UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES

FINAL ENVIRONMENTAL ASSESSMENT

for the

Management of predation losses to native bird populations on the barrier and Chesapeake Bay islands and coastal areas of the Commonwealth of Virginia

Prepared by:

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES
P.O. Box 130
Moseley, Virginia 23120

In Cooperation With:

UNITED STATES DEPARTMENT OF INTERIOR, FISH AND WILDLIFE SERVICE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

VIRGINIA DEPARTMENT OF GAME AND INLAND FISHERIES

October 26, 2005

SUMMARY OF PROPOSED ACTION

The United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS) program proposes to continue the current predator damage management program to restore and protect native bird populations nesting on coastal areas, barrier islands, and Chesapeake Bay islands within the Commonwealth of Virginia. Upon request for assistance, WS would provide technical assistance; remove raccoons, opossums, and red foxes from coastal, barrier, and Chesapeake Bay islands; disperse or move gull nesting colonies; and disperse or remove predatory gulls (laughing gulls, herring gulls, great black-backed gulls), fish crows, American crows, and common grackles to alleviate predation to threatened and endangered bird species, colonial nesting waterbirds, shorebirds, black ducks, and their nests and eggs. To the extent possible and as budgets allow, predator damage management would be conducted on private and public lands in Virginia when the resource owner (property owner) or land manager requests WS assistance.

Under the proposed action, WS would provide technical assistance which includes: instructional sessions; technical and biological information about raccoons, opossums, red foxes, gulls, crows, and grackles; information about habitat alterations, and harassment and dispersal methods; selling or distributing harassment tools to resource owners and land managers; and lethal damage management methods (e.g. migratory bird depredation permits). WS would assist resource owners and land managers with the U.S. Department of Interior, Fish and Wildlife Service migratory bird depredation permit process to obtain permits to lethally remove gulls to reinforce harassment programs and to destroy gull nests with eggs. As appropriate, WS would conduct direct damage management assistance with nonlethal and lethal methods. Nonlethal methods used by WS would include the use of pyrotechnics, lasers, electronic harassment, modified electric fencing around nests, effigies, repellents (e.g. Measurol), and habitat alteration. Lethal methods used by WS would include denning, shooting, M-44's, avicides (e.g. DRC-1339, Avitrol), gas cartridges, nest/egg destruction, and live capture (traps, snares, nets, etc.) followed by euthanasia. All management activities, including disposal requirements, would comply with appropriate Federal, State, and Local laws.

In most circumstances, WS recommends and utilizes an Integrated Wildlife Damage Management approach to manage wildlife conflicts. An integrated approach allows for lethal and nonlethal methods to be used sequentially or simultaneously. In this case, the data indicates a mutually exclusive relationship exists between these nesting native birds and mammalian predators. Therefore, various methods will be implemented sequentially with lethal methods used first on raccoons, opossums, and red foxes living on islands. Lethal methods would be followed up with nonlethal damage management methods such as harassment, exclusion, and habitat alteration where appropriate, effective, or practical to achieve native bird population restoration goals. A simultaneous integrated wildlife damage management approach would be used on gulls, crows, and grackles. In those situations where resource owners or land managers have already adopted a predator management plan that encompasses such a predator management approach, WS action would be to assist in the implementation of the integrated wildlife damage management program identified in the management plan.

Implementation of the proposed action would result in major beneficial impacts to threatened species such as piping plovers, Wilson's plovers, and gull-billed terns. The cessation or reduction of mammalian and/or avian predation on nesting threatened and endangered species, colonial waterbirds and shorebirds of management concern, and American black ducks would result in increased chick or duckling survival and fledgling, and eventually increased populations of these bird species. Other species that would indirectly benefit from this action would include nesting endangered loggerhead sea turtles and the diamond-back terrapin, a state species of management concern. An increase of colonial waterbirds, shorebirds, and black ducks would have major societal and ecological benefits. These bird species are considered valuable to bird watchers, ecologists, environmentalists, hunters, outdoor recreationalists, and local governments.

The level of take by WS would vary greatly each year due to funding and the number of and scope of requests for assistance to protect nesting shorebirds, colonial waterbirds, and black ducks nesting on islands and coastal areas of Virginia. As part of WS damage management activities, WS estimates that it will take no more than 500 raccoons, 50 red fox and 50 opossums per year. Raccoon, opossum and red fox populations on coastal, barrier, and Chesapeake Bay islands would be reduced or eliminated. Raccoon, opossum and red fox populations on the mainland would largely be unaffected by these actions and are expected to remain high. Laughing gulls, which are

native and were historically present in Virginia, and herring and great black-backed gulls, which neither were historically present to Virginia, would be managed to reduce or eliminate predation to native bird populations. Management actions would not reduce populations of these three gull species in Virginia below the 1984 population levels of 32,000 pairs of laughing gulls in 30 colonies, 3,000 pairs of herring gulls in 20 colonies, and 150 pairs of great black-backed gulls in 10 colonies. Gull management goals, including maintaining gull populations at or above 1984 population levels, were made by the Avian Partnership Council of Virginia and would be expected to provide moderate benefits for threatened and endangered species and nesting birds of management concern. Based upon current nesting population levels in Virginia, WS estimates that it could initially take up to 13,208 adult or juvenile laughing gulls, 1,200 adult or juvenile herring gulls, 1,000 adult or juvenile greater black back gulls, 750 sub-adult laughing gulls, 150 sub-adult herring gulls, and 100 sub-adult greater black back gulls; and other government agencies and individuals could take up to an additional 13,604 adult, sub-adult, or juvenile laughing gulls, 1,870 adult, sub-adult, or juvenile herring gulls, 872 adult, sub-adult, or juvenile greater black back gulls without causing nesting gull populations to drop below 1984 population levels. In addition, WS may take up to 1,000 great black-back gull nests, 1,200 herring gull nests, and 11,866 laughing gull nests. Other government agencies and individuals may take up to 500 great black-back gull nests, 1,501 herring gull nests, and 2,000 laughing gull nests. Management actions would be monitored to assure that gull populations in Virginia would not fall below 1984 population levels. If any population of gulls is reduced to the 1984 level, additional removal efforts would only be undertaken when gull populations exceed the 1984 population levels. As part of WS damage management activities, WS estimates that it will take no more than 100 common grackles and 200 crows per year. Common grackle and crow populations would largely be unaffected by these actions and are expected to remain high.

ACRONYMS

APHIS	Animal and Plant Health Inspection Service
AVMA	American Veterinary Medical Association
CCC	Cultural Carrying Capacity
CFR	Code of Federal Regulations
EA	Environmental Assessment
EIS	Environmental Impact Statement
EJ	Environmental Justice
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FY	Fiscal Year
IPM	Integrated Pest Management
IWDM	Integrated Wildlife Damage Management
MIS	Management Information System
MBTA	Migratory Bird Treaty Act
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
PM	Predator Management
SOP	Standard Operating Procedure
T&E	Threatened and Endangered
USGS	United States Geological Survey
USC	United States Code
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
USFWS	USDI, Fish and Wildlife Service
USN	United States Navy
VAC	Virginia Annotated Code
VDGIF	Virginia Department of Game and Inland Fisheries
WS	Wildlife Services

1.0 CHAPTER 1: PURPOSE AND NEED FOR ACTION

1.1 Introduction

The United States Department of Agriculture (USDA) is authorized and directed by law to protect American agriculture and other resources from damage associated with wildlife. The primary statutory authority for the USDA, Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) program is The Act of March 2, 1931, as amended (7 U.S. C. 426-426c; 46 Stat. 1468); the Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988 (P.L. 100-202); and the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act of 2001 (P. L. 106-387, October 28, 2000. Stat. 1549 (Sec 767)). WS activities are conducted in cooperation with other federal, state and local agencies; and private organizations; and individuals. Federal agencies, including the United States Department of Interior (USDI), Fish and Wildlife Service (USFWS), recognize the expertise of WS to address wildlife damage issues related to migratory birds.

Wildlife damage management, or control, is defined as the alleviation of damage or other problems caused by or related to the presence of wildlife. It is an integral component of wildlife management (Leopold 1933, The Wildlife Society 1990, Berryman 1991). The WS program uses an Integrated Wildlife Damage Management (IWDM) approach (sometimes referred to as Integrated Pest Management or IPM) in which a combination of methods may be used or recommended to reduce wildlife damage. IWDM is described in Chapter 1, 1-7 of The Animal Damage Control Program Final Environmental Impact Statement (USDA 1997). These methods include the alteration of cultural practices as well as habitat and behavioral modification to prevent damage. The control of wildlife damage may also require that the offending animal(s) be removed or that populations of the offending species be reduced through lethal methods.

Biological carrying capacity is the land or habitat's limit for supporting healthy populations of wildlife without degradation to the animals' health or their environment over an extended period of time (Decker and Purdy 1988). Wildlife acceptance capacity, or cultural carrying capacity, is the limit of human tolerance for wildlife or the maximum number of a given species that can coexist compatibly with local human populations (Decker and Purdy 1988). These terms are especially important in urban areas because they define the sensitivity of a local community to a specific wildlife species. For any given damage situation, there will be varying thresholds by those directly and indirectly affected by the damage. This threshold of damage is a primary limiting factor in determining the wildlife acceptance capacity. While the Commonwealth of Virginia has a biological carrying capacity to support more than the current number of raccoons, opossums, red foxes, gulls, grackles, and crows, the wildlife acceptance capacity is often much lower. Once the wildlife acceptance capacity is met or exceeded, people will begin to implement population or damage reduction methods, including lethal management methods, to alleviate damage and public health or safety threats (Loker et al. 1999).

WS's mission is to "provide leadership in wildlife damage management in the protection of America's agricultural, industrial and natural resources, and to safeguard public health and safety." This is accomplished through:

A) training of wildlife damage management professionals;
B) development and improvement of strategies to reduce economic losses and threats to humans from wildlife;
C) collection, evaluation, and dissemination of management information;
D) cooperative wildlife damage management programs;
E) informing and educating the public on how to reduce wildlife damage and;
F) providing data and a source for limited-use management materials and equipment, including pesticides (USDA 1989).

This Environmental Assessment (EA) evaluates ways by which this responsibility can be carried out to resolve conflicts with raccoons, opossums, red foxes, gulls, grackles, and crows preying on and/or suppressing nesting native bird populations on barrier and Chesapeake Bay islands and coastal areas in the Commonwealth of Virginia. This analysis relies mainly on existing data contained in published documents, including the Animal Damage Control Final Environmental Impact Statement (USDA 1997). The WS activities listed under the proposed action will be undertaken in compliance with relevant laws, regulations, policies, orders, and procedures including the Endangered Species Act. A Notice of Availability of the EA (pre-decisional and final) will be published consistent with APHIS NEPA procedures to allow interested parties the opportunity to obtain and review the document and comment on the proposed management activities.

WS is a cooperatively funded and service oriented program. Before any operational wildlife damage management is conducted, *Agreements for Control* or *WS Work Plans* must be completed by WS and the land owner/administrator. WS cooperates with private property owners and managers and with appropriate public land and wildlife management agencies, as requested, with the goal of effectively and efficiently resolving wildlife damage problems in compliance with all applicable federal, state, and local laws.

Individual actions on the types of sites encompassed by this analysis may be categorically excluded under the APHIS Implementing Regulations for compliance with the National Environmental Policy Act (NEPA) (7 CFR 372.5(c)). APHIS Implementing Regulations also provide that all technical assistance furnished by WS is categorically excluded (7 CFR 372.5(c)) (60 Federal Register 6,000 - 6,003 (1995)). WS has decided to prepare this EA to assist in planning predator management (PM) activities and to clearly communicate with the public the analysis of cumulative impacts for a number of issues of concern in relation to alternative means of meeting needs for such management. In addition, this EA has been prepared to evaluate and determine if there are any potentially significant cumulative impacts from the proposed and planned damage management program. This analysis covers WS's plans for current and future PM actions wherever they might be requested within the coastal ecosystems of the Commonwealth of Virginia.

1.2 Purpose

The purpose of this EA is to analyze the potential effects of WS activities in Virginia for the management of raccoon (Procyon lotor), opossum (Didelphis virginiana), red fox (Vulpes vulpes), laughing gull (Larus atricilla), herring gull (Larus argentatus), great black-backed gull (Larus marinus), fish crow (Corvus ossifragus), American crow (Corvus brachyrhynchos), and common grackle (Quiscalus quiscula) predation on native ground nesting threatened and endangered birds, colonial nesting waterbirds, and black ducks nesting on barrier islands, and Chesapeake Bay islands and coastal areas within the Commonwealth of Virginia. A second purpose is to organize a more effective native bird population restoration program by coordinating and uniting efforts of multiple federal agencies, state agencies, and private organizations. Throughout the remainder of this document laughing gulls, great black-backed gulls, and herring gulls will be referred to as gulls and fish and American crows will be referred to as crows.

1.3 Need For Action

The Virginia barrier and Chesapeake Bay island system (Appendix C) has long been renowned for hosting large numbers of nesting, migrating, and wintering colonial waterbirds, waterfowl, shorebirds, raptors, and songbirds (TNC and NOAA 1996). The islands have remained isolated, uninhabited by humans, and relatively little changed except by natural forces (Dueser et al. 1976). Recognition of the islands unique role in providing critical habitat has motivated several federal and state agencies and The Nature Conservancy to acquire portions of the barrier island landscape for enhanced protection. Many threats, including habitat loss and degradation, severe weather events, predation, disease, sea level rise, water quality decline, and human disturbance, place the avian communities in jeopardy (Erwin et al. 2003, Erwin et al. 2001, TNC and NOAA 1996). Of these threats to avian bird communities, predation is one of the few factors that is manageable (B. Truitt, The Nature Conservancy, pers. commun.).

Many avian species nesting on the Virginia barrier islands are in decline (Table 1). These species appear to be in decline due to predation on nesting birds or disturbance of nesting colonies by mammalian and avian predators (Wilke 2004, Wilke and Beck 2002, Erwin et al. 2001, T. Kain 1996, Hecht et al. 1996, Patterson et al. 1991, Cross 1991). The barrier islands provide extensive habitat for 27 beach and colonial nesting birds (Dueser et al. 2001, Moncrief et al. 1998). Declining species include common terns (Sterna hirundo), least terns (Sterna antillarum), royal terns (Sterna maxima), black skimmers (Rynchops niger), American oystercatchers (Haematopus palliatus), black ducks (Anas rubripes) and several herons (Williams et al. 2001). The piping plover (Charadrius melodus), a federal listed threatened species, Wilson's plover (Charadrius wilsonia), a state listed endangered species, and gull-billed terns (Sterna nilotica), a state listed threatened species, are also found nesting on some of the Virginia barrier islands. Some species, such as brown pelicans (Pelecanus occidentalis) and royal terns, have a portentous and precarious presence because they nest on only two islands in Virginia.

Native ground nesting birds are valuable public and natural resources in Virginia. The proposed action would increase the abundance of some native bird populations that ground nest on barrier, and Chesapeake Bay islands and coastal areas and whose populations have declined, in part, due to predation by native and introduced mammals, unprecedented population growth of gulls, increases in the crow population, and from common grackles (Table 2 and 3). The bird

species this action intends to benefit are piping plovers, a federally listed threatened species; Wilson's plovers, a state (Virginia) listed endangered species; gull-billed terns, a state (Virginia) threatened species; black ducks, a species of special concern; and various colonial and beach nesting waterbirds that are considered species of special concern by state and federal listing. These colonial nesting waterbirds include American oystercatchers, black skimmers, common terns, least terns, and brown pelicans. The term "a species of special concern" has no legal standing, but is a biological term used to describe species whose population status is of concern to state and federal wildlife management agencies because of population decline and is headed towards a more high profile status.

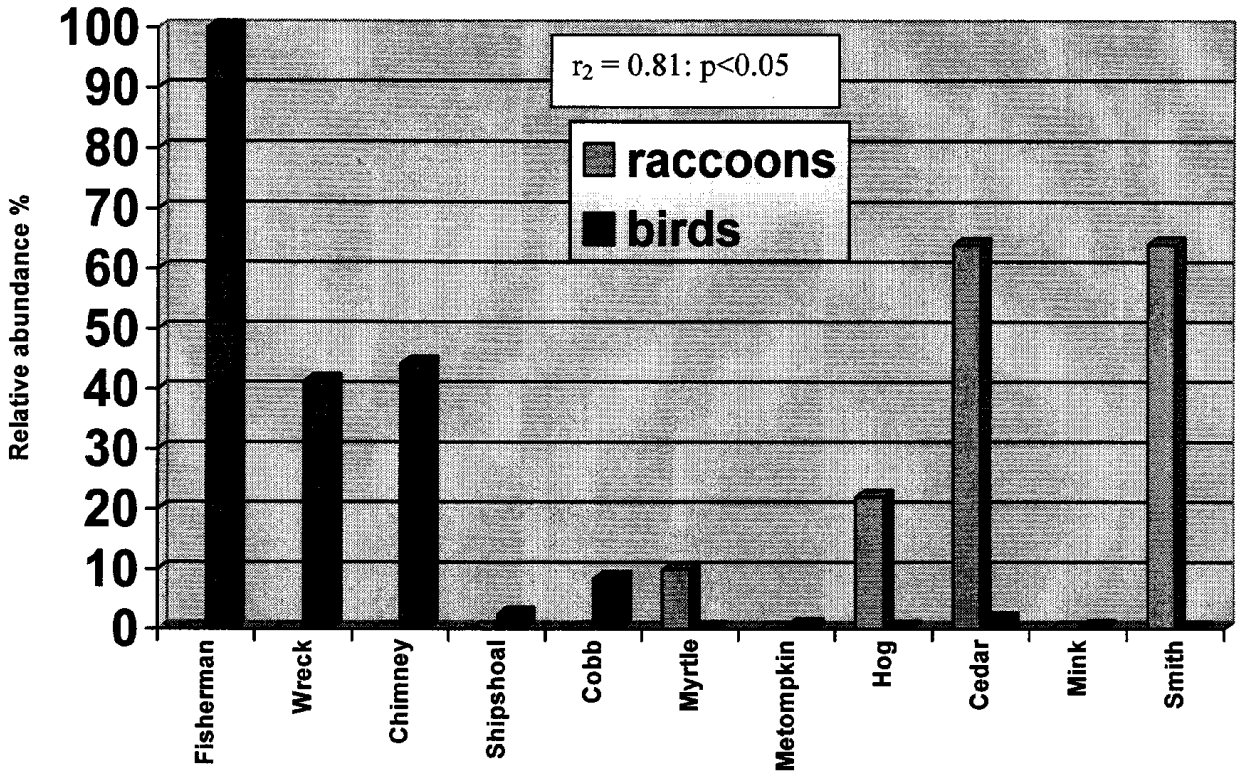


Figure 1. Relative abundance of nesting birds versus raccoons on barrier islands in Virginia, 1999. Data from The Nature Conservancy.

The native ground nesting birds this proposed action intends to benefit are preyed upon by native and introduced mammalian predators and abundant avian predators. The rates of predation on ground nesting bird eggs increase when predator density and diversity increase (Lariviere 2004). Mammalian predators include raccoons, a native species (Linzey 1998, Kaufmann 1982); red foxes, a species introduced from Europe by colonists (Kamler and Ballard 2002, Linzey 1998, Samuel and Nelson 1982, Paradiso 1969), and opossums, a species which has expanded its range northward since Europeans colonized North America (Gardner 1982). The avian predators include herring gulls, laughing gulls, great black-backed gulls, fish crows, American crows, and common grackles. Herring and great black-backed gulls have expanded their range out of the Canadian Maritimes into Virginia. Laughing gulls and both crow species have increased in abundance greatly in the 20th century (Sauer et al. 2004).

Raccoons began colonizing the barrier islands in the early 1900's. Some of the first records report Assateague and Chincoteague Island being colonized by raccoons in 1912 (Peninsula Enterprise, Chincoteague Notes, October 26,1912). Since the mid-1970's there has been a marked increase in the distribution and abundance of raccoons and red fox on Virginia's barrier islands (Erwin et al. 2001). In 1975-1977 only 6 of 11 barrier islands surveyed had red fox or raccoons, but by 1998, 11 of 14 barrier islands surveyed had red fox or raccoons (Erwin et al. 2001). Lariviere (2004) analyzed four hypothesis to explain range expanision of raccoons into the Canadian prairies and concluded the availability of food helped raccoons colonize new areas. He also concluded that raccoon introductions, meso-predator release (i.e., coyotes),

Table 1. Total number of colonial nesting waterbirds by island and by year on Virginia's barrier islands. Data is from B. Watts, College of William and Mary.

	Assa	Metom	Cedar	Das Shl	Parra	Sandy	Chm Pl	Hog	Rogue	Cobb	L. Cob	Wreck	Shp Shl	Gdwn	Mink	Myrtle	Smith	Fish	Total
1975	0	9498	158	198	346	470	170	2166	6	484	1400	3146	2530	0	0	1962	1294	6698	30526
1976	0	10668	116	380	204	290	5042	5925	0	406	1106	5150	1200	0	0	1094	2298	10356	44235
1977	88	7304	170	798	220	670	900	2256	84	3070	1692	8224	2084	0	126	1107	3392	19029	51214
1978	8	8444	42	423	132	0	427	1615	83	2292	764	8040	1286	0	0	548	1791	2121	28016
1979	0	5896	65	324	4	180	558	2137	0	1041	1188	16768	1042	75	95	407	3597	2434	35811
1980	0	8517	150	374	0	0	719	1816	0	1542	2402	3957	2534	0	0	462	2412	6624	31509
1981	0	10574	475	490	0	0	542	2491	0	2532	564	14586	2564	0	0	498	3102	5495	43913
1982	0	9322	198	602	0	192	1452	2250	0	1068	4	17663	1920	0	0	289	3298	5263	43521
1983	0	8052	525	1053	0	110	1436	2106	0	1675	0	10046	8066	0	0	610	1716	2550	37945
1984	0	7646	302	758	0	0	974	1266	0	1200	0	16370	4429	0	0	265	2083	5403	40696
1985	0	5397	176	82	0	67	712	1366	0	877	0	19980	1143	0	0	68	222	5977	36067
1986	24	11518	494	217	0	74	1290	1499	0	902	0	22809	2791	0	0	57	188	5853	47716
1987	100	7388	915	270	0	76	580	1359	0	1154	0	19248	2648	0	0	9	341	5570	39649
1988	18	1649	1377	381	0	28	523	1697	0	493	186	22925	2834	0	0	0	24	6903	39038
1989	6	610	1499	349	0	435	860	1009	0	220	1990	8879	1839	0	0	247	25	6733	24701
1990	0	578	1622	0	0	457	702	551	0	528	1818	9707	116	6	0	40	0	5475	21600
1991	0	397	2555	244	0	79	702	405	0	1004	3242	13861	125	0	0	53	0	6804	29471
1992	20	1243	1132	400	0	221	922	124	0	1495	1691	11049	146	0	0	4	0	5559	24006
1993	119	2048	1224	0	0	95	879	151	0	1017	646	9905	400	0	0	61	8	6271	22824
1994	50	1775	971	0	0	98	1370	72	0	801	105	5170	76	0	0	21	4	8107	18620
1995	66	963	2650	21	0	28	748	161	0	844	696	1222	667	0	0	76	0	9296	17438
1996	170	12	1550	151	0	108	928	115	0	1295	133	3437	185	0	0	0	14	11018	19116
1997	18	106	852	6	0	231	1073	282	0	975	326	1532	813	0	0	33	0	12041	18288
1998	0	167	671	650	0	234	790	96	0	408	725	2186	10	0	0	108	0	13537	19582
1999	6	29	418	749	0	373	744	22	0	800	289	1998	88	42	42	4	0	10434	16038
2000	22	47	1077	0	0	660	603	136	0	604	523	1990	390	0	0	50	0	8772	14874
2001	23	196	654	25	0	619	537	0	0	696	715	3749	20	0	0	18	0	9226	16478
2002	36	249	1486	0	0	480	493	0	0	580	415	3983	38	0	0	11	0	5453	13224
2003	78	163	1372	0	0	608	536	0	0	604	368	4419	34	0	137	28	2	3653	12002

Acronyms are Assa = Assawoman Island, Metom = Metompkin Island, Cedar = Cedar Island, Das Shl = Dawson Shoal, Parra = Parramore Island, Sandy = Sandy Marsh, Chm Pl = Chimney Pole Marsh, Hog = Hog Island, Rogue = Rogue Island, Cobb = Cobb Island, L. Cob = Little Cobb Island, Wreck = Wreck Island, Shp Shl = Ship Shoal Island, Gdwn = Godwin Marsh, Mink = Mink Island, Myrtle = Myrtle Island, Smith = Smith Island, and Fish = Fisherman Island.

and availability of denning sites are implausible for explaining raccoon colonization of the Canadian prairie. We believe the seasonal abundance of natural foods on the barrier islands and agricultural foods on the mainland contributed to the abundance and colonization of the islands by raccoons.

