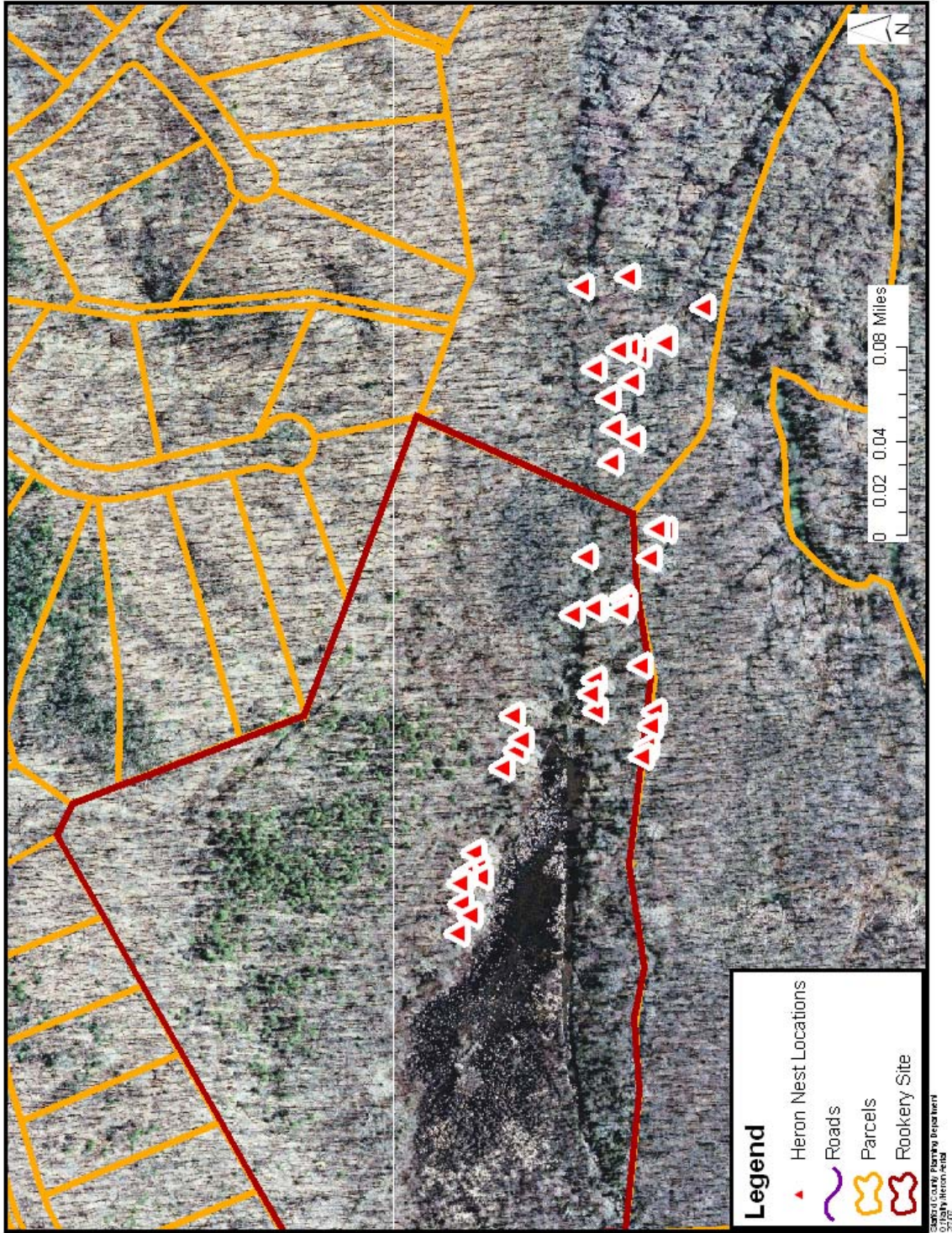
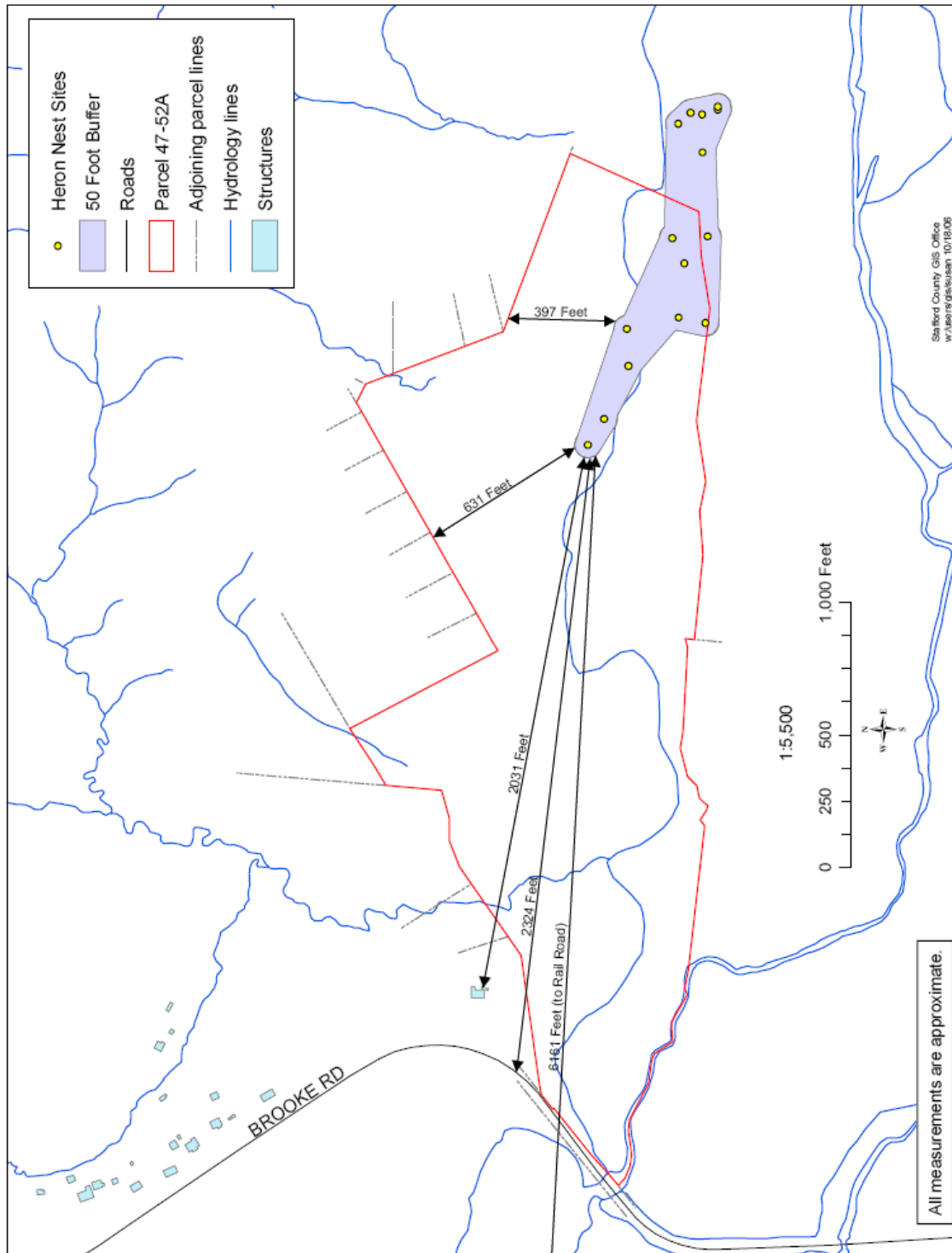


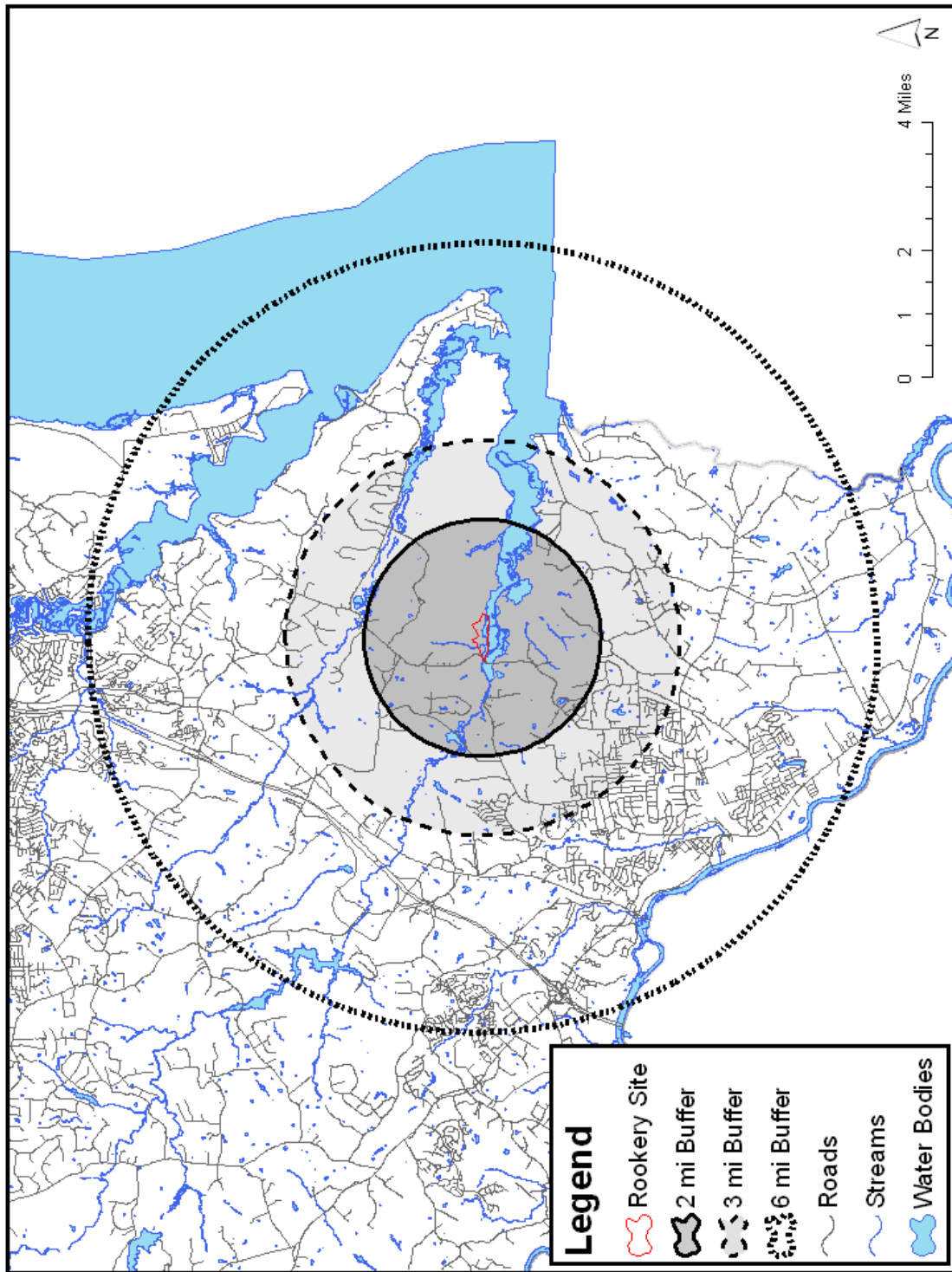
Figure 4. Potomac Creek heronry core nest area and distances to known features.



Foraging Areas

Using the center of the nest site as a prime point, the Geographic Information Systems office measured approximately 5 miles of shoreline within a 3-mile radius of the heronry, and about 7 miles of shoreline within a 6-mile radius (Figure 5). The 6-mile radius includes areas of the Rappahannock River along the southern boundary of Stafford County, Virginia. Field observations confirm that Great Blue Herons utilize the river banks for feeding. The 6-mile radius also includes the shoreline of the Potomac River from the southeastern county boundary line to the northern county boundary line. The area encompasses Chopawamsic Creek, Aquia Creek, Accokeek Creek, Potomac Creek, and their tributaries. The potential foraging area habitat has not been assessed as part of this study; however, the availability of potential habitat is noted.

Figure 5. Potential Great Blue Heron foraging areas within 2-mile, 3-mile, and 6-mile radius of Potomac Creek heronry.



