

Final Environmental Assessment

for

Public Deer Hunting on the Rappahannock River Valley National Wildlife Refuge

**(Caroline, Essex, King George, Lancaster, Middlesex, Richmond
and Westmoreland Counties, Virginia)**

November, 2001

Revised April, 2007

Prepared by:

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U.S. Department of Interior

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UNITED STATES FISH AND WILDLIFE SERVICE

ENVIRONMENTAL ACTION STATEMENT

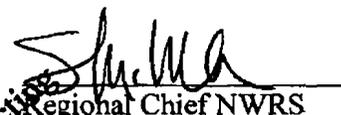
Within the spirit and intent of the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA) and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record and have determined that the action of :

Public Deer Hunting on Rappahannock River Valley National Wildlife Refuge.

- is a categorical exclusion as provided by 516 DM 6 Appendix 1. No further documentation will be made (Categorical Exclusion B.5 and C.2).
- is found not to have significant environmental effects as determined by the attached Environmental Assessment and Finding of No Significant Impact.
- is found to have special environmental conditions as described in the attached Environmental Assessment. The attached Finding of No Significant Impact will not be final nor any actions taken pending a 30-day period for public review (40 CFR 1501.4(e)(2)).
- is found to have significant effects, and therefore further consideration of this action will require a notice of intent to be published in the Federal Register announcing the decision to prepare an Environmental Impact Statement.
- is not approved because of unacceptable environmental damage, or violation of Fish and Wildlife Service mandates, policy, regulations or procedures.
- is an emergency situation within the context of 40 CFR 1506.11. Only those actions necessary to control the immediate impacts of the emergency will be taken. Other related actions remain subject to NEPA review.

Other supporting documents (list):

Final EA (April 2007), FONSI (April 2007), Revised Hunt Plan (March 2007)

- | | | | | | |
|-----|--|------------------------|-----|---|------------------------|
| (1) | 
Initiator | <u>4/23/07</u>
Date | (2) | 
Regional Environmental
Coordinator | <u>4/25/07</u>
Date |
| (3) | 
Regional Chief NWRS | <u>4-27-07</u>
Date | (4) | 
Regional Director | <u>4-27-07</u>
Date |

**FINDING OF NO SIGNIFICANT IMPACT
RAPPAHANNOCK RIVER VALLEY NATIONAL WILDLIFE REFUGE
HUNTING OF WHITE-TAILED DEER**

The U.S. Fish and Wildlife Service proposes to continue a public hunting program for white-tailed deer on the Rappahannock River Valley National Wildlife Refuge. We prepared a revised Environmental Assessment (EA) and released it for a 31-day public comment period ending on April 15, 2007. We considered all comments received during the public review period. We considered six alternatives and fully evaluated three in the EA. We evaluated the direct, indirect, and cumulative impacts of each alternative on the environment, and their potential contribution to the mission of the National Wildlife Refuge System, and the refuge's purposes and goals. We will continue to permit public deer hunting on specified tracts of land and in accordance with State and Federal laws and refuge-specific regulations.

The Service has analyzed the following alternatives to the proposal in an Environmental Assessment (copy attached):

Alternative 1 - No Action: Under this alternative, we would not offer any public deer hunting opportunities, nor would we engage in active deer population management, as was the situation when deer hunting was first proposed in 2002.

Alternative 2 - Managed Annual Public Hunt: This is our proposed action in the EA. We would consult with the Virginia Department of Game and Inland Fisheries and work within the State hunting framework in developing an annual hunt program. Our hunting program may be, and has been, more restrictive than the state seasons.

Alternative 3 – Professional Removal Only: Under this alternative, we would employ professional sharpshooters to manage deer populations.

The proposed action alternative was selected over the other alternatives because:

1. The proposed action offers the best solution for managing deer populations, promotes a compatible, priority recreational use of the refuge, and reduces deer damage to neighboring farms resulting in fewer crop depredation kill permits.
2. The proposed action is compatible with Service policy regarding the establishment of hunting on National Wildlife Refuges.
3. The proposed action is compatible with the purpose for which the Rappahannock River Valley NWR was established.
4. This proposal does not initiate widespread controversy.
5. There are no conflicts with local, state, regional, or federal plans or policies.

Implementation of the proposed action would be expected to result in the following environmental, social, and economic effects:

1. The refuge could better manage white-tailed deer populations, and thereby protect habitat used by priority migratory birds.
2. The hunting public would have increased opportunity for wildlife-oriented recreation.
3. Recreational opportunities for the non-hunting public would be largely unaffected.
4. Local businesses would benefit from hunters visiting from outside the refuge area.
5. The refuge would be promoting a traditional and culturally-important local land use.

Copies of the Environmental Assessment are available by writing:

Refuge Manager
Rappahannock River Valley NWR
P.O. Box 1030
Warsaw, VA 22572

Therefore, it is my determination that the proposal does not constitute a major Federal action significantly affecting the quality of the human environment under the meaning of section 102(2)(c) of the National Environment Policy Act of 1969 (as amended). As such, an environmental impact statement is not required. This determination is based on the following factors (40 CFR 1508.27):

1. **Both beneficial and adverse effects have been considered and this action will not have a significant effect on the human environment (EA, pages 23-35)**
2. **The proposal will not significantly affect any unique characteristics of the geographic area such as proximity to historical or cultural resources or ecologically critical areas (EA, pages 23-35).**
3. **There will be no cumulative significant impacts on the environment. Cumulative impacts have been analyzed with consideration of other similar activities on adjacent lands, in past action, and in foreseeable future actions (EA, pages 24-34).**
4. **The actions are not likely to adversely affect endangered or threatened species, or their habitats (Intra-Service Section 7 Biological Evaluation Form prepared).**
5. **We have coordinated this proposal with State and local governmental authorities (EA, coordination with others, pages 36-37).**

References: Revised Environmental Assessment of Public Deer Hunting on the Rappahannock River Valley NWR (April 2007), Revised Hunt Plan (March 2007), Compatibility Determination, Letters of Concurrence, Refuge-specific Regulations, Intra-Service Section 7 Evaluation



Regional Director
U.S. Fish and Wildlife Service
Hadley, Massachusetts **Acting**

4-27-07
Date

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INTRODUCTION

The U.S. Fish and Wildlife Service is pleased to present this Environmental Assessment which proposes to open the Rappahannock River Valley National Wildlife Refuge to white-tailed deer hunting. This document contains discussion on the feasibility and impacts of the proposed action and two alternatives, including the no-action alternative. These alternatives represent a reasonable range as required by the National Environmental Policy Act of 1969. They reflect management approaches based on existing wildlife populations, existing state and federal regulations, the Refuge's purposes and objectives, endangered species considerations, Service policies and guidance, and safety considerations.

In response to a 2003 lawsuit filed by the Fund for Animals, the U.S. Fish and Wildlife Service (Service) amended or rewrote environmental assessments that describe hunting programs at sixteen national wildlife refuges located in the Northeast Region. The new environmental assessments will address the cumulative impacts of hunting at all refuges which were named in or otherwise affected by the lawsuit. This document is an amended version of the original EA released in January 2002 that addressed the hunting programs at Rappahannock River Valley National Wildlife Refuge in Virginia. The Refuge has been conducting public hunts since the approval of the original EA and the collection of hunt-related data over the past few years now makes a more up-to-date analysis of cumulative impacts possible. This new document now contains cumulative impact information for each alternative.

There are several mandates that apply to hunting on national wildlife refuges, and that provide a legal framework and authority for recreation and public use of refuge lands. They are:

The National Wildlife Refuge System Administration Act of 1966, as amended by the **National Wildlife System Improvement Act of 1997**, consolidated the various categories of lands administered by the Secretary of the Interior through the Service into a single National Wildlife Refuge System. The Act establishes a unifying mission for the Refuge System, a process for determining compatible uses of refuges, and a requirement for preparing comprehensive conservation plans. This Act states first and foremost that the mission of the National Wildlife Refuge System should be focused singularly on wildlife conservation. This Act identifies six priority wildlife-dependent recreation uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation), clarifies the Secretary's authority to accept donations of money for land acquisition and places restrictions on the transfer, exchange or other disposal of lands within the refuge system. Most importantly, this Act reinforces and expands the "compatibility standard" of the Refuge Recreation Act. The Refuge Administration Act authorizes the Secretary, under such regulation as he/she may prescribe, to "permit the use of any area within the System for any purpose, including but not limited to hunting, fishing, public recreation and accommodation, and access whenever he/she determines that such uses are compatible with the major purposes for which such areas were established."

Executive Order 12996 (March 25, 1996)

This Executive Order, entitled "Management and General Public Use of the National Wildlife Refuge System," contains a directive to: "...recognize compatible wildlife-dependent recreational activities involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation as priority general public uses of the Refuge System..."

National Wildlife Refuge System Centennial Act

The Centennial Act was passed as part of Public Law 106-408 on November 21, 2000. The purpose of the legislation was to: (1) to establish a commission to promote awareness by the public; (2) to develop a long-term plan to meet the priority needs; (3) to require an annual report on the needs of the System; and (4) to improve public use programs and facilities.

Refuge Recreation Act

The Recreation Act requires that any recreational use on areas of the National Wildlife Refuge System be "compatible" with the primary purpose(s) for which the area was acquired or established. This Act also requires that sufficient funding be available for the development, operation and maintenance of recreational uses that are not directly related to the area's primary purpose(s).

Endangered Species Act

The Endangered Species Act of 1973, as amended, did not specifically address the Refuge System but it does directly affect management activities within the National Wildlife Refuge System. The Act directed Federal agencies to take actions that would further the purposes of the Act and to ensure that actions they carry out, authorize or fund do not jeopardize endangered species or their critical habitat.

The Code of Federal Regulations (CFR), Title 50:

Section 31.2(e) lists hunting as a method of surplus wildlife population control.
Section 31.15 states that the privilege of hunting may be extended to the general public.
Section 32.1 states that the opening of a wildlife refuge area to hunting will be dependant upon the provisions of law applicable to the area and upon a determination by the Secretary of the Interior that the opening of the area to the hunting of migratory game birds, upland game, or big game will be compatible with the principles of sound wildlife management and will otherwise be in the public interest.
Section 32.2 has provisions applicable to each person engaged in public hunting on a wildlife refuge area.
Section 32.3 explains the procedure for publication of special regulations.

Goals of the National Wildlife Refuge System

The mission of the System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. The action proposed by this environmental assessment is designed to help fulfill the broad goals of the National Wildlife Refuge System as they apply to this Refuge.

- a. To fulfill our statutory duty to achieve refuge purpose(s) and further the System mission.
- b. Conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered.
- c. Perpetuate migratory bird, inter-jurisdictional fish, and marine mammal populations.
- d. Conserve a diversity of fish, wildlife, and plants.
- e. Conserve and restore, where appropriate, representative ecosystems of the United States, including the ecological processes characteristic of those ecosystems.
- f. To foster understanding and instill appreciation of fish, wildlife, and plants, and their conservation, by providing the public with safe, high-quality, and compatible wildlife-dependent public use. Such use includes hunting, fishing, wildlife observation and photography, and environmental education and interpretation.

1.0 PURPOSE

The U.S. Fish and Wildlife Service proposes to manage the white-tailed deer (*Odocoileus virginianus*) population through public hunting on the Rappahannock River Valley National Wildlife Refuge (Refuge), a component of the Eastern Virginia Rivers National Wildlife Refuge Complex (Complex). As of December 31, 2001, the Refuge consisted of 11 units, acquired since 1996 when the first tract was purchased. Hunts have not been conducted on any of the units at least as long as they have been part of the Refuge, perhaps longer. This Environmental Assessment, therefore, proposes to establish a white-tailed deer management program for the existing 11 Refuge units, and any future land acquisitions using lawful methods of take as provided for in the Code of Virginia Hunting Regulations.

The Refuge is authorized to acquire up to 20,000 acres. Approximately 25% of this acreage will not be hunted due to inaccessibility (i.e. marsh or swamp). A portion of the remaining 15,000 acres will become part of the Refuge through conservation easements and, based on our easement template on such properties, the Refuge will likely have no control over hunting. The future quantity of Refuge easement acreage cannot be predicted, however, based on the current proportion of easements to fee simple ownership, (1,359.40 acres to 6352.27 acres respectively,

or 21.4%), it is anticipated that this ratio will remain in the final status of land acquisition. Therefore, a conservative estimate of the maximum acres enrolled in the Refuge big game hunt program should be no more than approximately 11,790 acres. We believe the actual area may be smaller since we hope to acquire a higher percentage in easements than we have to date.

Permits will be required within the State framework. The Refuge will establish season dates, bag limits, methods of take and other permit requirements on an annual basis, based upon public safety and Refuge management objectives.