Range expansion of opossums was encouraged by human activities, including relocation (Gardner 1982) and translocation. The opossum was native to Virginia in the 1500's, but their range did not include the Eastern Shore of Virginia until the early 1900's (Gardner 1982). Opossums were reported in Northampton County, Virginia in 1947 (Handley and Patton 1947). The first opossum was captured on a barrier island (Assawoman) in 2002 (J. Woods , USDA-APHIS-WS and B. Truitt, The Nature Conservancy, pers. commun.).

The changes in distribution of raccoons and red fox on Virginia's barrier islands from 1977 to 1998 suggest mammalian predation may be a major factor in colony site selection or success (Erwin et al. 2001). Nesting birds avoided islands with raccoons and red foxes (Keiss 2000). Concurrently with the increased distribution of raccoons and red fox on barrier islands was the reduction in beach-nesting colonial waterbirds from 23 colonies on 11 islands to 13 colonies on 10 islands from 1977 to 1998 (Erwin et al. 2001). There appears to be a mutually exclusive relationship between the use of barrier islands by raccoons and successful nesting by beach and colonial waterbirds (Keiss 2000, Dueser et al. unpub. data)(Fig. 1). Of 13 barrier islands surveyed in 1999, the mutually exclusive relationship was found on 12 islands. On N. Cedar Island, where both raccoons and ground nesting birds were found, however, the birds were nesting in lower abundance than historically. The Virginia Department of Game and Inland Fisheries reported a similar mutually exclusive relationship on Chesapeake Bay islands where black ducks nest (Bidrowski and Costanzo 2003, VDGIF, unpub. data).

Table 2. Colonial nesting waterbirds nesting on barrier and Chesapeake Bay islands that are identified in the North American Waterbird Conservation Plan (Kushlan et al. 2002) and their level of management concern.

Species	Level of concern
Black skimmer	High
Least tern	High
Gull-billed tern	High
Little tern	High
Royal tern	Moderate
Brown pelican	Moderate
Common tern	Low
Caspian tern	Low

Table 3. Colonial nesting waterbirds, shorebirds, and other birds that are of management concern to Virginia Department of Game and Inland Fisheries; U.S. Department of Interior, Fish and Wildlife Service, and bird conservation organizations. These bird species nest on barrier and Chesapeake Bay islands in Virginia.

Black skimmer	Piping plover
Least tern	Wilson's plover
Gull-billed tern	American Black duck
Royal tern	Black rail
Brown pelican	Henslow sparrow
Common tern	Salt-marsh sharp-tail sparrow
American oystercatcher	Seaside sparrow

Gulls have shown unprecedented population growth in the 20th century, primarily from consistent man-made food supplies from landfills and modern agriculture (Drury 1973, Erwin 1979, Verbeek 1977, Patton 1988, Belant and Dolbeer 1993). American crows and fish crows have also increased their populations since at least 1966 (Sauer et al. 2003). American crows have a wide range and are extremely abundant, being found widely distributed over much of North America, including most of the United States (National Audubon Society 2000, Johnson 1994). Fish crows primarily inhabit the coastal areas of the eastern and southeastern U.S. (Johnson 1994). Fish crows have caused major egg loss of nesting terns on Assateague Island in the early 1980's and are of concern for predation on

threatened piping plover nests (USFWS 2003).

Common grackles have declined nearly two percent per year from 1966 to 2003 (Sauer et al. 2004). While they have declined grackles are still relatively abundant compared to other birds due to a higher relative abundance (Sauer et al. 2004). This decline in common grackle abundance is widespread across the eastern and mid-western United States (Sauer et al. 2004). Grackles are opportunistic generalists that may prey on eggs or fledglings of other birds. They were reported to be minor and infrequent predators of piping plover, shorebird, and colonial waterbird eggs and fledglings (USFWS 2003, 2002).

1.3.1 Summary of Proposed Action

The proposed action is for the WS program to continue the current IWDM program that responds to requests for PM to protect native bird populations within the coastal ecosystems of the Commonwealth of Virginia. The proposed action would be conducted on coastal areas and barrier and Chesapeake Bay islands in Virginia. An IWDM approach, including Technical Assistance and Direct Control Assistance, would be implemented which would allow use or recommendation of any legal technique or method, used singly or in combination, to meet requestor needs for resolving conflicts with raccoons, red foxes, opossums, gulls, crows, or grackles (Appendix B). Cooperators requesting assistance would be provided with information regarding the use of practical and effective nonlethal and lethal techniques. Lethal methods used by WS would include trapping, snaring, shooting, avicides, predacides, and live trapping followed by euthanasia. Nonlethal methods used by WS would include habitat alteration, husbandry practices, wire barriers and deterrents, repellents, effigies, and harassment and other scaring devices. In many situations, the implementation of nonlethal methods such as habitat alteration, husbandry practices, and harassment would be the responsibility of the requestor to implement. Direct Control Assistance by WS would be allowed within the State, when requested and as budgets allow, on private property sites or public property where a need has been documented and upon completion of an *Agreement for Control*. All management actions, including disposal requirements, would comply with appropriate federal, state, and local laws. The goals of the proposed action are consistent with the goals for the draft Biological Conservation Region 30 (generally the coastal plan of Virginia to Maine) and draft waterbird plan (Parsons and Johnson 2005) which is where the islands are located.

1.3.2 Need for Predator Management to Protect Natural Resources

Wildlife management in modern environments has to contend with the inheritance of faunal and landscape changes caused by humans which affect the relationships between predators and prey (Reynolds and Tapper 1996). Raccoons, opossums, red foxes, laughing, herring, and great black-backed gulls, fish and American crows, and common grackles prey on variety of natural resources. Normally, this predation would be considered part of the function of a healthy ecosystem. However, major changes have occurred in the ecosystem that encompasses the coastal region of the Commonwealth of Virginia. Recently, the role of predatory mammals and their effects on avian diversity in fragmented habitats have been revealed (Erwin et al. 2001). Additionally, these changes have had a profound negative impact on the viability of some native bird populations which ground nest on Chesapeake and barrier islands and in coastal areas. Modern wildlife management action is needed to restore native ground nesting bird populations on barrier islands and Chesapeake Bay islands and in coastal areas in Virginia.

Native birds that nested on islands evolved in an environment free or mostly free of mammalian predators (Rolland et al. 1998, Kharitonov and Siegel-Causey, 1988, Wittenberger and Hunt 1985). The reproductive failure of colonial waterbirds due to range expansion or introduction of non-native or native predatory mammals is a growing management concern for conservation biologists (Cote and Sutherland 1997, Nettleship et al. 1994). Mammalian predators on islands often cause complete failure of bird colonies to fledge any young (Craik 1997, Viksne 1997) or significant declines in chicks fledged (Clode and MacDonald 2002).

Historically, avian predators (e.g., large gulls) were probably much reduced in abundance or distribution compared to today. Some avian predators (e.g., great black-backed and herring gulls) were historically absent from the Virginia ecosystem (AOU 1998 cited in O'Connell and Beck 2003, Blodget and Henze 1992, Good 1998, Erwin 1979b, Bailey 1913). Herring and great black- backed gulls are a substantial threat to colonial waterbirds and shorebirds nesting on the Virginia barrier island system from predation, competition, and displacement (Anonymous 1996). The ground nesting native birds the proposed action seeks to benefit were declining in abundance because the islands where they evolved now have predators that were

historically absent from these islands (AOU 1998 cited in O'Connell and Beck 2003, Blodget and Henze 1992, Erwin 1979b, Bailey 1913). Many of these shorebird and colonial waterbird species may be lost from the coastal, barrier islands and Chesapeake Bay ecosystem unless action is taken to restore natural ecosystems within which these birds evolved over time.

Some changes to the ecosystems of the coastal areas and Chesapeake Bay and barrier islands are the result of natural ecological actions. These actions include the westward migration of the Atlantic Coast barrier islands towards the shore. Some barrier islands in the Chesapeake Bay have been disappearing due to subsidence, erosion, and rising sea levels (Leatherman et al. 1995, B. Truitt, The Nature Conservancy, pers. commun., G. Costanzo, VA Dept. of Game and Inland Fisheries, pers. commun.). Other changes to the ecosystems of the barrier islands were the result of interference by post-Colonial man. These changes included the introduction of non-native species (red fox), extirpation of native species (red wolf [Canis rufus]), colonization of the islands by new predators expanding their range (opossum and greater black-backed gull), colonization of the islands and unprecedented population growth by raccoons, and consistent man-made food supplies from landfills and modern agriculture that allowed the unprecedented growth of gull populations (Drury 1973, Erwin 1979, Erwin 1979a) and probably crow populations.

Virginia's barrier islands are believed to have sufficient habitat unoccupied by ground nesting native birds. Thus, if predator populations are managed, then native ground nesting bird populations would likely increase to higher levels. This belief is based on the number of birds nesting on the islands being approximately ¼ of the population during the 1970's and early 1980's (Erwin et al. 2001).

1.3.2.1 Predator – prey relationships have been altered by man

Faunal communities in Virginia have changed over the last 400 years. These changes were primarily brought about by man. At the time of colonial settlement in the 1600's, red wolves were living on the eastern shore of Virginia and the associated barrier and Chesapeake Bay islands (Paradiso and Nowak 1983). Red wolves would have preyed upon raccoons. Red wolves were extirpated from Virginia by colonists by the 1880's (Paradiso and Nowak 1983). Also, species such as opossums, coyotes, great black-backed gulls, and herring gulls did not occur in Virginia until the 20th century . Fragmentation of the environment, stable food sources associated with modern agriculture, and other stable food resources (e.g., landfills, dumpsters) allowed survival of juvenile gulls and subsequent population growth and expansion (Drury 1973, Erwin 1979, Erwin 1979a). The European red fox was introduced by colonists from Europe during the colonization of North America (Kamler and Ballard 2002, Linzey 1998, Samuel and Nelson 1982, Paradiso 1969). These latter four species now breed in Virginia.

The expanding raccoon population, along with arrival of non-native red fox, and historically absent opossum, and herring and greater black backed gulls brought new predation pressure on colonial waterbirds, shorebirds, and black ducks nesting in the Chesapeake Bay region. With the elimination of the red wolf from the faunal comminuty, the only predation probably occurring on raccoons during the 20th century was recreational fur trappers and hunters. The decline of fur prices after 1980's led to lower harvest levels of raccoons and other furbearers (VDGIF, unpublished data).

1.3.3 Impacts to native birds nesting on islands

As described in the following subsections, many native birds nesting on barrier and Chesapeake Bay islands and in coastal areas have declined in abundance since the 1970's. Concurrent with these declines has been colonization of islands by raccoons, red fox, and opossums; an increase in abundance of laughing gulls, American and fish crows; and range expansion and increase in abundance of great black-backed and herring gulls. Common grackles in contrast are relatively abundant but have experienced long term population declines in Virginia and the eastern United States (Sauer et al. 2004). In addition, some native ground nesting birds have abandoned islands because of mammalian and avian predation or inter-specific nest site competition with gulls.

1.3.3.1 Harm to threatened and endangered bird populations

Piping and Wilson's plover

The piping plover is a federal listed threatened species protected by the Endangered Species Act. The Wilson's

plover is a state listed endangered species protected by Virginia Administrative Code 15-20-130. The barrier islands of Virginia comprise the most extensive and suitable habitat for nesting activities of both plover species in Virginia (Kain 1996). Virginia's barrier islands support almost one-fifth of the U.S. Atlantic population of piping plovers (Terwilliger 1994). Both species have declined due to several factors, including mammalian and avian predation (Patterson et al. 1991, Kain 1996, Hecht et al. 1996, Boettcher 2003 and 2002).

The recovery objective for piping plovers is to remove them from the List of Endangered and Threatened Wildlife and Plants by: 1) achieving well-distributed increases in numbers and productivity of breeding pairs, and 2) providing for long-term protection of breeding and wintering plovers and their habitat (Hecht et al. 1996). The criteria for delisting the Atlantic population of piping plovers may be considered when the following criteria have been met:

1. Increase and maintain for five years a total of 2,000 breeding pairs, distributed among four recovery units, with 400 pairs in the Southern (DE, MD, VA, NC) unit.

2. Verify the adequacy of a 2,000-pair population of piping plovers to maintain heterozygosity and allelic diversity over the long term.

3. Achieve five-year average production of 1.5 fledged chicks per pair in each of the four recovery units.

4. Institute long term agreements to assure protection and management sufficient to maintain the population targets and average productivity in each recovery unit.

5. Ensure long-term maintenance of wintering habitat to maintain survival for a 2,000 pair population.

The Commonwealth of Virginia is near the southern edge of the piping plover's breeding range and the northern edge of the Wilson's plover breeding range. Both species share similar nesting habitats. These nesting habitats are ocean front beaches, dunes, and over-wash sand flats on barrier islands as well as inland areas along the western shore of the Chesapeake Bay and associated river systems (Boettcher 2003). Ninety-two percent of all piping plovers and 97% of all Wilson's plovers in Virginia were found on the northern barrier islands from Assateague to Cedar Island in 2003 (Table 4).

There were 152 pairs of piping plovers in 2004; and 114 breeding pairs of piping plovers in Virginia during 2003 (Boettcher 2003, 2004)(Table 4). There were 27 pairs of Wilson plovers in 2004; and 31 breeding pairs of Wilson's plovers in Virginia during 2003 (Boettcher 2003, 2004)(Table 4). The piping plover population had decreased 22% and the Wilson's plover population had increased 15% in Virginia since 2002 due to cool and stormy spring weather (Boettcher 2003). Piping plover populations in Virginia have increased from 87 pairs in 1996 to 120 pairs in 2002, a time period when predator management was being conducted on the northern barrier islands where 90% of Virginia's piping plovers breed (Boettcher 2002). Prior to 1996 the number of piping plover breeding pairs fluctuated widely from 97 to 131 breeding pairs (Boettcher 2002), in part, due to predator management being conducted on only one northern barrier island (Assateague) and colonization of additional barrier islands by red fox and raccoons.

Piping plovers historically nested on more islands than in 2003. Persistent mammalian predation has resulted in piping plovers abandoning historical nesting sites (Boettcher 2002). Piping plovers have been absent from Craney Island, VA since 1997, Fisherman Island, VA since 1993, and Grandview Beach in Hampton, VA since 1991.

Gaines and Ryan (1988) estimated that 1.15 to 1.44 chicks must be fledged per pair to maintain a stable population. The Revised Piping Plover Recovery Plan calculated 1.25 chicks must be produced per pair for a stable population (Hecht et al. 1996). The number of piping plover chicks fledged per pair has been increasing in recent years in Virginia (Fig. 2). Nest predation was the major factor contributing to lower productivity on Assateague Island (Patterson et al. 1991) in Virginia. On Assateague Island, predation accounted for 91% of all known causes of nest failure (Patterson et al. 1991). Patterson et al. (1991) determined that red fox (47.6%), raccoons (28.6%), unidentified mammals (9.5%), and avian predators (14.3%) accounted for piping plover nest loss on Assateague Island. Kruse et al. (2001) also found raccoons, American crows, and mink caused 98% of all piping plover nest

loss in South Dakota. Anonymous (1999) reported that red fox was the primary predator of piping plovers in Maine.

Table 4. Distribution of piping plovers and Wilson's plovers in Virginia during 2002-2004. Data is from the 2002, 2003, and 2004 Virginia Plover Survey, VA Department of Game and Inland Fisheries.

SITE[A]	WILSON'S PLOVER		PIPING PLOVER					
	Number of pairs		Number of pairs			ESTIMATED CHICKS FLEDGED PER PAIR		
	2003	2004	2002	2003	2004	2002	2003	2004
Assateague Island *			32	39	44	1.56	1.95	2.30
Wallops Island *			0	1	2			3.00
Assawoman Island *	11	12	23	16	23	1.13	2.14	2.65
Metompkin Island *	13	10	33	31	41	1.07	1.68	2.02
Cedar Sandbar			8	6		0.67	1.33	
Cedar Island *	6	5	17	14	31	1.00	2.00	2.04
Hog Island	1							
Wreck Island				0	2			
Myrtle Island			6	5	5			
Ship Shoal Island			1	2	3			
Smith					1			
TOTAL	31	27	120	114	152	1.19	1.93	2.23

A. Locations where raccoons or red fox were removed to enhance nesting success and chick survival were marked with an "*".

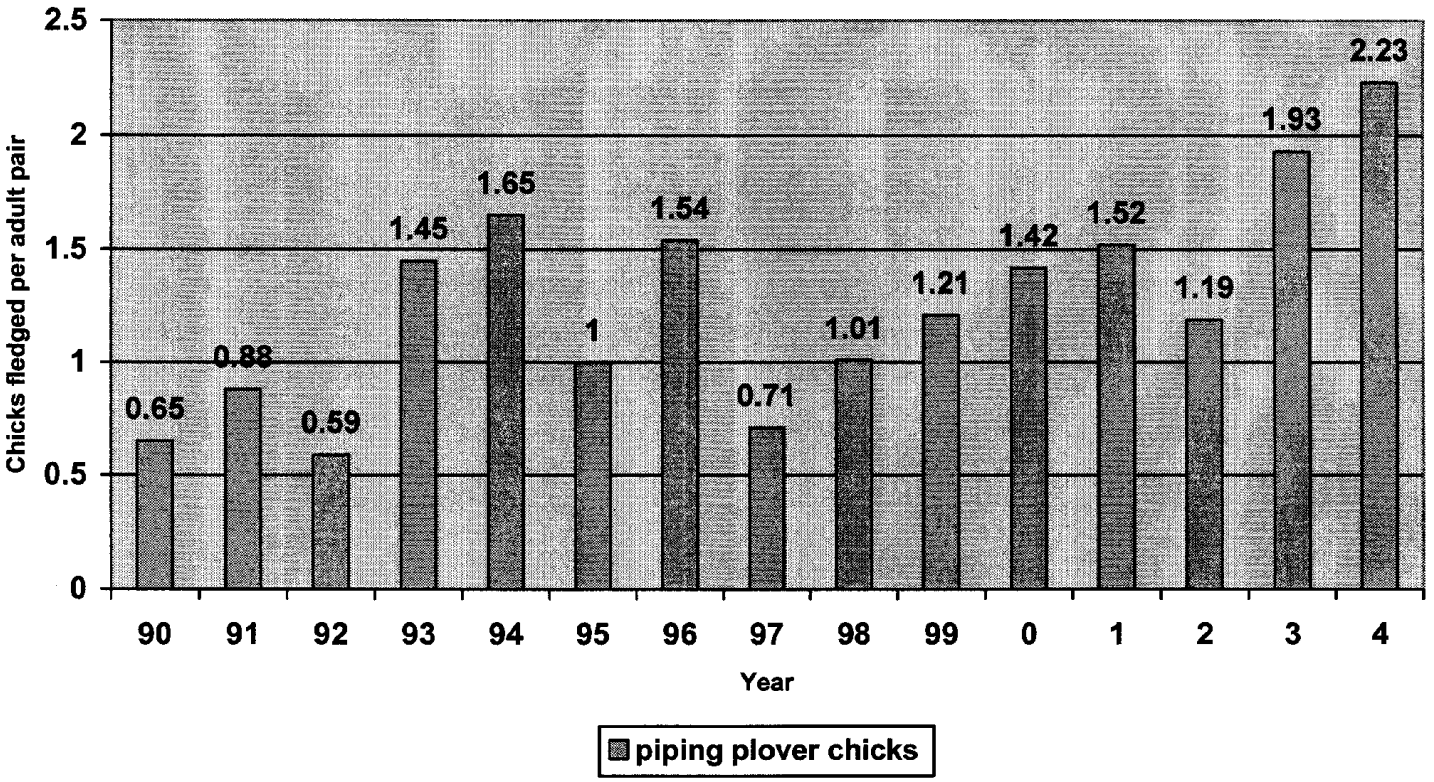


Figure 2. Annual statewide piping plover productivity estimates in Virginia 1990 – 2003. Annual estimates are obtained from ≥ 75% of nests laid annually. Data is from the VA Department of Game and Inland Fisheries. A stable population results when 1.24 chicks are produced per pair.

Also, chick mortality was substantial on Assateague Island; however, high fledgling mortality is typical for other species of the Charadrii family (Patterson et al. 1991). Chick mortality ranged from 40 to 92% on Assateague Island from 1986 through 1987 (Patterson et al. 1991). The cause of most chick mortality was undetermined (Patterson et al. 1991). The USFWS (2002) reported most chick loss on Assateague Island occurred from red fox, raccoon, gull, and crows. On Assawoman Island chick loss was from avian predators (e.g., red-tailed hawk) in 2002 (USFWS2002). Piping plover chick loss on Cedar Island may have been attributed to raccoons, red fox or human disturbance (USFWS 2002). Peregrine falcons may have factored into some chick loss on Metompkin Island (USFWS 2002). Kruse et al. (2001) determined the American kestrels and great horned owls accounted for 93% of piping plover chick loss in South Dakota. A common grackle was observed preying on a piping plover chick on Assateague Island (USFWS 1995). Fish crows were also observed preying on piping plover chicks (USFWS 1990). Nesting populations of piping plovers have been absent from Craney Island since 1997 and Grandview Beach in Hampton since 1991 and both sites are plagued with persistent mamamalian predator populations or severe human disturbance (Boettcher 2004). Ghost crabs (Ocypode quadrata) are an insignificant predator of piping plover chicks (Wolcott and Wolcott 1999).

Gull-billed tern

There are two distinct populations of gull-billed terns nesting in North America: in California and along the Gulf of Mexico and southeastern coasts (Via and Duffy 1992, Parnell et al. 1995). Clapp and Buckley (1984) estimate 3,019 pairs nest along the southeast coast. The gull-billed tern was listed as a state threatened species protected by Virginia Administrative Code 15-20-130. Virginia has the largest population of gull-billed terns among northeastern states because of its abundant barrier island beaches (Via and Duffy 1992). There were an estimated 6 – 20 nesting pairs in Virginia as of 1992 (Via and Duffy 1992). Gull-billed terns usually nest in colonies among common terns and black skimmers (Parnell et al. 1995).

The number of gull billed terns declined from about 1,000 in 1901 to 16 in 1906 due to the millinery trade (Via and Duffy 1992, Parnell et al. 1995). Bailey (1913) estimated no more than 12 pairs in 1913. With increased federal protection, gull-billed terns increased to 26 birds in 1932 (Austin 1932) and to about 100 birds in 1950's (Erwin 1979). Gull-billed terns increased to over 2,700 birds in Virginia during the 1970 before there populations collapsed during the 1980s (Fig. 3) (see Williams et al 1990). The largest nesting colonies were on Metompkin and Cobb Islands, VA (Williams et al. 1994).

The primary avian predators of terns in the northeast are laughing, herring, and great black-backed gulls (Buckley and Buckley 1972). During the 1975-1990 period when gull-billed tern populations plummeted from over 2,700 birds to about 200 birds, colonies of herring and great black-backed gulls increased ten-fold (Williams et al. 1994). Gulls may prey upon eggs and young of gull-billed terns (Parnell et al. 1995). These same gulls may also usurp tern nesting sites or prey on gull-billed terns nest or eggs or both (R. Beck, College of William and Mary, person. commun.). Human disturbance of very young chicks in a colony may result in heavy losses to weather, gulls, and other predators (Via and Duffy 1992).

Raccoons, red foxes, and rats are potential mammalian predators of gull-billed terns (Via and Duffy 1992). Predation often causes complete colony desertion (Parnell et al. 1995). Red fox preyed on a nesting colony of 300 black skimmers, 100 common terns, and 50 gull-billed terns on Metompkin Island, VA in July 1997 resulting in the birds abandoning the nesting colony (TNC 1998). Similar, a colony of 500 black skimmers, 250 common terns, and 50 gull-billed terns nesting on Ship Shoal Island, VA were raided by raccoons and the birds abandoned the nesting colony in 1997 (TNC 1998). Raccoons were also implicated in the abandonment of other colonial waterbird nesting colonies on Hog and Myrtle Island, VA in 1997 (TNC 1998).

Via and Duffy (1992) concluded that, with the exception of Virginia, it is unlikely gull-billed terns will be managed at the population level in the northeast. Populations of gull-billed terns nesting in Virginia need protection from human disturbance and mammalian and probably avian predation. Management of gull populations may be warranted since herring and great black-backed gulls have overrun many tern colonies in the northeast since the 1970's (Kress et al. 1983).

1.3.3.2 Harm to colonial nesting water bird populations

Colonial nesting waterbirds are species of birds that associate themselves with feeding, breeding, and roosting near water and they nest in congregations or groups. These birds are represented by terns, gulls, skimmers, pelicans, herons, egrets, cormorants, ibises, night herons, eiders, petrels, and guillemots. Colonial waterbirds are dependent on aquatic ecosystems for their survival. The North American Waterbird Conservation Plan (Kushlan et al. 2002) provides a continental framework for management of 210 species of waterbirds, including seabirds, coastal waterbirds, wading birds, and marsh birds utilizing aquatic habitats (Kushlan et al. 2002). The congregatory behavior of many waterbird species increases population risks by concentrating populations in limited areas (Kushlan et al. 2002). Eighty percent of waterbirds considered in the plan are colonial nesters (i.e., colonial waterbirds). One third of colonial waterbirds are at risk for serious population loss (Kushlan et al. 2002). The threats the plan identifies as requiring remedial action include destruction of inland and coastal wetlands, introduced predators, invasive species, pollutants, mortality from fisheries and other human disturbances, disturbance, and conflicts arising from abundant species (Kushlan et al. 2002). Colonial waterbirds in Virginia are affected by introduced predators (i.e., opossum via range expansion); invasive species (i.e., red fox); human disturbance (on beaches during late spring and summer), and conflicts arising from abundant species (i.e., raccoons; herring, laughing, and great black backed gulls; and fish and American crows. Common grackles were reported to be a minor and infrequent predator of piping plover, shorebird, and colonial waterbird eggs and fledglings.