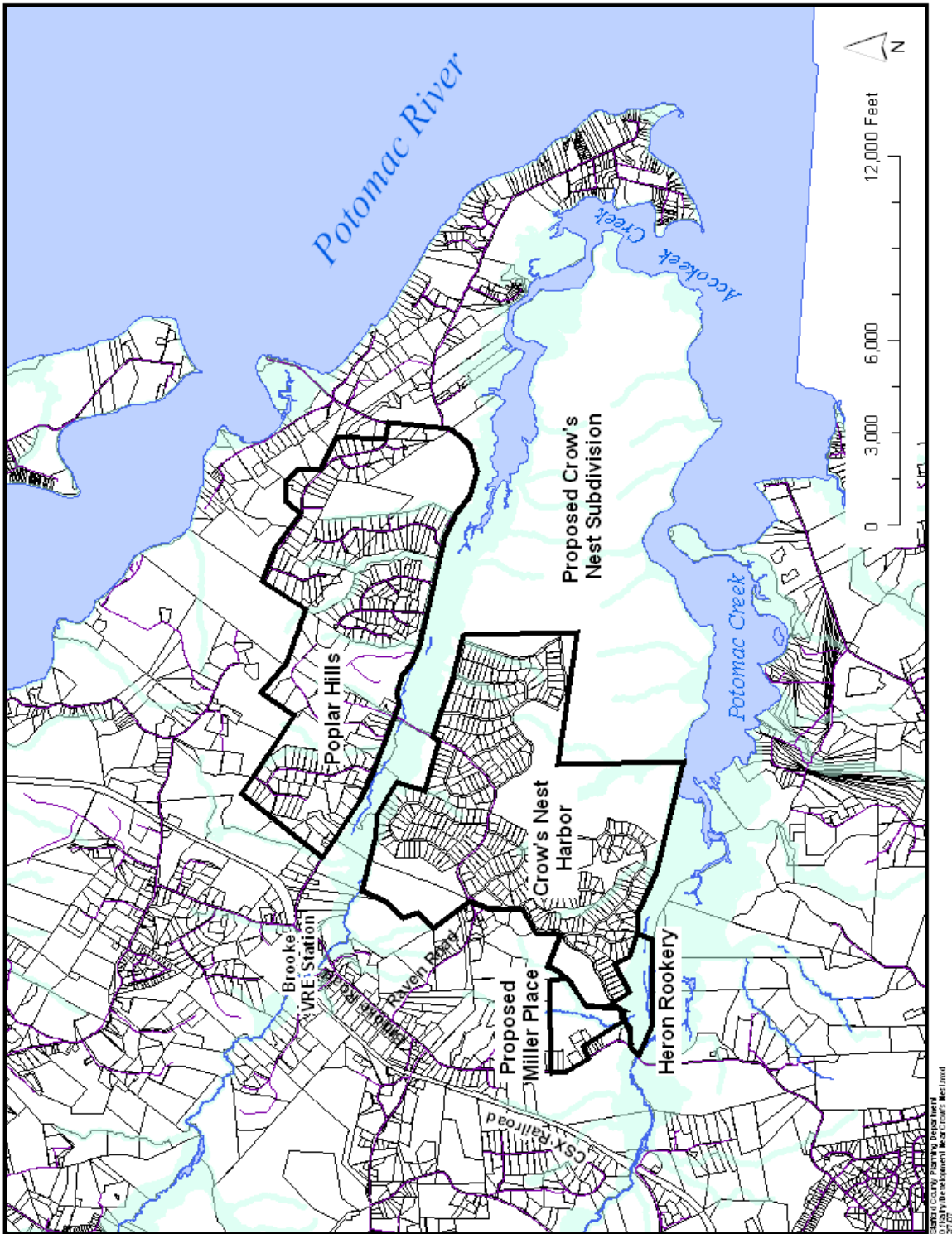
LAND DEVELOPMENT NEAR POTOMAC CREEK HERONRY

The Crow's Nest peninsula, including the heronry site, largely has remained undeveloped due to steep topography and limited access. Several attempts to develop the area have been made since the 1970's. In 1971, a developer proposed rezoning 4,725 acres of Crow's Nest for 1,000 single-family residences and 7,000 apartments and townhouses, as well as two golf courses, four marinas, an airpark/airport, and other commercial development. Financing never was obtained to pursue development.

In 1973, a developer created approximately 350 2-acre lots as Crow's Nest Harbor subdivision at the western end of the peninsula, just north of the heronry (Figure 6). No infrastructure, including roads and public water and sewer, ever was constructed and the developer did not pursue development of the project. However, most of the lots were sold to individual property owners. No homes have been constructed on the lots due to legal issues associated with infrastructure improvements; however, this may not preclude future development of the lots. Northern Virginia Conservation Trust purchased three of these lots in 2005 and accepted a fourth lot as a charitable donation. Stafford Lakes Limited Partnership owns approximately one-third of the lots. The distance from the nest loci to the Crow's Nest Harbor boundary is approximately 400 feet at the nearest point.

In 1978, the county Board of Supervisors down-zoned the peninsula to A-2, Rural Residential zoning, with a minimum allowable 1-acre lot size, following a revision to the Comprehensive Plan. The 1971 zoning no longer was considered valid.

Figure 6. Land development near Potomac Creek heronry.

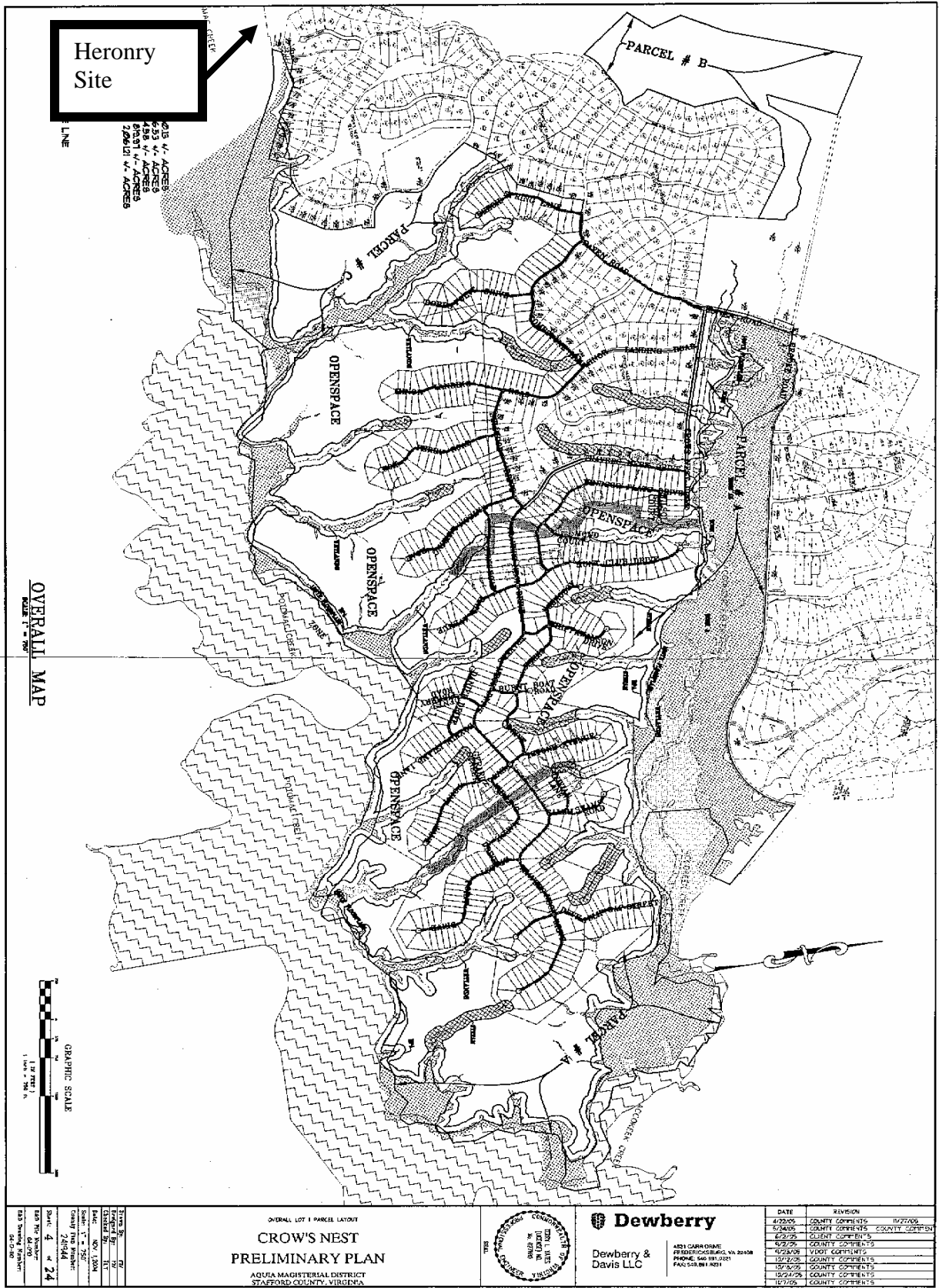


Most of the remaining land area on Crow's Nest peninsula is owned by Stafford Lakes Limited Partnership. In December 2004, the owner submitted a preliminary subdivision plan for development of 688 single-family homes on 1-acre lots over 3,230 acres (Figure 7). The distance from the heronry nest sites to the nearest proposed lots within the Crow's Nest subdivision is approximately 4,500 feet. The Planning Commission denied the application in 2005; however, litigation is pending over their action.

Attempts to Preserve Crow's Nest

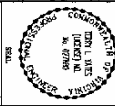
In 2000, U. S. Fish and Wildlife Service proposed to establish a National Wildlife Refuge on Crow's Nest to protect the diverse plant and wildlife habitat. The Final Environmental Assessment prepared by U. S. Fish and Wildlife Service (2000) identified a need for action to protect the area from threats that included timbering, recreational water activity, and development. In addition to recommendations for preservation of the overall peninsula, the Final Environmental Assessment noted specifically that protection of additional habitat surrounding the Potomac Creek heronry would be critical to sustain the colony in the future. Funding never was secured to purchase the property. The Commonwealth of Virginia attempted to purchase a portion of the peninsula in 2003, but negotiations between the property owner and the state collapsed and the property was not purchased. Local citizens have rallied in an attempt to preserve the entire Crow's Nest peninsula by forming grassroots organizations to raise awareness and funds to purchase the site. The Stafford County Board of Supervisors made a bona fide offer to the developer in 2006 to purchase a portion of the property, and the Board has considered condemnation, but there is no resolution to date.

Figure 7. Crow's Nest preliminary subdivision plan.



DATE	REVISION
4/22/05	COUNTY COMMENTS 10/27/05
5/24/05	COUNTY COMMENTS COUNTY COMMENTS
6/27/05	CLIENT COMMENTS
8/22/05	COUNTY COMMENTS
9/28/05	CLIENT COMMENTS
10/12/05	COUNTY COMMENTS
10/24/05	COUNTY COMMENTS
10/24/05	COUNTY COMMENTS
10/24/05	COUNTY COMMENTS

OVERALL LOT & PARCEL LAYOUT
CROW'S NEST
PRELIMINARY PLAN
 AQUILA MAGISTERIAL DISTRICT
 STAFFORD COUNTY, VIRGINIA



Dewberry
 Dewberry & Davis LLC
 4851 CARA DRIVE
 FREDERICKSBURG, VA 22408
 PHONE: 540.551.2021
 FAX: 540.551.2021

DATE	REVISION
4/22/05	COUNTY COMMENTS 10/27/05
5/24/05	COUNTY COMMENTS COUNTY COMMENTS
6/27/05	CLIENT COMMENTS
8/22/05	COUNTY COMMENTS
9/28/05	CLIENT COMMENTS
10/12/05	COUNTY COMMENTS
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10/24/05	COUNTY COMMENTS