1.1 Need for Action

A white-tailed deer management program is needed to provide a viable means to stabilize the local white-tailed deer population, to prevent habitat degradation due to over-grazing, to promote deer quality and health, to reduce deer/vehicle collisions, to collect biological data for management decisions, to minimize local crop damage resulting from overabundant deer, to provide for the wise use of a renewable natural resource, to provide a high quality hunting experience, and to maintain the important Rappahannock River Valley habitats in a healthy condition. Harvest data over a ten-year period from 1989 to 1999 indicate that the deer population on the Northern Neck peninsula (which includes King George, Westmoreland, Northumberland, Richmond, and Lancaster Counties) has increased considerably (nearly quadrupled in some years) while hunting effort remained proportionately the same (as indicated by the number of hunting permits issued) (Virginia Department of Game and Inland Fisheries Deer Harvest Data, 1999). Without a plan to manage deer, overbrowsing of seedlings by deer would negatively impact forest regeneration-- important for perpetuation of future bald eagle roosting and nesting habitat, and would degrade mid-story forest habitats for nesting and migratory songbirds (DeCalesta 1994, Russell and Fowler 1999, Augustine 1998a, Brown and Parker 1997, Van Deelen et al. 1996, Porter et al. 1991).

1.2 Location and Description of Rappahannock River Valley National Wildlife Refuge

The refuge acquisition boundary extends along both sides of the Rappahannock River from Skinkers Neck in the north to Belle Isle in the south. The refuge is approved to acquire 20,000 acres within the boundary area. As of December 31, 2001, the Refuge consisted of 11 units or tracts distributed on both sides of the Rappahannock River. As of 2007, the refuge now encompasses 7,711 acres in 17 tracts (Figure 1). The refuge was established primarily to benefit migrating and wintering waterfowl, the American bald eagle, and to protect essential forest and wetland habitat to benefit rare, threatened, and endangered species, migratory landbirds and waterbirds, anadromous fisheries, and resident wildlife, fish, and shellfish. The 11 units total over 4,800 acres of tidal and non-tidal marsh, riparian, bottomland hardwood, upland forest, shrub and oldfield, and openland habitats, including managed grasslands.

The purposes for which the Rappahannock River Valley National Wildlife Refuge was established are:

"...for the development, advancement, management, conservation, and protection of fish and wildlife resources...16 U.S.C. 742f(a)(4)... for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude... 16 U.S. C. 742f(b)(1) (Fish and Wildlife Act of 1956);

...for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ... 16 U.S.C. 3901(b), 100 Stat. 3583 (Emergency Wetlands Resources Act of 1986); and

...to conserve (A) fish or wildlife which are listed as endangered or threatened species ... or (B) plants ... 16 U.S.C. 1534 (Endangered Species Act of 1973)".

The Rappahannock River Valley, Presquile, and James River National Wildlife Refuges collectively form the Eastern Virginia Rivers National Wildlife Refuge Complex, whose administrative headquarters is located near Warsaw in Richmond County, Virginia.

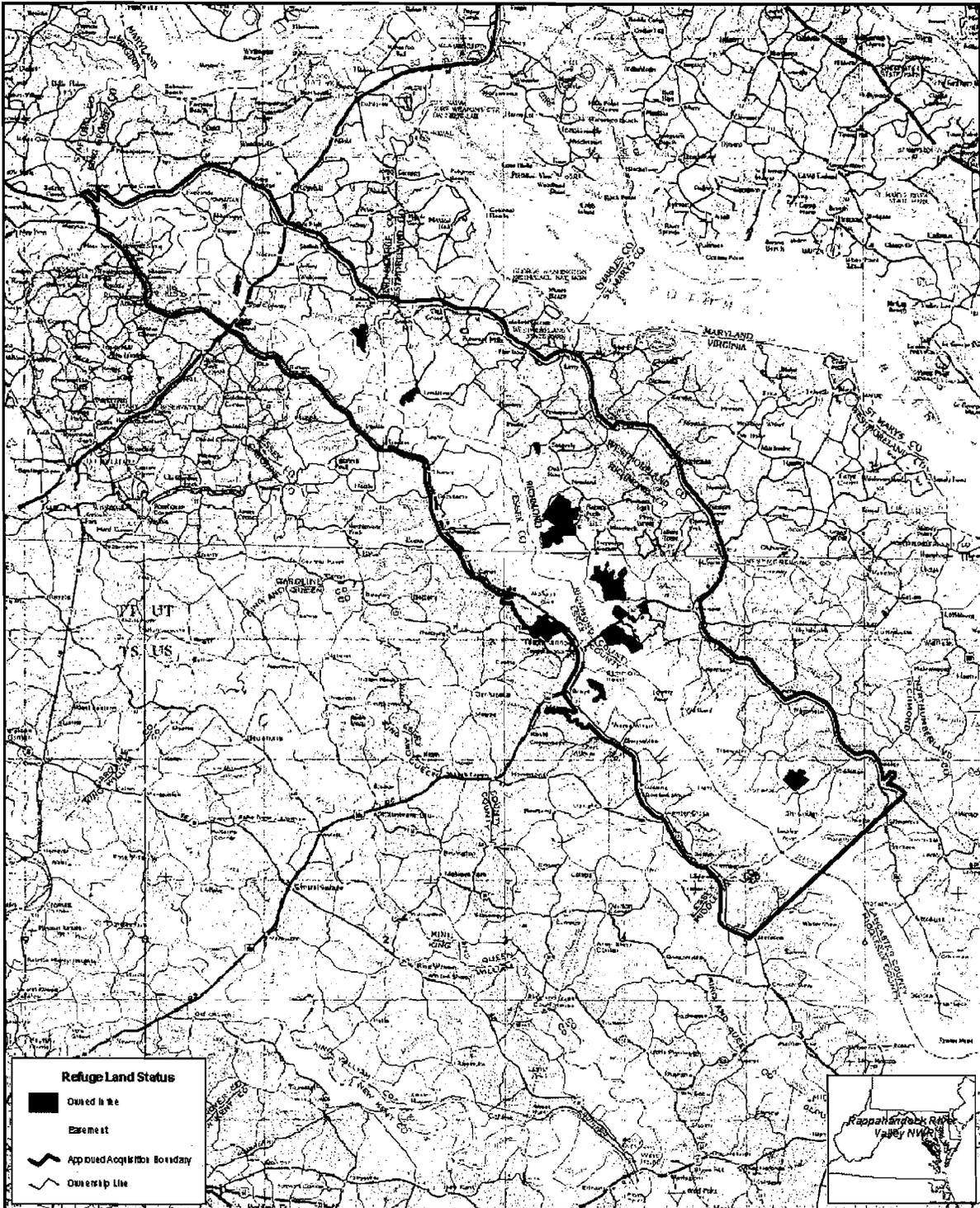


U.S. Fish & Wildlife Service

Land Status

Rappahannock River Valley National Wildlife Refuge

Caroline, Essex, King George, Lancaster, Middlesex, Richmond, and Westmoreland Counties, Virginia



Refuge Land Status

- Owned in fee
- Easement
- Appropriated Acquisition Boundary
- Ownership Line

Produced by the Division of Earth, Air, and Water
 Land Status Division at the Refuge
 November 2004. This map is available for
 digital download from the USFWS website
 at <http://www.usfws.gov>



This map is only an approximation
 of the actual land status. For a more
 detailed map of the refuge, contact the
 Refuge Manager at 1-800-368-6868. The
 Refuge Manager is located at the
 Rappahannock River Valley National Wildlife Refuge, 1000
 Rappahannock River, Stafford, VA 22459.

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2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 Summary of Alternatives Presented

The Service examined the feasibility and impacts of the proposed action and two alternatives, including the no-action alternative. These represent a reasonable range as required by the National Environmental Policy Act of 1969. They reflect management approaches based on existing wildlife populations, existing state and federal regulations, the Refuge's purposes and objectives, endangered species considerations, Service policies and guidance, and safety considerations. The alternatives presented in this Environmental Assessment are:

- 1) No action;
- 2) Managed annual public hunt for white-tailed deer (proposed);
- 3) Professional removal only.

2.2 Options Considered but Dismissed

Several options were considered during the environmental assessment proposal process but were eliminated as non-viable or unreasonable. These include reproductive intervention, live trapping and relocation, and habitat management and fencing. Further descriptions of these options are in the Appendix.

2.3 Alternative 1: No Action

The Service would manage the Refuge without the use of deer hunting, professional removal, or other deer suppression program.

2.4 Alternative 2: Proposed Action-Managed Annual Public Hunt

The Service would open designated portions of the Refuge annually on an as-needed basis within the framework of the hunting regulations, guidelines, and seasons as provided for in the Code of Virginia or the Virginia Game Department Regulation Manual. More specifically, this language would allow refuge management to permit the use of firearms, pursuit dogs, archery tackle, or any combination of methods of take that are within State regulations and are determined to be compatible with Refuge purposes to most efficaciously stabilize deer herds on Refuge property and provide quality wildlife-dependent recreational opportunities. Refuge units included in an annual public hunt may be enrolled in the State of Virginia's Deer Management Assistance Program (DMAP), which is based on the premise that deer herd density and condition are best managed by regulating antlerless deer harvest levels. Refuge management will evaluate past season's results on an annual basis and establish methods of take, the number of hunting days, and other hunting details for the following season. The Refuge may employ either the lottery or first-come, first-served systems, depending upon staff availability and public demand, whereby

applicants will be issued a hunting permit. The permit will contain binding regulations which must be observed by each hunter. All hunters will be expected to carry valid state hunting licenses and to comply with federal hunting regulations as contained in the Code of Federal Regulations (50 CFR Part 32) and current state regulations as contained in the Code of Virginia or Game Department Regulation Manual as well as any terms and conditions described in the Annual Hunt Program for access and conduct of the hunt. Hunter and general public safety will be a primary consideration in designing the conduct of the hunt each year. The number of daily permits issued each day would be determined annually based upon the number and size of the tracts included in the hunt that year, the condition and accessibility of the tracts, and availability of staff in order to safely administer the hunt. The Refuge will also provide accessible areas for the mobility-impaired.

Some specific regulations that are likely to be permanently reflected in the Annual Hunt Programs of Rappahannock River Valley NWR are:

- a) No hunting over bait;
- b) Only portable tree stands may be used and must be removed at the end of the day's hunt;
- c) The use of open fires is prohibited;
- d) A daily Refuge hunting permit will be required. The fee amount will be determined on an annual basis and will be non-transferable and non-refundable;
- e) Hunters may be required to check in and check out at the station designated for their tract;
- f) Hunters must obtain a permit and comply with State and Refuge regulations regarding safety clothing, the distance limits for discharging of firearms or bows near roads and right-of-ways, bag limits, firearm gauge limits, and hunting hours;
- g) Hunting while under the influence of intoxicants or narcotic drugs, or possessing same on Refuge property will be strictly prohibited.

2.5 Alternative 3: Professional Removal Only

Professional removal (sharpshooting) with skilled marksmen can be very efficient and cost effective (Cypher and Cypher 1988) if performed by experts that are well-equipped, trained, familiar with the local terrain, and familiar with the use of bait stations and deer behavior. However, this method does require considerable investment in specialized equipment, training, and use permits, such as for silencers, subsonic ammunition, suppressed rifles, the establishment and supplement of bait stations, refrigerated trucks (for storage and transport of the meat) and is therefore generally beyond the means of the limited staff and budget of most refuges to be done "in-house". In the case of the Rappahannock River Valley National Wildlife Refuge, this option would need to be contracted out. Sharpshooting is used in combination with managed hunts in Fairfax County, Virginia, with enhanced success than by either method used singly as deer are

capable of responding with avoidance behaviors that diminish marksmen's efforts (Earl Hodnett, Biologist for Fairfax County, August 1999, personal communication). Sharpshooting as the sole means of population reduction is only effective for a short period as deer quickly learn to avoid lights and trucks. More importantly, this option would deprive the public of one of the stated public-use objectives of the National Wildlife Refuge Improvement Act of 1997: to provide wildlife-dependent recreation on refuge lands.

3.0 AFFECTED ENVIRONMENT

3.1 Physical Environment

a. Climate

The climate of the lower Rappahannock River Valley is temperate, or more specifically, humid subtropical. This climate is determined by latitude, topography, prevailing westerly winds, and the influence of the Atlantic Ocean (Commonwealth of Virginia 1988). Average winter temperature is approximately 39 degrees Fahrenheit. Average annual precipitation is approximately 43 inches, with similar average monthly rainfall throughout the year. Prevailing winds are westerly with highest wind speeds in the spring (Robinette and Hoppe 1982).

b. Geology

The lower Rappahannock Valley is within the Coastal Plain Province. Major physiographic units within the area include coastal plain uplands, low marine terraces, and fluvial river terraces. Coastal marine uplands range in elevation between 90 and 170 feet above sea level. The soils are predominately well-drained. Low marine terraces vary in elevation from 10 to 50 feet above sea level and are generally level. This land feature parallels the Rappahannock River. Fluvial marine terraces range in elevation from sea level to 10 feet above sea level and are located along the Rappahannock River and its major tributaries (Robinette and Hoppe 1982). These terraces flank the Rappahannock River and are part of what is known as the Essex Escarpment. Historically the ocean floor, these lowlands follow the 50-foot contour line and are separated from adjacent uplands by what is known as the Essex Scarp. In some locations, the Essex Scarp borders the river forming high bluffs and steep cliffs that attract relatively large concentrations of Federally threatened bald eagles (Chesapeake Bay Foundation 1992). Much of the remaining land above the Essex Escarpment in the Refuge boundary is Coastal Plain uplands (Robinette and Hoppe 1982).

c. Soils

Primary soils found in the Refuge boundary include Rumford (loamy sand, 0-6 percent slopes, excessively drained), Emporia (sandy loam, 0-10 percent slopes, well drained), and Suffolk

(sandy loam, 0-6 percent slopes, well drained). Soils of lesser abundance include Atlee, Kempsville, Slagle, State, and Tetotum. These soils are loamy, and well drained to moderately well drained (Hoppe 1989, Robinette and Hoppe 1982, Nicholson 1981).

d. Water Quality of the Rappahannock River and Tributaries

Various water data are collected for the Rappahannock River by the Virginia Department of Environmental Quality at a station approximately 3.8 miles west of Fredericksburg upstream from the Refuge boundary. Average annual water temperature for 1991/1992 was 11.9° Centigrade. Percent oxygen saturation during the same period was 92 with highest saturation during January through March, and the lowest saturation level of 80% in April. Fecal coliforms were measured sporadically during the year. The highest level of 110 coliforms per milliliter was measured in late November. Alkalinity measurements were recorded six times during the year with a high of 33 milligrams per liter of CaCO₃ in November and a low level of 17 milligrams per liter in May. During water years 1907-1992, the mean annual discharge at the station was 1,637 cubic feet per second with the highest annual mean of 3,066 in 1979, and the lowest annual mean of 440 cubic feet per second in 1931 (Prugh 1993).