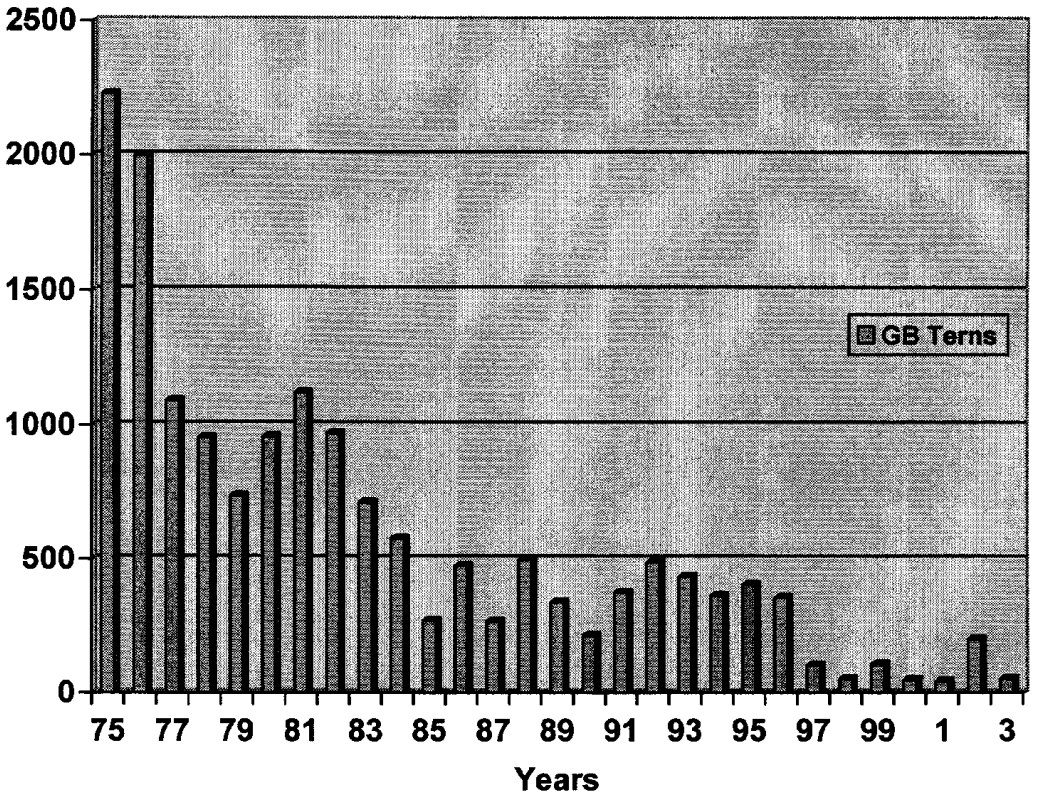


Figure 3. Gull-billed tern population nesting on Virginia barrier islands, 1975 – 2003. Data courtesy of the College of William and Mary, Center for Conservation Biology.

Colonial waterbirds live in habitats used by other wildlife species and humans. Thus, the wisest choice of conservation action is within the context of multi-species and multi-use management (Kushlan et al. 2002). In protecting and managing aquatic habitats, the needs of all birds relying on these habitats should be coordinated (Kushlan et al. 2002). One of the objectives of this environmental assessment is developing and implementing management goals and actions for multiple bird and mammalian species living on coastal, barrier and Chesapeake

Bay islands. The bird species of interest include threatened and endangered birds, colonial waterbirds, black ducks, gulls, and crows. The mammals of management interest are primarily raccoons, red fox, and opossum.

Most coastal wetlands in Virginia associated with barrier islands are protected because they are owned by the federal or state government or a few private conservation organizations or individuals. Thus, development and human access is restricted. Some of the Chesapeake Bay islands are owned by the state and federal government while a few islands are owned by private individuals. Human disturbance is a concern and is being managed on those barrier island beaches with high human use (e.g. Assateague Island, VA and MD).

Least tern

Small scattered breeding colonies of the least tern are found on over-wash areas on the beaches of barrier islands (Table 5). Two large colonies occur in Tidewater Virginia on the western shore of the Chesapeake Bay at Grand View Beach in Hampton, VA and Craney Island in Portsmouth, VA (Beck et al. 1990)(Table 5). Populations on the barrier islands show a decreasing population trend from 1975 to 1988 (Beck et al. 1990) and 1975 – 2003 (Fig. 4). The colonies at Grand View Beach, VA and Craney Island, VA were increasing in number and represented more than half of the total Virginia population in 1988 (Beck et al. 1990)(Table 5). Mammalian and avian predation and human disturbance have influenced least tern production and in some cases prevented successful nesting (Beck et al. 1990).

Least terns were virtually exterminated along the east coast during the last quarter of the 19th century for the millinery trade (Beck et al. 1990). In one three day period, 2,800 least terns were killed on Cobb Island, VA. Bailey (1913) reported that the Virginia population of least terns had been reduced to only a few scattered breeding pairs by the early 1900's. By the 1920's and 1930's much of the east coast had been re-colonized. Least terns continued to increase until the 1950's and then started to decline. Few least tern colonies were reported in Virginia from the 1950's through the 1970's (Beck et al. 1990). There were an estimated 1,500 least terns in Virginia in the 1970's (Downing 1973, Erwin et al. 1979). Least terns were found nesting on barrier islands and the western shore of the Chesapeake Bay in the 1970's and 1980's (Table 6).

Table 5. Adult least tern population size in Virginia, 1975 – 1988.

	Year													
Location	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Barrier islands	766	886	1,013	449	457	915	2,069	1,404	1,772	1,427	821	1,456	906	851
Craney Island	150	160	120	0	0	100	200	200	220	222	250	200	300	510
Grand View Beach	350	160	160	400	300	300	600	600	900	600	800	950	970	650
Total	1,266	1,206	1,293	849	1,057	1,315	2,869	2,204	2,893	2,249	1,871	2,597	2,176	2,011

Table 5, continued. Adult least tern population size in Virginia, 1989 – 2003. Data is unavailable for Craney Island and Grand View Beach. Data provided courtesy of B. Watts, College of William and Mary.

Location	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Barrier islands	613	515	837	543	529	739	404	327	115	324	122	318	427	538	341
Craney Island	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Grand View Beach	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total										2,342					2,342

Table 6. Locations of active least tern colonies surveyed from 1975 – 1988.

	Survey Year													
Location	75	76	77	78	79	80	81	82	83	84	85	86	87	88
Assateague Island				X	X	X	X	X	X	X	X	X	X	X
Assawoman Island			X									X	X	X
Cedar Island	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chimney Pole Marsh														
Cobb Island	X	X	X	X		X	X	X	X	X	X	X	X	X
Dawson Shoal														
Fisherman Island					X	X	X							
Godwin														
Hog Island	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Little Cobb Island		X		X	X									
Metompkin Island	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mink Island														
Myrtle Island	X	X	X		X	X		X	X	X	X	X	X	X
Parramore Island	X	X	X											
Rogue														
Sandy								X						
Ship Shoal Island	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Smith Island	X	X	X	X	X	X	X	X	X	X	X		X	X
Wreck Island				X	X						X			X
Craney Island	X	X	X			X	X	X	X	X	X	X	X	X
Grand View Beach	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Number of active locations	10	11	11	10	10	11	11	10	10	10	11	10	11	11

Least terns nesting on barrier islands are subject to a wide range of adverse conditions that can destroy large numbers of young and eggs, and force relocations of colonies from year to year (Beck et al. 1990). Under favorable climatic conditions, dramatic increases in populations can occur in a single breeding season (Beck et al. 1990). Flooding is the single greatest threat with its potential to obliterate entire colonies in a few hours (Beck et al. 1990). Although terns will re-nest two or three times in a single season, repeated washouts have occurred at critical times with devastating effect on the colonies (Beck et al. 1990).

The colonization of islands by mammalian predators has probably contributed to declines in least tern abundance on barrier islands. Least terns historically nested at Parramore Island but increases in vegetation and mammalian and avian predation have resulted in terns not using the island since 1977 (Beck et al. 1990). The increasing red fox population on Parramore may have contributed to least terns abandoning the island. Also, repeated visual sightings of raccoon and red fox occurred on Metompkin and Cedar Islands from 1986 – 1988 (Beck et al. 1990). Raccoon and red fox sign was also evident on Assawoman Island (Beck et al. 1990). Coyotes were observed on Smith Island in 1986 and 1987 (Beck et al. 1990). Red fox have destroyed up to 13 nests in a single night on Craney Island (Beck et al. 1990).

Avian predators of least terns include raptors and gulls. Observations indicate gulls are the greatest predator of tern chicks and eggs because of their large numbers and close proximity to least tern colonies (Beck et al. 1990). Herring and great black-backed gulls have been observed preying on least tern chicks and eggs (Beck et al. 1990, USFWS 1999, 1998). Other avian predators of least terns include fish crows and northern harriers.

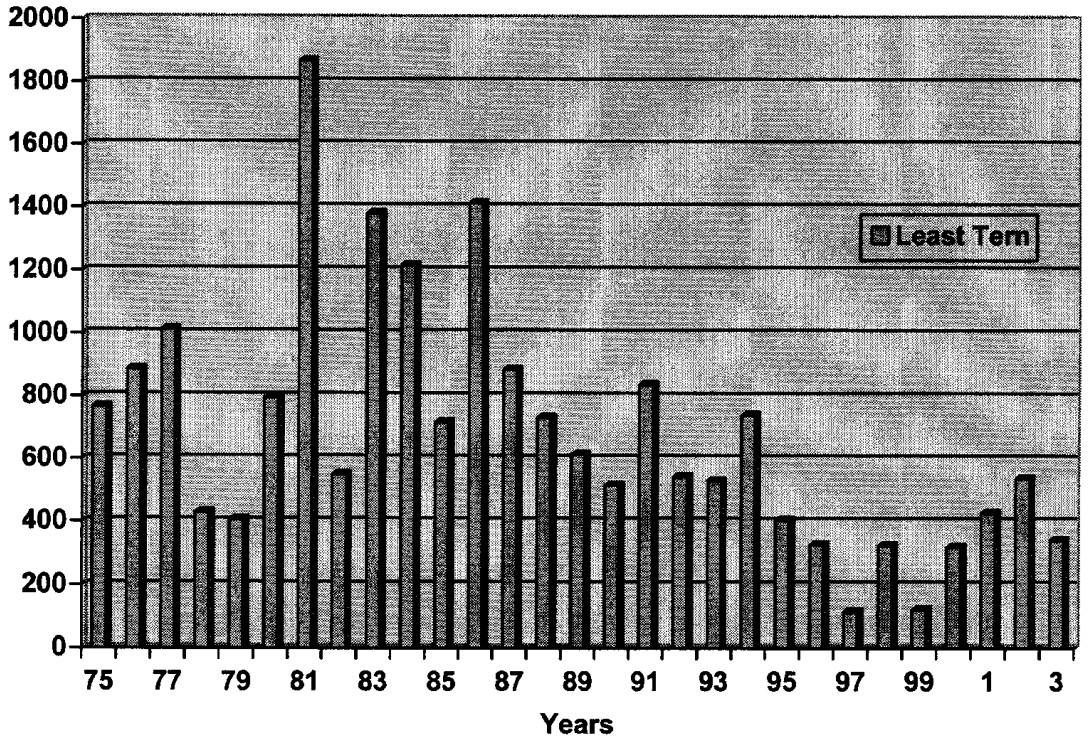


Figure 4. Population of least terns nesting on Virginia's barrier islands. Data courtesy of the College of William and Mary, Center for Conservation Biology.

Black skimmer

Skimmers are highly social birds nesting in colonies and forming large flocks outside the breeding season (Gochfeld and Burger 1994). Large successful colonies usually occupy the same site from year to year, while small or failed colonies usually relocated (Gochfeld and Burger 1994). Skimmers breed almost exclusively on barrier beaches, shell banks, spoil islands and salt marhes (Gochfeld and Burger 1994).

Skimmer colonies were eliminated over most of their range when the millinery trade and hunting extirpated herons, egrets, and terns which are the preferred nesting associates of skimmers (Gochfeld and Burger 1994). Skimmers appear to benefit from the great aggressiveness of terns towards predators and human intruders (Erwin 1979a). Skimmers on Cobb Island, Virginia, declined from thousands in 1902 to 300 in 1909 (Howell 1911). Black skimmers nesting on Virginia's barrier islands have declined about 85% from 1975 to 2003 (Fig. 5).

Many former suitable beach habitats are no longer available to skimmers due to development and recreational pressures (Gochfeld and Burger 1994). Inter-specific competition with gulls for nesting sites discourages settlement by terns and skimmers (Gochfeld and Burger 1994). Where skimmers must resort to low-lying beaches to avoid human disturbance, nests are vulnerable to flooding (Gochfeld and Burger 1994). The Virginia barrier islands are ideal for nesting by skimmers due to little human disturbance.

Mammalian and avian predators prey on skimmers. Mammalian predators include red fox, raccoons, and various mustelids (Gochfeld and Burger 1994). Mammalian predators tend to prey on adult skimmers and a colony has been eliminated by a fox (Gochfeld and Burger 1994).

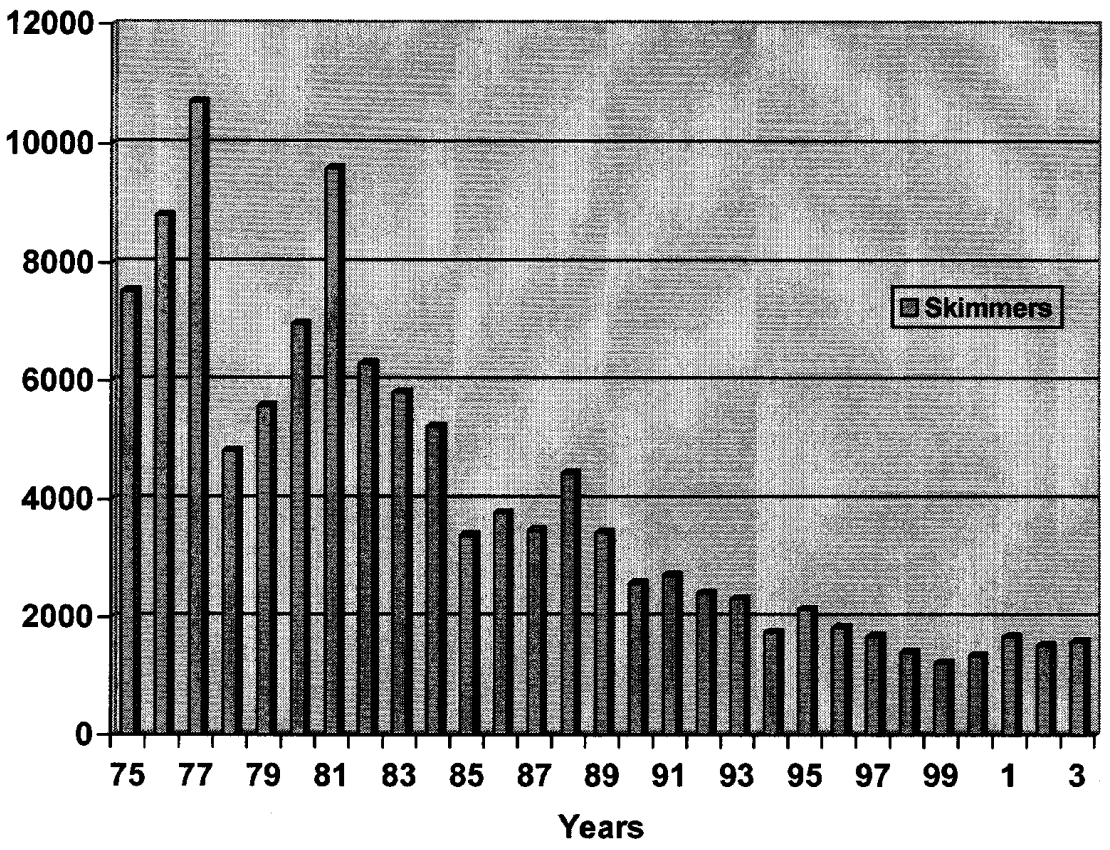


Figure 5. Population of black skimmers nesting on Virginia's barrier islands. Data courtesy of the College of William and Mary, Center for Conservation Biology.

Avian predators include gulls, crows, and blackbirds (ie. Common grackles) (Gochfeld and Burger 1994). Predation on skimmer nests can be important as eggs and chicks are vulnerable (Gochfeld and Burger 1994). Blus and Stafford (1980) reported intense predation by herring gulls. Gulls are the main predators of skimmers in New Jersey (Burger 1982). Raccoons eliminated a skimmer colony in Georgia (Gochfeld and Burger 1994). Predation on chicks accounted for 2-40% of chick mortality in New Jersey and New York (Gochfeld and Burger 1994). Herring gulls prey disproportionately on skimmer chicks than other chicks since skimmers are more likely to be in the open. Laughing gulls were significant predators of skimmers in Texas (Quinn 1989).

Royal tern

The royal tern is the flagship species among the crested terns which nests in extremely dense breeding colonies, forms creches (common nurseries for pre-fledging chicks), and has extended parental care (Buckley and Buckley 2002). Royal terns may live up to 28 years.

Royal tern breeding colonies favor isolated locations on barrier islands or other sandy sites free of terrestrial predators (Buckley and Buckley 2002). If predation is severe enough then royal terns will quickly desert a colony, sometimes permanently (Buckley and Buckley 2002). Direct predation on royal terns is rarely recorded (Buckley and Buckley 2002). Great black-backed gulls have taken adult royal terns. Laughing gulls, common grackles, and fish crows take royal tern eggs on the edge of the colony (Buckley and Buckley 2002). Laughing gulls were never observed preying on royal tern chicks (Buckley and Buckley 1972). Herring gulls were observed preying on royal

tern chicks on Fisherman Island in 2004 (P. Denmon, USFWS, pers. commun, Sept. 20, 2004).

Royal terns nested historically on Fisherman Island, VA. This was the largest colony of royal terns in Virginia with about 3,100 birds in 1999. It is believed part of the colony started nesting on Wreck Island in 2003 in response to raccoon predation (P. Denmon, USFWS, pers. commun.). More of the colony moved to Wreck Island in 2004. There were 1,119 adult royal terns on Fisherman Island and 1,533 adult royal terns on Wreck Island in 2004 (Data provided by the Dept. of Conservation and Recreation, Natural Heritage Program and Dept. of Game and Inland Fisheries). Royal terns have declined 78% from peak populations in 1977 (Fig. 6).

Buckley and Buckley (2002) reported there is no data on fledging rates or egg and chick mortality. They reported incidental observations suggest egg and chick mortality is normally very low. Mortality of adults is thought to be low with overall post-fledging survival averaging 82% in the first 7 years of life.

Brown pelican

The brown pelican is a permanent resident of the coastal marine environment. Of the world's pelican species, only the brown pelican feeds by the plunge-diving method (Shields 2002). Brown pelicans are highly social and breed in colonies free from human disturbance and predation by terrestrial mammals (Shields 2002). Brown pelicans are long-lived species that may reach more than 40 years of age, though only 30% survive beyond the first year and less than 2% survive more than 10 years (Shields 2002).

Brown pelicans were shot for meat and the millinery trade in the late nineteenth and early 20th century in southeastern United States. Shooting was blamed for brown pelican population declines in the 1920's and 1930's (King et al. 1977).

Brown pelicans nearly disappeared from North America due to the chemical DDT impairing reproduction and endrin in the food chain killing pelicans directly (Shields 2002). Both chemicals led to serious population declines. The brown pelican was removed from the endangered species list along the Gulf coast in the 1990s and its population has been restored to pre-chemical exposure levels (Shields 2002).

Historically, brown pelicans occurred along the Gulf and southeastern coasts north to South Carolina (Shields 2002). They expanded their range northward into North Carolina in 1929 (Pearson et al. 1942 cited from Shields 2002). The first recorded breeding of brown pelicans along the Atlantic coast of Virginia occurred in 1987 (Armistead 1987, Fig. 6). Most brown pelican populations are thought to be stable or increasing (Shields 2002).

Brown pelicans were more abundant in the Chesapeake Bay than the barrier islands (Watts 2004). One of the larger colonies of nesting brown pelicans occurs on Fisherman Island, VA in Virginia (P. Denmon, USFWS, pers. commun.), while the largest pelican colony now nests on Shanks Island, VA. Pelicans used to nest on Metompkin Island, VA in the late-1980's before unexplainably abandoning the nesting colony (B. Truitt, The Nature Conservancy, pers. commun.).

Gulls and crows are the most frequent nest predators of pelicans (Shields 2002). Avian predators usually target nests left unattended due to human disturbance (Schreiber and Risebrough 1972, Anderson and Keith 1980). Laughing gulls (Blus et al. 1977), herring gulls (Williams 1989), and fish crows (Schreiber and Risebrough 1972) have preyed on pelican eggs. Mammalian nest predators include raccoons (Schreiber 1979). Predation on adult pelicans is rare (Shields 2002).

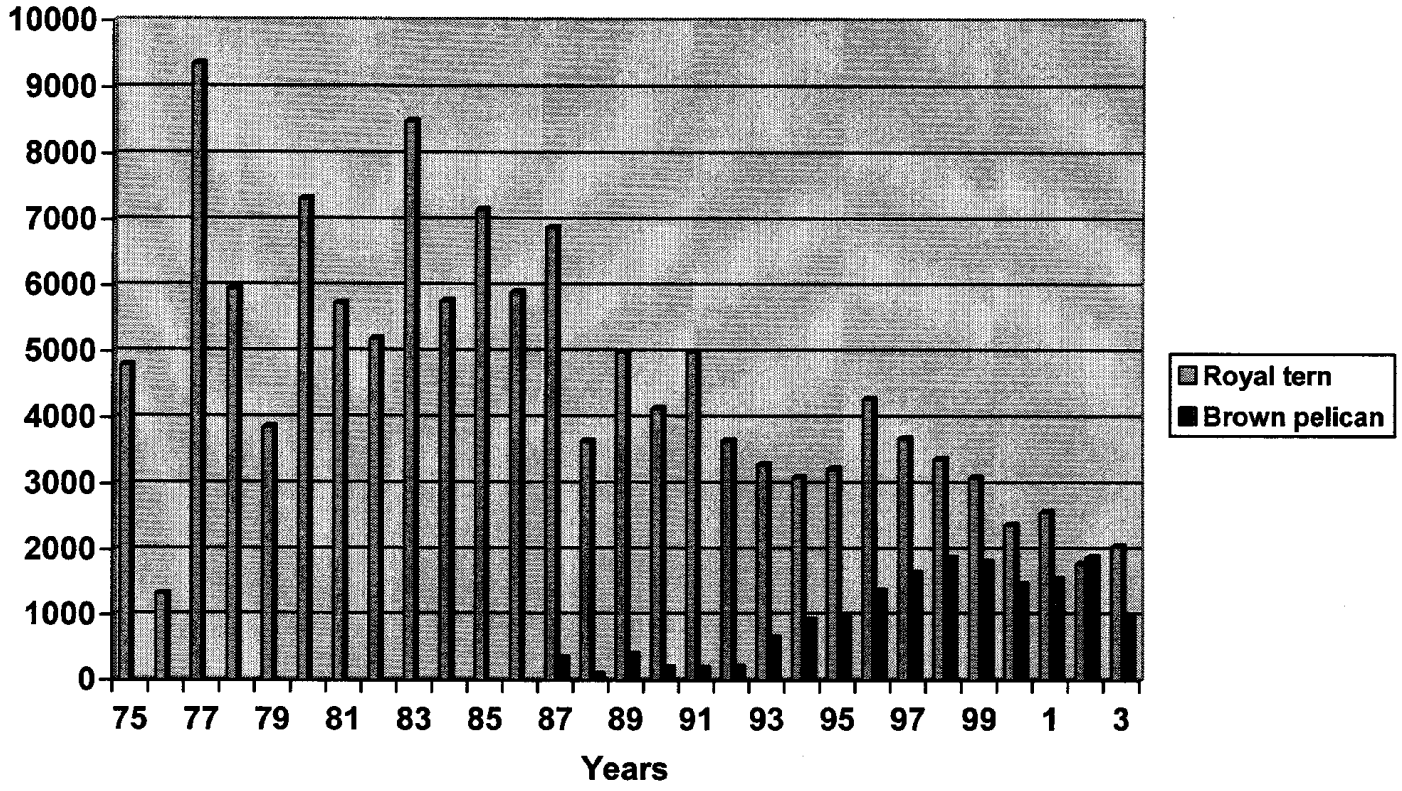


Figure 6. Populations of royal terns and brown pelicans nesting on Virginia's barrier islands. Data provided courtesy of the College of William and Mary, Center for Conservation Biology.