Other proposed development

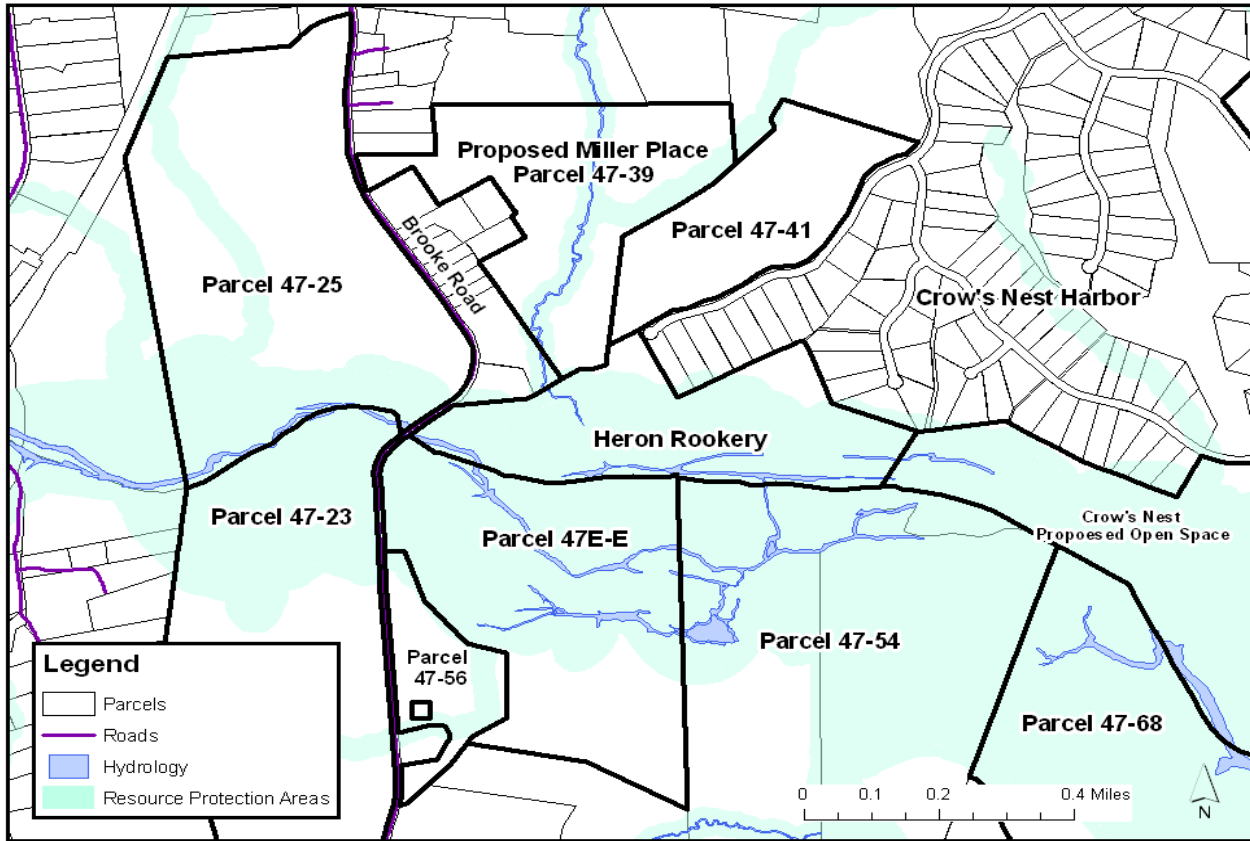
Since 2000, 135 lots have been recorded for the Poplar Hills subdivision and approximately 100 homes have been constructed on 1-acre lots north of the Crow's Nest peninsula (Figure 6). In September 2006, a preliminary subdivision plan to develop 15 single-family homes on 3-acre lots was submitted to the county for 80 acres located adjacent to the heronry site to the north (Figure 6). The boundary line of the proposed Miller Place subdivision is approximately 1,475 feet northwest of the nest sites.

Future development potential on adjacent properties

Several other properties have the potential for residential development in the vicinity of Potomac Creek heronry (Figure 8). Most properties are zoned A-1, Agricultural, except for Crow's Nest and Crow's Nest Harbor properties, which are zoned A-2, Rural Residential. A-1 zoning allows a minimum residential lot size of three acres, and A-2 allows a minimum residential lot size of one acre. This would mean that a 100-acre parcel would have the potential to support 33 3-acre lots in the A-1 zone, or 100 1-acre lots in the A-2 zone. All subdivision plans require approval by the Stafford County Planning Commission, and must be approved if those plans meet current county ordinance requirements. No current regulations exist that would require site developers to adhere to non-disturbance within recommended buffer areas.

Properties to the south of the heronry parcel could be developed for residences, although some portions are encumbered by Critical Resource Protection Area and must remain undisturbed. Development of Assessor's Parcels 47E-E (110 acres),

Figure 8. Development potential of properties adjacent to Potomac Creek heronry.



PARCEL #	AREA IN ACRES	ZONING DISTRICT	POTENTIAL # OF LOTS
47-23	164	A-1	54
47-25	194	A-1	64
47-39	80	A-1	26
47-41	52	A-1	17
47-54	227	A-1	75
47-56	24	A-1	8
47-68	138	A-1	46
47E-E	110	A-1	36

47-56 (24 acres), and 47-68 (138 acres) would be limited to areas south of the Critical Resource Protection Area, which means the closest development would be $\geq 1,600$ feet south of the heronry core area. Parcel 47-54 (227 acres) currently has limited development potential as it has no state road frontage, and partially is encumbered by the Critical Resource Protection Area. This area extends about 700 feet from the heronry core area. Some of the heron nest trees are located on this property, and Global Positioning System coordinates have not yet been obtained. One residential unit could be constructed on this property, with the potential for one additional unit if the property is subdivided. Without state road frontage, the maximum number of lots would be two. The property owner would be required to obtain right-of-way from adjacent property owners to construct a state road in the future. If state road frontage is extended, there would be potential for up to 75 3-acre lots.

Brooke Road bounds the heronry site to the west, approximately 2,300 feet from the core nest area. Across Brooke Road, Parcel 47-23 (164 acres) partially is encumbered by Critical Resource Protection Area. Development of this parcel would be limited to the area south of the buffer, which exceeds 2,800 feet from the core. Parcel 47-25 (194 acres) also is encumbered by Critical Resource Protection Area and a powerline easement. The developable area of the property would be $> 2,300$ feet from the core area.

Development to the north of the heronry site has the most potential for disturbance. Zoning here allows greater density than on parcels to the south and west. The existing 2-acre lots in Crow's Nest Harbor lie nearest to the core nest area. It is not known whether the existing topography here is sufficient to buffer noise and visual

disturbance from potential development. Additionally, north of the heronry is an undeveloped 80-acre parcel. Parcel 47-41 has no state road frontage, but access could be obtained if the adjacent Miller Place is developed.

As development pressure increases in the vicinity of the heronry, Northern Virginia Conservation Trust is concerned about potential negative impacts. Because herons are vulnerable to disturbance by humans and may abandon breeding colonies or have reduced reproductive success, failure to limit development on the peninsula and surrounding areas potentially could impact the future of the heronry. The desire of Northern Virginia Conservation Trust is to prepare management guidelines to ensure the long-term sustainability of this unique local resource.

MANAGEMENT OF POTOMAC CREEK HERONRY

Management History

No formal management guidelines previously had been established for Potomac Creek heronry prior to 2001. Northern Virginia Conservation Trust developed their current management plan using material prepared by the Army Corps of Engineers. The Land Stewardship Committee reviewed the plan, submitted input and formally adopted it on December 1, 2001 with the stated intention of periodic review and revision. Accordingly, the plan was updated in 2003 by Katie Goldberg. The plan briefly identifies goals for visitor control and site entrance limitations.

Mission

The mission of Northern Virginia Conservation Trust shall be to maintain the ecological integrity of the heronry site, providing for the management of the heronry and its surrounding riparian forested area, and to ensure the long-term sustainability of the colony.

Management Goals

Several general goals have been identified by Northern Virginia Conservation Trust regarding management of the site and associated properties. Achieving these goals will require a cooperative effort among site managers, local decision-makers, biologists and ecologists, and citizens. These goals include:

- Manage for Great Blue Heron habitat within the 70-acre property owned by Northern Virginia Conservation Trust
- Minimize the impact of development activities on surrounding properties

- Establish baseline data and standardized methodology for future data collection
- Identify and maintain function and value of associated foraging habitat, staging areas, and wintering grounds
- Identify additional habitat in the immediate vicinity that may be suitable for future expansion necessary to sustain the colony
- Work with property owners and local government officials to establish policies and procedures for equitable land conservation efforts.

Management policies and procedures

Northern Virginia Conservation Trust will oversee the management of the site. All parties, including volunteers or outside personnel, shall adhere to strict policies and procedures set by the Trust. Initially, a site steward will be appointed to oversee activities and make recommendations. It may be beneficial to train a core of volunteers who will be dedicated to the overall management of the site and assist the site steward as needed. Some standard policies include:

- No access to the site without the express consent of Northern Virginia Conservation Trust
- Site visits during the breeding season will be limited to qualified personnel with prior approval by Northern Virginia Conservation Trust. Qualified personnel includes a biologist with experience surveying heron colonies, and other personnel experienced with or trained in the identification of Great Blue Heron nests, eggs, nestlings, fledglings and adults
- The purpose of any site visit shall be stipulated up front and approved by Northern Virginia Conservation Trust

- No motorized vehicles shall be allowed on site during the heron breeding season
- No smoking
- Any land disturbance or alterations must have prior approval of Northern Virginia Conservation Trust and follow all applicable federal, state, and local permitting procedures.

Management Guidelines

This management plan includes a multi-faceted approach to consider all aspects of the life cycle of the Great Blue Heron. Management guidelines will be based on current research, existing knowledge of the colony, and surrounding land uses. However, because scientific studies have not yet been conducted by qualified individuals, this plan will serve as a basis for future recommendations. As more empirical data is gathered, additional sections may be added. Additional long-term goals then may be established.

Short-term prescriptions

Securing the site and limiting immediate human threats should be considered short-term goals that may be reached through the following strategies:

Post signage

Northern Virginia Conservation Trust staff posted signage in 2000 identifying a nature preserve, but during a site visit in early 2006, it was noted that some of the signage had been removed or was no longer visible. During fall 2006, “No Trespassing” signs were erected by Northern Virginia Conservation Trust staff along the entire northern property boundary. This area is most accessible due to the existing trail that shows

evidence of all-terrain vehicle use. In addition, the northern boundary is in close proximity to the proposed Crow's Nest, Crow's Nest Harbor, and Miller Place subdivisions, where surveying and other development-related activity has occurred. A site visit during fall 2006 confirmed the presence of survey flagging on those properties. According to county Zoning officials, property owners had used heavy machinery to locate potential drainfield sites on the Crow's Nest Harbor lots. Due to the site's steep terrain, some vegetation had to be cleared to allow access for that machinery.

Additional signage should be posted along the southern, eastern, and western property boundaries. Currently, the southern boundary is difficult to access due to wetlands and streams. However, canoeists sometimes paddle up Potomac Creek toward the heronry along the southern boundary. The western boundary runs along Brooke Road. Care should be taken to post discreet signage here that will not attract attention to the site.

Limit access

Deterring all-terrain vehicle riders and other unauthorized users along the northern boundary trail should be of immediate concern. A site visit in January 2007 confirmed recent all-terrain vehicle use along the trail. It may be necessary to install gates or other barriers with signage in two areas where the trail enters from off-site property.

Establish buffer areas

The core colony area currently is depicted as the nesting trees identified in 2006 and 2007. Buffer areas should be established from the core nest concentration to minimize disturbance to the colony. It should be noted that the Global Positioning