A majority of the Rappahannock River within the Refuge boundary has a salinity of between 0 and 15 parts per thousand. Salinity varies seasonally due primarily to precipitation and associated runoff and therefore is normally slightly lower in the spring than in the fall.

Numerous locations in the boundary area have been condemned to all shellfishing by the Virginia Department of Health, Division of Shellfish Sanitation. Areas are closed when subject water reach levels of 14 fecal coliforms per 100 milliliters. Condemned waters in the study area include portions of Lancaster creek on the Richmond/Lancaster County line, Parrott's Creek in Middlesex County, Totuskey and Richardson Creeks in Richmond County, the eastern branch of Farnham Creek in Richmond County, Hoskins and Mount Landing Creeks in Essex County, and the Rappahannock River and its tributaries upstream of Piscataway Creek in Essex County. It should be noted that much of this area is non-productive for shellfish (Wright, M. 1994. Virginia Department of Health, Division of Shellfish Sanitation. Richmond, VA. Pers.Comm.).

3.2 Biological Resources

1. Vegetation

a. Marsh

A major habitat component of the Refuge includes fresh, brackish, and salt water tidal marshes that flank the Rappahannock River and its tributaries. Freshwater tidal marshes are usually eutrophic (nutrient rich) or hyper-eutrophic, contain high levels of suspended sediments, and have depressed oxygen levels especially during the summer. Sediments of freshwater tidal marshes normally contain 20-50% organic material and have a pH of 6.0-6.5. Freshwater tidal wetlands occur at salinities from 0.0 parts per million (ppm) to 0.5 ppm. Plant diversity is very high in the brackish to fresh portions of the Rappahannock and includes major plant species such as wild rice (*Zizania aquatica*), three species of cattail (*Typha spp.*), arrow arum (*Peltandra virginica*), arrowheads (*Sagittaria cuneata*, *S. latifolia*), pickerelweed (*Pontederia cordata*), rushes (*Juncus spp.*), spikerushes (*Eleocharis*), bulrushes (*Scirpus spp.*), common and olney threequare (*Scirpus americanus*, *S. olneyi*), sedges (*Carex spp.*), nodding beggarticks (*Bidens laevis*), marsh hibiscus (*Hibiscus moscheutos*), swamp rose (*Rosa palustris*), cardinal flower (*Lobelia cardinalis*), buttonbush (*Cephalanthus occidentalis*), marsh mallow (*Kosteletzkya virginica*), water millet (*Echinochloa walteri*), and smartweeds (*Polygonum spp.*). Federally threatened sensitive joint vetch (*Aeschynomene virginica*) has been found in brackish, disturbed, marsh edges along the Rappahannock River and some of its tributaries within the Refuge boundary area, as well as a possibly native genotype of common reed (*Phragmites australis*) (Bernd Blossey, Cornell University, October 2001, pers. comm.). An aggressive campaign to halt the spread of invasive populations of the non-native genotype of common reed is underway.

Tidal freshwater marshes are valuable to numerous species of fish and wildlife. Anadromous fish that migrate between estuaries and the oceans depend heavily on freshwater tidal marshes as nursery areas. Juvenile blueback herring (*Alosa aestivalis*), alewives (*Alosa pseudoharengus*), and American shad (*Alosa sapidissima*) are found in greatest abundance in these marshes (Odum et al. 1984). Approximately 90% of the striped bass (*Morone saxatilis*) of the mid-Atlantic coast spawn in tributaries of the Chesapeake Bay (Bergren and Lieberman 1977). Striped bass spawn in fresh and brackish waters and juveniles use these waters as nursery habitat (Mitsch and Gosselink 1986). The Federally endangered shortnose sturgeon (*Acipenser brevirostrum*), though now virtually extinct from Virginia waters, and its close relative, the Atlantic sturgeon, spawn in nontidal and tidal fresh waters, and juveniles may spend years there before migrating to the ocean (Brundage and Meadows 1982).

More birds use freshwater tidal marshes than any other marsh type (Mitsch and Gosselink 1986). Of the various types of wetlands, Shaw and Fredine (1956) rated shallow, tidal freshwater marshes as the most important habitat for ducks, geese, and swans. Most species of North

American waterfowl use freshwater tidal wetlands during one or more seasons of the year. Most common species include wood ducks (*Aix sponsa*); dabblers such as mallards (*Anas platyrhynchos*), black ducks (*anas rubripes*), green-winged teal (*Anas crecca*), and pintails (*Anas acuta*); Canada geese (*Branta canadensis*), and tundra swans (*Olor columbianus*). At least 35 species of shorebirds and rails make extensive use of these marshes as do 15 species of wading birds such as bitterns, herons, egrets, and ibises (Odum et al. 1984).

b. Estuarine Emergent Marshes

Marshes located in the middle and downstream portion of the Refuge boundary area are dominated by those vegetative species more adapted to higher salinities. Vegetative communities are primarily composed of tall cordgrass (*Spartina cynosuroides*) and saltmarsh cordgrass (*Spartina alterniflora*), waterdock (*Rumex orbiculatis*) and brackish water mixed communities. Interspersed throughout these marshes are tidal guts, creeks, ponds, and potholes. Estuarine emergent marshes are among the most productive ecosystems in the world, with up to 25 metric tons per hectare of plant material produced annually (Niering and Warren 1977). Salt marshes are major producers of detritus and they serve as a growth substrate for algae and other organisms (Mitsch and Gosselink 1986). These products of the salt marsh are eventually transported to Bay waters where they serve as a vital link in the food web. Salt marshes, together with the dense mat of vegetation found in them, serve to control erosion by buffering wave energy and binding the marsh substrate. Salt marshes provide important habitat for larval fishes and many species of invertebrates. Species commonly found in salt marshes include fiddler crab (*Uca spp.*), black duck, clapper rail (*Rallus longirostris*) and yellow-crowned night heron (*Nyctanassa violacea*). The marshes downstream from Beverley Marsh are important wintering and breeding sites for marsh wrens (*Cistothorus palustris*) and least bitterns (*Ixobrychus exilis*). Sora rails (*Porzana carolina*) also use these marshes during migration.

c. Bottomland Hardwood Wetlands

Several locations within the Refuge boundary area contain bottomland hardwood wetlands. In general, these wetlands were formed from the deposition of alluvial material and downcutting of surface geology over time (Mitsch and Gosselink 1986). The resulting alluvial sediments generally range 10 to 80 meters thick. These systems are dependent upon waterborne sediments to maintain substrate elevation relative to the river. Sediment supplies may be threatened by many factors such as dam construction upstream. Flooding maintains riparian wetlands in numerous ways by providing sediment and nutrients and exporting organic and inorganic material.

This habitat type is found at Horse Head Point, Marsh Point, Toby's Point and Green Bay. Smaller tracts are found in the upper reaches of the lower Rappahannock and its tributaries. Such habitat is favored by prothonotary warblers (*Prothonotaria citrea*) and black ducks, and numerous species of amphibians. Dominant tree and shrub species in these wetlands include river birch (*Betula nigra*), sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvatica*), black gum (*Nyssa sylvatica*), sweet gum (*Liquidambar styraciflua*), southern bayberry (*Myrica cerifera*), groundsel-tree (*Baccharis halimifolia*), black willow (*Salix nigra*), and occasionally bald cypress (*Taxodium distichum*).

d. Forested Uplands

The forested uplands of the Rappahannock River Valley are dominated by such upper-story species as oaks (*Quercus spp.*), hickory (*Carya spp.*), tulip tree (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), loblolly pine (*Pinus taeda*), Virginia pine (*Pinus virginiana*), and such mid-story species as laurel (*Kalmia latifolia*), highbush blueberry (*Vaccinium corymbosom*), arrowwood (*Viburnum dentatum*), shadbush (serviceberry or juneberry) (*Amelanchier spp.*), paw-paw (*Asimini triloba*), dogwoods (*Cornus florida*, *C. alterniflora*), and winterberry holly (*Ilex verticillata*). With such height diversity and the often rugged terrain created by deep gullies and washes, suitable habitat is afforded for such neotropical avian migrants as woodthrushes (*Hylocichla mustelina*) and oven birds (*Seiurus aurocapillus*), which breed here, and a host of other warblers which migrate through here. Numerous species of spring wildflowers bloom in the forested uplands along the River.

e. Agricultural Land

Much of the uplands along the Rappahannock River in the Refuge boundary area is, or was, in agriculture. Major crops in this area are soybeans, corn, wheat, timber (usually pulpwood), and to a lesser degree, pastureland and haycrops for beef cattle.

2. Fish and Wildlife

Fish and wildlife diversity in the Boundary area may rival that of any area in Virginia. This factor is largely due to the varied habitat types and their juxtaposition on the landscape. Virtually every major habitat type in the Coastal Plain may be found in the Rappahannock River Valley, providing a rich mosaic for a diverse assemblage of fish and wildlife species.

a. Birds

The Rappahannock is perhaps best known for its waterfowl resource. The open water, marshes, and bottomland hardwoods associated with the river and its tributaries create excellent habitat for most North American waterfowl species. Tens of thousands of ducks, geese, and swans winter on the Rappahannock within the Refuge boundary area. Species of greatest abundance include Canada geese, ruddy ducks (*Oxyura jamaicensis*), canvasbacks (*Aythya valisneria*), mallards, black ducks, and ring-necked ducks (Doug Forsel. 1994. U.S. Fish and Wildlife Service Chesapeake Bay Field Office. Pers. Comm.). In the spring, wood ducks are the most abundant

breeder. The North American Waterfowl Management Plan (NAWMP) designated priority habitat areas in Canada and United States to focus protection efforts. The Rappahannock River is one of ten areas in Virginia targeted to receive concentrated habitat protection efforts under NAWMP for migratory waterfowl.

In addition to waterfowl, marshes and bottomland hardwood wetlands in the Refuge boundary area provide excellent habitat for a variety of wading birds, rails, and shorebirds. Examples include great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), great egret (*Ardea alba*), least bittern, sora rail, king rail (*Rallus elegans*), Virginia rail (*Rallus limicola*) woodcock (*Philohela minor*), common snipe (*Capella gallinago*), and shorebirds such as yellowlegs (*Tringa spp.*), killdeer (*Charadrius vociferus*) and spotted sandpiper (*Actitus macularia*).

Agricultural fields and managed grasslands in the Refuge boundary area provide yet another habitat type for bird diversity, and this is particularly so in those fields which provide grass buffer strips or are in various succession seres. Canada geese, tundra swans, and snow geese (*Cheb caerulescens*) by the thousands take advantage of the harvested corn and soybean fields. Some grassland obligates and grassland generalists that have been observed using grasslands or oldfields within the Refuge boundary area as breeding, wintering, migratory stop-over, or year-round habitat include Eastern meadowlark (*Sturnella magna*), Northern bobwhite (*Colinus virginianus*), wild turkey (*Meleagris gallopavo*), grasshopper sparrow (*Ammodramus svannarum*), field sparrow (*Spizella pusilla*), savannah sparrow (*Passerculus sandwichensis*), dickcissel (*Spiza americana*), bobolink (*Dolichonyx oryzivorus*), American kestrel (*Falco sparverius*), merlin (*Falco columbarius*), Northern harrier (*Circus cyaneus*), shorteared owl (*Aseo flammeus*), yellow-breasted chat (*Icteria virens*), Eastern towhee (*Pipilo erythrophthalmus*), indigo bunting (*Passerina cyanea*), barn swallow (*Hirundo rustica*), northern rough-winged swallow (*Stelgidopteryx serripennis*), tree swallow (*Tachycineta thalassina*), purple martin (*Progne subis*) whip-poor-will (*Caprimulgus vociferus*), common nighthawk (*Chordeiles minor*), and Eastern bluebird (*Sialia sialis*).