1.3.3.3 Harm to shorebird populations

Shorebirds are species of birds that associate themselves with feeding, breeding, and roosting near water and they tend to be solitary nesters. They are characterized by small bodies, thin legs, and no webbing on their feet. Their bills come in a variety of shapes and sizes. The United States Shorebird Conservation Plan (Brown et al. 2001) provides a coordinated national initiative for shorebird conservation for 53 species that regularly occur in the United States. Shorebirds are represented by sandpipers, plovers, knots, avocets, oystercatchers, yellowlegs, godwits, dunlins, turnstones, dowitchers, whimbrels, curlews, snipe, and phalaropes.

Habitats used by shorebirds have been significantly altered in the United States, especially wetlands, shorelines, and grasslands. Many shorebird species face significant threats from habitat loss, human disturbance, and different forms of habitat degradation such as predation, pollution, and prey resources (Brown et al. 2001).

American oystercatcher

The total North American population of American oystercatchers is estimated to be about 10,971 birds in 2003 (Brown et al. *in press*). About 3,200 American oystercatchers of the North American population are found in the North Atlantic region (Davis et al. 2001, Clark and Niles 2000). The low population size of oystercatchers yields a high ranking for conservation prioritization (Brown et al. 2000, Clark and Niles 2000). Throughout its range, the species is facing threats to its survival from habitat loss, human disturbance, and predation (Wilke and Beck 2002, Nol and Humphrey 1994). However, the recent establishment of large coastal reserves in Virginia and North Carolina helps to protect the center of its abundance (Nol and Humphrey 1994). Davis et al. (2001) estimates that

nearly 70% of the breeding population of American oystercatchers is found in four states: Florida, New Jersey, North Carolina, and Virginia.

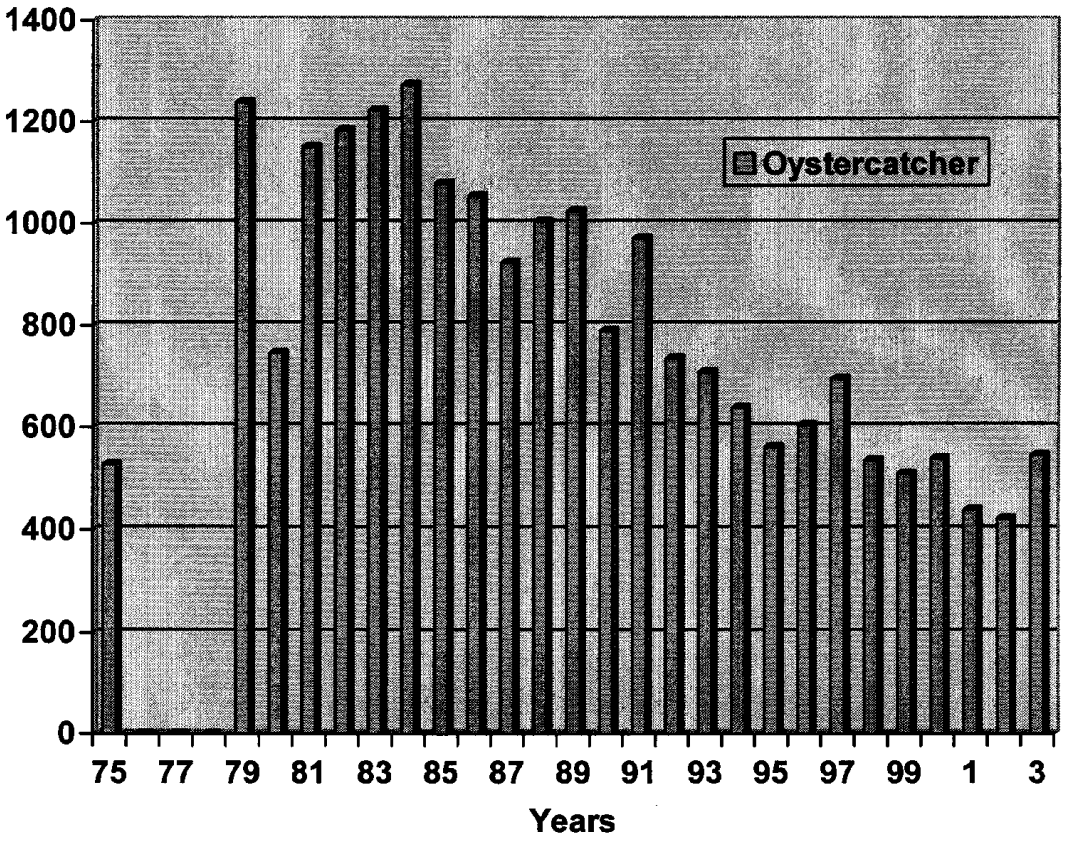


Figure 7. Population of American oystercatchers nesting on Virginia's barrier islands. Data provided courtesy of the College of William and Mary, Center for Conservation Biology.

The number of breeding American oystercatchers has declined on Virginia's barrier islands by more than 50% in the last 20 years (Davis et al. 2001, Williams et al. 2002, Fig. 6). This decline has occurred in relative absence of at least two major threats facing coastal waterbirds – development and human disturbance (Wilke 2004). American oystercatchers peaked in Virginia in 1984 at 1,274 individuals (Williams et al. 1990, Table 7). There were only 509 individual oystercatchers on Virginia's barrier islands in 1999 (Williams et al. 1997, and B. Williams, pers. commun. cited in Davis et al. 2001). Nearly 60% of breeding oystercatchers in Virginia nest on three barrier islands: Metompkin Island, VA; Cedar Island and sandbar, VA; and Fisherman Island, VA (Table 7).

Limited information is available on population dynamics of American oystercatchers (Davis et al. 2001). Adult oystercatchers have an annual survival rate of 92% (Davis 1999). They live at least 10 years (Nol and Humphrey 1994) and probably live 20 – 40 years (Davis et al. 2001). Occasional good breeding years were enough to keep long-term population growth rates stable or even positive (Davis 1999).

By 1900, American oystercatchers had been extirpated from areas north of Virginia because of market hunting, egg collecting, and human disturbance (Davis et al. 2001). In the last half of the 20th century, however, oystercatchers began re-colonizing portions of their former range in New York, New Jersey, and New England (Davis et al. 2001).

Nol (1989) reported 5-7% hatching success of American oystercatchers in Virginia and only 10% of nests fledged

oystercatcher chicks. Novick (1996), Davis et al. (2001), and NPS (2003) studied population dynamics of oystercatchers in North Carolina. Novick (1996) found that 36 nesting attempts resulted in 30 chicks hatching but only 7 chicks fledged. Predation was the main cause of chick loss and 5 chicks were run over by vehicles on the beach. Oystercatchers on Cape Lookout National Seashore in North Carolina bred more successfully in areas where human activity was low (Novick 1996). Davis et al. (2001) monitored 245 oystercatcher nests from 1997 – 1999 and reported 13% of nests hatched at least one egg, 14 chicks were fledged, and the number of chicks fledged ranged from 0.04 -0.15 per pair. The NPS (2003) at Cape Lookout National Seashore reported only 16% of nests hatched and only 8 chicks from 106 nests fledged. Thirty-one nests were lost to predation (NPS 2003).

Wilke (2004) and Wilke and Beck (2002) looked at oystercatcher productivity on three islands in Virginia with different management prescriptions and raccoon and red fox presence (Table 8). Metompkin Island, VA had red fox and raccoons but they were removed prior to the 2002 and 2003 nesting season. Wreck Island, VA had no red fox or raccoons in 2003. Fisherman Island, VA had raccoons in 2002 and 2003. No raccoons were removed from Fisherman Island, VA in 2002 but eleven raccoons were removed in late May which is near the end of the oystercatcher breeding season.

George (2002) reported oystercatcher productivity in Georgia ranged from 0.12 – 0.17 young fledged per pair in 2000 and 2001. Flooding and predation were the major causes of oystercatcher nesting failure.

Avian and mammalian predators feed upon eggs or chicks. Oystercatchers tend to be more common and more successful in areas with few or no terrestrial predators (Nol and Humphrey 1994). Predation was the major cause of clutch loss and accounted for 77% of 213 nests lost during the egg stage (Davis et al. 2001). Raccoons preyed on 79% of nests and feral cats preyed on the remainder (Davis et al. 2001). Severe weather or storm overwash caused 22% of nest failures. One nest was abandoned for unknown reasons. During a 4-year study in Virginia, Nol (1989) found 10% of oystercatcher nests failing to hatch were caused by predation and 90% by overwash. In Virginia, it appeared the cause of nest loss was predation and overwash, but the relative effect of these factors varies by location and variation in weather (Nol 1989).

Herring and great black-backed gulls eat oystercatcher chicks and eggs, and may compete with oystercatchers for nesting habitat (Nol and Humphrey 1994). Nol and Humphrey (1994) reported herring and great black-backed gulls killed oystercatcher chicks raised adjacent to gull colonies. Gulls were also observed eating eggs of American oystercatchers (Wilke and Beck 2002). Inter-specific competition with herring gulls at some sites limited the distribution and breeding success of oystercatchers (Nol and Humphrey 1994). Predation by crows on oystercatcher chicks and eggs is normally light (Nol and Humphrey 1994). Only one case of crow predation on oystercatcher chicks was documented among three Virginia barrier islands in 2003 (Wilke 2004).

Table 7. Number of American oystercatchers nesting on barrier islands and the western shore of Chesapeake Bay in Virginia. Data courtesy of the College of William and Mary, Center for Conservation Biology.

	Years																
Location	1975	1979	1980	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Assateague[B] Island																	
Wallops Island																	
Assawoman Island	20	46	32	6	12	11	44	28	26	24	12	5	4	16	23		14
Metompkin Island	60	234	124	303	253	294	283	364	165	266	284	177	289	194	224	145	109
Cedar Island/Sandbar	60	69	59	37	116	91	51	37	27	67	97	102	127	72	61	76	117
Parramore Island	8	21		38	19	22	18	8		9			6				
Hog Island	56	150	63	178	146	78	118	94	59	74	80	69	68	72	80	86	42
Rogue		6		51			11				21	3		3			3
Cobb Island	46	157	61	107	170	117	86	101	119	107	59	65	68	79	41	32	37
Little Cobb		46	8	41	8					5	14	8		12	5	8	24
Wreck Island	120	83	51	79	74	93	56	44	52	45	92	54	44	48	67	42	25
Myrtle Island	30	66	29	34	67	115	37	67	59	47	38	57	55	62	22	45	24
Ship Shoal Island	28	116	125	82	43	79	89	72	105	107	116	61	66	59	30	35	27
Smith Island	100	124	47	86	173	213	91	111	171	97	79	92	54	62	57	35	34
Fisherman Island		44	114	75	50	51	58	80	97	76	60	36	79	54	64	72	52
Other locations[A]		77	33	67	92	82	137	48	43	40	73	60	84	42	34	57	53
Grand View Beach																	
TOTAL	528	1239	746	1184	1223	1274	1079	1054	923	1004	1025	789	971	735	708	638	561

A. Other locations were Chimney Pole marsh, Daschle Shoal, and Sandy Beach.

B. Data for Assateague, Wallops, and Grandview Beach are available for selected years.

Table 7, Continued. Number of American oystercatchers nesting on barrier islands and the western shore of Chesapeake Bay in Virginia. Data courtesy of the College of William and Mary, Center for Conservation Biology.

	Years							
Location	1996	1997	1998	1999	2000	2001	2002	2003
Assateague Island[B]						30	12	
Wallops Island						n/a	3	
Assawoman Island	19	34	22	9	18	19	22	9
Metompkin Island	162	166	157	117	121	85	92	151
Cedar Island/Sandbar	110	119	83	94	103	93	83	81
Parramore Island								
Hog Island	42	94	32	72	34	32	42	18
Rogue								
Cobb Island	40	47	28	17	28	25	17	20
Little Cobb	8	10	11	13	12	20	12	22
Wreck Island	38	44	32	41	56	37	46	70
Myrtle Island	26	29	18	28	22	14	16	22
Ship Shoal Island	34	26	24	26	19	33	27	38
Smith Island	19	24	32	38	29	17	14	17
Fisherman Island	40	40	40	17	61	30	26	52
Other locations[A]	66	62	41	37	36	34	25	46
Grand View Beach						8	6	
TOTAL	604	695	535	509	539	477	443	546

A. Other locations were Chimney Pole marsh, Daschle Shoal, and Sandy Beach.
B. Data for Assateague, Wallops, and Grandview Beach are available for selected years.

Table 8. Comparison of oystercatcher productivity by management prescription on three barrier islands in Virginia.

	Metompkin Island		Fisherman Island		Wreck Island	
	Predators removed annually		Predators not removed		No predators present	
Year	% of nests hatched	Young fledged per pair	% of nests hatched	Young fledged per pair	% of nests hatched	Young fledged per pair
2003	77-90	1.05	33-46	0.21	82-93	1.26
2002	71	0.88	57	0.44	n/a	n/a

1.3.3.4 Harm to black duck populations

Virginia is the southern edge of the historical American black duck breeding range and still has nesting black ducks in some coastal areas (Longcore et al. 2000). The American black duck is listed as a species of management concern by the USFWS (USFWS 2005). The most common nesting locations used by black ducks in Virginia were Chesapeake Bay and barrier islands (Perry 2002). However, habitat/land use changes, erosion of Chesapeake Bay islands and marshes, and increases in avian and mammalian predator communities have led to a decline in nesting black ducks in Virginia (Bidrowski and Costanzo 2003). Also, increasing populations of some bird species (e.g., gulls) has led to competition for nest sites. Additionally, predation or the lack of critical habitat components may be limiting black duck breeding efforts on these islands (Bidrowski and Costanzo 2003).

The barrier island complex off Virginia's Eastern Shore could provide nesting habitat for black ducks, especially Smith, Ship Shoal, Mockhorn, Little Cobb, Cobb, Hog, Cedar, and Parramore Islands. Black ducks were found nesting on Cobb and Hog Island in 2003 (Bidrowski and Costanzo 2003). Depredated black duck nests were found on Parramore and Cedar Islands in previous years (Bidrowski and Costanzo 2003). Black ducks nesting on Hog Island in 1997 were depredated by raccoons (TNC 1998).

Black ducks currently are found nesting mainly on two large islands with upland habitat and 17 small "marsh" islands in the Chesapeake Bay (Table 9). Tangier and Watts Islands, VA represent the large wooded islands where black ducks nest. The 17 marsh islands range in size from < 2 acres to > 100 acres. The islands are located from several hundred yards to several miles offshore.

Table 9. Number of black duck nests monitored on selected Chesapeake Bay islands, 1996 – 2000.

	Islands				
Year	Parkers	Bernards	Watts	Tangier	Total
2000	27	0[A]	12	18	58
1999	24	22	5	n/a	51
1998	23	18	n/a	n/a	41
1997	16	15	11	29	71
1996	14	21	n/a	19	54

A. A red fox was found living on the island. No red fox lived on the other islands during the years 1996-2000.

The statewide black duck breeding population in Virginia has declined 69% from 1993 to 2000 (VDGIF, unpub. Data, Table 10). Most of the breeding black ducks in Virginia are found in the coastal marshes (G. Costanzo, VDGIF, pers. commun. and unpub. data). Black duck populations in Virginia have declined due to: 1) islands and habitat are dynamic and prone to storm erosion, sea level rise, and vegetation changes; 2) competition for nesting location with gulls, pelicans, cormorants, and other waterfowl; 3) predation by crows, gulls, raccoons, and red fox; and 4) human disturbance from recreation, commercial fishing, and egg poaching (G. Costanzo, pers comm. to M. Lowney, April 2, 2004). The dynamic nature of coastal areas and barrier and Chesapeake Bay islands makes habitat management of these lands impractical and impossible. While there has been some human disturbance that affects black duck nesting success, these disturbances are being managed on some lands by regulating human activity. There would be little human disturbance on most barrier islands because they are: 1) unoccupied by humans; 2) relatively large in size, with some greater than 1,000 acres, and 3) regulated for human activity. Human disturbance to nesting birds on Chesapeake Bay Islands is largely unregulated since most Chesapeake Bay islands are private property (G. Costanzo, email to M. Lowney, April 2, 2004).

Black ducks historically nested on more islands but have abandoned these islands since 1993 (VDGIF, unpub. data.). As of 2000, nine of the nineteen Chesapeake Bay islands in Virginia historically used by black ducks for nesting have been colonized by raccoons or red fox. Black duck nesting has since ceased on those islands (VDGIF, unpub. data.). During this time period these islands were colonized by raccoons or red fox. Raccoons colonized the Fox Island chain in Virginia (Great Fox, Clump, Does Hammock, Green Harbor, and South) in 1993, causing black ducks to abandon nesting on the Fox Island chain. Red fox colonized Shanks and Cheeseman Islands, VA in approximately 1998, causing black ducks to discontinue nesting on these islands. Black ducks also used to nest on several barrier islands. There used to be several black duck nests on Fisherman Island, VA during the 1990's, but they have since declined to 1 brood as raccoons have colonized the island in approximately year 2000.

The black duck nests on selected Chesapeake Bay islands were monitored from 1996 through 2000. The number of nests on the same island varied over time and no trend was evident. The number of nests monitored ranged from 14-27 on Parker Island, 15-22 on Bernards Island, 5-12 on Watts Island, and 18-29 on Tangier Island (VDGIF, unpub. data).

Table 10. Statewide black duck breeding population estimates in Virginia and Maryland. Data from Virginia Department of Game and Inland Fisheries.

	3-year running average	
Year	Virginia[A]	Maryland
1993	5,929	4,185
1994	5,310	2,769
1995	3,673	2,309
1996	2,322	2,826
1997	2,879	1,216
1998	2,732	1,216
1999	2,995	2,221
2000	1,813	2,274

A. Variance of +/- 90%.

Black duck nests were monitored on selected Chesapeake Bay islands from 1996 through 2000 (VDGIF, unpub.

data). Of the 228 black duck nests monitored on selected islands, 44% were successful. Of the unsuccessful nests on these selected islands, 28% were depredated and 12% were abandoned.

Annual breeding waterfowl surveys have been conducted in Virginia since 1990 (Bidrowski and Costanzo 2003). In addition, an aerial survey has been conducted from 1998 to 2003 on the barrier islands to monitor black duck breeding numbers (Bidrowski and Costanzo 2003).

The problems facing breeding black ducks in Virginia have been identified as: 1) limited nesting habitat; 2) habitat will be lost to erosion, other wildlife species, and human disturbance; 3) avian and mammalian predators colonizing islands; and 4) breeding populations of black ducks are declining (VDGIF, unpub. data). The Virginia Department of Game and Inland Fisheries identified potential management actions to produce black ducks. These potential management actions were to: 1) protect and manage remaining habitats; 2) remove predators and manage competing species; 3) provide nesting habitat and structures; 4) create nesting islands on mainland sites; and 5) take no action which would cause further decline of the species. Several studies throughout the range of black ducks indicate that predation may be operative at smaller spatial scales, and can be an important management tool to improve the status of black ducks (Serie 2002).

1.3.3.5 Harm to other species from raccoon and red fox predation

Two protected turtle species that would indirectly benefit from the proposed PM program include the Loggerhead sea turtle (Caretta caretta), a federal listed threatened species and the diamond-back terrapin (Macaclemys terrapin), a state species of management concern. Loggerhead sea turtles are the only sea turtles to nest in Virginia (Gaden 1994). Raccoons are the sea turtles' most serious nest predator (Gaden 1994). When the eggs hatch, the young turtles emerge from the sand and race towards the sea trying to evade a gauntlet of raccoons, gulls, and ghost crabs (Gaden 1994). Raccoons also prey heavily upon the eggs of diamond-back terrapins nesting on the Virginia barrier islands.

There is some concern that raccoons or red fox may be impacting the nesting success of high marsh guild species that are uncommon now on the barrier islands. Black rails (Laterallus jamaicensis) used to be more common on Cobb and Hog Islands (B. Truitt, TNC, pers. commun.). Henslow sparrows (Ammodramus henslowii) may nest on Wallops Island (B. Truitt, TNC, pers. commun.). Also, saltmarsh sharp-tail sparrows (Ammospiza leconteii) and seaside sparrows (Ammospiz amaritima) are rare on the barrier islands and may be affected by nest predators (B. Truitt, TNC, pers. commun.).

1.3.4 Need for raccoon, opossum, red fox, gull, crow, and grackle management to protect nesting birds

Raccoons and red fox have been increasing their colonization of barrier and Chesapeake Bay Islands (Table 11). Laughing and herring gull populations have increased annually by 4.22% and 16.04%, respectively, from 1966 to 2002 (Sauer et al. 2003) and these gulls have been observed feeding on piping plover chicks (USFWS 1999). Gull harassment and predation has resulted in irruptive piping plover production on Assateague Island (USFWS 2003, 2002, 2001, 2000 and 1999). Piping plover production became more linear once congregations of gulls preying on plovers were dispersed and killed (USFWS 2003, 2002, 2001, 2000 and 1999). Opossums are predators of ground nesting birds that have recently started colonizing the barrier islands. Grackles infrequently prey on eggs and fledglings of piping plovers and other birds.

1.3.4.1. Threatened and endangered birds (piping and Wilson's plovers and gull-billed terns)

Piping plover productivity has increased since predator management was expanded to more islands and raccoon and red fox removal efforts were increased (Table 12). Initially, the impact from removing a few gulls, crows, and grackles observed preying upon or harassing piping plover and other chicks was less clear, other than the immediate impact of saving a particular chick (USFWS 1999). Now, the impact of removing a few gulls and other avian predators is clearer in that plover production is more linear and less irruptive (Fig. 2). When no mammalian predator control efforts were undertaken on Assawoman Island, VA in 2000, approximately half the chicks were lost to gulls (USFWS 2000). Avian predators (e.g., gulls, crow) are suspected of many piping plover chick losses in 2000 (USFWS 2000); and most piping plover chick losses in 1999 (USFWS 1999). Much of the egg loss in 1996 was associated with avian predators and egg loss stopped when some gulls were shot (USFWS 1996). A laughing

gull was observed preying on a piping plover chick on Assawoman Island, VA in 1999 and 1998 (USFWS 1999, 1998).

Red fox are efficient predators of nesting birds (Sargeant et al. 1984). Just one or a few red fox preying on piping plovers can reduce productivity substantially (Keiss 2000). Even though mammalian and gull predator management efforts were conducted on Assawoman Island, VA in 2001, 54% of the chicks were preyed upon by red fox and gulls (USFWS 2001). For a three week period there was no red fox on Assawoman Island, VA and no predation on plovers, but when the red fox returned to the island numerous plover chicks disappeared (USFWS 2001). The arrival of red fox on Wallops Island, VA in 1996 coincides with the decline and no productivity of piping plovers through 2003 (Table 12).

Raccoons preyed on 4 nests on Assateague Island, VA during 2001 and 4 nests in 1997 (USFWS 2001, 1997). Barrier islands with raccoons had statistically significant fewer nesting waterbirds (Keiss 2000). The removal of raccoons by night shooting on Assateague Island from areas with nest predation resulted in the cessation of piping plover nest predation (USFWS 1997). Raccoons were found to be preying on adult piping plovers during the nesting season on Assateague Island in 1999, 1998, and 1997. Raccoons were found preying on plover chicks on Assateague Island in 1997 (USFWS 1997).

Table 12. Piping plover productivity estimates selected barrier islands in Virginia.

	Productivity estimate (number of chicks fledged)											
Island	2004	2003[A]	2002[A]	2001[A]	2000	1999	1998	1997	1996	1995	1994	1993
Assateague	2.30	1.87	1.56	2.31	1.61[A]	1.72[A]	1.22[A]	1.12[A]	1.46[A]	0.81[A]	2.12	1.07
Wallops	3.0[B]	0	0	0	0	0	0	0	0.67	2.00	0.67	1.33
Assawoman	2.65	2.00	1.13	1.61	1.94	1.66[A]	0.87[A]	0.42	1.45	1.00	1.08	2.00
Cedar	2.04	2.00	1.00	1.00	1.00[A]	0.62	1.07	0.00	2.15	-		-
Metompkin	2.02	1.68	1.07	1.05	1.00[A]	0.95[A]	1.00	1.11	1.33	2.25	1.25	1.75

A. Intensive raccoon and red fox removal was conducted to enhance piping plover productivity.
B. Productivity estimate was based on one nest.

1.3.4.2 Colonial waterbirds

The preponderance of increases over decreases indicates that mammalian predator removal has a positive effect on island use by colonial waterbirds and shorebirds (Dueser et al. 2003). For the six bird species monitored on six islands from 1998 to 2002, they increased significantly in abundance following removal of raccoon and red fox (Dueser et al. 2003). Dueser et al. (2003) reported least terns increased 17% on Metompkin Island and 80% on North Cedar Island from 2001 to 2002. The common tern declined 26% on North Cedar but remained far above its 5-year average. It is important to note that these population increases occurred in the face of incomplete predator removal (Dueser et al. 2003).