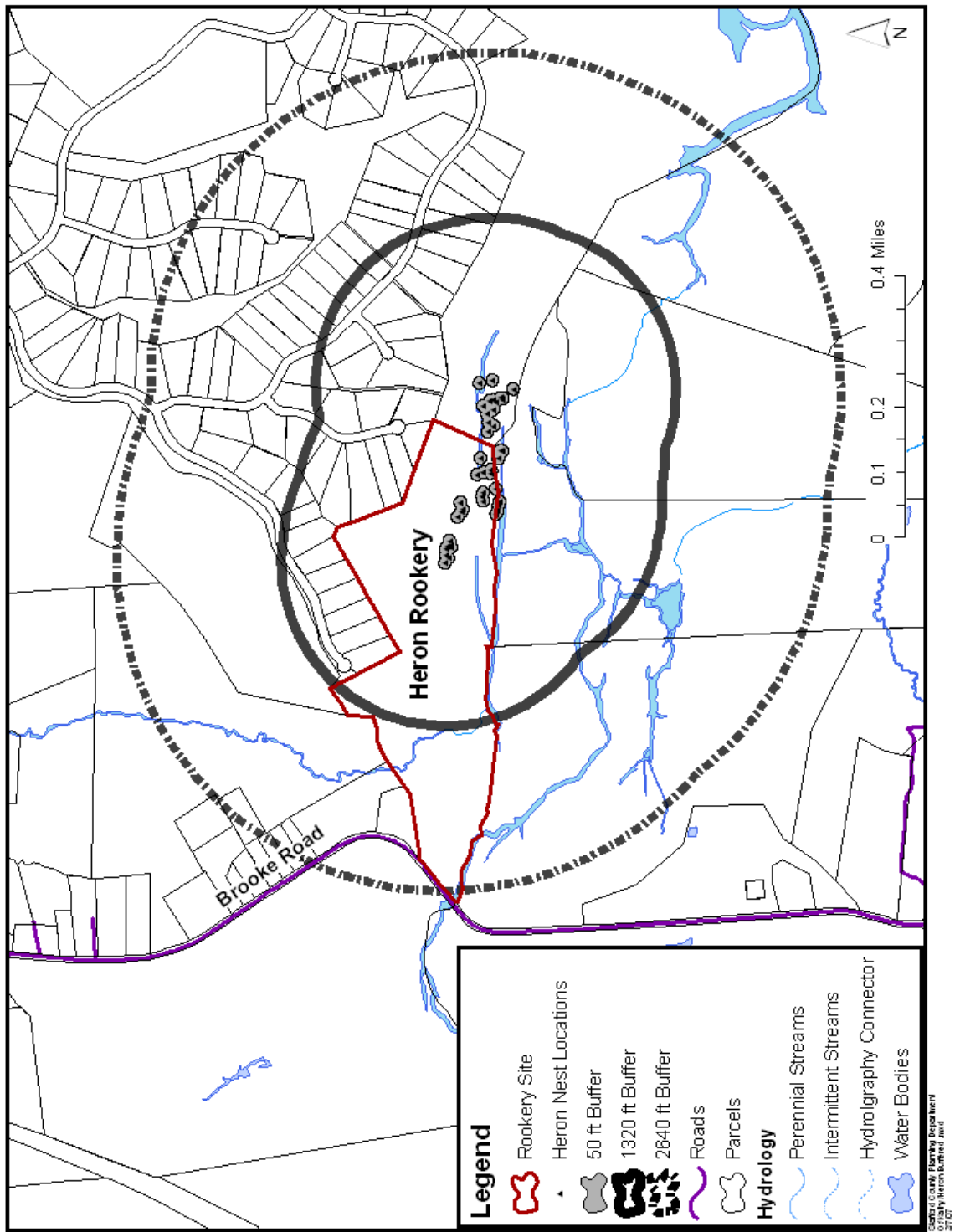
System coordinates and the buffer areas do not take into consideration the 10 nest trees located on the property to the south. Northern Virginia Conservation Trust should obtain permission from the property owner to access the nest sites to take readings.

Trained personnel eventually should assess the flushing distances for herons at Potomac Creek heronry to determine the actual buffers needed to minimize disturbance. Initial buffers zones should be established immediately; however, permanent buffers should be devised based on data collected over time. Habitat availability, function, value, necessary nest material and future growth and/or movement of the colony should be considered when establishing permanent buffer zones. Until then, the following buffer areas should be considered from the edge of the core area, as depicted in Figure 9:

- Buffer Zone 1: No access or disturbance within 1,320 feet (except for scientific purposes authorized by Northern Virginia Conservation Trust) from February 15-July 31.
- Buffer Zone 1: Limited pedestrian activity, as determined by Northern Virginia Conservation Trust, within 1,320 feet from August 1-February 14.
- Buffer Zone 2: No construction activity within 2,640 feet (includes timbering, road construction, building construction or any activity requiring heavy machinery).

Although U. S. Fish and Wildlife Service recommends restricting activities beginning March 15, the February 15 date is used here because herons have been observed engaging in early nest-building activities then. During the period when herons are absent from the

Figure 9. Proposed buffer areas from Great Blue Heron nests at Potomac Creek heronry.



colony, the integrity of the site shall be maintained. No clearing of native vegetation should be permitted within the limits of the established buffer areas unless deemed necessary by Northern Virginia Conservation Trust, as this may allow easier human and predator access to the colony.

The buffer areas, as depicted, encroach on privately-owned properties adjacent to the heronry. Buffer Zone 1 contains Critical Resource Protection Area to the south and east, so no development should occur here based on the limitations imposed by the county. To the west, Buffer Zone 1 is contained on Northern Virginia Conservation Trust property. However, to the north, Buffer Zone 1 encroaches into lots in Crow's Nest Harbor. This should be identified as an area of concern. It should be noted that certain infrastructure improvements such as roads, utilities, and passive recreational facilities are exempt from Critical Resource Protection Area regulations. Also, timber harvesting is an allowed use to certain extents within Critical Resource Protection Area buffers.

Buffer Zone 2 encroaches onto private property, but generally is contained within Critical Resource Protection Area buffer to the south, east, and west of the nest sites. Again, the primary area of concern is to the north of the colony.

Although buffer zones may be established, enforcement of these zones will depend upon the county's willingness to adopt protective measures, such as resource overlay districts. Ultimately, restrictive easements should be considered for land within the buffer areas that lie off-site from the Northern Virginia Conservation Trust property. In the meantime, because the recommended buffers encroach onto adjacent properties, Northern Virginia Conservation Trust and Stafford County Planning should work with property owners who may propose development activities. During the development plan

review process, the county should urge developers to abide by these buffer guidelines until such time that sufficient zoning regulations are established to require buffers.

Northern Virginia Conservation Trust should approach adjacent owners to inquire about purchase of property or easements to accommodate the buffer areas.

Monitor human activity

Monitoring the site for trespassing and other disruptive activity should begin immediately. The site steward shall conduct regular site inspections throughout the year. Local volunteers may be solicited for this activity to assist Northern Virginia Conservation Trust. Groups such as Friends of the Rappahannock, Friends of Stafford Creeks, and the Rappahannock Sierra Club are aware of the heronry site and likely would be sensitive to the need to restrict intrusive human activities. Training sessions could be provided by Northern Virginia Conservation Trust to interested individuals. It should be noted that no entrance to the site shall be permitted without the express consent of the Trust. Motion-detection or other security cameras may be considered to determine the extent of trespassing on site, and the time of day when these activities occur.

Long-term objectives

Site Inventory

Although some initial site assessments have been conducted by others, additional studies will be necessary to verify flora and fauna on site and adjacent to the heronry. Baseline surveys and monitoring efforts will be necessary to provide science-based decisions on management of Potomac Creek heronry in the future. Habitat needs and availability of suitable habitat for sustaining the Great Blue Heron colony will require

additional analysis based on inventories collected. Also, while the priority may be management for Great Blue Heron habitat, decisions need to ensure that habitats for other species are not compromised.

Qualified personnel trained in the identification of species should be utilized for this work. Virginia Department of Forestry, Virginia Department of Game and Inland Fisheries, and Virginia Department of Conservation and Recreation may be able to assist with these studies. Virginia Department of Conservation and Recreation provides assistance to localities for heritage resource site inventory work. Biologists conduct on-site inventories at a reduced cost. Costs would need to be determined by Virginia Department of Conservation at the time of request. Another program that offers assistance for plant and wildlife inventories include Virginia Department of Game and Inland Fisheries Wildlife Mapping in Virginia. This is an outreach program that allows citizens, community groups, and government organizations to collect data that contributes to the state's biological databases. Additionally, the Virginia Master Naturalist Program may assist in site inventory work through its statewide corps of volunteers. The local Central Rappahannock Chapter has certified naturalists who have completed 6 to 12 months of training. Graduate students from Virginia Tech or other area universities also may be willing to assist with these studies.

Vegetation assessment

An assessment of on-site vegetation should identify canopy and understory trees, as well as ground cover. Although herons may utilize various species of canopy trees for nesting, sycamores and tulip poplars currently are the tree species being used at Potomac Creek heronry. Trees within and near the core area that may be suitable for use as future

nest sites should be identified and located with Global Positioning System. Changes in use of particular tree species for nests should be noted. A determination should be made whether invasive species that may impact the growth of nest tree species are prevalent.

Vegetation type and density also may be important in terms of reducing colony disturbance. Vos et al. (1985) noted that a well-developed leaf canopy reduces the effects of disturbance. Dense ground vegetation also may deter humans and predators from penetrating the site. Vegetation types and communities may be mapped utilizing Geographic Information Services to assist in long-term analyses.

Wildlife identification

U. S. Fish and Wildlife Service (2000) noted the occurrence or potential occurrence of several species on the Crow's Nest peninsula known to prey on Great Blue Heron eggs and young. It will be important to verify predator species at the site and in the vicinity of the heronry. Initial inventories and subsequent monitoring of these species may provide a correlation between predation and nesting productivity. Nearby land development and habitat fragmentation may facilitate access to the heronry and increase predatory opportunities for species such as raccoons (*Procyon lotor*) that tend to thrive in suburban areas.

U. S. Fish and Wildlife Service (2000) also noted the potential occurrence of many aquatic and terrestrial species upon which herons feed. Studies will be necessary to determine the presence of significant prey species. Baseline inventories and subsequent population monitoring of these species will assist in determining the continued availability of food sources for the heron.

Colony Site Documentation

History of nest tree utilization

Efforts should be made to document the annual use of nest trees by herons to determine whether existing and potential future colony needs are being or can be satisfied on this property. Some of this information can be collected during the non-breeding season to preclude disturbance to the birds; however, observation during the nesting period will be necessary. Trees that contain nests should be numbered and identified individually by species, and located with a Global Positioning System reading. A nest tree survey was conducted by Stafford County Departments of Planning and Geographic Information Systems in January 2007 (Appendix C). Initial Global Positioning System coordinates were taken utilizing Trimble Geo XH equipment and ArcMAP programming. Diameters of nest trees for which access was available have been measured, but some trees could not be accessed due to thick underbrush (primarily greenbriar) (*Smilax rotundifolia*), standing water, or lack of authority to enter the site.

Annual nest tree documentation should include diameter at breast height (dbh) and height of the trees. Average height of nests in trees should be recorded. A general assessment of the condition of the trees is necessary. For example, any major branch damage or a tree that appears to be dying should be noted. Identifying trees with double trunks or any deformities will be useful to locate nest trees more quickly in subsequent visits to the site. Vennesland and Norman (2006) recommend marking trees with aluminum nails and tags for identification purposes. Nails should be placed close to the ground to allow for trees to be safely harvested in the future, and should not be hammered completely into the tree. Nanjemoy Heronry managers number individual

trees with aluminum tags. This allows for tagged trees to be identified in subsequent years. Tags can be added to trees when new nests are found. New Global Positioning System coordinates should be recorded for new trees. Standardized data sheets are recommended for each visit (Appendix C).

Nest counts

It is important to conduct nest counts during the non-breeding season because the birds will be absent from the site, thus reducing potential impacts. Also, nests can be seen more readily when leaves are off the trees. Optimum months in Stafford County, Virginia, would be November through January, before herons return to the site in mid-February.

Vennesland and Norman (2006) recommend counting the number of nests in each tree to help assess spatial movement of nests within the stand over time. The number of nests counted in the non-breeding season then can be compared to those used during the nesting season to establish the percentage of nest occupancy. This will allow for a more reliable estimation of actual nest usage each year. Nests on the ground should be noted separately for reference, particularly if they are intact. They most likely were blown to the ground and may be rebuilt in the next season. Nests may be counted manually; however, sampling methods may be necessary for larger heronries or heronries where access is difficult. Nest counts at Mason Neck heronry, which have numbered as high as 1,600, still are conducted by manually counting each nest (Joe Witt, pers. comm.). The Mason Neck heronry is divided into sections and volunteers are assigned by section. To ensure each tree is counted only once, chalk markings easily can identify trees already counted. Depending on the future size of the heronry, the number of people conducting

the count will vary. One data recorder and two designated counters are sufficient to document Potomac Creek heronry at its current size. Stafford County Planning staff likely will continue annual counts until such time that Northern Virginia Conservation Trust has sufficient staff or volunteers.

Mapping and data storage

Mapping of the core colony area should be updated annually to determine expansion or loss of area. Individual trees should be mapped to show any changes over time. Data from the 2006 and 2007 nest counts currently are stored in ArcGIS with Stafford County's Geographic Information Systems division, but will be turned over to Northern Virginia Conservation Trust for centralized storage. Release of any data must be authorized by the Trust.

Measuring nesting success and productivity

Long-term monitoring of nesting activity is important to assess colony size, nesting success, and nesting productivity (Vennesland and Norman, 2006). Nesting success is the proportion of nests that successfully fledge young, whereas nesting productivity is the number of young fledged per successful, active nest. Moul et al. (2001) consider an "active nest" to be one with feces on the foliage or ground below, or having birds present on the nest, and a "successful nest" to have one or more chicks observed. Because active nest and fledgling counts must be conducted during the period when herons are most vulnerable to disturbance, it is imperative that monitoring be conducted by professionals with knowledge and experience to ensure that potential impact is minimized. Various methods for establishing visual contact with nestlings have been utilized at other sites, as discussed below. The least invasive method will need to be

determined at this site by Northern Virginia Conservation Trust, based on field studies. Field studies will be necessary to establish lines of visibility and the distance needed for observation based on the herons' disturbance response.