The forested wetlands and uplands in the Refuge boundary area serve as breeding and/or wintering habitat for a multitude of migratory, non-game birds such as warblers, flycatchers, wrens, nuthatches, tanagers, orioles, finches, vireos, mimids, icterids, corvids, chickadees and titmice, cuckoos, woodpeckers, thrushes, owls, and hawks. Games species such as northern bobwhite (quail), mourning dove, and wild turkey are also abundant in the upland forests of the Refuge boundary area.

b. Mammals

A diverse assemblage of mammals inhabit the Refgue boundary area. Wetland habitats are dominated by a abundance of furbearers including such species as muskrat (*Ondatra zibethica*), raccoon (*Procyon lotor*), beaver (*Castor canadensis*), river otter (*Lutra canadensis*), longtailed weasel (*Mustela frenata*), and mink (*Mustela vison*). Large to medium mammals in the uplands include white-tailed deer (*Odocoileus virginianus*), red fox (*Vulpes vulva*), opossum (*Didelphis marsupialis*), Eastern cottontail rabbit (*Sylvilagus floridanus*), gray squirrel (*Sciurus carolinensis*), Eastern chipmunk (*Tamias striatus*), ground hogs (woodchuck)(*Marmota monax*),

and striped skunk (*Mephitis mephitis*). On extremely rare occasions, black bear (*Ursus americanus*) have been observed attempting to migrate from the Piedmont to the Great Dismal Swamp. Small mammals species found or expected here include meadow vole (*Mycrotis pennsylvanicus*), least shrew (*Cryptotis parva*), shorttail shrew (*Blarina brevicauda*), southeastern shrew (*Sorex longirostris*), rice rat (*Oryzomys palustris*), white-footed mouse (*Peromyscus leucopus*), Eastern harvest mouse (*Reithrodontymus humulis*), Eastern mole (*Scalopus aquaticus*), star-nosed mole (*Condylura cristata*), and at least two species of bats, the big brown bat (*Eptesicus fuscus*) and the red bat (*Lasiurus borealis*).

c. Reptiles and Amphibians

Possibly as much as 80% of the frog species, 60% of the reptile species, and 25% of the salamander species native to Virginia are found in the Refuge boundary area (Mitchell 1994) (See Table 1).

d. Fish

As one of three major tributaries of the Chesapeake Bay, the Rappahannock River is a major spawning and nursery ground for anadromous fish species, including striped bass (*Morone saxatilis*), American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), and Atlantic sturgeon (*Acipenser oxyrinchus*). It also provides important nursery grounds to the catadromous American eel (*Anguilla rostrata*). The Virginia Institute of Marine Science identified over 100 species of finfish and shellfish in the Rappahannock River from 1967-1992 (Seaver, D. 1993. Virginia Institute of Marine Science. Pers. Comm.).

A large assemblage of resident fishes is also found here, including white perch (*Morone americana*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and channel catfish (*Ictalurus punctatus*). The blue catfish (*Ictalurus furcatus*) is non-native resident species that was introduced by the Virginia Department of Game and Inland Fisheries. The Rappahannock River also is an important nursery to several coastal, migratory species, including weakfish (*Cynoscion regalis*), Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), Atlantic menhaden (*Clupea harengus*), bluefish (*Pomatomus saltatrix*) and summer flounder (*Paralichthys dentatus*).

Table 1: Selected Species of Reptiles and Amphibians Found in the Lower Rappahannock River Valley

Frogs and Toads

Northern Cricket Frog
 Leopard Frog
 Spring Peeper
 Northern Gray Treefrog
 Green Treefrog
 Bull Frog
 Pickerel Frog
 Spadefoot Toad
 American Toad
 Fowler's Toad

Scientific Name

Acris crepitans
Rana utriculariala
Hyla crucifer
Hyla versicolor
Hyla cinerea
Rana catesbeiana
Rana palustris
Scaphiopus holbrooki
Bufo americanus
Bufo woodhousei fowleri

Turtles and Lizards

Eastern Box Turtle
 Eastern Painted Turtle
 Stinkpot
 Snapping Turtle
 Red-Bellied Turtle
 Mud Turtle
 Eastern Five-Lined Skink
 Ground Skink
 Six-Lined Racerunner

Scientific Name

Terapene carolina
Chrysemys picta
Sternotherus odoratus
Chelydra serpentina
Pseudemys rubriventris
Kinosternon subnubrum
Eumeces fasciatus
Sciincella lateralis
Cnemidophorus sexlineatus

Salamanders

Spotted
 Marbled
 Red Spotted Newt
 Greater Siren

Scientific Name

Ambystoma maculatus
Ambystoma opacum
Notophthalmus viridescens
Siren lacertina

Snakes

Copperhead
 Eastern Worm
 Scarlet
 Black Racer
 Northern Ringneck
 Rainbow
 Eastern Hog-Nosed
 Eastern Kingsnake
 Black Ratsnake
 Northern Watersnake
 Brown Watersnake
 Rough Greensnake

Scientific Name

Agkistrodon contortrix
Carphophis amoenus
Cemophora coccinea copie
Coluber Constrictor
Diadophis punctatus edwardsi
Farancia erytrogramma
Heterodon platyrhinus
Lampropeltis getulus
Elaphe obsoleta
Nerodia sipedon
Nerodia taxipilota
Opheodrys aestivus

Numerous species of shellfish inhabit the lower Rappahannock River. Two of these species, the eastern oyster (*Crassostrea virginica*), and the blue crab (*Callinectes sapidus*), are critical to commercial and recreational fisheries.

e. Threatened and Endangered Species

The following Federally threatened or endangered species may be found within or very near the Boundary area seasonally or year-round:

Common Name	Scientific Name	Federal Status
Bald eagle	<i>Haliaeetus leucocephalus</i>	Threatened
Green turtle	<i>Chelonia mydas</i>	Threatened
Loggerhead sea turtle	<i>Caretta caretta caretta</i>	Threatened
Kemp's Ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered
Northeast beach tiger beetle	<i>Cicindela dorsalis dorsalis</i>	Threatened
Piping plover	<i>Charadrius melodius m.</i>	Threatened
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Endangered
Small whorled pogonia	<i>Isotria medeoloides</i>	Threatened
Sensitive joint vetch	<i>Aeschynomene virginica</i>	Threatened
Swamp Pink	<i>Helonias bullata</i>	Threatened

Of this list, the bald eagle, sensitive joint vetch, and small whorled pogonia are by the far the most common endangered or threatened species in the Refuge boundary area. Bald eagles nest throughout the Rappahannock River Valley and large summer and winter concentrations are located in the Horse Head Point area in Essex, King George, and Westmoreland counties, and at Fones Cliffs in Richmond and Westmoreland counties. Peak winter counts often number in excess of 200 birds and summer counts have been climbing steadily in recent years. In the summer of 1993, for example, over 40 active bald eagle nests were found on the river (Byrd 1994), while 80 active nests were counted in 2001 (Brian Watts, College of William and Mary, Center for Conservation Biology, unpub.). On a winter bald eagle survey in February, 2005 from Tappahannock upriver to Rappahannock Academy, 395 bald eagles were counted, more than half of which were juveniles (Refuge staff). The threatened small whorled pogonia is a terrestrial orchid found in mature forests with open understories. It has been found in at least two locations in Caroline county. The threatened sensitive joint vetch is an annual legume that is locally abundant along marsh edges in the river's brackish-to-fresh transition zone. This plant has been found in nearly a dozen locations within the Refuge boundary in Westmoreland, Essex counties (Va. Dept. of Game and Inland Fisheries 2001) and Richmond county (Refuge staff 2001).

The remaining endangered or threatened species are much less common in the Refuge boundary area and may occur there only infrequently if at all. The shortnose sturgeon may only be in infrequent visitor in Virginia estuaries. The shortnosed sturgeon, Kemp's, loggerhead, and green turtles occur in the river off Middlesex and Lancaster Counties. Northeastern beach tiger beetles occur in Lancaster and Middlesex counties. The swamp pink, a perennial herbaceous plant, is found in swamps, bogs, and along streamsides, and is known to occur in Caroline County. The

piping plover occurs in Middlesex County (Va. Dept. of Game and Inland Fisheries 2001; Va. Dept. of Conservation and Recreation, Div. of Natural Heritage 2001).

Some species found the in lower Rappahannock River Valley in or very near the Refuge boundary area are listed by the Commonwealth of Virginia as either threatened or endangered:

Common Name	Scientific Name	State Status
Bachman's sparrow	<i>Aimophila aestivalis</i>	Threatened
Bald eagle	<i>Haliaeetus leucocephalus</i>	Threatened
Barking treefrog	<i>Hyla gratiosa</i>	Threatened
Eastern tiger salamander	<i>Ambystoma tigrinum tigrinum</i>	Endangered
Loggerhead shrike	<i>Lanius ludovicianus migrans</i>	Threatened
Mabee's salamander	<i>Ambystoma mabeei</i>	Threatened
Peregrine falcon	<i>Falco peregrinus</i>	Threatened
Upland sandpiper	<i>Bartramia longicauda</i>	Threatened
Sensitive joint vetch	<i>Aeschynomene virginica</i>	Threatened
Small whorled pagonia	<i>Isotria medeoloides</i>	Endangered
Swamp pink	<i>Helonias bullata</i>	Endangered
Northeastern beach tiger beetle	<i>Cicindela dorsalis dorsalis</i>	Threatened
Piping plover	<i>Charadrius melodus melodus</i>	Threatened
Kemp's Ridley sea turtle	<i>Lepidochelys kempii</i>	Endangered
Loggerhead sea turtle	<i>Caretta caretta caretta</i>	Threatened
Green sea turtle	<i>Chelonia mydas</i>	Threatened
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	Endangered

Bachman's sparrow occurs in Lancaster and Caroline counties. The loggerhead shrike occurs in Middlesex, King George, and Caroline counties. Peregrine falcons occur in Lancaster, King George and Middlesex counties. Upland sandpipers occur in all counties within the Refuge boundary area. The remainder of these species occur in one or more counties within the Refuge boundary area, except for the barking treefrog, eastern tiger salamander, and Mabee's salamander, which occur very near the boundary area in Mathews County (Va. Dept. of Game and Inland Fisheries 2001; Va. Dept. of Conservation and Recreation, Div. of Natural Heritage 2001).

3.3 Socio-Economic Resources

The Rappahannock River Valley landscape is dominated by expansive forests and agricultural land dotted with small communities. Over 50% of the landscape is forested and timber production and wood processing are important industries in the area. Much of the level land in the Refuge boundary area is adjacent to the river where a majority of the agricultural land is located. Major agricultural crops include corn, soybeans, wheat, barley, and to a lesser degree, truck crops such as tomatoes and melons. The population of the lower Rappahannock River Valley may best be described as rural. The population of all counties within the study area is approximately 84,000 which includes the counties of Caroline, Essex, King George, Lancaster, Middlesex, Richmond, and Westmoreland. The population of all counties in the Boundary area

is expected to grow by 15% between 1990 and 2010 to a total of 97,000 (Baird 1994, Rhodes 1994, Black 1994). The largest cities in the study area include Tappahannock (pop. 2,068) and Warsaw (pop. 1,375) (2000 Census, Town Offices of Warsaw and Tappahannock).

3.4 Recreational Opportunities

1. Fishing, Hunting, and Wildlife Observation

The Rappahannock River provides many fish and wildlife recreational opportunities. Excellent fishing is available due to the abundance of fin fish and shellfish resources. The lower portions of the river provide fishing for marine species such as weakfish (*Cynoscion regalis*), spotted seatrout (*Cynoscion nebulosus*), spot (*Leiostomus xanthurus*), croaker (*Micropogonias undulatus*), and bluefish (*Pomatomus saltatrix*), while the upper portions of the Refuge boundary area provide fishing for such species as catfish, largemouth bass, and bluegill. Fishing for anadromous species can be good seasonally in any portion of the lower Rappahannock River. The first impediment to fish migration is found at Embrey Dam near Fredericksburg and is scheduled for removal by 2005.

The Virginia river wetlands do not hold as high numbers of waterfowl as do the eastern shore coastal marshes, but the area is still extremely important as a wintering and stopover habitat, hence duck hunting is a popular tradition in the area. Various types of waterbird hunting are available: sea and diving duck hunting is best in the lower portions of the river, while puddle duck and Canada goose hunting are best in the upstream portions. Such species as Canada goose, mallard, wood duck, and scaup are frequently hunted on the river.

In the upland portions of the Refuge boundary area, most popular game species normally hunted in Virginia, such as white-tailed deer, turkey, cottontail rabbit, bobwhite quail, mourning dove, and gray squirrel are found the Rappahannock River Valley. White-tailed deer hunting is clearly a very popular big-game species in the counties in the Boundary area, as can be seen from Table 2 "Virginia Deer and Turkey Harvests and Big Game License Sales for Counties in the Refuge Boundary Area, 1998-2000" below. Total hunting expenditures for Virginia for food, lodging, equipment, travel, and other related costs for the year 1996 was \$518.891 million, 2.5 % of the U.S. total. (U.S. Department of the Interior 1996).

Trapping of furbears also occurs in the marshes and major tributaries of the river. The most popular species are muskrat, raccoon, beaver, and mink.