1.3.4.3 Shorebirds

The number of American oystercatcher chicks fledged in 2003 on Metompkin Island, VA was 5 times greater than on Fisherman Island, VA where no predator control was conducted until late in the nesting season (1.05 vs. 0.21 chicks per pair)(Wilke 2004, Table 8). Productivity in 2002 on Metompkin Island, VA was double that for Fisherman Island, VA (0.88 vs. 0.41 chicks per pair) where no predator removal was conducted (Wilke and Beck 2002). The data suggest that removal of mammalian predators from Metompkin Island, VA had a positive effect on the breeding performance of American oystercatchers (Wilke 2004, Wilke and Beck 2002). Additionally, the fledgling rate for Metompkin and Wreck Islands, VA were higher than that reported in the scientific literature (Wilke 2004, Wilke and Beck 2002). Keiss (2000) reported statistically significant more nesting waterbirds on islands without raccoons than islands with raccoons.

1.3.4.4 Impact of gull predation and inter-specific competition on other bird species

Large gulls are voracious predators of eggs and chicks of colonial birds and may threaten rare or endangered species

(Guillemette and Brousseau 2001). Large gulls also prey on waterfowl eggs and fledglings (Sovada et al. 2001). Great black-backed and herring gulls often prey on auks, larids, cormorants, ducks, and terns (Guillemette and Brousseau 2001, O'Connell and Beck 2003, Nocera and Kress 1996, Becker 1995, Burness and Morris 1992, Blodgett and Henze 1992, Kress et al. 1983). Predation by gulls may occur during the day or night (Guillemette and Brousseau 2001, Nocera and Kress 1996). Proximity of tern and skimmer nesting colonies increases nest and fledgling predation by herring and great black-backed gulls (O'Connell and Beck 2003, Becker 1995). Becker (1995) reported fledgling success varied from 0-19% for common terns breeding adjacent to a herring gull colony because the gulls ate 44-94% of the tern chicks . Thus the common tern nesting density decreased over the years (Becker 1995). Guillemette and Brousseau (2001) reported herring gulls preyed upon 61-66% of the common tern chicks in a colony. Becker (1995) and Guillemette and Brousseau (2001) believed gull predation on tern chicks was a specialized from of predation practiced by relatively few gulls in adjacent nesting colonies.

Gull predation limits the nesting success of terns and skimmers on the Virginia barrier islands (O'Connell and Beck 2003) and some Chesapeake Bay Islands (R. Beck, College of William and Mary, unpub. data). Coinciding with the establishment of breeding herring and great black-backed gull colonies in Virginia was the lower nest success and population declines of black skimmers, common terns, least terns, and gull-billed terns on the Virginia barrier islands (O'Connell and Beck 2003). Tern and skimmer colonies experienced statistically significant greater rates of disturbance from great black-backed gulls and herring gulls when they nested near gull colonies (O'Connell and Beck 2003). Overall, gull predation on tern and skimmer nests was similar where black-backed and herring gull colonies nested adjacent to or away from tern and skimmer colonies because of aerial foraging by laughing gulls (O'Connell and Beck 2003). Terns and skimmers fledged chicks from only 3% of eggs produced and gull predation was confirmed for 27% of the eggs (O'Connell and Beck 2003). O'Connell and Beck (2003) observed herring gulls on foot and laughing gulls on the wing prey upon ¼ of the tern and skimmer chicks and eggs on a Virginia barrier island. A herring gull was observed on Assateague Island, VA preying on a least tern chick in 1999 (USFWS 1999).

Nest site competition between gulls and skimmers and gulls and terns results in skimmers and terns nesting in areas more prone to flooding, thus resulting in higher nest failure (O'Connell and Beck 2003, Kress et al. 1983). Flooding accounted for 21% of common tern and black skimmer nest failures (O'Connell and Beck 2003). Nest site competition can be so intense with laughing gulls that nesting common terns, black skimmers, and gull-billed terns will decline over years (Fig. 8, R. Beck, College of William and Mary, pers. commun.). Common terns may nest in non-traditional nest sites among large rocks comprised of riprap around an artificial island (e.g., South Island) to avoid laughing, herring, and great black-backed gull predation (R. Beck, College of William and Mary, pers. common.).

Adverse effects of invasive herring and great black-backed gulls on other seabird populations became apparent in Maine by 1920 (Norton 1924 cited in Blodget and Henze 1992). This problem moved south down the coast as these gull populations expanded their range and abundance (Blodgett and Henze 1992). The gull population in Massachusetts increased from about 100 pairs in the 1930's to nearly 50,000 pairs in the mid-1980's (Blodget and Henze 1992). The subsequent increase in gulls coincided with a sharp decline in common and roseate terns (Blodget and Henze 1992).

Great black-backed gulls were found nesting on Fisherman Island, Virginia, in 1970 (Scott and Cutler 1970 cited in Watts and Byrd 1998). Since the 1970's, the species has rapidly colonized other locations on both barrier and Chesapeake Bay islands (Watts and Byrd 1998). The great black-backed gull population has increased greater than 20-fold since the mid-1970's (Watts and Byrd 1998). On a more local scale, Williams et al. (1990) reported counting zero breeding great black-backed gulls on Virginia's barrier islands in 1975, but counted 561 breeding pairs on the same islands in 1986. The gulls had declined to 330 birds on the same barrier islands by 1998 (Williams et al. 2000) and then increased to 466 birds during 2003 (Williams, unpublished data).

A single herring gull nest was located on Cobb Island, Virginia in 1948 (Murray 1952 cited in Watts and Byrd 1998). The number of herring gull colonies and pairs has increased over the last 40 years to 9 colonies containing >2,600 pairs in 1977 and to 35 colonies containing > 8,800 pairs in 1993 (Erwin and Korschgen 1979, Watts and Byrd 1998). On a more local scale, the number of herring gulls observed on Virginia's barrier islands increased from 1,320 birds in 1975 to 3,959 birds in 1988 before decreasing to 2,724 birds in 1998 (Williams et al. 1990, Williams unpublished data).

Table 11. Occurrence of raccoons (R), red fox (F), and opossum (O) among barrier islands in Virginia.

	Year														
Island	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Assateague Island	R, F	R, F	R, F	R, F							R, F	R, F	R, F	R, F	
Assawoman Island								R, F	F	F	R, F[A]	R, F[A]	R, F[A]	R, F[A]	
Cedar Island/Sandbar							R	R, F	R, F	R, F	R. F	R, F	R[A]	R, F[A]	
Cobb Island		F									R	R		R	
Fisherman Island											R	R	R	R[A]	
Hog Island								R	R	R	R	R	R	R	
Little Cobb															
Metompkin Island		F					R, F[A]	R, F	F	R, F[A]	R, F[A]	F[A]	R[A], F[A]	R, F[A]	
Mink														R	
Mockhorn									R	R	R	R	R	R	
Myrtle Island						R					R	R		R[A]	
Parramore Island	R	R	R	R	R	R	R	R	R, F	R, F	R, F	R, F	R, F	R, F[A]	
Revel									R		R			R, F[A]	
Rogue											R	R		R	
Ship Shoal Island							F		R		R				
N. Smith & Smith Island									R	F, R	R, F	R	R[A]	R, F	
Wallops Island								R, F	R, F	R, F	R, F,	R, F	R, F, O[A]	R, F, O[A]	R. F, O[A]
Wreck Island											R		R		

A. Extirpated or reduced in abundance during management program prior to nesting season.

Table 11, continued. Occurrence of raccoons (R) and red fox (F) among barrier islands in Virginia.

	Year														
Island	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Assateague Island															
Assawoman Island				R, F											F
Cedar Island/Sandbar															R
Cobb Island				R											
Fisherman Island															
Hog Island	F			R											R, F
Little Cobb															
Metompkin Island															
Mink															
Mockhorn															
Myrtle Island															
Parramore Island	R	R	R	R, F	R										R, F
Revel			R	R	F		F								
Rogue															
Ship Shoal Island															
N. Smith & Smith Island				R											R?
Wallops Island															
Wreck Island															

A. Extirpated in management program prior to nesting season.

Laughing gulls were the most numerous nesting colonial waterbird in Virginia in 1977 and 1993 (Erwin and Korschgen 1979, Watts and Byrd 1998). Laughing gulls have shown a noticeable increase in numbers and distribution from 1977 to 1993 (Watts and Byrd 1998). Laughing gulls have also expanded their nesting distribution from barrier islands to include the Chesapeake Bay islands since 1977 (Watts and Byrd 1998). On a more local scale, the number of laughing gulls counted on Virginia's barrier islands increased from 3,730 birds in 1975 to 20,680 birds in 1988 before declining to 6,685 birds in 1998 (Williams et al 1990, 2000) and 1,701 birds in 2003 (Williams, unpublished data).

South Island, a man-made island which is part of the Hampton Roads Bridge Tunnel complex, was colonized by common terns, black skimmers, and gull-billed terns in the 1970's (R. Beck, College of William and Mary, pers. commun., May 21, 2004). There used to be more than 3,500 nesting pairs of common terns on South Island, VA during the late 1990's. The island was colonized by 9 pairs of laughing gulls in 1999 which increased to more than 3,000 pairs in 2004 (R. Beck, College of William and Mary, pers. commun., May 21, 2004, Fig 8). Also, 150 pairs of herring gulls and 17 pairs of black backed gulls used the island for nesting in 2004. The gulls out-competed the terns and skimmers for nest sites, preyed on eggs, and preyed on fledgling terns and skimmers. Since the gulls colonized the island, common tern numbers have declined to 791 pairs in 2003. The number of nesting common terns increased to 1,178 pairs in 2004 by nesting among the rocks comprising the riprap surrounding the man-made South Island, VA. Also, there were only 18 pairs of black skimmers and 5 pairs of gull-billed terns attempting to nest among the thousands of gulls in 2004.

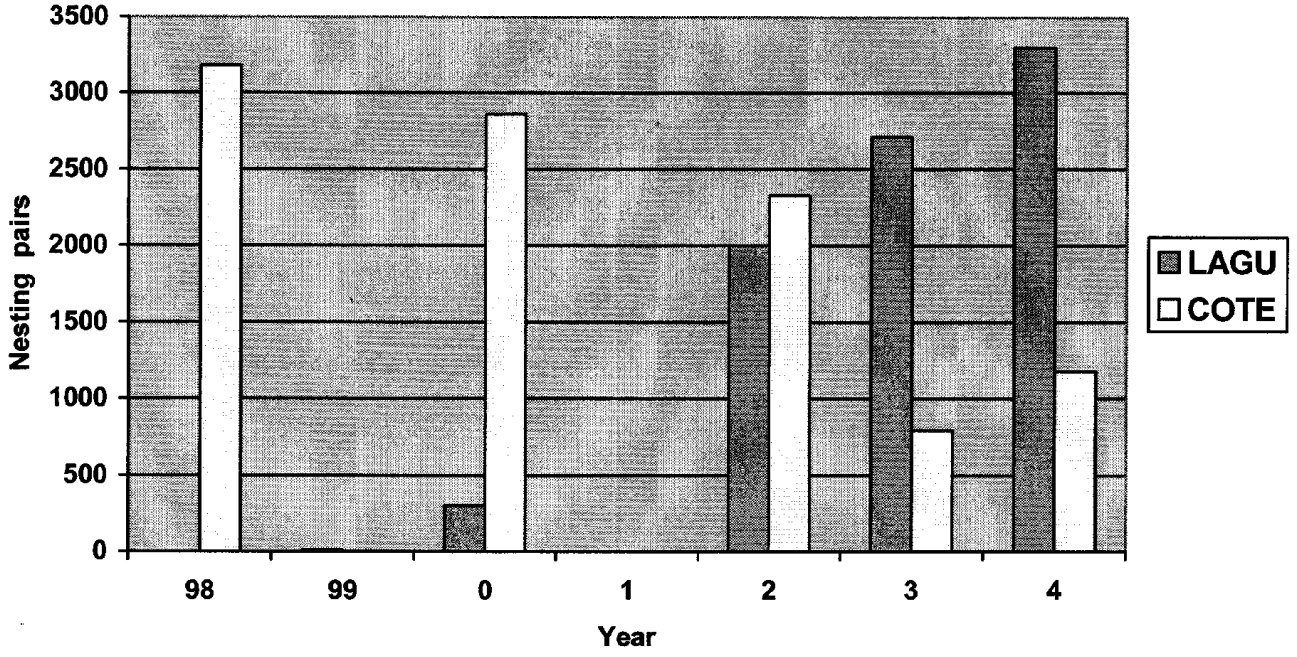


Figure 8. Impacts on nesting common terns from gull nest site competition on South Island, Hampton, Virginia. LAGU = laughing gulls, COTE = common terns.

The USFWS has been managing mammalian predation on Assateague Island, VA to increase piping plover production since 1987 (USFWS, Chincoteague NWR, unpub. report, 1988). However, they have been unable to reach or exceed the recovery goal of producing at least 1.5 chicks per adult pair until an integrated gull predation program, which included shooting predatory gulls, was implemented in 1999 (USFWS 1999, J. Schroer, FWS, pers. commun., Fig. 9).

Herring and great black-backed gulls preyed on piping plover chicks and adults at Gateway National Park in New York (Witmer et al. 1996). After a three years of gull harassment and nest destruction, the gull colony remained and continued to loaf near plovers. This resulted in declining productivity although the number of breeding pairs of

piping plovers remained constant at 15-18 pairs over a 3 year period. Plovers responded to the presence of gulls by nesting further away from the gull colony.

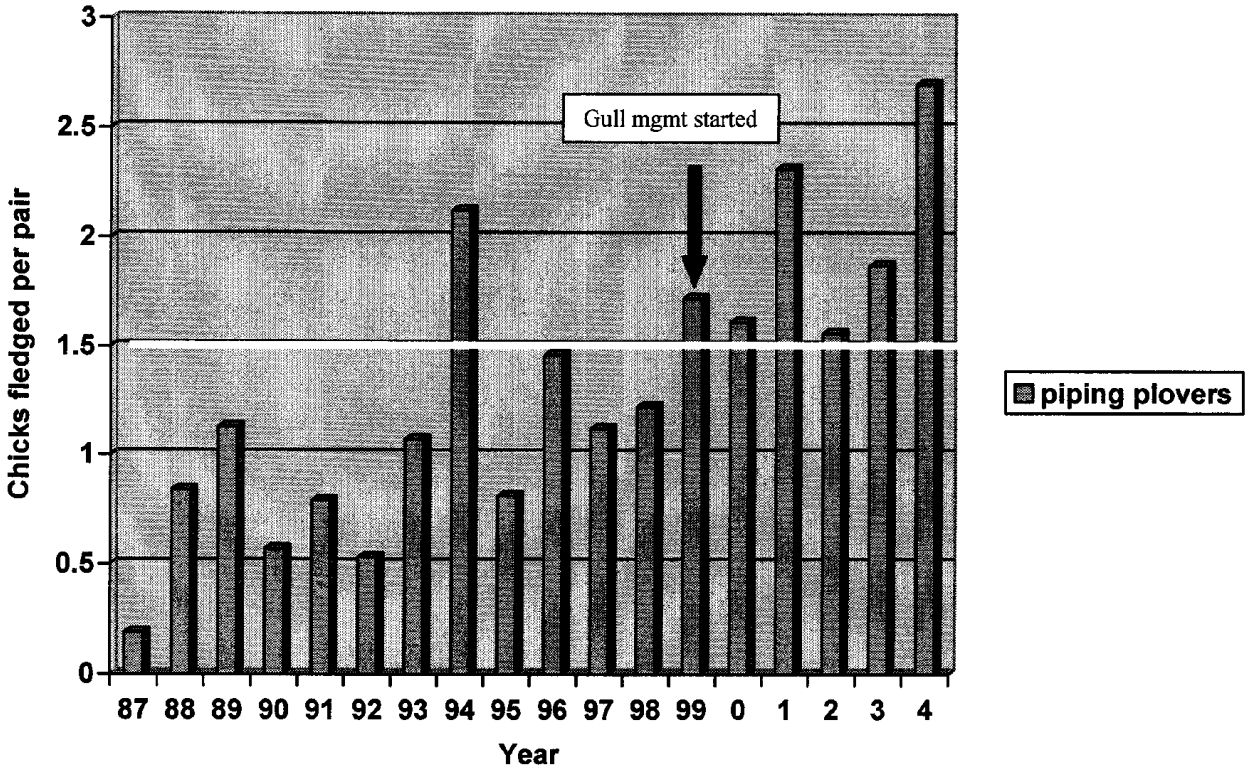


Figure 9. Number of chicks fledged per pair of piping plovers on Assateague Island, VA, 1987 – 2004. Piping plover recovery plan calls for producing at least 1.5 chicks per pair. Data provided courtesy of the U.S. Fish and Wildlife Service.

1.3.4.5 Impacts of coyotes on nesting birds, red fox, and raccoons.

A few barrier islands in Virginia infrequently have coyotes. Coyotes have been seen on Assateague and Fisherman Islands (USFWS 1999 and B. Arquilla, College of William and Mary, pers. commun. June 1, 2004). Red fox are severe predators on nesting ducks in uplands (Johnson et al. 1989). Coyotes also prey on ground nesting waterfowl (Zoellick et al. 2004) but are believed less to be less detrimental to duck production than red fox (Johnson et al. 1989). While coyotes and red fox are both territorial, in sympatric populations, coyotes exclude red foxes (Sargeant et al. 1993). Sovada et al. (1995) found predation on nesting waterfowl by red fox was lower in areas predominated by the presence of coyotes (4% of nest depredated by red fox) versus areas predominated by red fox (27% of nests predated by red fox). Sargeant et al. (1993) found a weak inverse relationship between the presence of coyotes and raccoons and predation on nesting ducks or nests. This data suggests the presence of coyotes may be beneficial to reducing predation on nesting shorebirds, colonial waterbirds, and black ducks by red fox and raccoons.

While Sovada et al. (1995) found the presence of coyotes beneficial to duck nesting success in the prairie pothole region, Sovada et al. (1995) cautioned that the study was conducted where coyote populations were low and substantial acreage was enrolled in the Conservation Reserve Program which would have resulted in greater dispersion of nesting ducks and reduced risk to predation. Also, Sovada et al. (1995) stated the difference in nest success between areas predominated by coyotes versus red fox does not apply to all habitat types.

The barrier islands are vastly different habitat than the prairie where Sovada et al. (1995) studied the impacts of coyotes to nesting ducks. The impact of coyote predation on nesting shorebirds, colonial waterbirds, and black ducks in Virginia has not been studied. Shorebirds often nest on barrier island beaches with no vegetation or sparse

vegetation where the cryptic coloration of the eggs and incubating adult has evolved to protect them from predators. Colonial waterbirds nest in sparse to moderately dense grasses at exceptionally high densities where aggressive behavior evolved to protect them from avian predators. Black ducks would nest in moderately dense grasslands or forbes on the barrier islands.

Coyotes have been removed from other islands to protect shorebirds and colonial waterbirds from predation. The impact of coyote removal is partially understood in that it results in increased bird production. Coyotes were removed annually from Monomoy National Wildlife Refuge in Massachusetts to protect nesting piping plovers and roseate terns, federal listed threatened species, because they have preyed on these birds in past years (M. Chandler, USDA, APHIS, WS, pers. commun.). Henke and Bryant (1999) reported the density of mesopredators (e.g., gray fox, bobcat, and badgers) increased in west Texas grassland habitats 12-months after coyote densities were reduced.

Information about whether coyotes are detrimental or beneficial to shorebird, colonial waterbird, or black duck nesting success are unclear due to the paucity of data and scarcity of experiences with coyotes depredating shorebirds or colonial waterbirds. What is becoming more clear is ground nesting shorebirds and colonial waterbirds on the Virginia barrier islands appeared to evolve in an environment with no mammalian predators.

1.3.5 Effectiveness of predator removal to increase breeding bird populations

Bird populations may be regulated by density dependent and independent factors including food supply, territorial space, nesting sites, predation, and parasites (Cote and Sutherland 1997). Cote and Sutherland (1997) showed predator removal benefited nesting bird populations by increasing the number of breeding individuals. Predator removal can be an important management activity necessary to maintain some bird populations because nest predation accounts for the largest share of nest failure in most species of songbirds (Martin 1992) and rates of nest predation can be so great that some local populations cannot be self-sustaining and have been labeled population sinks (Pulliam 1988, Brawn and Robinson 1996). Predator removal can reduce early avian mortality on eggs and chicks (Cote and Sutherland 1997). Similarly, post-breeding population sizes are also significantly larger following the removal of predators. However, predator removal does not necessarily affect bird breeding population sizes to the same extent. Predator removal studies that examine the benefit of breeding bird populations are not consistent in their results, with some studies showing increased breeding populations whereas other studies show no effect or decreases (Cote and Sutherland 1997). These results are not unexpected given how bird populations are regulated (hunted versus non-hunted species)(Cote and Sutherland 1997).

Predator removal studies may fail to enhance breeding bird populations for hunted species because the fall population was reduced enough by hunting each year that fewer birds were available to breed in the spring (Cote and Sutherland 1997). In this instance the size of the breeding population remains stable due to hunting mortality. While the breeding bird population was not increased for some hunted species by predator removal, the number of chicks fledged was increased and, therefore, more game animals were made available for harvest during hunting seasons (Cote and Sutherland 1997).

Some Virginia barrier islands are relatively small (< 600 hectares) and support few raccoons and red fox. These islands appear to offer an abundance of suitable nesting habitat in the absence of mammalian predators (Dueser et al. 2003). These islands would include Metompkin, North Cedar, Wreck, Ship Shoal, and Myrtle. Removal programs on these islands also demonstrated that incomplete removal of predators may produce only limited benefits. It appears that leaving even 1-2 predators may significantly reduce habitat suitability for nesting colonial waterbirds and shorebirds (Dueser et al. 2001). However, complete removal of all predators resulted in the strongest nesting season observed on Metompkin Island in many years (Dueser et al. 2001).

Dueser et al. (2001) believed predator removal is unlikely to be effective on some islands over the long term because of the diversity and abundance of predators (e.g., Parramore Island, VA), proximity to the mainland (e.g., Mockhorn Island, VA), proximity to other islands with abundant predators (e.g., Revel) or a combination of the above (e.g., Fisherman). However, allowing raccoon and red fox populations to persist and increase on these islands will result in the loss of some colonial waterbird, shorebird, and black duck populations. Also, federal agencies and others must comply with the Endangered Species Act to prevent certain species from declining or disappearing from occupied habitat.

Predator removal to enhance bird populations may be an effective solution with long-term benefits if predators cannot re-colonize the islands naturally (Cote and Sutherland 1997) or readily. On the mainland the limited evidence available suggests that predator removal has short-term benefits and these benefits disappear without regular maintenance (Cote and

Sutherland 1997). In other words, on the mainland for benefits to continue, predator removal most likely would be conducted annually. If predator removal is conducted with other measures such as habitat improvement, predator removal could likely be conducted less frequently.

The conservation practices of game and non-game birds should be integrated (Ball et al. 1994). Population declines of both game and non-game birds are a function of large-scale modification of the landscape and predator communities (Ball et al. 1994) due to human activity. Therefore, solutions that are most effective, efficient, and impact the greatest number of species of similar guilds would be conducted at a large scale, preferably at the landscape level.

1.3.5.1 Effectiveness of predator removal to increase non-game bird populations

Predation is one of many mortality factors that influence wildlife populations. Predators often play critical roles in the composition and function of wildlife populations in ecosystems (Witmer et al. 1996). The effects of predation on birds can be detrimental to local populations or islands, especially when predator densities are high or when predators gain access to areas not historically occupied (Bailey 1993, Stoudt 1982). In general, ground nesting birds suffer the highest predation rates, followed by cliff/burrow nesters. Tree nesters benefit from the lowest rates of predation (DeVos and Smith 1995).

Predator removal has been conducted to increase survival of fledglings and to increase breeding populations of threatened or endangered wildlife, rare species, and species not traditionally hunted (Reynolds and Tapper 1996). Numerous studies have shown that nest predation accounts for the largest share of nest failures of neotropical migratory songbirds and contribute to low recruitment rates (Heske et al. 2001, Nelson 2001). Increased rates of nest predation are believed to be largely related to habitat fragmentation, habitat degradation, and other changes in related landscape features (Heske et al. 2001, Nelson 2001, Sovada et al. 2001). The impacts of predation vary geographically because of habitat composition and structure and species composition of predator communities (Nelson 2001, Sovada et al. 2001). Also, when implemented, the effectiveness of predator removal to protect these non-game species has varied due to compensatory mortality (predator species composition), predator removal strategies and methodologies used (i.e. human bias), and geographic location. Some of these predator removal programs have resulted in increased populations and fledglings of species of management interest. Other predator removal programs have had mixed effectiveness.