Vegetation present during the nesting period is dense at Potomac Creek Heronry, and observation is difficult. A high knoll to the north of the site provides limited visibility into the colony. It may be possible to construct an observation tower or stand on this knoll, but it likely would require approval of the property owner. Some colony managers in Washington State and Canada utilize remote video cameras to observe herons throughout the breeding season. Cameras are installed during the non-breeding season and used to monitor colony activity. Costs associated with remote video camera use would need to be taken into consideration. Start up costs for one video camera and live stream video by the City of Victoria, British Columbia, was approximately \$7,000 with annual cost of about \$1,200 (Mike Leskiw, pers. comm.). Obviously, > 1 camera would be necessary to view multiple nests. Another option to consider for nest counts would be aerial views. A determination would need to be made whether low-flying aircraft could capture clear views of the nests without disturbing the colony. This may be possible early in the season before trees have leaved out; however, the timing of nest occupancy would need to be determined. Costs associated with this activity also would need to be assessed.

Survey protocol established by Vennesland and Norman (2006) for measuring nesting productivity recommends testing colony response to intruders. Eventually, the birds may habituate to this type of activity. As previously stated, herons respond to disturbance differently, especially at various times of the season (i.e., less sensitive late in

the season). The protocol recommends slow, deliberate movements, and suggests entering the site late in the day when the birds are tired and less active. They may be less likely to leave the nest at this time. Also, the threat of predation may be reduced at this time of day if adults leave the nest. Windy days can disguise human noises and movements; however, during the first two weeks after hatching, it is best to work on warm, windless days so hatchlings are not exposed if adults flush. Intrusion during rainy days should be avoided. Another consideration is to coincide fledgling counts with low tide, a time of day when adults actively would be foraging and already away from the nest, so flushing impact is reduced.

Vennesland and Norman (2006) noted a series of behaviors that generally occur prior to flushing, which can be used to determine when human approach should be terminated during counts. At first response, herons will be alert and silent. Next, they will vocalize with “chortle” or “cluck” calls. Louder screams will be heard prior to flushing from the nest. They then may circle above the nest until the threat is gone. Loud or sudden noises may cause immediate flushing without the progression in behavior. The protocol suggests that, if vocalization is detected, all human movement and noise should stop until the vocalization stops. It also suggests that, if > 1 heron leaves its nest, especially during the incubation period, people should leave the colony immediately.

The protocol recommends making several visits throughout the breeding season to track nesting attempts and successes. Some nests may be abandoned for various reasons, such as disturbance or predation of eggs. Some birds may re-nest if the first attempt is not successful. Adult herons standing on a nest with no visible nestlings likely are

initiating a new nesting attempt. An adult heron lying flat on a nest probably is incubating eggs or brooding recently hatched nestlings. Nestlings seen on branches near the nest likely are between 6-7 weeks old. Behavior can be misleading, so this should not be used as the sole determinant for the chronology of nesting.

Timing of site visits can be based on the established nesting chronology. Once the time of hatching is established, fledging dates can be estimated. Indications of hatching include vocalizations by young, and eggshells on the ground. When hatchlings hatch on their own, the egg will open on the latitudinal axis near the top of the egg. However, if the egg is smashed, or has holes along the longitudinal axis, it most likely is the victim of a predator.

Nesting productivity should be assessed systematically. Analysis of long-term data will assist decision-making about how best to sustain the colony. Because colony size and productivity may fluctuate yearly, due to weather events or other impacts, trend analysis will be important. Ultimately, regional trends in heron populations should be studied so that changes in heron numbers at Potomac Creek heronry are not based solely on local factors.

Habitat Protection

Colony site

The Potomac Creek heronry requires full protection of the core nesting area. Because some nests currently are located off-site, Northern Virginia Conservation Trust should consider further acquisitions of property or implementing new easements to protect these nests. Quinn and Milner (2004) recommend that several alternate forested

stands be left in the vicinity of colonies. Although some portions of the Crow's Nest peninsula potentially may serve as alternate nesting area, this will depend upon subsequent development. As proposed in the Crow's Nest preliminary subdivision plan submitted to the county, approximately 1,000 acres of open space is proposed along Potomac Creek and Accokeek Creek. However, this area is less secluded with highly variable vegetation, soil structure, and topography.

Sustaining the current nesting area will depend upon the level of development in the surrounding area. In addition to disturbance factors, increased stormwater run-off may cause flooding, waterways siltation, and stream washouts, which in turn can affect prey species. Furthermore, improper pesticide use in the vicinity may increase toxic discharges into the water systems, so contaminant loads and effects will need monitoring. Availability of long-term data will be useful to guide decision-making on how best to avoid/reverse habitat changes due to water quality alterations. Increased widths for Critical Resource Protection Area buffers on the up-stream corridors may be necessary for properties that are developed. The buffers also could be increased to include intermittent streams.

Staging area

Once staging areas are identified, evaluation and recommendations for their protection will be required. Recommendations may include minimizing disturbance to and maintaining existing habitat, and providing suitable alternate habitat in the vicinity of the heronry.

Foraging habitat

Identification and protection of heron foraging areas will be crucial to long-term maintenance of the colony. Although the Chesapeake Bay overlay buffers and wetland regulations provide some degree of protection to vulnerable shoreline systems, additional measures may need to be considered. Mapping heron foraging areas would provide a baseline from which an assessment of impacts anticipated to arise from development in areas surrounding the site could come. Also, water quality should be monitored to assess potential contamination of fish or other prey within these foraging grounds.

Short and Cooper (1985) established a habitat suitability index model to assist in determining foraging areas, based on distance from colonies, availability of fish prey <10 inches, and presence of shallow water (<20 inches) and a firm substrate. Kenyon (2006) studied flight patterns and direction of herons departing from and returning to colonies to determine foraging area locations. Observers were located along flight paths to verify the herons' ultimate destinations. Observers located at these eventual foraging areas used vanishing compass bearings to plot the birds' routes back to their colony. Observations began 2-3 hours before low tide to maximize the number of readings. Kenyon (2006) cautioned that bearings could be misleading as birds sometimes go to a secondary foraging site or roost site prior to returning to the colony. Because the colony location is known for birds using the Potomac Creek heronry, flight direction can be measured from the heronry as the birds leave or make their return flight. Kenyon (2006) noted that all known colonies must be associated with vanishing bearings from one or more foraging sites, and that all vanishing bearings from a site must be investigated to determine if they

are associated with a colony. Investigation included utilization of several observers along the flight path who communicated via cellular phone.

Because herons are susceptible to disturbance while foraging, determining whether they habituate to nearby boat traffic would seem to be important in this case. Bratton (1990) noted that few foraging herons flushed when disturbance was > 200 feet away. Therefore, it may be necessary to consider a setback distance from the shore for boating traffic. Setback distances could be posted with signage, and monitored by the Virginia Department of Game and Inland Fisheries, who currently monitor no-wake zones along Stafford County's waterways.

Feeding territory size and location may change each year (Quinn and Milner 2004). Erwin (1979) suggested monitoring seasonal use patterns of herons at coastal feeding sites over several annual cycles, and identifying biological "production hot-spots" for protection and further research.

Non-breeding habitat

Wintering ground studies in the vicinity of the heronry are limited, so areas utilized during the non-breeding season need to be identified to assess potential threats. This may require a regional effort, in coordination with managers of Mason Neck and Nanjemoy heronries, as birds from these areas may utilize the same wintering grounds. Resources such as the College of William and Mary's Center for Conservation Biology and the Waterbird Monitoring Partnership may be important cooperators as well.

LOCAL CONSERVATION STRATEGIES

Duerksen et al. (1997) suggests that, to achieve environmental protection, a compromise between the needs to preserve the environment, maintain the economy, and protect private property rights is needed. Recommendations must come from scientifically sound data, and be legally and politically tenable. Duerksen et al. (1997) identified several groups and stakeholders who need to come together to set and achieve goals for environmental action. These include landowners, developers, and environmental advocates; ecologists; attorneys; land trust representatives; planners; and decision-makers. In the context of this plan, some of those stakeholders include:

- Northern Virginia Conservation Trust
- Stafford Lakes Limited Partnership
- Property owners within Crow's Nest Harbor
- Other adjacent property owners within the designated buffer areas
- Save Crow's Nest grass roots organization
- Stafford County Planning Department
- Stafford County Planning Commission
- Stafford County Board of Supervisors

Northern Virginia Conservation Trust should initiate contact with property owners to inquire about property acquisition or request buffer easements on adjacent properties. In addition, they should continue discussions with the county to pursue other land conservation options. The Trust may employ community activists to urge county officials to incorporate protection measures for the heronry, as well as other sensitive resource areas.

Conservation Programs

Property near the heronry currently is not suitable for high-density housing or commercial/industrial development. However, as the county continues to grow, and the demands to use undeveloped parcels increases, installation of infrastructure, such as public water, sewer, and higher capacity roads, could become a reality. An existing railroad line lies ~1 mile west of the heronry, and future transportation needs may draw development toward the Brooke Commuter Rail Station (Figure 6).

Stafford County has identified preservation and enhancement of natural resources as a goal in its Comprehensive Plan. Many strategies are recommended throughout the plan, but cannot be implemented without additional ordinances to set regulations and enforcement standards. Stafford County policymakers have an opportunity to facilitate land use planning for environmental sustainability through various regulatory tools. Several programs could be instituted to enhance land conservation and have direct application to properties near the Potomac Creek heronry. The following is a sample list of land use planning tools that could be utilized. No single solution is recommended over another, but by offering a variety of choices, property owners and developers may choose those that better meet their needs.

Transfer of Development Rights

In 2006, the Virginia General Assembly authorized localities in the Commonwealth of Virginia to establish Transfer of Development Rights programs. In essence, this allows a property owner to develop property at a higher density in exchange for limiting development on another piece of property. Areas suitable for Transfer of Development Rights application would be designated by the locality and property owners

would be responsible for negotiations with land developers. At this time, the state-enabling legislation does not allow land banks to be established for Transfer of Development Rights programs. Stafford County presently is studying the feasibility of adopting a program. Areas like Crow's Nest potentially could be eligible for inclusion in such a program.

Purchase of Development Rights

Stafford County has been considering a voluntary Purchase of Development Rights program since 2000. With this program, the county would pay a property owner the difference between open space value and development value to limit development of a property. The county has lowered property tax rates in recent years to off-set increased assessment values. Most likely, a tax increase would be needed to initially support a Purchase of Development Rights program. The biggest limiting factor for a county-wide program has been identifying a funding mechanism. As interest in Purchase of Development Rights programs grows statewide, additional funding may be offered through grants available from the state. Governor Tim Kaine established a committee in 2006 to review funding opportunities for Purchase of Development Rights programs. Governor Kaine proposed \$20 million in the 2007 budget for land conservation, including \$5 million for matching grants for local programs.

A Purchase of Development Rights program would benefit property owners adjacent to the heronry site who are interested in keeping their property and retaining equity. Property owners would benefit from tax relief on lower land values.

Conservation Easements

In 2006, the county's Agricultural Commission recommended that the Board of Supervisors implement a conservation easement program. Several land trust organizations operate in the area with whom owners could negotiate an easement agreement. The idea of a county-run program would facilitate the placement of an easement through local contacts. Ultimately, the easement would be held by a third party to permanently restrict future development on a property. Conservation easements provide tax benefits to property owners, including a federal deduction, state tax credit, and inheritance tax benefits. Conservation easements on properties that surround the heronry would limit development on properties deemed significant to maintain the integrity of the heronry.

As previously mentioned, to the east of the heronry site is the proposed subdivision for Crow's Nest. As depicted on the proposed preliminary subdivision plan, land immediately fronting on Potomac Creek currently is designated open space. Should this subdivision plan be approved, a permanent conservation easement should be placed on that open space to ensure that it remains open and undisturbed even if the rest of the peninsula is developed.

Overlay Districts

A Sensitive Resource Overlay District was proposed in 2003 to protect wildlife habitat and species, but it was not adopted. An Overlay District would benefit the heronry if the Planning Commission and Board of Supervisors were inclined to support it. State enabling legislation currently allows for overlay districts. These are supplemental to the existing zoning designation. If an area was designated as a resource overlay

district, specific buffer guidelines would be enacted and construction activities would be prohibited; all action would be enforced by the county. In this case, the overlay could encompass the 70-acre property and areas off-site that fall within the recommended buffer zones. The district could be amended as necessary to incorporate future expansion. Overlay districts also could be established over significant foraging grounds and include setbacks for new construction or boating activity. The feasibility of an overlay district should be investigated by Northern Virginia Conservation Trust, with the assistance of Stafford County Planning Department. This could serve as a pilot program for other sensitive habitat areas in the county.