Table 2: Virginia Deer and Turkey Harvests and Big Game License Sales from 1999-2000 for Counties in the Refuge Boundary Area (adapted from VDGIF data, bear excluded, other counties excluded)

County	Year	Deer	Turkey	License Sales
Caroline	1998	3690	154	1156
	1999	3325	161	1016
	2000	3194	171	964
Essex	1998	1450	70	1479
	1999	1713	37	1578
	2000	1662	70	1804
King George	1998	1802	27	772
	1999	1334	28	723
	2000	1419	30	642
Lancaster	1998	662	39	441
	1999	688	43	384
	2000	767	27	417
Middlesex	1998	435	11	366
	1999	473	31	353
	2000	503	18	369
Richmond	1998	606	25	294
	1999	665	43	203
	2000	789	31	274
Westmoreland	1998	942	38	799
	1999	938	32	722
	2000	884	32	735

There are at least two bird-watching clubs in the area: the Northern Neck Audubon Society and the Westmoreland County Bird Club, which offer regular monthly bird walks and lecture series. Various other conservation and nature-based organizations, such as the Chesapeake Bay Foundation, Ducks Unlimited or Friends of the Rappahannock River, hold public events which focus on the region's wild living resources. The Refuge also holds occasional wildlife-dependant events for the public such as bird walks, fishing, and nature tours, while permanent public use facilities are being developed.

2. Public and Private Recreational Lands

The Refuge comprises most of the publicly-owned land in the Boundary area. Several publicly-owned, large land tracts located the Northern Neck peninsula in or near the Boundary area are: Belle Isle State Park in Lancaster County (700 acres), Westmoreland State Park (1,300 acres),

Lands End Waterfowl Refuge (a Virginia Department of Game and Inland Fisheries property) in King George County (463 acres), George Washington Birthplace National Monument in Westmoreland County (550 acres), and Caledon Natural Area State Park in King George County (2,574 acres). None of these permit hunting (although Land's End may introduce a managed big-game hunt in 2002 or 2003).

Various private facilities are located along the Rappahannock River or its tributaries. Most cater primarily to boaters and campers; however there are several that were established for conservation and wildlife observation purposes. The Virginia Outdoors Foundation holds 5,691 acres in several easements distributed throughout all but one county (Middlesex) in the Refuge boundary area. The Nature Conservancy holds conservation easements on approximately 175 acres in Essex County and owns two preserves in the Refuge boundary area—729 acres in Westmoreland county and 350 acres in Caroline county.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter compares and contrasts the environmental consequences of implementing each of the alternatives described in Chapter 2. Important considerations in the establishment of the Rappahannock River Valley NWR were to benefit migratory birds and threatened or endangered species, thus many management actions pivot upon the protection of wetland and upland forested habitats, and endangered or threatened plant habitat. The consequences of the three alternatives are discussed from this perspective.

4.1 Impacts of the No-Action Alternative

The no-action alternative includes long-term negative effects such as potential for a disease epidemic (Demarais et al 2000), increase in automobile accident rates, browsing pressure on vegetation and crops, and severe habitat degradation (Cypher and Cypher 1988). Overbrowsing will eventually affect the abundance and distribution of vegetative species and have continued effects on the composition of forest canopy for a long time after the deer herd is reduced. For grasslands, cover would quickly regenerate (Porter 1991), however, species composition may be permanently altered. The effects on vegetation composition and forest regeneration are of great concern to Refuge management for maintaining bald eagle and other migratory bird habitat. The intensity of grazing on woody browse in forest fragments is inversely proportionate to the availability of field forbs (Augustine and Jordan 1998). Pastures and old fields are vulnerable to overgrazing when deer densities are high because they contain more and higher quality forage, especially in spring and summer (Johnson et al.1995). Cumulative effects of grazing over successive years may result in reduced plant reproduction and growth (Augustine and Frelich 1998) and height (Anderson 1994), which exposes sensitive plants and places them at risk of extirpation (Augustine and Frelich 1998). The Refuge is concerned about the impacts this phenomena may have on breeding and wintering bird populations and on the existing exemplary plant communities found on the Refuge.

Cumulative Impacts of the No Action Alternative

In addition to the impacts described above, we expect this alternative to result in the following cumulative impacts.

Impacts to White-tailed deer:

One management concern is that ungulate populations generally overshoot the ultimate carrying capacity of the habitat before equilibrium is reached (McCullough 1982). White-tailed deer are more prone to habitat alteration during this process than many other species due to their high reproductive potential (McCullough 1982; McCullough 1997), with substantial impact on the vegetation. Deer foraging habits and preferences can change plant composition and structure over time (Russell and Fowler 1999, Augustine and Jordan 1998, Brown and Parker 1997, Van Deelen et al. 1996, Porter et al. 1991) and such alterations have subsequent impacts on other wildlife, such as songbird species richness and abundance (DeCalesta 1994). This impact is magnified when other factors, such as mild weather, alternative food sources (such as crops), and reduced annual mortality allow populations to quickly increase in numbers. In a recent study on the impacts of deer on the songbird community on islands in British Columbia, heavily browsed islands had far fewer birds than the deer-free islands. These islands had only about one-third as many birds overall and only about one-tenth as many of those birds that depend primarily on understory vegetation. Two typically common bird species—the fox sparrow (*Passarella iliaca*), which nests in the understory, and the rufous hummingbird (*Selasphorus rufus*), which forages in the understory—were completely absent from the heavily browsed islands (Allombert et al. 2005).

In addition to a general decrease in habitat quality, impacts of high deer densities include a decline in overall deer population health as evidenced by decreased body weights, increased occurrence of deformities, increased levels of internal and external parasitism, decreased body fat deposits, and disease transmission (Cypher and Cypher 1988, Fischer et al. 1995, Demarais et al. 2000).

If allowed to progress unchecked by natural predators or management, deer reproductive potential can be very high. For example, just one mating pair can grow to 1,000 in 10 years, including natural mortality (Yarrow and Yarrow 1999). Although a weak correlation exists between density and fertility rates (reproduction declines at high densities), substantial reproduction still occurs when densities exceed 50 deer per square kilometer (247 acres) (Swihart 1998). This is because of a higher number of adult does in the population, and even though they have lowered reproduction, collectively they produce a large number of offspring each year. The goal of the Refuge, therefore, is not to only manage the deer herd to protect habitat but also to protect the overall health of the herd.

Finally, local communities have relied on hunting to curb population growth and limit crop damage from deer, and to provide outdoor recreation. Many of the Refuge units were once farms that participated in local hunts or were open to local hunt clubs. To permanently retire these units from hunting or some type of population reduction would in effect undermine and impair local

ability to curb deer population growth on Northern Neck and would result in a loss of wildlife-dependent recreational opportunity. This loss is contrary to the goals of the NWR System.

Impacts to Non-hunted Wildlife:

If the local deer population were to increase to a density of 15-20 deer per square mile the effects of browsing by deer would likely negatively affect forest regeneration, resulting in degradation of habitat for resident wildlife that use forest understory vegetation and regenerating forest; negative effects of deer browsing on forest regeneration and understory vegetation have been demonstrated by numerous researchers (see review by Russell et al. 2001) when deer population densities have reached 15-20 deer per square mile. Other than the negative impacts from overpopulation of deer, no other impacts to non-hunted wildlife are expected as a result of the no action alternative.

Impacts to Threatened and Endangered Species:

As noted previously, there are only two Federal-listed threatened species that are regularly found on the refuge: bald eagle and sensitive joint-vetch. We expect no impact to either of these species to occur from taking no action on deer hunting.

Other Wildlife Dependent Recreational Programs:

More days of opportunity for other wildlife-dependent recreation would be available. For the tract that is permanently open to the public, this would mean 10-16 days in which the refuge would not be closed to all but hunt-permit holders. The other tracts are open by reservation only and receive very few requests from the public. Under this alternative, there would be no conflict with hunting on dates when reservations were requested.

Refuge Facilities:

There would be somewhat less impact to refuge roads and trails, however it is not expected to be a significant difference in light of other uses that occur throughout the year.

Cultural Resources:

No noticeable difference in impacts to cultural resources would result from this alternative compared to other alternatives.

Refuge Environment and Community:

There would likely be an unquantifiable loss of potential economic revenue to the local community due to the reduction in visitation. There would be a loss of historic wildlife-dependent recreational opportunities in the local and regional community. The Refuge provides excellent, high-quality, public hunting opportunities. In 2006, we issued over 400 permits to over 150 individual participants. Under this alternative, the refuge would fail to meet one of its objectives to provide opportunities for compatible scientific research, environmental education, and fish and wildlife-oriented recreation.

Summary—Impacts of the No-Action Alternative

The cumulative impacts that would accrue over time by not allowing any hunting on the refuge would negatively effect deer populations and non-hunted resident wildlife populations as a result

of degradation of their habitat. The cumulative effect of closing deer hunting over a broad region would likely be a negative effect on habitat for some species of resident birds, mammals, herpetofauna, and insects. There would likely be no effect on either of the refuge's threatened species. There would be minor additional opportunity for wildlife-dependent recreation other than hunting, but we would not provide one of the six priority uses of the refuge system. There would no impact on refuge facilities or cultural resources. There would be a potential loss of economic benefits and traditional recreational opportunities in the community. In summary, this alternative is not in the best interests of the natural resources of the refuge, local community, and the region, and it is not consistent with Service policy and the National Wildlife Refuge System Improvement Act.

4.2 Impacts of the Proposed Action: Managed Annual Public Hunt

Based on a nationwide survey of all states (Krausman 1992), deer were effectively controlled with hunting and habitat manipulation in many areas where they were overpopulated. The remaining overpopulated herds were either not hunted, had an inadequate doe harvest, or an inadequate general harvest. Because the population of deer in the Refuge boundary area is open, with numerous tracts and corridors for movement and contact with other herds, it is unlikely that hunting will reduce the population to such low levels as to place it at risk of becoming genetically bottlenecked. Also, no prevention or control of epizootic hemorrhagic disease exists to date except by keeping populations below the carrying capacity of their habitats. In a 10-year study in northwestern Pennsylvania examining the impacts of varying densities of deer on deer health and habitat, starvation mortality resulted when densities reached higher than 25 deer per square kilometer (247 acres). Species richness and abundance of shrubs and herbaceous vegetation was also shown to decline when deer densities reach between 4-8 deer/km² (deCalesta and Stout 1997). At high densities, deer may act as a host reservoir for Lyme-disease bearing ticks (Jones et al. 1998). Reducing the deer population will reduce the potential for Lyme disease transmission. Based on these considerations, it is anticipated that hunting would have a positive impact on deer health and quality and habitat condition. Reducing the deer population will also benefit the surrounding human community by reducing damage on crops and residential landscape vegetation.

No adverse impacts to vegetation from trampling by hunters are likely, as most species will have already undergone senescence or become dormant. Soil and water quality are not expected to experience any negative effects under this alternative. The deer hunt would occur outside of the breeding period of most species, thereby avoiding any potential disturbance. The Refuge will abide by the joint Service-State Bald Eagle Protection Guidelines for Virginia. These guidelines provide distance and time-of-year restrictions for activities that could disturb nesting or roosting eagles. Guidelines in effect as of this Environmental Assessment would dictate a season closure of December 1. A Section 7 Consultation with the USFWS Virginia Field Office determined that there will be no adverse impact on bald eagles. No adverse effects on migratory birds or inter-jurisdictional fishes are anticipated as a result of establishing a hunt program. Wintering or resident birds (such as bobwhite quail, wild turkey and savannah sparrows), small mammals, and reptiles may experience some flushing, but there is ample cover in the form of marsh, hedgerows,

shrubland, and tall grasses for flushed wildlife to repair to, therefore it is expected that this disturbance will be temporary and normal use will resume shortly after the hunt closes each day.

A managed hunt would provide the public with a quality wildlife-dependent recreational opportunity, as is consistent with the requirements of the National Wildlife Refuge Improvement Act of 1997. The Refuge will be open to hunting starting from the State season opening (usually first week in October) until the end of November or early December. The Refuge may close to other public uses during hunt days, unless these uses can be safely sequestered from locations of hunting activity.

Cumulative Impact of the Proposed Alternative—Managed Annual Public Hunt

Impacts on White-tailed Deer:

The Refuge refers to the Virginia Department of Game and Inland Fisheries Deer population management objectives (i.e., reduce, stabilize, or increase population) for guidance on its annual hunt program objectives in addition to other inputs, such as changes in habitat quality. The state’s objectives are set on a county/city management unit basis. Achievement of stabilization or reduction would necessitate management action by the Refuge, as no action would result in population increase.

Table 1 below shows the deer population trends on private lands for each county containing a Refuge unit and the adjacent counties (amended from the Virginia 2006 Deer Management Plan for the entire state). These trends were obtained by “examining the annual rate of change in the population index (i.e., antlered buck harvest per unit area) over the 10-year period from 1996-2005. An exponential regression was used to determine trends in population. The status of the deer population in each county was considered to be increasing or decreasing if the annual rate of change in the population index was $>2.26\%$ (either positive or negative) and the statistical significance level of the exponential regression model was $p < 0.10$ (r^2 Value ≥ 0.301). Annual rates of change that exceeded 2.26% represent a change of at least 25% in the population index over the decade ($1.0226^{10} = 1.25$). Counties that displayed a rate of change between 0 and ± 2.26 were deemed to be stable” (2006 Virginia Deer Management Plan).