There have been several predator removal programs conducted in Virginia to benefit non-game bird species. All of these programs have resulted in increases in productivity. Wilke (2004) demonstrated the effectiveness of raccoon and red fox removal from barrier islands in Virginia to increase oystercatcher productivity. On islands where an aggressive integrated raccoon and red fox removal program was implemented prior to nesting, the result was a five fold increase in productivity and a near tripling in egg hatching success between two Virginia barrier islands (Wilke 2004). A raccoon and red fox removal program on Assateague Island, VA was implemented after several studies implicated mammalian predation as a cause for low productivity and chick survival (Cross 1989, Patterson et al. 1991). The result has been an increase in productivity and population of piping plovers on Assateague Island, VA and other Virginia barrier islands (Fig. 2 and 9, Table 12). Larger increases in piping plover productivity were realized when gull predation was minimized by removal efforts.

Butchko and Small (1992) conducted mammalian and avian predator removal in California to benefit the endangered California least tern. Coyotes, raccoons, skunks, ground squirrels, ravens, crows, kestrels, and loggerhead shrikes were preying on least tern nests and fledglings. Because other exclusion methods were unable to reduce predation to allow satisfactory productivity, predator removal was implemented. Prior to predator removal there were 0.27 chicks fledged per breeding pair of least terns in 1987. After predator removal was initiated the number of chicks fledged ranged from 1.48 to 1.66 per pair in 1988. The number of chicks fledged increased in the early 1990's to the highest recorded number of chicks fledged (Butchko and Small 1992). A metapopulation model for the California least tern was developed to predict the persistence of the least tern population and the effects of various management actions (Akcakaya et al. 2003). The model demonstrated the reduction of predation did increase substantially the viability of the population under the assumption of low vital rates (e.g., survival and fecundity).

Removal of medium sized predators (e.g., raccoons, opossums, red fox, and skunks) has resulted in increased survival of waterfowl nests, hens, and ducklings fledged in prairie habitat (Garrettson et al. 1996). The impacts of

medium sized predator removal on grassland nesting birds in prairie habitat has been less clear (Garrettson et al. 1996, Dion et al. 1999). The impacts appear confounded because of compensatory mortality where the removal of some predator species (e.g., raccoons, skunks, and red fox) resulted in other species (e.g., ground squirrels) increasing predation on grassland nesting songbirds (Dion et al. 1999).

1.3.5.2 Effectiveness of predator removal to increase waterfowl populations

Beauchamp et al. (1996) showed there has been a dramatic pattern of decline in waterfowl nest success in the past 50 years in the prairie pothole region of Canada and the United States. Hatching rates dropped from 33% in 1935 to 10% in 1992 (Beauchamp et al. 1996). Low nest success, which reflects high nest predation, is viewed as the most important limitation on waterfowl productivity on the prairies (Greenwood et al. 1987). Human alteration of the predator community on the prairie has contributed to low duck nesting success (Garrettson et al. 1996). Also, changes in the predator community and predator abundance in the artic has resulted in high predation rates on waterfowl and nests because predators gained access to previously isolated habitat (Sovada et al. 2001). Alteration of the animal community on the prairies by eliminating gray wolves (Canis lupus) and reducing coyotes (Canis latrans) has allowed red fox, raccoons, and skunks to flourish (Sargeant et al. 1993). Also, raccoons are a recent, non-native, arrival to the prairies (Kaufmann 1982, Stoudt 1982).

Garrettson et al. (1996) found predator (e.g., raccoons, foxes, and skunks) removal by trapping alone (e.g. leghold traps, snares, conibears in box sets, and shooting) greatly improved nest success in ducks. The high brood counts of ducks on the experimental areas suggest that the high nest success resulted in dramatic improvements in duck recruitments, even if brood survival remained the same between experimental and control sites (Garrettson et al. 1996, Garrettson and Rowher 2001). Upland duck nest success increased from 6 to 52%, dabbling duck nesting success increased significantly (P=0.002) from 24% to 53%, and diving duck nesting success increased significantly (P=0.03) from 29% to 57% with predator removal (Garrettson et al. 1996, Garrettson and Rowher 2001). An added benefit of predator removal was the number of duck broods increased by an order of magnitude with almost three times as many broods at sites with predator removal than control sites (Garrettson et al. 1996).

Sargeant et al. (1995) found small increases in duck nest success on the prairie when using trapping alone on relatively small sites (351 acres). Restrictions were placed on the types of traps used and work schedules which hindered removal of predators. The restrictions on the use of snares during the Sargeant et al. (1995) study reduced their effectiveness for lethally removing foxes. Garrettson et al. (1996) found snares greatly increased effectiveness for spring trapping fox and snares accounted for 70% of all fox captured. Conibear traps captured 75% of raccoons (Garrettson and Rowher 2001).

1.3.6 Scale predator management needs to be conducted at to be effective

Predator removal can be conducted on comparatively small units of land or across the landscape. Garrettson et al. (1996) conducted raccoon, fox, and skunk removal on 10,240 acre blocks of prairie habitat to increase waterfowl productivity. Intense trapping did not remove all predators from these large blocks of prairie habitat (Garrettson et al. 1996). Hoff (1999) trapped duck nest predators in township size blocks (24,537 acres) to increase waterfowl nest success. Nest success was greater on trapped (36%) than untrapped (15%) areas (Hoff 1999). In contrast, Sargeant et al. (1995) removed the same waterfowl nest predators on 351 acre blocks of prairie habitat to increase waterfowl productivity. Chodachek (2003) removed nest and nesting duck predators from small sites (640 acres) annually and found nest success was about double from sites without predator management (53% versus 28.7%). Both approaches, trapping large blocks and small blocks of land resulted in increases in breeding waterfowl populations and number of fledgling produced. Although, trapping large blocks (24,537 acres) is more cost effective than trapping mid-size blocks (10,240 acres) or planting nesting cover (Hoff 1999).

1.3.7 Historic management of native bird populations on islands

The coastal islands off the eastern shore of Virginia are the only undeveloped islands on the eastern seaboard (Hayden and Hayden 1994). The 14 barrier islands are from 0.3 to 0.75 miles offshore, range from 3 – 30 feet in elevation, and vary from 68 to 17,500 acres (Moncrief 1994, Hayden and Hayden 1994). The islands extend 70 miles along the seaward margin of the southern Delmarva Peninsula.

The Chesapeake Bay islands are more varied in development. Some islands have human development (e.g., Tangier)

whereas others have no development. Also, some islands are expected to disappear due to erosion, rising sea levels, or subsidence. There are two large Chesapeake Bay islands and about 17 small "marsh" islands in Virginia. The large islands are Tangier and Watts. The 19 Chesapeake Bay islands range in size from less than 2 acres to more than 100 acres.

There are several man-made (e.g., Craney) and storm created islands along the southwestern portion of Chesapeake Bay. The man-made islands have extensive human disturbance from depositing dredge spoil which benefits the birds nesting there because succession is set back almost annually. On the other hand, the storm created islands have extensive human disturbance during summer months from beach activities which is to the detriment of some nesting bird species.

1.3.7.1 Barrier Islands

Barrier islands are those islands located on the Atlantic Ocean side of the eastern shore of Virginia (Appnedix C).

Assateague Island, VA and MD

Assateague Island consists of 8,587 acres in Virginia and about 7,000 acres in Maryland and is located east of the Eastern Shore of Virginia and Maryland. It is the northern most island and one of the largest islands in the barrier island chain. The island's habitat consists of extensive overwash areas, dunes, large patches and extensive hedgerows of myrtle and cattail, extensive salt marsh grasslands, several large freshwater impoundments and moist soil management units, large forested areas of loblolly pine and mixed pine-hardwood forests, and extensive sandy beaches.

Predator removal was initiated in 1988 with efforts focused on raccoons and red fox (Table 13).

Assawoman and Wallops Island, VA

Assawoman Island consists of about 354 acres and Wallops Island consists of about 3,840 acres. Both islands are located east off the Eastern Shore of Virginia. Assawoman and Wallops Islands were separate islands until the late 1980's when the inlet between the islands closed, forming a bridge. The island's habitat consists of overwash areas, dunes, extensive hedgerows of myrtle and cattail, extensive salt marsh grasslands, and extensive sandy beaches. Wallops Island also has large tracts of upland forests. Raccoons and red fox colonized the more southern Assawoman Island wherein predator populations exploded and colonial waterbird populations crashed (TNC 1998). Red fox then swam the narrow inlet between Assawoman Island and the more southern Metompkin Island, VA to inhabit Metompkin Island, VA.

Predator management was initiated in 1995 with a limited program to remove red fox and raccoons. Several raccoons and 5 red fox were removed in 1995. In 1997 efforts were made to remove red fox denning sites on the island. Removal of raccoons and red fox to enhance production of piping plovers, and colonial waterbirds intensified in 2001. Opossums were also removed from Assawoman and Wallops Islands. Raccoon, opossum, and red fox were removed from both islands in 2001-2003 (Table 13).

Cedar Island, VA

Cedar Island consists of about 4,531 acres and is located east of the Eastern Shore of Virginia. The island was once comprised of an island and a sandbar, but they were recently joined to become North Cedar Island. A breach occurred in the southern part of the island which was then named Cedar Island. Both will be collectively referred to as Cedar Island in this EA. This barrier island is south of Metompkin Island, VA. The island's habitat consists of mainly bullrush salt-water marsh, low foredunes, and sparse grassland in the north and sparse grassland and overwashed areas in the south (McCaffrey and Dueser 1990). There are small patches of Atlantic red cedar and wax myrtle. There are some abandoned storm damaged houses on the north end of North Cedar Island. An old Coast Guard Station, now privately owned, and a fishing camp are occasionally occupied. There is some residential development along the south end of Cedar Island.

Raccoon removal efforts were initiated in conjunction with work on Metompkin Island, VA in 2001 (Table 13).

Cobb Island, VA

Cobb Island consists of about 1,300 acres and is located near the southern end of the barrier island chain. The island's habitat consists of dense spartina grasslands with xeric dunes (McCaffrey and Dueser 1990). No predator control work has been conducted on this island.

Fisherman Island, VA

Fisherman Island consists of 1,850 acres and is located east of the Eastern Shore of Virginia. It is the southern most barrier island. The island's habitat consists of overwash areas, dunes, swale, and shrub thickets. Raccoons have been present on the island since at least 1999. They have had a negative effect on species presence and production. Raccoon presence has caused black ducks to abandon the island as a nesting site (G. Costanzo, VDGIF, pers. commun.). In 2003, raccoons preyed on nesting brown pelicans, American oystercatchers, willets, and clapper rails eggs. An estimated 25% of pelican eggs were destroyed by raccoons on one week (P. Denmon, USFWS, pers. commun, May 2003, Categorical Exclusion May 14, 2003). There was concern that royal terns would abandon their nesting colony if disturbed by raccoons. Raccoon predation is believed to have resulted in a laughing gull colony declining from 3,800 nests in 2001 to 800 nests in 2002, and zero nests in 2003 (P. Denmon, Fisherman Island NWR, pers. commun.).

Several hundred to several thousand herring gulls have nested on the island since at least the mid-1970's (P. Denmon, USFWS pers. commun. January 7, 2004 and September 20, 2004). Herring gulls were observed preying on royal tern chicks in 2003 (P. Denmon, USFWS pers. commun. January 7, 2004). Herring gulls harass and attempt to prey on oystercatcher chicks. It is believed herring gulls may have factored into piping plovers abandoning Fisherman Island in 1993 or 1994 (P. Denmon, USFWS pers. commun. January 7, 2004).

Thousands of royal terns nest on Fisherman Island. The island was the only island in Virginia where royal terns nested until 2003 (P. Denmon, USFWS pers. commun. January 7, 2004). Predation and harassment by raccoons may have caused some royal terns to move to Wreck Island to nest. Fisherman Island also had the largest population of brown pelicans in Virginia until recently (P. Denmon, USFWS, pers. commun.).

Intensive raccoon removal efforts were started in late spring 2003 to reduce egg predation on pelicans (Table 13). Raccoons were also removed because of concern that predation and harassment of royal terns would cause them to abandon their nesting colony or not nest.

Hog Island, VA

Hog Island consists of about 3,610 acres. The island is comprised of accreting beaches, salt marsh, tall shrub thickets dune-grassland, and open dune-shrub thickets (McCaffrey and Dueser 1990). No predator control work has been conducted on this island.

Little Cobb Island, VA

Little Cobb Island consists of about 68 acres. The island is comprised of sparse grassland, erosion and overwashed areas (McCaffrey and Dueser 1990). No predator control work has been conducted on this island.

Metompkin Island, VA

Metompkin Island consists of about 741 acres and is located east of the Eastern Shore of Virginia. The island's habitat consists of foredunes with sparse grassland dissected by overwash and inlets areas (McCaffrey and Dueser 1990). Also, there are small patches of myrtle, phragmites, and cattail.

Metompkin Island hosted extraordinary nesting concentrations of piping and Wilson's plovers and numerous colonial waterbirds during the 1970's and 1980's (Williams et al. 1990). The nesting bird concentrations were some of the highest ever recorded on the Atlantic coast. The availability of suitable nesting habitat and the lack of predators were cited as the reason for the concentrations of nesting colonial waterbirds. In 1996 and 1997, few colonial waterbirds even attempted to nest on Metompkin Island (Williams et al. 1996).

Metompkin Island is significant in that is produces more oystercatchers than any other location on the east coast (B. Truitt, TNC, pers. commun.). Also, Metompkin Island has one of the highest historical productivity rates for colonial waterbirds among islands on the east coast (Table 1). Thus, management efforts have been undertaken to continue the high productivity of waterbirds as many of these populations are in decline.

A limited trapping program was conducted in the winter of 1995 resulting in several raccoons and 5 red fox being removed (Table 13). This program has continued because red fox and raccoons continue to re-colonize the island.

Mockhorn Island, VA

Mockhorn Island consists of about 7,000 acres and is located near the southern end of the barrier island chain. The island's habitat consists of tidal marsh and salt marsh cordgrass. There are some hummocks of Atlantic red cedar, loblolly pine, wax myrtle and other upland plants (VDGIF, no date). No predator control work has been conducted on this island.

Mink Island, VA

Mink Island consists of about 490 acres and is located east of the Eastern Shore of Virginia. The island's habitat consists mainly of salt marsh (McCaffrey and Dueser 1990). Predator control work was conducted on this island in 2001 only (Table 13).

Myrtle Island, VA

Myrtle Island consists of about 841 acres and is located east of the Eastern Shore of Virginia. The island's habitat consists of dense fore-dune grassland (McCaffrey and Dueser 1990). Raccoon populations exploded in the 1990's resulting in colonial waterbirds abandoning suitable habitat (TNC 1998). Predator control was conducted on this island (Table 13). However, raccoon abundance declined abruptly and most sign was very old. No raccoons were removed from this island during predator control efforts.

Parramore Island, VA

Parramore Island consists of about 5,429 acres and is one of the large islands in the barrier island chain along the Eastern Shore of Virginia. The island's habitat consists of pine and hardwood forests, interior fresh water marshes, brackish marshes, and interior open dune – shrub thickets (McCaffrey and Dueser 1990). Parramore Island is believed to offer the most black duck nesting and brood rearing habitat of the islands in the barrier island chain because there are several freshwater ponds on the island (G. Costanzo, VDGIF, pers. commun.).

The island had probably one of the highest rural raccoon densities in North America with 1 raccoon per four acres of land (B. Truitt, TNC, pers. commun.). Hanlon et al. (1989) reported raccoon densities on Parramore Island of one raccoon per 6 acres of land.. This raccoon density was subsequently reduced to one raccoon per 12 acres of land after a large fire, hurricane, and raccoon trapping program began (R. Dueser, Utah State Univ. pers. commun. October 22, 2004). Raccoon population reduction was started in winter 2003 in an effort to reduce dispersal to adjacent islands and reclaim Parramore Island for black ducks and other ground nesting birds (Table 13).

Revel Island, VA

Revel Island consists of about 1,097 acres and is located between Parramore Island and the mainland in VA. The island's habitat consists of pine-hardwood forests (McCaffrey and Dueser 1990). Removal of raccoons was initiated in winter 2003 in conjunction with management activities on Parramore Island (Table 13).

Rogue Island, VA

Rogue Island consists of about 265 acres and is a small island located southwest of Hog Island in VA. The island's habitat consists of salt marsh with salt pond and dense grassland (McCaffrey and Dueser 1990). No predator control has been conducted on this island.

Ship Shoal Island, VA

Ship Shoal Island consists of about 635 acres and is one of the southern barrier islands. The islands habitat consists of salt marsh and overwash beach on the north end and the south end has dense mesic grassland and salt marsh (McCaffrey and Dueser 1990). Raccoon populations exploded in the 1990's resulting in colonial waterbirds abandoning suitable habitat (TNC 1998). In 1997, nearly 500 nesting black skimmers, 250 common terns, and 50 gull-billed terns abandoned their nesting colonies in July due to raccoon predation (TNC 1998). Raccoon removal efforts started in 2001 on this island (Table 13).

Smith Island, VA

Smith Island consists of about 730 acres and is located east of the Eastern Shore of Virginia. The island's habitat consists of sparse grassland and overwash and inlet areas in the north end of the island. The south end of the island consists of dune ridges with shrub thickets and pine-hardwood forests alternating with brackish marsh (McCaffrey and Dueser 1990). Raccoon populations exploded in the 1990's resulting in colonial waterbirds abandoning suitable habitat (TNC 1998). Raccoon removal efforts started in 2001 on this island (Table 13).

Wreck Island, VA

Wreck Island consists of about 698 acres and is located near the southern end of the barrier island chain. The island's habitat consists of dense grassland and dunes (McCaffrey and Dueser 1990). Raccoon use of the island is sporadic. Raccoon removal efforts were initiated in 2001 on this island because late winter surveys indicated presence, but no raccoons were present during spring removal efforts (Table 13).

1.3.7.2 Chesapeake Bay Islands

Bernard Island, VA

Bernard Island is about 28 acres and is located about 2 miles west of the Eastern Shore of Virginia near the Maryland state line. This is one of the "marsh" islands. Red fox colonized the island in 2000 and there was no black duck reproduction on the island that year. (G. Costanzo, VDGIF, unpublished data).

Finneys Island, VA

Finneys Island is about 111 acres and is located within ½ mile of the west shore of the Eastern Shore of Virginia. The island is comprised of marsh habitat.

Fox Island Chain, VA

The Fox Islands are comprised of several islands totaling about 179 acres and are located near the Maryland state line south of Cedar Island Wildlife Management Area in Maryland. This Fox Island chain of islands is comprised of Great Fox, Clump, Little Fox, Does Hammock, South, and Green Harbor Islands. The islands are one of the 17 smaller "marsh islands" of the Chesapeake Bay. The chain was colonized by raccoons in 1993 and viable black duck production has ceased (G. Costanzo, pers. commun. to M. Lowney, April 2, 2004).

Goose and Fishbone Islands, VA

Goose Island is about 79 acres and Fishbone Island is about 14 acres. They are located in the middle of the Chesapeake Bay north of Tangier Island and about 6 miles south of the Smith Island complex in Maryland.

Parker Island, VA

Parker Island is about 75 acres and is located less than ½ mile from the west shore of the Eastern Shore of Virginia. The island is marsh habitat.

Queens Ridge, VA

Queens Ridge is about 8 acres and is located east of Goose Island. This island is comprised of marsh habitat.

Scarborough Island, VA

Scarborough Island is about 10 acres and is located near Finneys Island and within 1 mile of the west shore of the Eastern Shore of Virginia. The island is comprised of marsh habitat.

Shanks and Cheeseman Islands, VA

Shank Island is about 80 acres and Cheeseman Island is about 47 acres. These island are and collection of several islands and are "marsh islands". They are located about 11 ½ miles from the western shore and less than ½ mile from the large Smith Island complex in Maryland. These islands were colonized by red fox in 1998 and no longer support a viable nesting black duck population. (G. Costanzo, VDGIF, pers. commun.).

Tangier Island, VA

Tangier Island is about 981 acres and is located in the middle of the Chesapeake Bay, about 14 miles from the western shore. Part of the island supports a small town and fishing industry. Several smaller islands are associated with Tangier Island. Part of Tangier is wooded and part of the island is marsh.

Watts Island, VA

Watts Island is about 114 acres, is located near the middle of the Chesapeake Bay, and is eroding. This is the only other Chesapeake Bay island with wooded upland.

1.3.7.3 Western Shore Chesapeake Bay Islands

South Island, VA

South Island is a small man-made island, less than 8 acres, constructed as part of the Hampton Roads Bridge Tunnel (Interstate 64) during the 1970's. The island consists of buildings, parking lots, and some natural areas maintained in short grass and forbs.

Craney Island, VA

Craney Island is about 2,600 acres in size and located in Portsmouth, VA. The island is much larger now than the original island because of the deposition of dredge spoil. The island consists of dredge spoil bank cells, beaches, construction debris, a fuel farm, some upland areas, and a closed landfill. The James River and Elizabeth River flow around the island which is situated at the southern entrance to the Chesapeake Bay.

Grand View Beach Islands and Peninsula, Hampton, VA

The small islands were broken off Grand View Beach peninsula during a nor'easter in the early 2000's. There is no development on the islands or beach which are located in the City of Hampton, VA. The peninsula is part of a publicly owned natural area.

1.3.8 Summary of impacts to ground nesting native bird populations on islands

Predation is one mortality factor adversely affecting sensitive ground nesting native bird populations on the coastal areas and barrier and Chesapeake Bay islands that can be managed to enhance populations. Predation pressures on ground nesting birds are often a function of changes to habitat and predator communities at the landscape level. These changes have resulted in severe local and regional population declines, some ground nesting bird species abandoning islands, and delay in recovery

of some threatened bird populations. Population declines have occurred because ground nesting native bird species evolved

Table 13. Number of raccoons and red fox removed from barrier islands to enhance production of piping plovers, colonial waterbirds, and shorebirds.

	Assateague	Assawoman	Cedar	Fisherman	Metompkin	Parramore	Smith	Wallop
1988	241 rac, 46 rfox							
1989	53 rac, 22 rfox							
1990	77 rac, 23 rfox							
1991	137 rac, 31 rfox							
1992	84 rac, 36 rfox							
1993	24 rac, 9 rfox							
1994	18 rac, 2 rfox							
1995	-				5 rfox, 2 rac			
1996	-							
1997	1 rfox, 3 rac				rfox			
1998	9 rac	2 rfox						
1999	23 rac, 1 rfox 1 coy 55 hgulls 8 bbgulls 57 lgulls 5 rbgulls	1 rfox						
2000	13 rac, 2 rfox 21 hgulls 10 bbgulls, 184 lgulls, 2 rbgulls				9 rfox			
2001	26 rac, 18 fox 59 hgulls 7 bbgulls, 194 lgulls 14 rbgulls		6 rac		2 rfox 1 rac		8 rac	3 rac
2002	11 rac, 8 rfox 179 hgull 17 bbgull, 146 lgull 10rbgull	1 rfox						8 rfox 24 rac 15 opos 1 fcat
2003	8 rac,2 rfox 86 hgulls 19 bbgulls 71 lgulls 5 rbgulls	2 rac 4 rfox	7 rac	11 rac	1 rfox	270 rac 10 rfox	3 rac	3 rfox 24 rac 17 opos
2004	42 rac 7 rfox 136 hgull 228 lgull 35 bbgull 6 rbgull	8 rfox	13 rac	5 rac 5 fcrows 200 hgull nests	2 rfox 1 rac	92 rac 5 rfox	57 rac	2 rfox 6 rac 3 opos

Acronyms are Assatg = Assateague Island, Assa = Assawoman Island, Cedar = Cedar Island, Fisher = Fisherman Island, Metomp = Metompkin Island, Mink = Mink Island, Myrtle = Myrtle Island, Parra = Parramore Island, Ship shl = Ship Shoal Island, Smith = Smith Island, Wallop = Wallops Island, rfox = red fox, opos = opossum, fcat = feral cat, coy =coyote, fcrow = fish crow, hgull = herring gull, and rac = raccoon.

in environments and faunal communities that were much different than what exists today on the coastal areas and barrier and Chesapeake Bay islands. Predation pressure on ground nesting native birds on the Virginia coastal areas and barrier and Chesapeake Bay islands is attributed to predators that were either introduced (e.g., red fox), expanded their range (e.g., opossum, herring and great black-backed gull), or increased their population substantially due to alterations in the predator community and habitat changes at the landscape level (e.g., raccoons). Predator management programs have been

implemented on some Virginia barrier islands and have resulted in increases in ground nesting bird productivity and breeding populations. It is likely that predator management programs would need to occur for long periods of time to maintain viable breeding populations of many ground nesting native birds in coastal Virginia. This investment of resources to maintain these populations would likely be beneficial because these barrier islands are considered the last stronghold of many native breeding bird species on the Atlantic coast.