Cluster Development

To compensate for land that may be taken through an overlay designation or placed under an easement, the county could consider allowing cluster developments in the A-1 and A-2 zoning districts. Currently, clustering is allowed only in higher density developments, generally within the Urban Service Area. Clustering allows a reduction in lot size in exchange for on-site open space retention. For example, a 100-acre property zoned A-1 with a minimum lot size of 3 acres could be subdivided into approximately 33 lots. Under a cluster proposal, the property still could be subdivided into 33 lots, but, with lot size reduced to 1 acre, homes would be clustered into a smaller area. In the Crow's Nest area, homes could be situated away from the heronry, and open space would be maintained closest to the heronry. The developer obtains the same number of lots, and infrastructure costs realistically would be reduced.

Performance Standards

The county could incorporate performance standards into the subdivision or zoning ordinance. Performance standards would establish regulations for all major subdivisions under review. The standards could include requirements to maintain natural vegetation rather than allow clearcutting on the site, as presently allowed. Other requirements might include the exclusion of lots within Critical Resource Protection Areas; extension of Critical Resource Protection Areas to include all wetlands, intermittent streams and 100-year flood plain; and restricting development on slopes that exceed 25 %.

COMMUNITY ADVOCACY AND OUTREACH

Incorporating greater public involvement in this conservation planning process comes with a challenge: how to educate people about the values and vulnerability of the heronry while, at the same time, preventing further intrusion onto the site. Providing greater knowledge about the heronry likely will invite both intentional and unintentional consequences. Vandalism is a concern, but greater public awareness also would entice curious parties to come see this unique resource. If people are not aware of herons' vulnerability to disturbance, they may not realize their role in causing further harm. It would be important for Northern Virginia Conservation Trust to establish an educational program and determine target audiences, such as local schools, environmental groups, and adjacent property owners.

If adjacent properties are developed, Northern Virginia Conservation Trust could help create Homeowners Association covenants or documents that restrict activities such as roaming pets, pesticide applications, construction, and trash storage. It will be important to foster stewardship by promoting the ecological importance of the heronry and discuss how disturbance may cause abandonment. Northern Virginia Conservation Trust could enlist property owners to monitor property boundaries for trespassing. Homeowners Association meetings would provide a forum for open discussion between the Trust, property owners, and county officials.

To fulfill the needs of those who desire to see the heronry, regulated off-season tours could be provided. In addition, video footage could be obtained and provided on Northern Virginia Conservation Trust's website. Fund-raising activities such as "adopt-a-heron" could be considered. For example, the "adopt-a-heron" program in Chilliwack,

British Columbia, collects money that is used to follow the nesting cycle and keep track of the number of chicks hatched and fledged.

Fiscal impacts

If Northern Virginia Conservation Trust is successful in finding willing sellers for property adjacent to the heronry, land acquisition cannot happen without funding.

Currently, lots in Crow's Nest Harbor are assessed between \$16,000 and \$32,000 for lots ranging from 2 to 3 acres. The entire 3,200-acre Crow's Nest parcel is assessed at \$20 million, although the owner has placed current value at \$60 million. Other lands in the vicinity average \$6,200 per acre in assessed value. Land or easement acquisition likely will be the greatest expense associated with management of the heronry. Northern Virginia Conservation Trust should pursue partnerships that would help reduce costs. Grants and fundraising opportunities should be explored. The Trust currently solicits \$500 donations on their website to help protect the heronry, although any charitable donation is welcome.

If the county adopts a Purchase of Development Rights or conservation easement program, funding methods should be identified and recommendations made for purchasing easements on parcels of land adjacent to the heronry. The county actively should pursue willing landowners in the Crow's Nest area to participate in either program.

The county may help Northern Virginia Conservation Trust obtain grants for certain activities that otherwise could be cost-prohibitive. Local governments often can apply for state and federal grants, as well as low-interest loans, that smaller non-governmental organizations are not eligible to pursue.

Other costs that may be incurred by Northern Virginia Conservation Trust include funding for a site steward, and biologists or other personnel needed to conduct site studies if volunteers are not available. In addition, Geographic Information Systems capabilities and associated costs should be reviewed. Further, a cost analysis should include equipment such as cameras and video equipment; gates or other physical barriers to deter trespassers; and aerial photography.

CONCLUSIONS

This management plan is just the first of many steps necessary to protect the Potomac Creek heronry. The focus of my planning effort was to obtain pertinent baseline data about the heronry and consider the implications of alternative land uses on property in the vicinity of the heronry. As additional data is gathered and assessed over the next several years, recommendations very likely will be need to be modified. Activities such as bird banding may be needed for monitoring purposes, and water-quality studies and tissue repositories for chemical analysis may be considered. Many questions will arise, including, among others, the following: can development and conservation both occur without dire consequences to the heron colony? Will phased development habituate the heron colony to human activity? What are the consequences if herons abandon the colony?

Potomac Creek heronry is a unique, local resource with irreplaceable public value. Citizens have shown an interest in the heronry through letter-writing campaigns to the Board of Supervisors and local newspapers. Many have adopted the Great Blue Heron as a symbol of environmental preservation. Save Crow's Nest presents an annual environmental report card to the county Board of Supervisors and uses a "heron vote" to indicate positive actions by supervisors for environmental protection throughout the year. In addition, a local advocacy group, Citizens to Serve Stafford, holds a yearly "Adopt-a-Heron" campaign to bring public awareness to environmental issues in Stafford. Contestants decorate large, plastic herons and seek votes by the public for the best one. The herons then are displayed in various locations, including the County Administration Center. Engaging private land owners and citizens from the beginning will foster better

working relationships and help Northern Virginia Conservation Trust achieve the goals set out in this plan. Involvement from local officials will be necessary to achieve some of the goals and recommendations set out in the plan.

The protection of Potomac Creek heronry and surrounding land could result in perpetual benefits for the county and its residents. To begin with, keeping land in its natural state will reduce the need for costly infrastructure improvements necessary to support new homes and residents outside the Urban Service Area. In addition to roads and utilities, the need for new schools, police and emergency services, and other public services continues to increase as the local population increases and expands to these more rural areas.

Conserving land near the heronry will help maintain functional natural ecosystems. Less land development equates to less stormwater runoff, and reductions in contaminant levels and pollutants in the watershed. This also will protect wetlands and native vegetation, ultimately maintaining high-quality habitat for a variety of terrestrial and aquatic species. Affected property owners will benefit from reduced taxes on land with conservation easements. Also, home values may increase 15 to 20% when located adjacent to open space (Brabec 1992), so existing homeowners may realize a financial gain.

The county is obligated to protect the heronry pursuant to the 1997 mitigation agreement that compensates for the wetlands destroyed during construction of the airport. Allowing development that would negatively impact the heronry, as demonstrated by current research, would be in violation of that agreement. If county officials follow through with implement of protective measures for the Potomac Creek heronry, they will

be closer to achieving the desired goals stated in the county's Comprehensive Plan and the Wildlife Habitat Protection Plan. The county would assist in protection of the heronry, as well as the associated wetland habitat.

Finally, Northern Virginia Conservation Trust will take a step closer to meeting its initial goal of managing the Potomac Creek heronry in a manner that allows for a sustainable Great Blue Heron population, which ultimately contributes to the welfare of the regional heron population. The success of this plan will depend upon a collaborative effort led by the staff and supporters of Northern Virginia Conservation Trust.

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Deborah Landau, The Nature Conservancy, Maryland/DC Chapter, 7/25/06

Kim Marbain, U. S. Fish and Wildlife Service, 8/31/06

Steve Roble, Virginia Department of Conservation and Recreation, 6/22/06

Joe Witt, Mason Neck Wildlife Refuge, 7/25/06

APPENDIX A. FEDERAL AND STATE REGULATIONS

Federal regulations from the United States Code:

Migratory Bird Treaty Act

16 U.S.C. §§ 703-712, July 3, 1918, as amended 1936, 1960, 1968, 1969, 1974, 1978, 1986 and 1989.

Lacey Act

16 U.S.C. § 701, May 25, 1900.

Federal Water Pollution Control Act (Clean Water Act)

33 U.S.C. §§ 1251-1387, October 18, 1972, as amended 1973-1983, 1987, 1988, 1990-1992, 1994, 1995 and 1996.

State regulations from the Code of Virginia, 1950 (as amended):

Chesapeake Bay Preservation Act

Chapter 21, §10.1-2100 through 2116

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

A. List of plant species recorded on the Crow's Nest peninsula as of July 12, 1999 (U. S. Fish and Wildlife Service 2000).

Common Name	Scientific Name
TREES	
Tulip poplar	<i>Liriodendron tulipifera</i>
River birch	<i>Betula nigra</i>
American hornbeam	<i>Carpinus caroliniana</i>
Bitternut hickory	<i>Carya cordiformis</i>
Sweetgum	<i>Liquidambar styriaciiflua</i>
American beech	<i>Fagus grandifolia</i>
Southern red oak	<i>Quercus falcate</i>
Chinquapin oak	<i>Quercus muehlenbergii</i>
Black oak	<i>Quercus velutina</i>
Swamp oak	<i>Quercus bicolor</i>
Chestnut oak	<i>Quercus prinus</i>
Northern red oak	<i>Quercus rubra</i>
Black jack oak	<i>Quercus marilandica</i>
Willow oak	<i>Quercus phellos</i>
Post oak	<i>Quercus stellata</i>
Slippery elm	<i>Ulmus rubra</i>
Virginia pine	<i>Pinus virginiana</i>
Ash-leaved maple/box elder	<i>Acer negundo</i>
Green ash	<i>Fraxinus pennsylvanica</i>
Hackberry	<i>Celtis occidentalis</i>
Red bud	<i>Cercis canadensis</i>
White ash	<i>Fraxinus americana</i>
Sycamore	<i>Platanus occidentalis</i>
SHRUBS AND VINES	
Chinquapin	<i>Castanea pumila</i>
American holly	<i>Ilex opaca</i>
Maple-leaved viburnum	<i>Viburnum acerifolium</i>
Pawpaw	<i>Asimina triloba</i>
Sassafras	<i>Sassafras albidum</i>
Spicebush	<i>Lindera benzoin</i>
Flowering dogwood	<i>Cornus florida</i>
Wineberry	<i>Rubra phoenicolasius</i>
Black cherry	<i>Prunus serotina</i>
Elderberry	<i>Sambucus canadensis</i>
Deerberry	<i>Vaccinium stamineum</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

SHRUBS AND VINES (Cont.)

Common winterberry holly	<i>Ilex verticillata</i>
Wild hydrangea	<i>Hydrangea arborescens</i>
Wax myrtle	<i>Myrica cerifera</i>
Witch hazel	<i>Hamamelis virginiana</i>
Common greenbriar	<i>Smilax rotundifolia</i>

HERBS

Jack-in-the-pulpit	<i>Arisaema triphyllum</i>
Boneset	<i>Eupatorium perfoliatum</i>
Sunflowers	<i>Helianthus spp.</i>
Black snakeroot	<i>Cimicifuga racemosa</i>
Mayapple	<i>Podophyllum peltatum</i>
Wingstem	<i>Actinomeris alternifolia</i>
Beef-steak plant	<i>Perilla frutescens</i>
False Solomon's seal	<i>Smilacina racemosa</i>
Blood root	<i>Sanguinaria canadensis</i>
Jumpseed	<i>Tovara virginiana</i>
Spring beauty	<i>Claytonia virginica</i>
Bedstraw-cleavers	<i>Galium aparine</i>
False nettle	<i>Boehmeria syria</i>
Large houstonia	<i>Houstonia purpurea</i>
Wild licorice	<i>Galium circaezans</i>
Anise-root	<i>Osmorhiza longistylis</i>
Stinging nettle	<i>Urtica dioica</i>
Spotted wintergreen	<i>Chimaphila maculate</i>
Indian strawberry	<i>Duchesnea indica</i>
Yarrow	<i>Achillea millefolium</i>
Hollow joe-pye weed	<i>Eupatorium rugosum</i>
Blue-eyed grass	<i>Sisyrinchium spp.</i>
Indian cucumber root	<i>Medeola virginiana</i>
Spotted touch-me-not	<i>Impatiens capensis</i>
Indian pipe	<i>Monotropa uniflora</i>
Plantain	<i>Plantago major</i>
Four-square yam	<i>Dioscorea quaternata</i>
Pink lady's slipper	<i>Cypripedium acaule</i>
Partridgeberry	<i>Mitchella repens</i>
Lyre-leaved sage	<i>Salvia lyrata</i>
Halberd-leaved tearthumb	<i>Polygonum arifolium</i>
Wild ginger	<i>Asarum canadense</i>
Common agrimony	<i>Agrimonia gryposepala</i>
Common ragweed	<i>Ambrosia artemisiifolia</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

HERBS (Cont.)