We expect the proposed hunt to have a positive impact on the health of the deer herd by limiting overbrowsing, deer-borne diseases, and improvements in the quality of the habitat on the refuge specifically, and would contribute to the overall health of deer and habitat quality on the surrounding landscape. The 1999 Virginia Deer Management Plan also shows a correlation between deer density and automobile collisions with deer. Herd reduction is expected to improve these statistics as well.

Table 1. 2006 Virginia private land deer population status by county or city (modified from 2006 Virginia Deer Management Plan, irrelevant counties removed)

County/City	R^1	r^2	Objective	Status	Objective Met?
	Value				
Caroline ³	1.18%	0.078	Stabilize	Stable	Yes
Essex	2.85%	0.443	Stabilize	Increasing	No
King & Queen	4.11%	0.517	Stabilize	Increasing	No
King George	-0.90%	0.042	Stabilize	Stable	Yes
Lancaster	6.73%	0.779	Stabilize	Increasing	No
Louisa	4.57%	0.768	Stabilize	Increasing	No
Middlesex	3.87%	0.439	Stabilize	Increasing	No
Northumberland	8.60%	0.924	Stabilize	Increasing	No
Richmond	6.55%	0.659	Stabilize	Increasing	No
Spotsylvania	5.13%	0.605	Stabilize	Increasing	No
Stafford	3.05%	0.591	Stabilize	Increasing	No
Westmoreland	4.63%	0.544	Stabilize	Increasing	No

¹ R = Percent annual change in population index. Population trends were considered significant when R (the percent annual change in the population index) values were less than -2.26% or greater than 2.26% ($1.0226^{10} = 1.25$ or a 25% increase or decrease over the 10-year period) and the r^2 values ≥ 0.301 ($p < 0.10$).

³ Caroline data does not include Fort AP Hill.

Current population reconstruction computer models indicate that Virginia's statewide deer population has been relatively stable over the past decade, fluctuating between 850,000 and 1,050,000 animals (mean = 945,000). The status of the deer population is assessed by monitoring the annual harvest of antlered bucks per square mile of estimated deer habitat. These data are conservative because it is a minimum count, and thus represents an index to the total population. The statistic on annual harvest of antlered bucks per unit area routinely is used as an index of the deer population and, when viewed over time, allows the agency to monitor changes in the population. The index is based on the assumption that, in most habitats, deer populations exhibit density-dependent population responses (i.e., deer condition and reproductive rates inversely correlate with deer density). While the antlered buck index is generally assumed to track changes in population size, interpretation of the index can also be influenced by other factors such as habitat quality, hunting regulations, hunting pressure, hunter selectivity, and population density. Trend analyses indicate that deer populations on private lands increased significantly in 30 management units and declined significantly in only 2 units during 1994-2003. Deer populations on public lands increased significantly in only 1 management unit and declined in 2 units during 1994-2003.

During the past deer season, 223,198 deer were reported killed by hunters in Virginia. This total included 106,595 antlered bucks, 19,652 button bucks, and 96,951 does (43.4%). This represents a 4% increase from the 215,082 deer reported killed last year. It is also 7% higher than the last 10 year average of 208,300.

White-tailed deer management in Virginia is based on the fact that herd density and health are best controlled by regulating antlerless deer kill levels and female deer kill numbers have been at record levels for the past four consecutive years.

Deer management objectives and regulations are set on a county basis, and regulations are evaluated and amended every other year on odd years. Over the vast majority of the Commonwealth of Virginia, current deer management objectives call for the deer herd(s) to be stabilized at their early to mid 1990's deer kill levels and appear to be working fairly well over most of the state (Virginia Draft Deer Management Plan 2006-2015).

The Refuge tracts are distributed on two landmasses, the Northern Neck and Middle Peninsula, each of which are bounded on three sides by open water and thus impeding migration. Deer appear to exhibit strong site fidelity and limit migration to rotating between winter and summer ranges, within 8-14 km in one study (Nelson 1979). Extension of deer range also appears to be a slow, incremental process through matrilineal members and some do not migrate at all for part of their lives (Nelson and Mech 1999). Any impacts, whether short-term or cumulative, should thus be restricted to these relatively isolated populations, and would have no relationship to cumulative impacts of other refuges in the state.

The impact of the proposed hunt on resident white-tailed deer on Refuge property should directly result in a reduction of the herd. However, the proportion of deer killed on the Refuge is considerably small compared to the harvest on surrounding private lands. Only 39 deer were killed in 2003, 33 in 2004, 88 in 2005, and 82 in 2006. The number of corresponding hunt permits issued were 51 in 2003, 283 in 2004, 339 in 2005, and 409 in 2006. The inaccessibility and difficulty of the terrain may explain the relatively low levels of harvest per hunter effort.

In each year since the opening of the deer hunt program, the Refuge has only offered a limited number of hunt days with the entire state season. Shotgun and muzzleloader days averaged 10-16 collectively. The number of archery days in 2006 was 31, with an average of 33 seasonal permits issued. This is the highest number ever issued since opening. All hunting on the Refuge ends on or about the 1st of December, to comply with time-of-year restrictions for the bald eagle nesting season. Guidelines for bald eagle management in Virginia recommend December 15 as the date to implement time-of-year restrictions, but we have chosen the earlier date to afford this species an additional degree of protection.

The limited number of hunt days, low harvest levels, the relative isolation of the local herds, and the high reproductive potential of deer (see above, page 26), suggest that the proposed hunt program will have a low impact on the deer population for the short and long term.

Impacts on Non-Hunted Wildlife:

We expect some minor disturbance by hunting to non-hunted wildlife. Non-hunted resident wildlife would include resident birds, small mammals such as voles, moles, mice, shrews, and bats; reptiles and amphibians such as snakes, turtles, salamanders, frogs and toads; and invertebrates such as moths, insects and spiders. These species have very limited home ranges and hunting could not possibly affect their populations regionally; thus, only local effects will be discussed.

In summary, the impact of limited deer hunting is not expected to result in any thing more than temporary flushing or relocation. This would mostly be due to hunting dogs traversing the property from private property nearby. The refuge does not permit dogs and has been engaged in negotiations with the local hunting community to find ways to limit their presence on refuge property. Displacement of resident birds is usually brief, infrequent, and short distance. Disturbance would be unlikely for many small mammals, such as bats, which are inactive during fall and winter when hunting season occurs, and/or are nocturnal. Hibernation or torpor by cold-blood reptiles and amphibians also limits their activity during the hunting season when temperatures low, making encounters with reptiles and amphibians infrequent and inconsequential to local populations. Invertebrates are also not active during cold weather and will have few interactions with hunters during the hunting season. The Service anticipates no measurable negative cumulative impacts to resident non-hunted wildlife populations locally, regionally, or globally due to this alternative.

Because of the ability of individual refuge hunt programs to adapt refuge-specific hunting regulations to changing local conditions, and the wide geographic separation of individual refuges, we anticipate no direct or indirect cumulative effects non-hunted wildlife of hunting on all refuges.

Impacts on Threatened and Endangered Species:

As noted previously, there are only two Federal-listed threatened species that are regularly found on the refuge: bald eagle and sensitive joint-vetch. The guidelines for bald eagle management in Virginia suggest implementing time-of-year restrictions for nesting eagles on December 15. The guidelines suggest that hunting within 750 feet of an occupied nest should not occur between December 15 and July 15. Because bald eagles are a focal species for refuge management, we have chosen to cease all hunting on or around December 1 in order to afford eagles an additional degree of protection, even in areas outside the 750-foot primary management zone. Therefore our hunt program goes above and beyond the recommended guidelines and is not expected to have any negative impact on bald eagles.

Sensitive joint-vetch is an annual legume that, in the refuge area, occurs only along the edges of freshwater tidal creeks and the Rappahannock River. It is very unlikely that any hunting will occur in this remote and wet environment. In the event that hunters did use these areas, the plants will have already set seed and died. Disturbance by hunters walking in these areas could have a positive impact in knocking down seed into the soil where they could germinate the following growing season rather than being blown or washed into the open water. However, it is very unlikely that hunting will have any impact, positive or negative, on this species.

Other Wildlife-Dependent Recreational Programs:

Other wildlife-dependent recreation is restricted on days on which hunting is allowed on the Refuge; however this chiefly concerns only one out of the current 17 tracts, as it is the only tract open to the public on a full-time basis. In this situation, it is open only to hunt permit-holders on the 10-16 days of hunting during the month of November. This tract is not open to archery hunting in order to limit the impact to other refuge users. Therefore on the Wilna Tract, which is the only tract open daily, hunters will have exclusive use for a maximum of 4.38% of the year, while other recreational users will have use of the tract for 95.62% of the year, to the exclusion of hunters.

Refuge Facilities:

No impacts to roads or trails used by hunters can be distinguished from that occurring from other recreational users, refuge personnel, or service visitors. Hunter vehicles must stay on roads, and hunters must access hunt areas on foot. The refuge has less than one mile of prepared surface trails and is mostly in the Accessible Only Hunt Area (wheelchair accessible). The Refuge roads are mostly gravel and dirt and are more affected by frequency and amount of precipitation than actual vehicle use.

Refuge Cultural Resources:

No impacts to known cultural resources on Refuge or adjacent lands are expected. The Refuge has few known historic sites all of which are house sites. Two are in no-hunting zones and two are not but are off-limits to any recreational user.

Refuge Environment and Community:

Impacts to habitats and vegetation are discussed above. No impacts to soils, air quality and water quality are anticipated. Hunter density is adjusted for each tract open to hunting for safety and quality of hunt experience, but on average is about 25 acres per hunter. The largest tract of 1,111 acres is capped at 14 hunters on a given day. Solitude is not expected to be any more impacted by hunter use, which is regulated by density and number of days, than by other recreational users which are not counted or registered (except for tracts open by reservation) but have the majority of the year available to them.

Adjacent lands are also hunted in all but one situation, where only archery is allowed on that particular tract (Port Royal) since it is close to town. No impacts to adjacent lands and associated natural resources would result from hunting on Refuge property any more than would result from the hunting occurring directly on adjacent lands.

Potential impacts to and the safety of nearby residents remains a primary concern in the development of the hunt program. Areas where the refuge boundary is not well marked or understood are closed to hunting.

Impacts to Economy

Opening the refuge to public hunting is expected to have a positive impact on the local economy.

The opportunities to hunt on the refuge are presented to the general public (as opposed to local hunt clubs) and through VDGIF website and publications reach interested citizens statewide.

While no specific analysis of increased revenue to the local economy resulting from hunters visiting from out of the area is available, analyses of hunting and fishing at national and state levels are available annually from several sources, such as the U.S. Fish and Wildlife National Survey of Fish, Hunting, and Wildlife Dependent Recreation 2006 report

(<http://federalaid.fws.gov/surveys/surveys.html>). It is assumed that increased visitation to this area by hunters from outside regions must contribute to the local economy.

Summary—Impacts of the Proposed Alternative

The cumulative impacts that would accrue over time by permitting deer hunting on the refuge would have a stabilizing effect on deer populations and would not negatively impact non-hunted resident wildlife populations. Over the long term, habitat used by deer and non-hunted species is less likely to be degraded due to overbrowsing by deer. There would likely be no effect on either of the refuge's threatened species. There would be some minor loss of opportunity for wildlife-dependent recreation other than hunting, but we would be providing opportunities for all six priority uses of the refuge system. There would be no impact on refuge facilities or cultural resources. There would be a potential gain of economic benefits and traditional recreational opportunities in the community. In summary, this alternative is in the best interests of the natural resources of the refuge, local community, and the region, and it is consistent with Service policy and the National Wildlife Refuge System Improvement Act.

4.3 Impacts of Professional Removal Only

In general, this alternative will have the same impacts as the managed public hunt alternative with respect to deer populations and habitats but is expected to involve less personnel and less time. While this alternative may also have the added benefit of shorter time periods for which the refuge would need to be closed to other public activities, it does deprive the public of hunting as one source of wildlife-dependent recreation. Hunting, trapping, and fishing are very popular in this region. Deer management by professional removal only would also be more costly than the proposed alternative by many magnitudes since outsourcing would be required for equipment and personnel.

Cumulative Impacts of the Professional Removal Alternative

Impacts on White-tailed deer:

Section 4.2 above addressed the anticipated take on resident deer and is applicable to this alternative as well. The anticipated take by professional sharpshooters may be somewhat higher than that from public hunting, but this is dependent on a number of variables: the number of days and number of sharpshooters deployed; the distribution, density, and strategic location of bait and ambush stations. All things being equal between public hunting and sharpshooting, the latter still ought to be more effective because these professionals can work outside the state regulations and can adapt their methods to deer response. However, professional sharpshooting

is expensive and would thus limit the number of days the Refuge could engage in this method of control, in which case public hunting could result in higher levels of take.

Impacts on Non-Hunted Wildlife:

Disturbance by hunting to non-hunted wildlife would be somewhat less under this alternative. Non-hunted resident wildlife would include resident birds, small mammals such as voles, moles, mice, shrews, and bats; reptiles and amphibians such as snakes, turtles, salamanders, frogs and toads; and invertebrates such as moths, insects and spiders. These species have very limited home ranges and hunting could not possibly affect their populations regionally; thus, only local effects will be discussed. This method has the potential to cause additional disturbance to other wildlife when operations are conducted at night, due to use of trucks and lights throughout a given tract.