1.4 OBJECTIVES OF THE VIRGINIA PROGRAM TO MANAGE PREDATION LOSSES TO NATIVE BIRDS GROUND NESTING ON ISLANDS

The objectives of this program will be measured in numbers of birds fledged (nest success), breeding population size, or the number of nests preyed upon. The number of birds fledged or nest success is a measure of success on a specific property. Breeding population is a product of survival at breeding and winter locations over a 12-month period. Number of nests preyed upon will be a measure of the efficacy of mammalian and avian predator management.

Where nest success or fledgling rate and breeding population are known then net productivity will be used to measure efficacy of predator management. Net productivity is nest success multiplied by the breeding population. This is the best measure of net productivity. WS and cooperators want to see an increasing breeding population and an increase in the number of chicks fledged.

Population objectives were set using existing conservation plans (e.g., Watts 1999) and by consultation with the U.S. Fish and Wildlife Service and Virginia Department of Game and Inland Fisheries. These agencies have wildlife management authority for the federal government (e.g., migratory birds) and the Commonwealth of Virginia (mammals and non-migratory birds). Moreover, population objectives for the proposed action are consistent with draft population objectives for Biological Conservation Region 30. This zone consists of open water, maritime and coastal communities, forested communities, emergent marsh, grasslands, and shrub-scrub habitats in the coastal plain from the Chesapeake Bay to southeastern Maine.

The North American Landbird Conservation Plan uses the late 1960's as the baseline for recovery of 192 landbird species of Continental Importance (Rich et al. 2004). Action required to meet national landbird population objectives can take place regionally or locally (Rich et al. 2004). These necessary conservation actions and population objectives will be identified in regional plans (e.g., Mid-Atlantic Coastal Plain Conservation Plan). Watts (1999) proposed a reasonable population objective would be to return populations to the pre- or early BBS levels (late 1960's). Where population objectives for specific species were unavailable, population objectives were established using the mean population for 1975 – 1979 from the annual colonial waterbird survey (see Williams et al. 1990). The colonial waterbird survey is the longest running survey in Virginia of colonial waterbird populations.

The population objectives for selected species are to achieve:

a) piping plover – 1.25 chicks fledged per breeding pair (Hecht et al. 1996) and a minimum breeding population in Virginia and Maryland of 300 breeding pairs (Watts 1999). Net productivity can be calculated for this species.

b) American oystercatchers – a minimum breeding population in Virginia of 313 breeding pairs.

c) black skimmers – a minimum breeding population in Virginia of 3,744 breeding pairs.

d) royal terns – a minimum breeding population in Virginia of 2,532 breeding pairs.

e) gull-billed terns – a minimum breeding population in Virginia of 1,000 breeding pairs (Watts 1999).

f) least terns - a minimum breeding population in Virginia of 350 breeding pairs.

g) Wilson's plover – a minimum breeding population in Virginia of 21 breeding pairs.

h) common tern – a minimum breeding population in Virginia of 2,738 breeding pairs.

h) American black duck - a minimum breeding population in Virginia of 2,965 breeding pairs (G. Costanzo, VDGIF, pers. commun.).

1.5 RELATIONSHIP OF THIS ENVIRONMENTAL ASSESSMENT TO OTHER ENVIRONMENTAL DOCUMENTS

A number of other NEPA documents have been prepared that analyzed the potential environmental effects of predation management programs in Virginia and the methods used in monitoring and surveillance. Pertinent information from those analyses has been incorporated by reference into this EA.

Those documents include:

Wildlife Services Programmatic EIS. APHIS-WS has issued a final Environmental Impact Statement (EIS) (USDA 1997) and Record of Decision on the National APHIS-WS program.

Crow Damage Management in the Commonwealth of Virginia. APHIS-WS in Virginia has issued an environmental assessment (USDA 2000) and Decision and Finding of No Significant Impact.

Management of coyote, dog, and red fox predation on livestock in the Commonwealth of Virginia. APHIS-WS in Virginia has issued an environmental assessment (USDA 2002) and Decision and Finding of No Significant Impact.

Draft Environmental Impact Statement for the Chincoteague National Wildlife Refuge Master Plan was prepared by the USFWS in 1992 (USFWS 1992) that analyzed the impacts of predator management to protect federally listed threatened bird species on the refuge. A Record of Decision for the Master Plan was signed on December 27, 1993.

1.6 DECISIONS TO BE MADE

Based on the scope of this EA, the decisions to be made are:

- Should WS continue a PM program within the coastal ecosystems of the Commonwealth of Virginia restore and protect native bird populations?.
- If not, how should WS fulfill its legislative responsibilities for managing predator damage to natural resources?
- Should WS attempt to implement one of the alternatives to an IWDM strategy as described in the EA?
- Might the proposed WS PM have significant adverse impacts requiring preparation of an EIS?

1.7 RELATIONSHIP OF AGENCIES DURING PREPARATION OF THE EA

Based on agency relationships, Memorandum of Understanding's (MOU's), and legislative authorities, WS is the lead agency for this EA, and therefore responsible for the scope, contents, and decisions made. The USFWS, National Aeronautics and Space Administration (NASA), and VDGIF provided input throughout the EA preparation to ensure an interdisciplinary approach in compliance with NEPA, and agency mandates, policies, and regulations.

1.8 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT ANALYSIS

1.8.1 Actions Analyzed. This EA evaluates predator damage management on raccoons, opossums, red fox, gulls, crows and grackles by WS to protect threatened and endangered, colonial nesting waterbirds, shorebirds, and black ducks that ground nest on coastal areas and barrier and Chesapeake Bay islands within Virginia. Management actions could be conducted on public or private lands wherever such management is requested from the WS program.

1.8.2 Period for Which this EA is Valid. This EA will remain valid until WS determines that new needs for action, changed conditions or new alternatives having different environmental effects must be analyzed. At that time, this analysis and document will be reviewed and revised as necessary. This EA will be reviewed each year to ensure that it is complete and still appropriate to the scope of the State PM activities.

1.8.3 Site Specificity. This EA analyzes the potential impacts of PM and addresses activities on all public and private lands within the coastal ecosystems of Virginia under MOUs, Cooperative Agreements, and in cooperation with the appropriate public land management agencies. It also addresses the impacts of PM in areas where additional agreements may be signed in the future. Because the proposed action is to reduce damage and because the program's goals and directives are to provide services when requested, within the constraints of available funding and workforce, it is conceivable that additional PM efforts could occur. Thus, this EA anticipates this potential expansion and analyzes the impacts of such efforts as part of the program.

Planning for the management of predator damage must be viewed as being conceptually similar to federal or other agency actions whose missions are to stop or prevent adverse consequences from anticipated future events for which the actual sites and locations where they will occur are unknown but could be anywhere in a defined geographic area. Examples of such agencies and programs include fire and police departments, emergency clean-up organizations, insurance companies, etc. Although some of the sites where predator damage will occur can be predicted, all specific locations or times where such damage will occur in any given year cannot be predicted. This EA emphasizes major issues as they relate to specific areas whenever possible, however, many issues apply wherever predator damage and resulting management occurs, and are treated as such. The standard WS Decision Model (Slate et al. 1992) would be the site-specific procedure for individual actions conducted by WS in Virginia (see Chapter 3 for a description of the Decision Model and its application).

The analyses in this EA are intended to apply to any action that may occur *in any locale* and at *any time* within the coastal ecosystem of Virginia. In this way, APHIS-WS believes it meets the intent of NEPA with regard to site-specific analysis and that this is the only practical way for WS to comply with NEPA and still be able to accomplish its mission.

1.8.4 Public Involvement Process. Issues related to the proposed action were identified through involvement and planning/scoping meetings with numerous federal land managers and wildlife agencies, state wildlife departments, other state and local agencies, academic institutions, private organizations and wildlife advocates. The public involvement process will allow review and comment of this EA by the public, state and federal agencies, organizations, businesses, and Native American tribes. Legal notices informing the public about the availability of the EA will be published in the Richmond Times Dispatch and Virginia Pilot in Virginia. Also, letters requesting review and comment will be sent to state and federal agencies, organizations, businesses, and citizens located in Virginia whose interests are local. A Notice of Availability for this EA and Decision/FONSI or Notice of Intent to prepare an EIS will be published in the two newspapers above and mailed to those who comment on the EA once a decision is reached.

1.9 AUTHORITY AND COMPLIANCE

[1]1.9.1 Authority of Federal and State Agencies in Predator Damage Management in the Commonwealth of Virginia

1.9.1.1 WS Legislative Authority

The primary statutory authority for the WS program is The Act of March 2, 1931 (7 U.S.C. 426-426c; 46 Stat. 1468), as amended in the Fiscal Year 2001 Agriculture Appropriations Bill, which provides that:

"The Secretary of Agriculture may conduct a program of wildlife services with respect to

---

[1] See Chapter 1 of USDA (1997) for a complete discussion of federal laws pertaining to WS.

injurious animal species and take any action the Secretary considers necessary in conducting the program. The Secretary shall administer the program in a manner consistent with all of the wildlife services authorities in effect on the day before the date of the enactment of the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2001."

Since 1931, with the changes in societal values, WS policies and it's programs place great emphasis on the part of the Act discussing "bring (damage) under control", rather than "eradication" and "suppression" of wildlife populations. In 1988, Congress strengthened the legislative mandate of WS with the Rural Development, Agriculture, and Related Agencies Appropriations Act. The Act states, in part:

"That hereafter, the Secretary of Agriculture is authorized, except for urban rodent control, to conduct activities and to enter into agreements with States, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the control of nuisance mammals and birds and those mammals and bird species that are reservoirs for zoonotic diseases, and to deposit any money collected under any such agreement into the appropriations accounts that incur the costs to be available immediately and to remain available until expended for Animal Damage Control activities."

1.9.1.2 Fish and Wildlife Service (USFWS)

The USFWS is responsible for managing and regulating take of native bird species that are listed as migratory under the Migratory Bird Treaty Act of 1918 (as amended) and those plant and wildlife species that are listed as threatened or endangered under the Endangered Species Act 1972 (as amended). Sections 1.9.2.2 and 1.9.2.3 below describe WS's interactions with the USFWS under these two laws.

The USFWS authority for action is based on the MBTA of 1918 (as amended), which implements treaties with the United States, Great Britain (for Canada), the United Mexican States, Japan, and the Soviet Union. Section 3 of this Act authorized the Secretary of Agriculture:

"From time to time, having due regard to the zones of temperature and distribution, abundance, economic value, breeding habits, and times and lines of migratory flight of such birds, to determine when, to what extent, if at all, and by what means, it is compatible with the terms of the convention to allow hunting, taking, capture, killing, possession, sale, purchase, shipment, transportation, carriage, or export of any such bird, or any part, nest, or egg thereof, and to adopt suitable regulations permitting and governing the same, in accordance with such determinations, which regulations shall become effective when approved by the President."

The authority of the Secretary of Agriculture, with respect to the Migratory Bird Treaty, was transferred to the Secretary of the Interior in 1939 pursuant to Reorganization Plan No. II. Section 4(f), 4 Fed. Reg. 2731, 53 Stat. 1433.

1.9.1.3 Virginia Department of Conservation and Recreation, Natural Heritage Program

The Virginia Department of Conservation and Recreation, Natural Heritage program's mission is to conserve Virginia's biodiversity through inventory, protection, and stewardship. The Virginia Natural Area Preserves Act, 10.1-209 through 217 of the Code of Virginia codified the Department's powers and duties related to statewide biological inventory: maintaining a statewide database for conservation planning and project review, land protection for the conservation of biodiversity, and the protection and ecological management of natural heritage resources (habitats of rare, threatened, and endangered species, significant natural communities, geologic sites, and other natural features.

1.9.1.4 Virginia Department of Game and Inland Fisheries Legislative Mandate

The Virginia Department of Game and Inland Fisheries (VDGIF), under the direction of the Governor-appointed Board of Directors, is specifically charged by the General Assembly with the management of the

state's wildlife resources. Although many legal mandates of the Board and the Department are expressed throughout the Code of Virginia, the primary statutory authorities include wildlife management responsibilities (29.1-103), public education charges (29.1-109), law enforcement authorities (29.1-109), and regulatory powers (29.1-501). In 1990, the Board of Directors adopted mission statements to help clarify and interpret the role of VDGIF in managing the wildlife resources of Virginia.

They are:

- To manage Virginia's wildlife and inland fisheries to maintain optimum populations of all species to serve the needs of the Commonwealth;
- To provide opportunity for all to enjoy wildlife, inland fisheries, boating and related outdoor recreation; and
- To promote safety for persons and property in connection with boating, hunting, and fishing.

VDGIF currently has a MOU with WS. This document establishes a cooperative relationship between WS and VDGIF, outlines responsibilities, and sets forth annual objectives and goals of each agency for resolving wildlife damage management conflicts in Virginia.

1.9.1.5 Virginia Department of Agriculture and Consumer Services – Office of Pesticide Services

The Office of Pesticide Services provides support to the Virginia Department of Agriculture and Consumer Services and the Virginia Pesticide Control Board. The Office of Pesticide Services certifies applicators, registers pesticide products, and issues pesticide business licenses. They permit the safe and effective control of pests that attack our crops, structures, and health and that of our domestic animals. The Office of Pesticide Services conducts its duties and enforcement through the Virginia Pesticide Control Act, 3.1-249.27 – 78.

1.9.1.6 National Aeronautics and Space Administration, Wallops Flight Facility

For the Wallops Flight Facility, as a part of Goddard, our overall vision is:

Wallops Flight Facility will be a national resource for enabling low-cost aerospace-based science and technology research.

Wallops is a national resource for providing low-cost integration, launch and operation of suborbital and small orbital payloads that support space-based research focused on Earth and its environments.

The Wallops Flight Facility mission is to:

Enable scientific research through the development and deployment of low-cost, highly capable suborbital and orbital research/payload carriers and science platform mission services.

Enable aerospace technology and facilitate commercial use of space through advanced technology development, testing, operational support, and facilitation of the commercial launch activity at WFF.

Enable education, outreach and innovative partnerships by providing science and technology educational opportunities, and pursuing innovative partnerships with academia, other government agencies, and industry.

The NASA Vision: "To improve life here, To extend life to there, To find life beyond."

The NASA Mission: "To understand and protect our home planet, To explore the universe and search for life, To inspire the next generation of explorers... as only NASA can."

1.9.2 COMPLIANCE WITH OTHER FEDERAL LAWS AND REGULATIONS.

Several other federal laws authorize, regulate, or otherwise affect WS wildlife damage management. WS complies with these laws, and consults and cooperates with other agencies as appropriate.

1.9.2.1 National Environmental Policy Act of 1969 (NEPA)

WS prepares analyses of the environmental impacts of program activities to meet procedural requirements of this law. This EA meets the NEPA requirement for the proposed action in Virginia. When WS operational assistance is requested by another federal agency, NEPA compliance is the responsibility of the other federal agency. However, WS could agree to complete NEPA documentation at the request of the other federal agency.

1.9.2.2 Endangered Species Act of 1972 (ESA)

It is federal policy, under the ESA, that all federal agencies shall seek to conserve threatened and endangered (T&E) species and shall utilize their authorities in furtherance of the purposes of the Act (Sec.2(c)). WS conducts Section 7 consultations with the U.S. Fish & Wildlife Service (USFWS) to use the expertise of the USFWS to ensure that "*any action authorized, funded or carried out by such an agency . . . is not likely to jeopardize the continued existence of any endangered or threatened species . . . Each agency shall use the best scientific and commercial data available*" (Sec.7(a)(2)). WS obtained a Biological Opinion (B.O.) from USFWS in 1992 describing potential effects on T&E species and prescribing reasonable and prudent measures for avoiding jeopardy (USDA 1997, Appendix F).

Section 9 of the ESA makes it illegal for any person subject to the jurisdiction of the United States to "take" any federally listed endangered or threatened species of fish or wildlife without a special exemption. Under the ESA, "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding, and sheltering.

1.9.2.3 Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-711; 40 Stat. 755), as amended.

The MBTA and the MBTA Reform Act of 2004 (Division E, Title I, Sec. 143 of the Consolidated Appropriations Act, 2005, Pub. Law 108-447) provides USFWS regulatory authority to protect bird species that (1) belong to a family, group, or species covered by one or more of the four migratory bird conventions with the U.S. , and are (2) native to the U.S. or its territories. A native migratory bird is one that is present as a result of natural biological or ecological processes. The law prohibits the "*take*" of migratory bird species listed in Title 50 Code of Federal Regulations §10.13 (including birds, eggs, and nests occupied by eggs and/or chicks) by any entity, unless authorized by individual permits, depredation orders, or hunting regulations. All actions conducted in this EA will be in compliance with the regulations of the MBTA, as amended.

WS will obtain depredation permits covering PM activities that involve the taking of species for which such permits are required in accordance with the MBTA and USFWS regulations, or will operate as a named agent on MBTA permits obtained by cooperators.

WS provides assessments for persons experiencing migratory bird damage to obtain information on which to base damage management recommendations. Damage management recommendations could be in the form of technical assistance or operational assistance. In severe cases of damage caused by migratory birds, WS provides recommendations to the USFWS for the issuance of depredation permits to private and public entities. The ultimate responsibility for issuing such permits rests with the USFWS.

Title 50 Code of Federal Regulations, Section 21.43 is a depredation order for blackbirds, cowbirds, grackles, crows, and magpies. The order stipulates that a federal permit is not required to control these birds when they are found committing or about to commit depredation upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. Also, the killing of these birds shall not be construed to authorize the killing of these birds contrary to state laws or regulations.

1.9.2.4 National Historic Preservation Act (NHPA) of 1966 as amended

The NHPA of 1966, and its implementing regulations (36 CFR 800), requires federal agencies to: 1) determine whether activities they propose constitute "undertakings" that has the potential to cause effects on historic properties and, 2) if so, to evaluate the effects of such undertakings on such historic resources and consult with the Advisory Council on Historic Preservation (i.e. State Historic Preservation Office, Tribal Historic Preservation Officers), as appropriate. WS actions on tribal lands are only conducted at the tribe's request and under signed agreement; thus, the tribes have control over any potential conflict with cultural resources on tribal properties.

Each of the PM methods described in Appendix B that might be used operationally by WS do not cause major ground disturbance, do not cause any physical destruction or damage to property, do not cause any alterations of property, wildlife habitat, or landscapes, and do not involve the sale, lease, or transfer of ownership of any property. In general, such methods also do not have the potential to introduce visual, atmospheric, or audible elements to areas in which they are used that could result in effects on the character or use of historic properties. Therefore, the methods that would be used by WS under the proposed action are not generally the types of activities that would have the potential to affect historic properties. If an individual activity with the potential to affect historic resources is planned under an alternative selected as a result of a decision on this EA, then site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary.

There is potential for audible effects on the use and enjoyment of a historic property when methods such as propane exploders, pyrotechnics, firearms, or other noise-making methods are used at or in close proximity to such sites for purposes of hazing or removing depredating wildlife. However, such methods would only be used at a historic site at the request of the owner or manager of the site to resolve a damage problem, which means such use would be to benefit the historic property. A built-in mitigating factor for this issue is that virtually all of the methods involved would only have temporary effects on the audible nature of a site and can be ended at any time to restore the audible qualities of such sites to their original condition with no further adverse effects. Site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary in those types of situations.

A copy of this EA is being provided to Chickahominy, Mattaponi, Monacan, and Pamunkey American Indian tribes in Virginia to allow them opportunity to express any concerns that might need to be addressed prior to a decision.

1.9.2.5 Federal Fungicide, Insecticide, and Rodenticide Act (FIFRA)

FIFRA requires the registration, classification, and regulation of all pesticides used in the United States. The Environmental Protection Agency (EPA) is responsible for implementing and enforcing FIFRA. All chemical methods used or recommended by the WS program in Virginia are registered with and regulated by the EPA and VDACS, Office of Pesticide Management (OPM) and are used by WS in compliance with labeling procedures and requirements.

1.9.2.6 Executive Order 12898 - *"Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations."*

Executive Order 12898, entitled, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" promotes the fair treatment of people of all races, income levels

and cultures with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Environmental justice is the pursuit of equal justice and protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, or socioeconomic status. It is a priority within APHIS and WS. Executive Order 12898 requires Federal agencies to make environmental justice part of their mission, and to identify and address disproportionately high and adverse human health and environmental effects of Federal programs, policies and activities on minority and low-income persons or populations. APHIS implements Executive Order 12898 principally through its compliance with NEPA. All WS activities are evaluated for their impact on the human environment and compliance with Executive Order 12898. WS personnel use only legal, effective, and environmentally safe wildlife damage management methods, tools, and approaches. It is not anticipated that the proposed action would result in any adverse or disproportionate environmental impacts to minority and low-income persons or populations.

1.9.2.7 Executive Order 13045 – "Protection of children from environmental health and safety risks.

Executive Order 13045 was passed to help protect children who may suffer disproportionately from environmental health and safety risks for many reasons. Predator management activities as proposed in this EA would only involve legally available and approved methods that have been subjected to safety evaluations and testing. The analysis in this EA supports a conclusion of negligible to no risk of adverse effects to children from the predator management strategy that would be implemented on un-inhabited off-shore islands. Implementation of the proposed action would not increase environmental health or safety risks to children. Therefore, federal involvement in predator management programs is consistent with the goals of EO 13045.

1.9.2.8 Executive Order 13112 of February 3, 1999 –"Invasive Species "This Order prevents the introduction of invasive species and provides for their control to minimize the economic, ecological, and human health impacts that invasive species cause. In Virginia, red fox are recognized as invasive species that have adverse ecological impacts.

1.9.2.9 Executive Order 13186 – "Responsibilities of Federal Agencies to Protect Migratory Birds" was signed on January 10, 2001 and requires: "Each Federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations, is directed to develop and implement, a Memorandum of Understanding with the Fish and Wildlife Service that shall promote the conservation of migratory bird populations." WS has developed a draft Memorandum of Understanding (MOU) with the USFWS as required by this Executive Order and is currently pending review and approval by the two agencies. WS will abide by the MOU once it is finalized and signed by both parties.

1.9.2.10 The Native American Graves and Repatriation Act of 1990. The Native American Graves Protection and Repatriation Act requires federal agencies to notify the Secretary of the Department that manages the federal lands upon the discovery of Native American cultural items on federal or tribal lands. Federal projects would discontinue work until a reasonable effort has been made to protect the items and the proper authority has been notified.

1.9.2.11 Coastal Zone Management Act (CZMA) of 1972, as amended (16 U.S.C. 1451-1464). This law established a voluntary national program within the Department of Commerce to encourage coastal states to develop and implement coastal zone management plans. Funds were authorized for cost-sharing grants to states to develop their programs. Subsequent to federal approval of their plans, grants would be awarded for implementation purposes. In order to be eligible for federal approval, each state's plan was required to define boundaries of the coastal zone, identify uses of the area to be regulated by the state, determine the mechanism (criteria, standards or regulations) for controlling such uses, and develop broad guidelines for priorities of uses within the coastal zone. In addition, this law established a system of criteria and standards for requiring that federal actions be conducted in a manner consistent with the federally approved plan. The standard for determining consistency varied depending on whether the federal action involved a permit, license, financial assistance, or a federally authorized activity.

We have determined that the proposed action would be consistent with the State's Coastal Zone

Management Program. A copy of the Pre-decision EA was sent to the Virginia Department of Environmental Quality for review to provide an opportunity for the agency to notify WS as to whether they agree with this determination.

1.9.3 COMPLIANCE WITH OTHER STATE LAWS.

1.9.3.1 Virginia Nuisance Bird Law

This Act allows the Commissioner of Agriculture for the Virginia Department of Agriculture and Consumer Services (VDACS) to conduct surveys and investigations of economic loss or public nuisances caused by birds. The Commissioner may then develop a plan of action when birds are causing economic loss or are detrimental to the health and welfare of the public, or create a public nuisance. This Act also allows the Commissioner to provide technical assistance for the suppression of nuisance birds. This Act allows the Commissioner to cooperate with federal and state agencies, other public and private agencies, organizations, institutions, and persons.

1.9.3.2 Virginia Pesticide Law

This Act allows the Commissioner of Agriculture for Virginia Department of Agriculture and Consumer Services (VDACS) to allow for the registration of pesticides, certify pesticide applicators, and conduct enforcement of pesticide statutes. The law creates a Pesticide Control Board that will adopt rules and procedures to conduct business. Business shall include having the power and duty to appoint advisory committees; contract for research projects; publish reports; consult with other state agencies regarding disposal of pesticides; compliance with standards for safe work conditions, and protection of fish and wildlife; inform the citizens of alternative non-chemical alternatives; require individuals to be adequately trained; cooperate, receive grants-in-aid, and enter into agreements with any federal or state agencies; and to consult with the Department of Health. The Board may also adopt regulations to implement the Act.

1.9.3.3 Possession, Transportation, and Release of Wildlife by Authorized Persons

This regulation (4 VAC 15-30-50) authorizes employees of federal wildlife management agencies and local animal control officers in the performance of their duties to take problem wildlife in the Commonwealth of Virginia. According to VDGIF, permits to take migratory birds are issued by the USFWS and not VDGIF, therefore no state permit is required of WS to take migratory birds in Virginia.