Lizard's tail	<i>Saururus cernuus</i>
Wood rush	<i>Cinna arundinacea</i>
Deer tongue grass	<i>Panicum clandestinum</i>
Wild rye grass	<i>Elymus villosus</i>
Shining clubmoss	<i>Lycopodium lucidulum</i>
Tree clubmoss	<i>Lycopodium obscurum</i>
Running pine	<i>Lycopodium flabelliforme</i>
Moonseed	<i>Menispermum canadense</i>
Violet wood sorrel	<i>Oxalis violacea</i>
Clearweed	<i>Pilea pumila</i>
Nightshade	<i>Circaea spp.</i>
Beech-drops	<i>Epifagus virginiana</i>
Huckleberry	<i>Gaylussacia frondosa</i>
Bur-reed	<i>Sparganium eurycarpum</i>
Wood betony	<i>Pedicularis canadensis</i>
Skullcap	<i>Scutellaria spp.</i>
Smooth beard-tongue	<i>Penstemon laevigatus</i>
Brome grass	<i>Bromus pubescens</i>
Dollar-leaf	<i>Desmodium rotundifolium</i>
Soft-stem bulrush	<i>Scirpus validus</i>
Southern wild rice	<i>Zizaniopsis miliacea</i>
Water pennywort	<i>Hydrocotyle ranunculoides</i>
Hairy woodrush	<i>Luzula acuminata</i>
Manna grass	<i>Clyceria striata</i>
Cranesbill	<i>Ceranium maculatum</i>
Fringed loosestrife	<i>Lysimachia ciliate</i>
Stilt grass	<i>Microstegium vimineum</i>
Toothwort	<i>Dentaria heterophylla</i>
Yellow wood sorrel	<i>Oxalis europaea</i>
Large-seeded corydalis	<i>Corydalis flavula</i>
Rattlesnake forget-me-not	<i>Myosotis scorpioides</i>
American bugbane	<i>Cimicifuga americana</i>
Virginia snakeroot	<i>Aristolochia serpentaria</i>
White snakeroot	<i>Eupatorium rugosum</i>
Frost grape	<i>Vitis vulpine</i>
Puttyroot	<i>Aplectrum hyemale</i>
Moonseed	<i>Menispermum canadense</i>
Buttercup	<i>Ranunculus micranthus</i>
Hair grass	<i>Deschampsia flexuosa</i>
Yellow-flag iris	<i>Iris pseudacorus</i>
Turtlehead	<i>Chelone glabra</i>
Ginseng	<i>Panax quinquefolium</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

HERBS (CONT.)

Trailing arbutus	<i>Epigaea repens</i>
Robin's plantain	<i>Erigeron pulchellus</i>
Common enchanter's nightshade	<i>Circaea lutetiana</i>
Purple fringed orchid	<i>Habenaria peramoena</i>
Ground pine	<i>Lycopodium obscurum</i>
Wild comfrey	<i>Cynoglossum virginianum</i>
Zig-zag goldenrod	<i>Solidago flexicaulis</i>
Ghost pipe	<i>Orobanche uniflora</i>
Small-flower baby-blue-eyes	<i>Nemophila aphylla</i>
Downy yellow violet	<i>Viola pubescens</i>

FERNS

Christmas fern	<i>Polystichum acrostichoides</i>
Wood fern	<i>Dryopteris spinulosa</i>
Glade fern	<i>Athyrium pycnocarpon</i>
Silvery fern	<i>Athyrium thelypteroides</i>
Yellow corydalis fern	<i>Botrychium virginianum</i>
Hay-scented fern	<i>Dennstaedtia punctilobula</i>
Brittle bladder fern	<i>Cystopteris fragilis</i>
Maidenhair fern	<i>Adiantum pedatum</i>
Grape fern	<i>Botrychium spp.</i>
Broad beech fern	<i>Thelypteris hexagonoptera</i>
Cinnamon fern	<i>Osmunda cinnamomea</i>
Sensitive fern	<i>Onoclea sensibilis</i>
Lowland bladder fern	<i>Cystopteris protrusa</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

B. List of bird species encountered at or immediately adjacent to Crow's Nest (U. S. Fish and Wildlife Service 2000). List derived from Migratory Bird Survey (1 season), Breeding Bird Survey (1 season), and Christmas Bird Count (31 years). Note: this is not a comprehensive list.

Common Name	Scientific Name
LOONS/GREBES	
Common loon	<i>Gavia immer</i>
Horned grebe	<i>Podiceps auritus</i>
Pied-billed grebe	<i>Podilymbus podiceps</i>
WADING BIRDS	
Double-crested cormorant	<i>Phalacrocorax auritus</i>
Great blue heron	<i>Ardea herodias</i>
Green-backed heron	<i>Butorides virescens</i>
Little blue heron	<i>Egretta caerulea</i>
American coot	<i>Fulica americana</i>
WATERFOWL	
American black duck	<i>Anas rubripes</i>
American wigeon	<i>Anas americana</i>
Bufflehead	<i>Bucephala albeola</i>
Blue-winged teal	<i>Anas discors</i>
Canada goose	<i>Branta canadensis</i>
Canvasback	<i>Aythya valisineria</i>
Common goldeneye	<i>Bucephala clangula</i>
Common merganser	<i>Mergus merganser</i>
Gadwall	<i>Anas strepera</i>
Greater scaup	<i>Aythya marila</i>
Green-winged teal	<i>Anas crecca</i>
Hooded merganser	<i>Lophodytes cucullatus</i>
Lesser scaup	<i>Aythya affinis</i>
Mallard	<i>Anas platyrhynchos</i>
Mute swan	<i>Cygnus olor</i>
Northern pintail	<i>Anas acuta</i>
Northern shoveler	<i>Anas clypeata</i>
Red-breasted merganser	<i>Mergus serrator</i>
Ruddy duck	<i>Oxyura jamaicensis</i>
Redhead	<i>Aythya americana</i>
Ring-necked duck	<i>Aythya collaris</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

WATERFOWL (CONT.)

Snow goose	<i>Chen caerulescens</i>
Tundra swan	<i>Cygnus columbianus</i>
White-winged scoter	<i>Melanitta fusca</i>
Wood duck	<i>Aix sponsa</i>

RAPTORS

Bald eagle	<i>Haliaeetus leucocephalus</i>
Barred owl	<i>Strix varia</i>
Black vulture	<i>Coragyps atratus</i>
Cooper's hawk	<i>Accipiter cooperii</i>
Northern harrier	<i>Circus cyaneus</i>
Osprey	<i>Pandion haliaetus</i>
Red-shouldered hawk	<i>Buteo lineatus</i>
Red-tailed hawk	<i>Buteo jamaicensis</i>
Turkey vulture	<i>Cathartes aura</i>

SHOREBIRDS

Bonaparte's gull	<i>Larus philadelphia</i>
Caspian tern	<i>Sterna caspia</i>
Forster's tern	<i>Sterna forsteri</i>
Greater black-backed gull	<i>Larus marinus</i>
Herring gull	<i>Larus argentatus</i>
Ring-billed gull	<i>Larus delawarensis</i>
Royal tern	<i>Sterna maxima</i>
Spotted sandpiper	<i>Actitis macularia</i>

NEOTROPICAL MIGRATORY SPECIES

Acadian flycatcher	<i>Empidonax virescens</i>
American redstart	<i>Setophaga ruticilla</i>
American robin	<i>Turdus migratorius</i>
Bay-breasted warbler	<i>Dendroica castanea</i>
Barn swallow	<i>Hirundo rustica</i>
Black and white warbler	<i>Dendroica caerulescens</i>
Black-throated blue warbler	<i>Dendroica caerulescens</i>
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>
Brown-headed cowbird	<i>Molothrus ater</i>
Canada warbler	<i>Wilsonia canadensis</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

NEOTROPICAL MIGRATORY SPECIES (CONT.)

Chestnut-sided warbler	<i>Dendroica pensylvanica</i>
Chipping sparrow	<i>Spizella passerina</i>
Common yellowthroat	<i>Geothlypis trichas</i>
Eastern phoebe	<i>Sayornis phoebe</i>
Eastern wood-pewee	<i>Contopus virens</i>
Fox sparrow	<i>Passerella iliaca</i>
Gray catbird	<i>Dumetella carolinensis</i>
Great crested flycatcher	<i>Myiarchus crinitus</i>
Hermit thrush	<i>Catharus guttatus</i>
Hooded warbler	<i>Wilsonia citrina</i>
Indigo bunting	<i>Passerine cyanea</i>
Kentucky warbler	<i>Oporornis formosus</i>
Louisiana waterthrush	<i>Seiurus motacilla</i>
Magnolia warbler	<i>Dendroica magnolia</i>
Northern parula	<i>Parula americana</i>
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>
Northern waterthrush	<i>Seiurus noveboracensis</i>
Ovenbird	<i>Seiurus aurocapillus</i>
Palm warbler	<i>Dendroica palmarum</i>
Pine warbler	<i>Dendroica pinus</i>
Purple martin	<i>Progne subis</i>
Red-eyed vireo	<i>Vireo olivaceus</i>
Red-winged blackbird	<i>Agelaius phoeniceus</i>
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>
Ruby-crowned kinglet	<i>Regulus calendula</i>
Scarlet tanager	<i>Piranga olivacea</i>
Solitary vireo	<i>Vireo solitarius</i>
Swainson's thrush	<i>Catharus ustulatus</i>
Swainson's warbler	<i>Limnothlypis swainsonii</i>
Tree swallow	<i>Tachycineta bicolor</i>
Veery	<i>Catharus fuscescens</i>
White-eyed vireo	<i>Vireo griseus</i>
White-throated sparrow	<i>Zonotrichia albicollis</i>
Wood thrush	<i>Hylocichla mustelina</i>
Worm-eating warbler	<i>Helmitheros vermivorus</i>
Yellow-bellied sapsucker	<i>Sphyrapicus varius</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

NEOTROPICAL MIGRATORY SPECIES (CONT.)

Yellow-billed cuckoo	<i>Coccyzus americanus</i>
Yellow-rumped warbler	<i>Dendroica coronata</i>
Yellow-throated vireo	<i>Vireo flavifrons</i>
Yellow-throated warbler	<i>Dendroica dominica</i>
Yellow warbler	<i>Dendroica petechia</i>

RESIDENT PERCHING BIRDS

American crow	<i>Corvus brachyrhynchos</i>
American goldfinch	<i>Carduelis tristis</i>
Blue jay	<i>Cyanocitta cristata</i>
Brown creeper	<i>Certhia americana</i>
Brown thrasher	<i>Toxostoma rufum</i>
Carolina chickadee	<i>Poecile carolinensis</i>
Carolina wren	<i>Thryothorus ludovicianus</i>
Common grackle	<i>Quiscalus quiscula</i>
Dark-eyed junco	<i>Junco hyemalis</i>
Downy woodpecker	<i>Picoides pubescens</i>
Eastern bluebird	<i>Sialia sialis</i>
European starling	<i>Sturnus vulgaris</i>
Fish crow	<i>Corvus ossifragus</i>
Golden crowned kinglet	<i>Regulus satrapa</i>
Hairy woodpecker	<i>Picoides villosus</i>
House finch	<i>Carpodacus mexicanus</i>
Mourning dove	<i>Zenaida macroura</i>
Northern cardinal	<i>Cardinalis cardinalis</i>
Northern flicker	<i>Colaptes auratus</i>
Northern mockingbird	<i>Mimus polyglottos</i>
Pileated woodpecker	<i>Dryocopus pileatus</i>
Red-bellied woodpecker	<i>Melanerpes carolinus</i>
Red-headed woodpecker	<i>Melanerpes erythrocephalus</i>
Eastern towhee	<i>Pipilo erythrophthalmus</i>
Song sparrow	<i>Melospiza melodia</i>
Tufted titmouse	<i>Baeolophus bicolor</i>
White-breasted nuthatch	<i>Sitta carolinensis</i>
White-throated sparrow	<i>Zonotrichia albicollis</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

C. Confirmed mammals and mammals likely to be found on the Crow's Nest peninsula. (U. S. Fish and Wildlife Service 2000).