Displacement of resident birds at night is a concern as finding safe and secure shelter for overnight survival is critical for warmth and protection from predators. Bait stations would need to be placed out in the open where birds are less likely to be resting for the night. Disturbance would be unlikely for many small mammals, such as bats, which are inactive during fall and winter when hunting season occurs, and/or are nocturnal. Hibernation or torpor by cold-blood reptiles and amphibians also limits their activity during the hunting season when temperatures low, making encounters with reptiles and amphibians infrequent and inconsequential to local populations. Invertebrates are also not active during cold weather and will have few interactions with hunters during the hunting season.

Impacts on Threatened and Endangered Species:

As noted previously, there are only two Federal-listed threatened species that are regularly found on the refuge: bald eagle and sensitive joint-vetch. The guidelines for bald eagle management in Virginia suggest implementing time-of-year restrictions for nesting eagles on December 15. Sharpshooting could be managed to comply with the guidelines and therefore no impact to eagles would be expected.

Sensitive joint-vetch is an annual legume that, in the refuge area, occurs only along the edges of freshwater tidal creeks and the Rappahannock River. We would not permit sharpshooters to use these areas, and therefore there would be no impact to this species.

Impacts on Other Wildlife-Dependent Recreation Programs

Refuge tracts would be closed to all other activities on the days designated for sharpshooting operations, except where night-time operations are planned. The total number of days of closure is expected to be less than that for public hunting because some operations would be conducted at night, and because this alternative would likely involve fewer days because of expense. If the number of closure days was half that of the proposed action, there would be a net loss of up to eight days at the Wilna tract for other wildlife-dependent recreation, or 2.19% of the entire year.

Refuge Facilities

No impacts to refuge roads, trails, or other facilities are likely to be incurred by this alternative.

Cultural Resources

No impacts to known cultural or historic sites are likely to be incurred by this alternative.

Refuge Environment and Community

Some temporary negative impacts to habitats/vegetation and soils may be incurred by this alternative, if trucks and personnel are concentrated and off-road. The amount of damage is unquantifiable without knowing the frequency, distribution, density, and locations of bait and ambush stations. Nonetheless, the damage would be mostly in the form of trampling and rutting and would be temporary. The quantity is presumed to be less than that from overbrowsing by high deer populations.

No impacts to adjacent lands and associated natural resources would occur other than a positive response of the vegetation resulting from reduced deer browsing.

A high potential for disturbance of nearby residents exists from operations conducted at night, depending on proximity to houses. Conversely, a high potential for improvement with community relations also exists with this alternative if perceived as reducing herbivory by deer on landscaping plants and crops. Whether this would be a more significant impact over public hunting is not known.

As indicated earlier, this alternative would remove inputs to the local economy from indirect expenditures by out-of-town hunters. Impacts would be more greatly felt in smaller communities and would be less noticeable in larger towns with a diversity of attractions. There would be a loss of historic wildlife-dependent recreational opportunities in the local and regional community. The refuge provides excellent, high-quality, public hunting opportunities. In 2006, we issued over 400 permits to over 150 individual participants. As with Alternative 1, the refuge would fail to meet one of its objectives to provide opportunities for compatible scientific research, environmental education, and fish and wildlife-oriented recreation.

Summary—Impacts of Professional Deer Removal

The cumulative impacts that would accrue over time by removing deer using professional sharpshooters on the refuge would have a stabilizing effect on deer populations. Provided that measures were taken to avoid disturbing birds, this alternative would not negatively impact non-hunted resident wildlife populations. Over the long term, habitat used by deer and non-hunted species is less likely to be degraded due to overbrowsing by deer. There would likely be no effect on either of the refuge's threatened species. There would be some minor loss of opportunity for wildlife-dependent recreation other than hunting, but less than that due to the proposed alternative. There would be no impact on refuge facilities or cultural resources. There would be a potential loss of economic benefits and traditional recreational opportunities in the community, although some community members would likely appreciate the potentially higher numbers of deer removed. In summary, this alternative would be effective in managing the deer population but in general would not be in the best interests of the local community or the region, and would be inconsistent with the National Wildlife Refuge System Improvement Act.

4.4 Other Past, Present, Proposed, and Reasonably Foreseeable Hunts and Anticipated Impacts

No other hunts were conducted by the refuge in the past, are occurring now, or have been proposed. It is likely that the refuge's Comprehensive Conservation Plan (CCP) will contain a proposal to establish a spring wild turkey hunt and a waterfowl hunt. The timing of these future proposed hunts has not been determined, but the expected timeframes will be published in the CCP.

Regarding turkey hunting, we will likely propose only a spring gobbler hunt. We will likely limit waterfowl hunting to only two days per week, as we do at Plum Tree Island NWR, which is another refuge in the EVRNWRC. The immediate and cumulative impacts of these programs will be fully assessed prior to any proposed opening. We have the flexibility to limit the numbers of permits, days of the week, and times of day when hunting would be allowed to ensure that both hunted and non-hunted species receive adequate protection to ensure the long-term health and survival of these populations.

Spring gobbler season usually takes place in early April, during the onset of amphibian breeding and movement from wintering to breeding habitats. However, movements generally take place at night, while the turkey hunts are conducted during the day. Also, movement usually occurs around vernal pools and forested swamp, while turkey hunts are conducted more on the dry uplands. Disturbance to early returning migratory songbirds is expected to also be minimal, as birds are only just beginning to scout for and lay claim to breeding territories, and leaf out has not yet completed. Small mammals and basking reptiles may flush and seek cover temporarily in the presence of humans, but no lasting effect on their daily life cycles or local abundance is expected.

Waterfowl hunting would occur in the marsh, in the fall and early winter, and therefore would have little to no impact on non-hunted wildlife. Waterfowl would receive additional protection from a limited and highly regulated refuge hunt program over what occurs at present. Currently, hunters are free to establish permanent or floating blinds in close proximity to refuge lands and hunting can occur from these blinds during the entire State season. By exercising our riparian rights, we could reduce the local impact to waterfowl by requiring other hunters to remain at least 500 yards from a licensed refuge hunting location. At Plum Tree Island NWR, we limit hunting to Tuesdays, Saturdays, opening days and holidays.

We would ensure no negative impact to threatened and endangered species. We expect no impact to deer populations. There will be some additional loss of other wildlife-dependent recreational opportunity if we allow turkey hunting, but the season is short (31 days in 2007), and we would likely offer hunting for only a portion of those available dates. There should be no loss of other recreational opportunity due to waterfowl hunting. There would be additional potential benefits to the local economy resulting from more expenditures by visitors, and there would be additional opportunities for local citizens and others to engage in traditional wildlife-dependent recreation.

4.5 Anticipated Impacts if Individual Hunts are Allowed to Accumulate

As described in section 4.2 above, “Cumulative Impact of the Proposed Alternative—Managed Annual Public Hunt”, several factors play a collective role in preventing overharvest of deer in the region where the refuge is located (see page 28). These are the high reproductive potential of deer, the relative isolation and disjunct geographical location of the region, the limited geographic mobility, and the inaccessibility of much of the landscape (making it difficult for hunters to reach deer). Over time, as Northern Neck and Middle Peninsula of Virginia become more developed, and more rural land is converted into residential and commercial zones, deer

will be compressed onto smaller tracts of suboptimal habitat, as we have seen occur in northern Virginia. This will have a greater impact on deer health and population than hunting.

5.0 CONSULTATION AND COORDINATION WITH OTHERS

The draft environmental assessment is being forwarded to the following agencies, groups, and individuals for comments and review. In addition, a news release announcing the availability of the Draft EA for public review will be sent to local media servicing the area. Copies will also be placed at local libraries and in the Refuge headquarters.

A. Federal Agencies

- U.S. Fish and Wildlife Service, Northeast Region
- U.S. Department of Agriculture, Natural Resources Conservation Service
- National Park Service, George Washington Birthplace National Monument

B. State Agencies

- Department of Game and Inland Fisheries (Williamsburg and Fredericksburg Districts)
- Department of Environmental Quality, Division of Water Program Coordination
- Department of Agriculture & Consumer Services, Office of Plant & Pest Services
- Department of Forestry
- Department of Conservation and Recreation
- Department of Historic Resources
- Chesapeake Bay Local Assistance Department
- Virginia Marine Resources Commission

C. County Agencies:

- County Administrator, Caroline County
- County Administrator, Essex County
- Tappahannock Town Manager
- Warsaw Town Manager
- County Administrator, King George County
- County Administrator, Lancaster County
- County Administrator, Middlesex County
- County Administrator, Richmond County
- County Administrator, Westmoreland County

Northern Neck Planning District
Middle Peninsula Planning District
RADCO Planning District(Caroline and King George Counties)

D. Private Organizations:

Ducks Unlimited	Three Rivers Soil and Water Conservation District
The Nature Conservancy	Northern Neck Soil and Water Conservation District
Trust for Public Land	Local hunt clubs
Essex County Farm Bureau	

6.0 LIST OF PREPARERS

U.S. Fish and Wildlife Service, Rappahannock River Valley NWR

Sandy C. Spencer, Wildlife Biologist
Joe McCauley, Refuge Manager, reviewer

7.0. REGULATORY COMPLIANCE

As noted in the Introduction section, the Rappahannock River Valley National Wildlife Refuge (NWR) was opened for white-tailed deer hunting in 2002. Prior to the opening, all the necessary documents required for opening a national wildlife refuge to hunting were prepared. They included: A hunt plan, compatibility determination, environmental assessment, decision document (finding of no significant impact), Endangered Species Act section 7 evaluation, letter of concurrence from the Commonwealth of Virginia, draft news release, and draft refuge-specific regulations.

As the Refuge continued to expand and as we gained experience in managing the hunt over the past four seasons, some minor changes or adjustments were made. These primarily concern the administration of the hunt, particularly regarding hunter selection. In 2006, the Refuge joined other federally managed lands in the Commonwealth of Virginia's hunt registration system, where hunters can register online. We also carried out some predicted expansions to the hunt program, as indicated in the original version of the EA and Hunt Plan. This included opening up additional tracts to hunting. The tracts opened originally were the Tayloe, Wilna, and Wright tracts, totaling about 2,800 hunting acres. In subsequent years, Hutchinson, Laurel Grove, Mothershead, Toby's Point, and Port Royal tracts have been opened, increasing the hunting acreage to 5,088 acres. Another expansion included increasing the number of days from 6 to about 10 with one month of open season for archery on certain tracts in order to better accomplish deer population goals. None of these changes, either individually or cumulatively, will cause a significant change in the environmental impacts of our hunting program beyond what was predicted in 2001. The net effect of these changes will be to stabilize the local deer population, strengthen our management control over the procedures of the hunt, and to further reduce potential disturbance and impact to vegetation and wildlife.

The original Draft EA was made available for public review and comment on December 14, 2001. A news release was sent to local newspapers notifying the public that copies of the EA were available from the Eastern Virginia Rivers National Wildlife Refuge Complex office, and also available for review at the Essex County Public Library and the Richmond County Community Library. The comment period closed January 14, 2002. The Final Environmental Assessment was completed in February 2002 and made available for public review during the spring of 2002.

Public response to the revised draft EA

This Revised EA, and accompanying revised White-Tailed Deer Hunting Plan, was issued for public review and comment from March 15 to April 15, 2007. News releases were sent to the Northern Neck News, the Freelance Star, the Richmond Times Dispatch, the Rappahannock Times, the Rappahannock Record, the Caroline Progress, the Northumberland Echo, the Journal, the Southside Sentinel, the Westmoreland News, and other media outlets. The news release was published in several local and regional newspapers. Copies of the Draft revised EA were placed for review at the Essex County Library, the Richmond County Community Library, and at the Refuge Complex headquarters in Warsaw, Virginia. Copies could also be downloaded from the refuge website: www.fws.gov/northeast/rappahannock.

We received a total of 14 written comments on the Draft EA. Of these, 13 indicated support for the Service's proposed action of continuing a public deer hunting program. Those who wrote in support of the proposed action included representatives of four local hunt clubs and two county farm bureaus, five individuals, one church, and one non-profit organization, Safari Club International (SCI). Issues cited for their support included maintaining the health of the deer population, minimizing crop depredation, maintaining healthy vegetative communities, providing recreational opportunities, maintaining support for the refuge system, providing a source of donated food, and reducing the number of kill permits issued to farmers suffering crop damage.

Included among the comments from those who support the proposed action were some specific suggestions, including the following:

From the Richmond County and Westmoreland County farm bureaus: Both farm bureau responses indicated a desire to expand the number of days of the current deer hunting program. While we could expand the deer hunt within the parameters of the proposed action, there is currently no compelling reason to do so, as we have some remaining hunter capacity within the current program. We will continue to consult with the Virginia Department of Game and Inland Fisheries to ensure that our program is contributing to the overall State management goals for white-tailed deer, to the extent permitted by Federal law and policy.

From Safari Club International: The suggestion was made to highlight the cumulative impact of implementing the no action alternative on support for the refuge system that accrues from hunters, and that could be lost if hunting is curtailed. SCI also recommends noting the

cumulative benefit to refuge system habitats. We believe we have adequately assessed the cumulative impacts of the proposed action (see pages 24 to 34).