Common Name	Scientific Name
CONFIRMED SPECIES	
White-tailed deer	<i>Odocoileus virginianus</i>
Beaver	<i>Castor canadensis</i>
Muskrat	<i>Ondatra zibethicus</i>
Ermine	<i>Mustela erminea</i>
Mink	<i>Mustela vison</i>
River otter	<i>Lontra canadensis</i>
Black bear	<i>Ursus americanus</i>
Red fox	<i>Vulpes vulpes</i>
OTHER POTENTIAL SPECIES	
Gray fox	<i>Urocyon cinereoargenteus</i>
Long-tailed weasel	<i>Mustela frenata</i>
Deer mouse	<i>Peromyscus maniculatus</i>
White-footed mouse	<i>Peromyscus leucopus</i>
Eastern harvest mouse	<i>Reithrodontomys humulis</i>
House mouse	<i>Mus musculus</i>
Southeastern shrew	<i>Sorex longirostris</i>
Short-tail shrew	<i>Blarina brevicauda</i>
Least shrew	<i>Cryptotis parva</i>
Pygmy shrew	<i>Sorex hoyi</i>
Star-nosed mole	<i>Condylura cristata</i>
Meadow vole	<i>Microtus pennsylvanicus</i>
Woodland vole	<i>Microtus pinetorum</i>
Eastern chipmunk	<i>Tamias stratus</i>
Gray squirrel	<i>Sciurus carolinensis</i>
Red squirrel	<i>Tamiasciurus hudsonicus</i>
Southern flying squirrel	<i>Glaucomys volans</i>
Woodchuck	<i>Marmota monax</i>
Eastern cottontail	<i>Sylvilagus floridanus</i>
Raccoon	<i>Procyon lotor</i>
Opossum	<i>Didelphis virginiana</i>
Red bat	<i>Lasiurus borealis</i>
Hoary bat	<i>Lasiurus cinereus</i>
Big brown bat	<i>Eptesicus fuscus</i>
Little brown bat	<i>Myotis lucifugus</i>
Evening bat	<i>Nycticeius humeralis</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

D. Amphibian and Reptile species observed or potentially occurring on the Crow's Nest peninsula. (U. S. Fish and Wildlife Service 2000. VDGIF Fish and Wildlife Information Service)

Common Name

Scientific Name

CONFIRMED SPECIES

Eastern cricket frog	<i>Acris crepitans crepitans</i>
Eastern American toad	<i>Bufo americanus americanus</i>
Fowler's toad	<i>Bufo fowleri</i>
Northern dusky salamander	<i>Desmognathus fuscus</i>
Red backed salamander	<i>Plethodon cinereus</i>
Eastern snapping turtle	<i>Chelydra serpentine serpentine</i>
Eastern painted turtle	<i>Chrysemys picta picta</i>
Eastern mud turtle	<i>Kinosternon subrubrum</i>
River cooter	<i>Pseudemys concinna</i>
Eastern box turtle	<i>Terrapene carolina</i>
Red eared slider	<i>Trachemys scripta elegans</i>
Northern copperhead	<i>Agkistrodon contortrix</i>

PROBABLE SPECIES

Northern spring peeper	<i>Pseudacris crucifer crucifer</i>
American bullfrog	<i>Rana catesbeiana</i>
Southern green frog	<i>Rana clamitans melanota</i>
Pickerel frog	<i>Rana palustris</i>
Southern leopard frog	<i>Rana sphenoccephala</i>
Spotted salamander	<i>Ambystoma maculatum</i>
Northern two-lined salamander	<i>Eurycea bislineata</i>
Southern two-lined salamander	<i>Eurycea cirrigera</i>
Red spotted newt	<i>Notophthalmus viridescens</i>
Red salamander	<i>Pseudotriton ruber</i>
Spotted turtle	<i>Clemmys guttata</i>
Eastern worm snake	<i>Carphophis amoenus amoenus</i>
Black rat snake	<i>Elaphe obsoleta obsoleta</i>
Northern water snake	<i>Nerodia sipedon sipedon</i>
Eastern garter snake	<i>Thamnophis sirtalis sirtalis</i>
Rough green snake	<i>Opheodrys aestivus</i>

POSSIBLE SPECIES

Green tree frog	<i>Hyla cinerea</i>
Wood frog	<i>Rana sylvatica</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

POSSIBLE SPECIES (CONT.)

Eastern spadefoot	<i>Scaphiopus holbrooki</i>
Southeastern chorus frog	<i>Pseudacris feriarum feriarum</i>
Cope's gray treefrog	<i>Hyla chrysoscelis</i>
Marbled salamander	<i>Ambystoma opacum</i>
Three-lined salamander	<i>Eurycea guttolineata</i>
Four-toed salamander	<i>Hemidactylium scutatum</i>
White spotted slimy	<i>Plethodon cylindraceus</i>
Mud salamander	<i>Pseudotriton montanus</i>
Smooth earth snake	<i>Virginia valeriae</i>
Eastern musk turtle	<i>Sternotherus odoratus</i>
Northern red-bellied cooter	<i>Pseudemys rubriventris</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

E. Aquatic species found in Potomac Creek and Accokeek Creek (U. S. Fish and Wildlife Service 2000. Virginia Department of Game and Inland Fisheries' Wildlife Information Online).

Common Name	Scientific Name
Alewife floater mussel	<i>Anodonta implicata</i>
Eastern elliptio mussel	<i>Elliptio complanata</i>
Eastern floater mussel	<i>Pyganodon cataracta</i>
Squawfoot mussel	<i>Strophitus undulatus</i>
Triangle floater mussel	<i>Alasmidonta undulate</i>
Alewife	<i>Alosa psuedoharengus</i>
Striped bass	<i>Morone saxatilis</i>
American eel	<i>Anguilla rostrata</i>
Largemouth bass	<i>Micropterus salmoides</i>
Bluegill	<i>Lepomis macrochirus</i>
Brown bullhead	<i>Ameiurus nebulosus</i>
Common carp	<i>Cyprinus carpio</i>
Creek chub	<i>Semotilus atromaculatus</i>
Creek chubsucker	<i>Erimyzon oblongus</i>
Blacknose dace	<i>Rhinichthys atratulus</i>
Rose dace	<i>Clinostomus funduloides</i>
Tessellated darter	<i>Etheostoma olmstedii</i>
Fallfish	<i>Semotilus corporalis</i>
Longnose gar	<i>Lepisosteus osseus</i>
Banded killfish	<i>Fundulus diaphanous</i>
Cutlip minnow	<i>Exoglossum maxillingua</i>
Eastern silvery minnow	<i>Hybognathus regius</i>
Eastern mosquitofish	<i>Gambusia holbrooki</i>
Mummichog	<i>Fundulus heteroclitus</i>
White perch	<i>Morone americana</i>
Yellow perch	<i>Perca flavescens</i>
Chain pickerel	<i>Esox niger</i>
Redfin pickerel	<i>Esox americanus</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Gizzard shad	<i>Dorosoma cepedianum</i>
American shad	<i>Alosa sapidissima</i>
Satinfin shiner	<i>Cyprinella analostamas</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
Common shiner	<i>Luxilus cornutus</i>
Spottail shiner	<i>Notropis hudsonius</i>
Swallowtail shiner	<i>Notropis proene</i>
Northern hog sucker	<i>Hypentelium nigricans</i>
White sucker	<i>Catostomus commersoni</i>

APPENDIX B. PLANT AND ANIMAL SPECIES LISTS

AQUATIC RESOURCES (CONT.)

Redbreast sunfish

Lepomis auritus

Warmouth

Lepomis gulosus

Blue crab

Callinectes sapidus

Tidewater mucket

Leptodea ochracea

Eastern lampmussel

Lampsilis radiata

Paper pondshell

Utterbackia imbecillis

Atlantic sturgeon

Acipenser oxyrinchus

Shortnose sturgeon

Acipenser brevirostrum

APPENDIX C. 2007 NEST TREE DATA

Tree #	Tree species	Tree diameter in inches	# of nests	Condition of tree	GPS coordinates- Latitude	GPS coordinates - Longitude
1	Sycamore	26.4	5	Leaning	38.35579979670	-77.38100615450
2	Sycamore	30.0	3	Woodpecker holes	38.35551026870	-77.38093244680
3	Sycamore	33.6	21		38.35505356070	-77.38118512830
4	Sycamore	28.8	2		38.35528940920	-77.38142401750
5	Sycamore	30.0	6		38.35528885080	-77.38146129920
6	Tulip Poplar	21.6	1		38.35532795440	-77.38142096480
7	Sycamore	28.8	5	Leaning at base	38.35545058150	-77.38155069510
8	Sycamore	27.6	6		38.35549900420	-77.38148499880
9	Tulip Poplar	24.0	1		38.35557484780	-77.38150820680
10	Sycamore	31.2	11	Leaning	38.35572780290	-77.38164831420
11	Sycamore	26.4	4		38.35549726730	-77.38175548630
12	Sycamore	18.0	2		38.35549726730	-77.38175548630
13	Sycamore	NM	1		38.35549726730	-77.38175548630
14	Tulip Poplar	19.2	1		38.35549726730	-77.38175548630
15	Sycamore	NM	1		38.35564015840	-77.38188272920
16	Sycamore	24.0	1		38.35564015840	-77.38188272920
17	Sycamore	26.4,19.2*	8	Double trunk	38.35560939440	-77.38211101740
18	Tulip Poplar	39.6	3	Double trunk	38.35549181930	-77.38220844840
19	Sycamore	26.4,25.2*	9	Double trunk	38.35563230060	-77.38238390900
20	Sycamore	28.8	3	Damaged at top (wind?)	38.35530386430	-77.38292300290
21	Sycamore	26.4	4		38.35535044870	-77.38290393500
22	Sycamore	26.4,22.8,24.0**	22	Triple trunk	38.35540283690	-77.38313626390
23	Sycamore	31.2	14		38.35579760200	-77.38311712590
24	Sycamore	NM	3		38.35556531680	-77.38344073000
25	Tulip Poplar	27.6	1		38.35555180950	-77.38347233010
26	Tulip Poplar	25.2	1		38.35557849920	-77.38354342370
27	Sycamore	33.6	11	Vine covered	38.35573484890	-77.38351771650
28	Tulip Poplar	26.4	3		38.35574949330	-77.38352261740
29	Tulip Poplar	NM	1		38.35587744530	-77.38357281980
30	Tulip Poplar	32.4	4	Forked	38.35546732270	-77.38397771680
31	Tulip Poplar	NM	1		38.35546732270	-77.38397771680
32	Sycamore	26.4	10		38.35538404210	-77.38433794910
33	Sycamore	21.6	1		38.35540887330	-77.38444827660
34	Sycamore	25.2	3		38.35542943220	-77.38460327770
35	Sycamore	27.6,14.4*	1		38.35546278470	-77.38468797920
36	Sycamore	NM	15		NM	NM
37	Sycamore	NM	3		NM	NM
38	Sycamore	NM	17		NM	NM
39	Sycamore	31.2	6		38.35574475220	-77.38408555810

40	Sycamore	NM	5	Woodpecker holes	38.35577235870	-77.38419088380
41	Sycamore	NM	8		38.35574488830	-77.38431997840
42	Sycamore	36.0	14		38.35625257480	-77.38435294710
43	Sycamore	NM	4		38.35620065950	-77.38454232960
44	Sycamore	NM	7		38.35623324290	-77.38462263520
45	Sycamore	NM	5		38.35631844140	-77.38476089880
46	Sycamore	27.6,21.6,22.8**	23	Triple trunk	38.35650093500	-77.38541833810
47	Tulip Poplar	25.2	2		38.35648102060	-77.38554185590
48	Sycamore	25.2	6	Double trunk (2nd trunk damaged)	38.35646725920	-77.38560881910
49	Sycamore	18.0	2		38.35656203760	-77.38558558370
50	Sycamore	26.4	1		38.35658989690	-77.38565553160
51	Sycamore	24.0	1		38.35658540040	-77.38582144750
52	Sycamore	24.0	1		38.35661137140	-77.38604971820
53	Sycamore	27.6,26.4*	17	Double trunk	38.35653135510	77.38591010170
54	Sycamore	NM	1		NM	
55	Sycamore	NM	2		NM	
56	Sycamore	NM	1		NM	
57	Sycamore	NM	8		NM	
58	Sycamore	NM	1		NM	
59	Sycamore	NM	1		NM	
60	Sycamore	NM	2		NM	
61	Sycamore	NM	1		NM	
62	Sycamore	NM	9		NM	
63	Sycamore	NM	6		NM	
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*Measurement of both trunks
** Measurement of three trunks
NM=No measurement

Vitae

Kathy Chestnut Baker received a B. S. in Geography from James Madison University, Harrisonburg, Virginia in 1985. After working with computer aided drafting and design for an engineering firm in Virginia Beach, she joined the Stafford County (Virginia) Planning Department in 1988. Kathy was a development plans reviewer for several years before transferring to the long range planning division, where she focused on land use planning and environmental issues as a senior planner. She became Assistant Director of Planning in 2005, and continues to work and live in Stafford County.