The Humane Society of the United States (HSUS) provided 23 pages of comments, generally in opposition to the Service's proposed action. The majority of the comments are general in nature and do not specifically reference this EA. However, some of the general comments relate to the processes undertaken in this EA and deer management in general. We provide the following responses to correspond to the headings found in the general HSUS comment letter:

Procedural objections - HSUS alleges inadequate notice and availability of the draft documents, and suggests that the Service provided itself with inadequate time to conduct a thorough analysis of impacts. **Response:** We note the comment, but disagree with its findings. The original EA was released for public comment and review prior to opening to public deer hunting for a 32-day period. The Final EA was also made available for public review. The draft and final rules were published in the Federal Register prior to opening in 2002. The revised EA provided approximately 10 pages of additional information concerning the cumulative impacts of the three alternatives we examined, and was available on the refuge website and other locations for 31 days.

FWS Legal Obligations – HSUS refers to several laws, among them the Refuge Recreation Act, National Wildlife Refuge System Administration Act, and the National Wildlife Refuge Improvement Act. HSUS cites requirements regarding available funding, compatibility standards, and monitoring, and alleges a failure by the Service to comply with these requirements. **Response:** We note the comments but disagree with its findings. Within the staffing and management capability funding provided for refuge operations, there is sufficient funding to conduct the proposed action. In addition, we charge hunters a fee, the proceeds of which are used to maintain the hunting program in accordance with Federal law. A compatibility determination was conducted by the refuge manager and approved in 2002. HSUS suggests hunting is incompatible because of the potential impact on other users. However, non-hunting users have many more opportunities to engage in other compatible recreational activities than do hunters. We work cooperatively with the Virginia Department of Game and Inland Fisheries to monitor deer populations in the counties where the refuge is located. We have also engaged in monitoring other wildlife populations and their habitats, including breeding birds, wintering birds, endangered and threatened species, rare plant communities, fish, frogs, butterflies, and others.

NEPA Compliance – HSUS alleges that the Service has failed to comply with the provisions of the National Environmental Policy Act. Specifically mentioned are prior litigation and cumulative impacts, a reasonable range of alternatives, and public participation. Regarding prior litigation and cumulative impacts, HSUS alleges that the Service has failed to comport with the requirements of the lawsuit that resulted in the issuance of this revised EA. HSUS also alleges the Service failed to evaluate a reasonable range of alternatives, including non-lethal methods of population control. Lastly, HSUS alleges the Service failed to meaningfully engage the public. **Response:** Regarding cumulative impacts, we issued this revised EA in order to better address the cumulative impacts of our proposed action and other alternatives. Pages 24-34

of this document address the cumulative impacts to white-tailed deer, non-hunted wildlife, threatened and endangered species, other wildlife-dependent recreation, refuge facilities, cultural resources, the community and environment, and the economy. Regarding alternatives, we examined a reasonable range of alternatives, including three non-lethal alternatives that were eliminated from consideration early due to reasons stated on pages 45-47. We fully evaluated three additional alternatives, including the no action alternative. Regarding public involvement, we have continuously engaged with the public on deer hunting since 2002. We have made minor modifications to our program in response to concerns from citizens. As noted above, we fully complied with NEPA guidelines in soliciting public comments on the original and revised draft EAs. We posted the draft revised EA on our website, along with our revised hunt plan, to give interested parties from across the country an opportunity to comment. We received 14 written comments, which in our experience, is more than we typically have received in response to other EAs issued from this refuge.

ESA Compliance – HSUS alleges non-compliance with the Endangered Species Act regarding preparation of a Biological Assessment and Biological Opinion. **Response:** In addition to the in-depth analysis we conducted as part of this document, we also completed a Section 7 Intra-Service Evaluation. This evaluation determined that the proposed action is not likely to have an affect on the bald eagle, thereby negating the requirement for a Biological Assessment and Biological Opinion. We are in full compliance with the Bald Eagle Management Guidelines for Virginia, prepared jointly by the Service and the Center for Conservation Biology at the College of William and Mary. The refuge manager has determined that the proposed action will have no effect on the sensitive joint-vetch. There are no other threatened species known to occur on existing refuge lands.

Role of Non-Consumptive Wildlife Recreation – HSUS discusses trends in wildlife recreation showing increases in non-consumptive use and decreases in hunting. They suggest that the Service has failed to capitalize on these trends in terms of potential economic gain for the refuge system. **Response:** Congress has provided clear direction to the refuge system by listing six priority uses and encouraging refuges to accommodate these uses where they are compatible. There is no hierarchy within the six priority uses, and we currently provide opportunities for all six at this refuge. As noted above, non-consumptive users have many more opportunities to engage in compatible recreation than do hunters on the refuge tract that is open daily, 96% of the calendar year for non-consumptive users versus 4% for hunters.

Potential Hunts Proposed on National Wildlife Refuges – HSUS mentions several types of hunting in this section of their comment letter, but only one, deer hunting, pertains to this EA. In their general comments, HSUS states that overpopulation is not a scientific term but is tied more to human perceptions and values. HSUS discusses deer populations and notes that many landscapes in the United States are highly altered and deriving natural deer population levels is nearly impossible. They state that deer are a part of the ecosystems in which they reside and can be a “keystone species or an ecosystem engineer.” They acknowledge that deer can result in community-wide changes of vegetation. HSUS further states that they found no studies showing ecosystem effects of white-tailed deer herbivory and that browsed and unbrowsed forests eventually reach the same climax condition. Lastly, they claim there is no data regarding

a decrease in vehicle collisions from hunting. **Response:** We generally agree with these statements. We often refer to overpopulation in terms of “cultural carrying capacity” in addition to the biological carrying capacity. We have objectives to manage habitats for a variety of fish and wildlife species, with an emphasis on migratory birds. As HSUS acknowledges, deer can have a substantial local impact on vegetative communities. In this case, deer can impact understory and mid-story vegetation to the detriment of bird species whose habitats we are working to protect and enhance. Therefore, in our professional judgment, and based on our wildlife objectives, deer can be considered to be overpopulating prior to the point where they begin to show serious signs of biological overpopulation such as malnutrition, disease, starvation, and manifestations of genetic inbreeding. The reason deer are referred to as keystone species or ecosystem engineers is due to their ability to have significant effects on the communities where they reside. We agree that deer are a part of the ecosystems where they reside, and no where in this document do we propose to eliminate deer from the landscape, but rather to manage them in balance with their habitats and those used by other species. Most of the land we manage on this refuge is far from reaching a climax forest condition. We are managing grasslands, shrublands, early successional forests, and some more mature forests. Therefore the claim that deer have little or no impact on the eventual climax forest condition is irrelevant. We do not cite any specific literature regarding deer vehicle relationships. HSUS cites one study that, according to comments in their letter, “found an increase in collisions leading up to a peak on the first day of hunting season with a steady decline thereafter.” This would suggest that hunting does indeed cause a decline in the number of deer/vehicle collisions, at least during the hunting season.

Summary of public comments

In summary, we received a total of 14 written comments, 13 in support, and one from the Humane Society of the United States generally opposing hunting but not specifically commenting on this document. All comments were considered. We believe we have provided sufficient and well-documented justification for a finding of no significant impact under the National Environmental Policy Act.

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9.0 APPENDIX

Alternatives Considered but Dismissed

1) Reproductive intervention:

Reproductive intervention or birth control is the general category for a number of fertility control methods available, each with varying rates of success. Immunocontraception with porcine zona pellucida (PZP) vaccine injection, is probably the best known and most widely applied. Steroid implantation has been available since the 1970s. Remote prostaglandin injection (Denicola 1997), oral vaccination with a live vector (Miller et al. 1999a), and GNRH vaccines are more recent and lack long-term evaluation of effectiveness. Sterilization is a permanent option, although not widely applicable. Effectiveness and efficiency of any of the above forms of reproductive intervention is affected by a number of factors including method of application or delivery, need or ability to capture the animal, the number of treatments needed to ensure effectiveness, size of the population, status of the population (confined or free ranging), and longevity of treatment.

Immunocontraception (PZP injection) is most effective at preventing pregnancy when hand injected and combined with subsequent boosts. The PZP vaccination produces reversible infertility lasting 1-4 years (Miller et al. 1999b), however, it requires two injections, four weeks apart, to be effective for at least two years (McShea et al. 1997). Effectiveness at reducing population number and growth rate is greatly reduced when dealing with large and open populations due to the need to treat a large percentage of the females over a large area. For a large population, contraception rates of less than 50% of does will curb growth in 30 years, but will not reduce the size. Even rates of greater than 50% require at least a 5-10 year planning horizon to see significant population declines (Seagle and Close 1996). Therefore, the cost, effort, expertise, manpower, and handling time will continue for years before achieving any results.

Another obstacle to PZP immunocontraception is the adjuvant used for the initial injection (an adjuvant is a microbial aid necessary for boosting the vaccine once inside the animal's bloodstream). Complete Froine's, the most commonly used, contains heat-killed tuberculin cells, which causes subjects to test false positive for TB. The FDA, which has jurisdiction over its commercial use, currently does not permit use of this adjuvant on other than tightly controlled or isolated populations and in combination with ear-tagging (in order to prevent the public from consuming escaped deer). There are two other adjuvants undergoing field tests but both are not yet effective as boosters and still pending FDA approval (Rick Naugle, 2000, August. Humane Society of the U.S. Pers. Comm.).

Subcutaneous steroidal implants have been used during the past 25 years with varying rates of effectiveness in reducing deer pregnancy (and now remote delivery of this treatment is possible) but the long-term effectiveness is uncertain. In addition, the same factors that confound the PZP method at the population level apply (Connecticut Department of Environmental Protection 1988). Because of the uncertainty of long-term health effects on deer and subsequent impacts on

the food-web (including human consumption of treated deer), the FDA will not approve application on free-ranging deer at this time (DeNicola et al. 2000).

Oral delivery of contraceptives has a number of concerns that make this method ill-advised and impractical: it is not species-specific (risks ingestion by non-target species), bait and supplies are wasted on non-target species, deer sometimes reject treated bait, and it is difficult to manage dosage control. Currently, the method is not working at the field or captive level. Oral vaccinations through live-vector delivery is a relatively new method, and is species-specific, but is not long-acting and so must be delivered on a frequent and regular basis (Alan Rutberg, 2000, August. Humane Society of the U.S. Pers. Comm.).

Another field method currently being tested is the Gonadotropin Reducing Hormone (GnRH) vaccine. Continued exposure to GnRH results in reduced production of reproductive hormones of both sexes (leutenizing and follicle stimulating hormones for females, testosterone in males). Its effects are dramatic, even on behavior and antler development. This is a new method and the affect on deer and their behavior needs further evaluation prior to application in the field (Ibid.).

Sterilizations must be done annually, the number of which must be calculated based on the number of fertile females in the herd. Great care must be taken to reduce the number of sterilizations in time to prevent a population crash and bottleneck (Boone and Wiegert 1994). Again, this option is not effective for open populations unless performed at a landscape level.

No matter which birth control method is used, more than 50% of the females will need to remain infertile to effect a reduction in population size (Hobbs et al. 2000, Seagle and Close 1996). All of the above described techniques are compromised at the individual and population levels due to the openness of the population. Because these operations entail multiple captures, considerable handling time, facilities for holding captured animals or conducting surgery, risk to personnel and animals, trauma losses, and constant or recurring expense means that at this stage of development they are not viable methods in the field. This situation may change in a few years as applications of these techniques are improved upon.

2) Live trapping and relocation:

The live trapping and relocation approach entails transporting captured animals to a new location outside the impacted area. Disadvantages, however, far outweigh the advantages. Capture and handling of deer involves risk to deer and handlers. Deer are susceptible to capture myopathy, a form of muscle dysfunction that is stress-related and can result in delayed mortality. Trauma losses can amount to about 4% of capture and transfer efforts (Virginia Department of Game and Inland Fisheries, 1999. Wildlife Information Publication). The mortality potential attendant to handling is amplified by placing individuals in unfamiliar surroundings (Cypher and Cypher 1988).

Finding suitable release sites is increasingly more difficult as most locations cannot accommodate more deer and are experiencing their own population management problems. A further complication to this alternative is the recent increase in Lyme-Disease. Northern Virginia deer, for example, are infested with a type Lyme Disease-bearing ticks not found in more distant

populations (Dan Lovelace. 2000, July. Biologist. Virginia DGIF Pers. Comm.).

3) Habitat management and fencing:

This approach manipulates the existing habitat to induce behavioral changes in deer and reduce human/deer conflicts. An example would be to lower the biological carrying capacity by removing forage species, and/or changing landscape elements such as water features, forest edge, or construction of enclosures. This alternative is incompatible with one of the management goals for the Refuge, which is to promote and maintain its grassland habitats for grassland breeding birds, the very type of habitat that is also favorable to deer. This alternative is also confounded by the ready availability of crops, such as corn, so near to Refuge units. Equally unfeasible would be enclosure of Refuge units, as this would interfere with the normal and necessary movements of many species of wildlife and pose a hazard to deer that attempt to breach the fence, and be beyond the maintenance abilities of a limited staff.

In addition to the practical and ecological concerns listed above, selection of any of these alternatives, would prevent the Refuge from realizing the potential to offer hunting opportunities to the public. Hunting is a priority public use of the National Wildlife Refuge System and is encouraged where it is compatible with Refuge purposes.