1.10 PREVIEW OF THE REMAINDER OF THIS EA

This EA is composed of five (5) chapters and three (3) appendices. Chapter 2 discusses and analyzes the issues and affected environment. Chapter 3 contains a description of each alternative, alternatives not considered in detail, mitigation and standard operating procedures (SOP). Chapter 4 analyzes environmental consequences and the environmental impacts associated with each alternative considered in detail. Chapter 5 contains the list of preparers of this EA. Appendix A contains the literature cited used during the preparation of the EA. Appendix B contains a description of the methods used or recommended to reduce damage caused by raccoons, opossums, red foxes, gulls, grackles, and crows. Appendix C contains pictures of the bird species to be protected. Appendix D is the response to comments from issues or concerns raised by the public during the public comment period.

2.0 CHAPTER 2 - ISSUES

Chapter 2 contains a discussion of the issues, including issues that will receive detailed environmental impacts analysis in Chapter 4 (Environmental Consequences), issues that have driven the development of mitigation measures and/or standard operating procedures, and issues that will not be considered in detail, with rationale. Pertinent portions of the affected environment will be included in this chapter in the discussion of issues used to develop mitigation measures. Additional description of affected environments will be incorporated into the discussion of the environmental impacts in Chapter 4.

2.1 Issues. The following issues have been identified as areas of concern requiring consideration in this EA. These will be analyzed in detail in Chapter 4:

- Effects on target species populations of raccoon, opossum, red fox, gull, common grackle and crow
- Effects of predation on protected resources - native bird species
- Effects of control methods on nontarget wildlife species populations, including T&E species
- Effects of control methods on human health and safety
- Effects on aesthetic values of target species and protected resources
- Effects on recreation
- Effects on economics
- Humaneness and animal welfare concerns of control methods used

2.2 ISSUES ADDRESSED IN THE ANALYSIS OF ALTERNATIVES

2.2.1 Effects on Target Species Populations of Raccoon, Opossum, Red Fox, Gull, Common Grackle and Crow

A common concern among members of the public is whether wildlife damage management actions adversely affect the viability of target species populations. The target species selected for analysis in this EA are raccoons, opossums, red foxes, gulls, common grackles, and crows. WS estimates that no more than 500 raccoons, 50 opossums, 50 red fox, 100 common grackles and 200 American or fish crows are likely to be killed under the proposed action in any one year by WS. The initial level of lethal removal of gulls by WS could reach 15,408 adult or juvenile birds (13,208 laughing gulls, 1,200 herring gulls, and 1,000 greater black back gulls) and up to 1,000 sub-adult gulls (750 laughing gulls, 150 herring gulls, and 100 greater black back gulls). Juvenile birds may be taking during nest destruction as part of the total take. Adult and sub-adult gull take by other person or agencies could reach 15,806 gulls (13,064 laughing gulls, 1,870 herring gulls, and 872 greater black back gulls). Sub-adult gulls are 1, 2, or 3 year-old gulls with juvenile plumage characteristics (Peterson 1980). In addition, up to 50,000 eggs could be initially removed under the proposed action by WS (2,000 eggs or 1,000 nests of greater black back gulls, 2,400 eggs or 1,200 nests of herring gulls, and 35,598 eggs or 11,866 nests of laughing gulls) and by other persons or government agencies (1,000 eggs or 500 nest of greater black back gulls, 3,002 eggs or 1,501 nests of herring gulls, and 6,000 eggs or 2,000 nests of laughing gulls). In subsequent years gulls and eggs would be removed as needed to reach and maintain historic native bird population goals and objectives. However, breeding populations of laughing, herring, and great black-backed gulls would be maintained at or higher than the population levels found in Virginia in 1984-1985.

Breeding gull populations in Virginia would be maintained at no less than 32,000 pairs of laughing gulls in 30 colonies; 3,000 pairs of herring gulls in 20 colonies; and 150 pairs of great black-backed gulls in 10 colonies. These are the breeding populations of gulls that were found in Virginia in 1984-85 (Andrews 1990). As reported by Watts (2004),the current breeding population of gulls in Virginia exceeds the 1984-1985 population goal by 25,872 adult laughing gulls (12,936 pairs), 3,070 adult herring gulls (1,535 pairs), and 1,872 adult great black-backed gulls (936 pairs). Also, the Mid-Atlantic New England Maritime Working Group (MANEM) recognized the need for local population management for laughing, herring, and great black-backed gulls in the Mid-Atlantic region. MANEM is comprised of federal and state wildlife and natural resource agencies, and environmental and birding organizations, and researchers and academics from the region. Gull populations would be monitored by regional waterbird surveys. WS would use this survey data when developing annual gull damage management goals and objectives.

The level of lethal removal of target species will likely be less than the predicted levels described above due to the limited amount of funding that is currently available and the level of removal will vary greatly each year due to variability in funding and number of requests for assistance. In addition, for many target species the level of lethal removal would likely decline in future years as local target species populations are reduced to a level that allows native bird populations to reach and maintain population goals and objectives.

Impacts of West Nile virus on bird populations. West Nile (WN) virus has emerged in recent years in temperate regions of North America, with the first appearance of the virus in North America occurring in New York City in 1999 (MMWR 2002, Rappole et al. 2000). Since 1999 the virus has spread across the United States and was reported to occur in 44 states and the District of Columbia in 2002 (MMWR 2002). West Nile virus is typically transmitted between birds and mosquitoes. Mammals can become infected if bitten by an infected mosquito, but individuals in most species of mammals do not become ill from the virus. The most serious manifestation of the WN virus is fatal encephalitis in humans, horses, and birds. West Nile virus has been detected in dead bird species of at least 138 species, including starlings, house sparrows and pigeons (CDC 2003). Although birds infected with WN virus can die or become ill, most infected birds do survive and subsequently develop immunity to the virus (CDC 2003, Cornell University 2003). In some bird species, particularly Corvids (crows, blue jays, ravens, magpies), the virus causes disease (often fatal) in a large percentage of infected birds (Audubon 2003, CDC 2003, Cornell University 2003, MMWR 2002). In 2002, WN virus surveillance/monitoring programs revealed that Corvids accounted for 90% of the dead birds reported with crows representing the highest rate of infection (MMWR 2002). Large birds that live and die near humans (i.e. crows) have a greater likelihood of being discovered, therefore the reporting rates tend to be higher for these bird species and are a "good indicator" species for the presence of WN virus in a specific area (Cornell University 2003, Audubon 2003). According to US Geological Survey (USGS), National Wildlife Health Center, information is not currently available to know whether or not WN virus is having an impact on bird populations in North America. USGS states that it is not unusual for a new disease to cause high rates of infection or death because many birds do not have the natural resistance to the infection. Furthermore, it is not known how long it will take for specific bird populations to develop sufficient resistance to the virus to survive infections. Surveys of wild birds completed in the last three years have shown that some birds have already acquired antibodies to the virus (USGS-NWHC 2003). Based upon available Christmas Bird Counts and Breeding Bird Surveys, USGS-NWHC (2003) states that there have been declines in observations of many local bird populations, however they do not know if the decline can be attributed to WN virus or to some other cause. A review of available crow population data by Audubon (2003) reveals that at least some local crow populations are suffering high WN virus related mortality, but crow numbers do not appear to be declining drastically across broad geographic areas. USGS does not anticipate that the commonly seen species, such as crows and blue jays, will be adversely affected by the virus to the point that these bird species will disappear from the U.S. (USGS-NWHC 2003).

2.2.2 Effects of Predation on Protected Resources - Native Bird Species

Some bird enthusiasts and professional wildlife biologists are concerned if the proposed action would reduce predation and increase fecundity of native ground nesting bird species populations on coastal islands of Virginia to the desired population goals and objectives. The benefits of the predator control program would be an increase in some federally listed T&E species (e.g. piping plover, Roseate tern) and state listed T&E species (e.g., Wilson plover). Other ground nesting native birds likely to benefit from the reduction or removal of raccoons, opossums, red fox, crows, grackles, and gulls include black ducks, American oystercatchers, black skimmers, and common terns.

2.2.3 Effects of Control Methods on Nontarget Species populations, including T&E Species

A common concern among members of the public and wildlife professionals, including WS personnel, is the impact of damage management methods and activities on nontarget species, particularly Threatened and Endangered Species. WS's standard operating procedures include measures intended to mitigate or reduce the effects on nontarget species populations and are presented in Chapter 3. WS uses control methods that are as target selective as possible or applied in a way to reduce the likelihood of capturing non-target species (e.g., trap placement, trap type, or bait used).

Special efforts are made to avoid jeopardizing Threatened and Endangered Species through biological evaluations of

the potential effects and the establishment of special restrictions or mitigation measures. WS has consulted with the USFWS under Section 7 of the ESA concerning potential impacts of PM methods on T&E species and has obtained a Biological Opinion (B.O.). For the full context of the B.O., see Appendix F of the ADC FEIS (USDA 1997, Appendix F). WS is also in the process of reinitiating Section 7 consultation at the program level to assure that potential effects on T&E species have been adequately addressed.

2.2.4 Effects of Control Methods on Human Health and Safety

Some people may be concerned that WS's use of firearms, pyrotechnic scaring devices, traps, snares, lasers and the application of avicides and predicides could cause injuries to people. WS personnel occasionally use rifles and shotguns to remove raccoons, opossums, red foxes, gulls, or crows that are causing damage. There is some potential fire hazard to private and public property from pyrotechnic use. There is little potential for human exposure to foothold traps and snares because traps and snares are set on islands where public access is restricted or prohibited and trapping mostly occurs at a time of year (November – May) when there is little human use. There is little potential for human exposure to avicides and predicides since these chemical methods are used on islands where public access is restricted or prohibited. In addition, when M-44 devices are used by WS, warning signs are posted on boat landings and M-44 sites informing people about the presence of these devices. There is minimal potential for flash blindness, afterimage, and glare to people who might come into contact with the laser.

2.2.5 Effects on Aesthetic Values of Target Species and Protected Resources

2.2.5.1 Effects on Human Affectionate-Bonds with Individual Animals and on Aesthetic Values of Wild Birds and Mammals

The human attraction to animals has been well documented throughout history and started when humans began domesticating animals. The American public is no exception and today a large percentage of households have pets. However, some people may consider individual wild animals and birds as "pets" or exhibit affection toward these animals, especially people who enjoy coming in contact with wildlife. Therefore, the public reaction is variable and mixed to wildlife damage management because there are numerous philosophical, aesthetic, and personal attitudes, values, and opinions about the best ways to reduce conflicts/problems between humans and wildlife.

Some individual members or groups of wildlife species habituate and learn to live in close proximity to humans. Some people in these situations feed such animals and/or otherwise develop emotional attitudes toward such animals that result in aesthetic enjoyment. In addition, some people consider individual wild birds and mammals as "pets," or exhibit affection toward these animals. Examples would be people who visit a city park to feed waterfowl or pigeons and homeowners who have bird feeders or bird houses. Some people feed raccoons at their homes or red fox at local parks. Many people do not develop emotional bonds with individual wild animals, but experience aesthetic enjoyment from observing them.

There may be some concern that the proposed action or alternatives would result in the loss of aesthetic benefits to the public, resource owners, or neighboring residents. Wildlife generally is regarded as providing economic, recreational, and aesthetic benefits (Decker and Goff 1987), and the mere knowledge that wildlife exists is a positive benefit to many people. Aesthetics is a philosophy dealing with the nature of beauty, or the appreciation of beauty. Therefore, aesthetics is truly subjective in nature and is dependent on what an observer regards as beautiful.

Wildlife populations provide a range of social and economic benefits (Decker and Goff 1987). These include direct benefits related to consumptive and non-consumptive use (e.g., wildlife-related recreation, observation, harvest, sale), indirect benefits derived from vicarious wildlife related experiences (e.g., reading, television viewing), and the personal enjoyment of knowing wildlife exists and contributes to the stability of natural ecosystems (e.g., ecological, existence, bequest values) (Bishop 1987). Direct benefits are derived from a user's personal relationship to animals and may take the form of direct consumptive use (using up the animal or intending to) or non-consumptive use (viewing the animal in nature or in a zoo, photography) (Decker and Goff 1987). Indirect benefits or indirect exercised values arise without the user being in direct contact with the animal and come from experiences such as looking at photographs and films of wildlife, reading about wildlife, or benefiting from activities or contributions of animals such as their use in research (Decker and Goff 1987). Indirect benefits come in two forms: bequest and pure

existence (Decker and Goff 1987). Bequest is providing for future generations and pure existence is merely knowledge that the animals exist (Decker and Goff 1987).

Public reaction to damage management actions is variable because individual members of the public can have widely different attitudes toward wildlife. Some individuals, who are negatively affected by wildlife, would support removal or relocation of damaging wildlife. Other individuals affected by the same wildlife may oppose removal or relocation. Individuals unaffected by wildlife damage may be supportive, neutral, or opposed to wildlife removal depending on their individual personal views and attitudes. Some members of the public who oppose removal of wildlife do so because of human-affectionate bonds with individual wildlife. These human-affectionate bonds are similar to attitudes of a pet owner and result in aesthetic enjoyment

The public's ability to view wild birds or mammals in a particular area would be more limited if the birds or mammals are dispersed, removed, or relocated. However, immigration of birds from other areas could possibly replace the animals dispersed, removed or relocated during a damage management action. In addition, the opportunity to view or feed other birds and mammals would be available if an individual makes the effort to visit other areas away from the area where damage abatement methods are being implemented. Even where damage abatement methods are being implemented, gulls, grackles and crows frequently are available for viewing, albeit in lower abundance.

Some people do not believe that individual birds or bird rookeries should even be harassed to stop or reduce damage problems. Some of them are concerned that their ability to view birds and other wildlife species are lessened by WS non-lethal harassment efforts.

2.2.5.2 Public support for predator management

Kellert and Berry (1980) estimated that 20% of the population was strongly concerned about the proper treatment of animals. Another 20% of the population was strongly oriented toward the material value of animals. In addition, Kellert and Berry (1980) maintained that some people hold a "strong affection" toward animals while others are indifferent toward them. These and other attitude and value differences are the foundation for the intractable conflicts between subgroups of the public (e.g. animal rights organizations and hunters or wildlife agencies) (Butler et al. 2003).

Some animal rights activists have speculated that animal protectionism is increasing (Butler et al. 2003). Coincidently, some wildlife professionals believed the public was becoming more protectionistic, but this belief is not supported by any study (Butler et al. 2003). Recent human dimension research, by Butler et al. (2003) and Messmer et al. (1999), found the public is becoming less protectionist and less tolerant of wildlife damage (IAFGA 2004). While Messmer et al. (1999) found strong support for predators' right to exist, the public did not support an outright ban on predator hunting or trapping. To the contrary, the public supported predator management (e.g., raccoon, skunk, opossum, gulls, grackles, crows) to benefit avian recruitment (Messmer et al. 1999). Also, Messmer et al. (1999) found greater support to control gulls and crows than foxes to enhance avian recruitment. This support was greater when the avian species was threatened or endangered and predator species were less charismatic (Messmer et al. 1999).

2.2.6 Effects on recreation

Coastal islands are used for swimming, fishing, sunbathing, picnics, shell collecting, hunting, bird watching, trapping furbearers, and other outdoor activities. Some people would be concerned that predator management activities would restrict recreation on these islands.

Predator management activities would mostly occur from November through May and would have little impact on recreation activities that take place during the summer months. However, during the nesting season some local areas would remain closed to public access to limit disturbance of nesting birds or survival of fledglings, thereby affecting those persons that would potentially use these areas for recreational activities. Swimming, sunbathing, and picnics would probably not be affected by predator management activities because these activities typically occur during warmer temperatures in summer months. These same people would probably be pleased with the increased numbers or diversity of birds because of predator management activities.

Some local hunters and trappers would be concerned about impacts of management activities on their recreation. Local hunters may be concerned that PM methods may catch or harm hunting dogs. Though raccoon and red fox hunting are not very common on the eastern shore of Virginia, some individuals who hunt on barrier islands may be affected. Duck hunters across Virginia would be pleased with the goal of increasing the number of black ducks. Bird watchers would be pleased with the increased number and diversity of birds likely to occur from this program.

People who like to fish may be concerned about PM methods on their pets that roam the beaches and may also want to be informed about PM methods being implemented because of a lack of familiarity with those methods. Fishers would probably be pleased with the increased number or diversity of birds since this would likely add to their fishing experience.

2.2.7 Effects on economics

There are several bird watching festivals on the eastern shore of Virginia. These festivals infuse thousands of visitors and dollars into the local economy (A. Avery, USFWS, person. commun. February 2, 2005,)(R. Rulon, Eastern Shore of Virginia Chamber of Commerce, pers. commun. February 23, 2005). Millions of people visit the national wildlife refuges on the eastern shore of Virginia annually to watch wildlife, fish, hunt, and participate in other recreational activities. Chincoteague National Wildlife Refuge had 3 million visitors in FY2003 (J. Schroer, USFWS, pers. commun.). These people contribute dollars into the local economy at restaurants, motels, and local businesses. These people would be positively affected by an increase in bird species abundance and diversity. These positive effects would be expected to result in additional people attending birding festivals and additional dollars infused into the local economy.

Some people would be concerned about the cost effectiveness of the program. Some people may believe a value can not be placed on migratory birds and calculating a cost:benefit ratio would under-represent the value of the birds to society and the environment. Other people would believe that it is not cost effective to remove predators from the environment to protect other wildlife resources.

2.2.8 Humaneness and Animal Welfare Concerns of Control Methods Used by WS.

The issue of humaneness and animal welfare, as it relates to the killing or capturing of wildlife is an important but very complex concept that can be interpreted in a variety of ways. Schmidt (1989) indicated that vertebrate pest damage management for societal benefits could be compatible with animal welfare concerns, if "*. . . the reduction of pain, suffering, and unnecessary death is incorporated in the decision making process.*"

Suffering is described as a "*. . . highly unpleasant emotional response usually associated with pain and distress.*" However, suffering "*. . . can occur without pain . . . ,*" and "*. . . pain can occur without suffering . . .* " (AVMA 1987). Because suffering carries with it the implication of a time frame, a case could be made for "*. . . little or no suffering where death comes immediately . . .* " (CDFG 1991), such as shooting.

Defining pain as a component of humaneness in WS methods appears to be a greater challenge than that of suffering. Pain obviously occurs in animals. Altered physiology and behavior can be indicators of pain, and identifying the causes that elicit pain responses in humans would "*. . . probably be causes for pain in other animals . . .* " (AVMA 1987). However, pain experienced by individual animals probably ranges from little or no pain to significant pain (CDFG 1991).

Pain and suffering, as it relates to WS damage management methods, has both a professional and lay point of arbitration. Wildlife managers and the public would be better served to recognize the complexity of defining suffering, since "*. . . neither medical or veterinary curricula explicitly address suffering or its relief*" (CDFG 1991).

Therefore, humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal, and people may perceive the humaneness of an action differently. The challenge in coping with this issue is how to achieve the least amount of animal suffering within the constraints imposed by current technology and funding.

WS has improved the selectivity and humaneness of management techniques through research and development.

Research is continuing to bring new findings and products into practical use. Until new findings and products are found practical, a certain amount of animal suffering could occur when some PM methods are used in situations where nonlethal damage management methods are not practical or effective.

WS personnel are experienced and professional in their use of management methods so that they are as humane as possible under the constraints of current technology, workforce and funding. Mitigation measures/SOPs used to maximize humaneness are listed in Chapter 3.

2.3 ISSUES CONSIDERED BUT NOT IN DETAIL WITH RATIONALE

2.3.1 Appropriateness of Preparing an EA (Instead of an EIS) For Such a Large Area.

Some individuals might question whether preparing an EA for an area as large as all the coastal islands of Virginia would meet the NEPA requirements for site specificity. Wildlife damage management falls within the category of federal or other agency actions in which the exact timing or location of individual activities cannot usually be predicted well enough ahead of time to accurately describe such locations or times in an EA or EIS. The WS program is analogous to other agencies or entities with damage management missions such as fire and police departments, emergency clean-up organizations, insurance companies, etc. Although WS can predict some of the possible locations or *types* of situations and sites where some kinds of wildlife damage will occur, the program cannot predict the specific locations or times at which affected resource owners will determine a bird or mammal damage problem has become intolerable to the point that they request assistance from WS. Nor would WS be able to prevent such damage in all areas where it might occur without resorting to destruction of wild animal populations over broad areas at a much more intensive level than would be desired by most people, including WS and state agencies. Such broadscale population management would also be impractical, if not impossible, to achieve.

If a determination is made through this EA that the proposed action would have a significant environmental impact, then an EIS would be prepared. In terms of considering cumulative impacts, one EA analyzing impacts for a region of a state may provide a better analysis than multiple EA's covering smaller zones.

3.0 CHAPTER 3: ALTERNATIVES INCLUDING THE PROPOSED ACTION

WS developed alternatives to resolve predator damage to native bird populations and will analyze these alternatives in detail in Chapter 4. The purpose is to identify the appropriate alternative for alleviating predator damage to native birds.

Alternatives were developed for consideration using the WS Decision Model (Slate et al. 1992) as described in Chapter 2 (pages 20-35), Appendix J (Methods of Control), Appendix N (Examples of WS Decision Model), and Appendix P (Risk Assessment of Wildlife Damage Control Methods Used by USDA, Wildlife Services Program) of the ADC FEIS (USDA 1997).

The No Action alternative is a procedural NEPA requirement (40 CFR 1502), is a viable and reasonable alternative that could be selected, and serves as a baseline for comparison with the other alternatives. The No Action alternative, as defined here, is consistent with the Council on Environmental Quality's (CEQ's) definition (CEQ 1981).

Alternatives analyzed in detail are:

1) Alternative 1 - Integrated Wildlife Damage Management/Predator Management Program (Proposed Action/No Action). This is the Proposed Action as described in Chapter 1 and it is also the no action alternative because the program would continue to be implemented as it had been prior to preparation of this EA.

2) Alternative 2 - Nonlethal PM Only by WS.

3) Alternative 3 – Technical Assistance Only

4) Alternative 4 - Lethal PM Only by WS.

5) Alternative 5 - No Federal WS PM. This alternative consists of no federal PM program.

3.1 DESCRIPTION OF THE ALTERNATIVES

3.1.1 Alternative 1 - Integrated Wildlife Damage Management/ Predator Management Program (Proposed Action/No Action)

The proposed action is for the WS program in the Commonwealth of Virginia to continue the current Integrated Wildlife Damage Management (IWDM) program that responds to requests for PM to protect and restore native bird populations on the coastal, barrier, and Chesapeake Bay islands of Virginia (Table 14). An IWDM approach, including Technical Assistance and Direct Control Assistance, would be implemented which would allow use of any legal technique or method, used singly or in combination, to meet requestor needs for resolving conflicts with raccoons, red fox, opossum, gulls, grackles, and crows (Appendix B). Cooperators requesting assistance would be provided with information regarding the use of practical and effective nonlethal and lethal techniques. WS would respond to requests for assistance by 1) providing technical assistance and advice to resource owners and land managers on actions they could take to reduce damages caused by predators, and/or 2) conducting direct operational control actions for the resource owner or land manager.

Actions implemented by resource owner or land manager

Resource owners and land managers requesting WS assistance would be provided with information regarding the use of effective and practical nonlethal and lethal techniques. Resource owners and land managers may choose to implement WS recommendations on their own, use contractual services of private businesses, use volunteer services of private organizations, use contractual services of Wildlife Services or take no action. Implementation of nonlethal methods such as habitat alteration, husbandry practices, harassment, scare devices, and mechanical repellents is usually the responsibility of the resource owner or land manager.

Migratory Bird Permits - Resource owners and land managers may choose to apply for a migratory bird depredation permit from the USFWS to lethally remove gulls and their eggs, as required by the implementing regulations of the

Migratory Bird Treaty Act (MBTA) for depredation control (50 CFR 21.41). No USFWS permit is required to non-lethally harass migratory bird species or to destroy nests that do not have eggs (USFWS 2003). No USFWS migratory bird permit (50 CFR 21.43) or Virginia state issued permit is required to take crows or grackles, or their eggs to protect native bird species. In most circumstances, the USFWS requires nonlethal methods be used and shown ineffective or impractical before the USFWS will issue a migratory bird depredation permit to take gulls and their eggs. In this situation, WS would evaluate the damage and complete a Migratory Bird Damage Report (WS Form 37) which would include information on the extent of the damages, the number of gulls present, and a recommendation for the number of gulls or gull eggs that should be taken to best alleviate the damages. Following USFWS review of a complete application for a depredation permit, including a Migratory Bird Damage Report, from a resource owner or land manager, a depredation permit could be issued by the USFWS to authorize the lethal removal of a specified number of gulls or a specified number of eggs as part of an IWDM approach to reduce gull depredation on native bird species. Upon receipt of a depredation permit, the resource owner or land manager, or appropriate sub-permittee may commence the authorized activities. As a condition of the permit, the permit holder must submit a written report of their activities upon expiration of the permit to the USFWS. Permits may be renewed by the USFWS annually as needed to resolve damages. Resource owners or land managers could conduct PM using any method authorized on their permit, including shooting, egg oiling or destruction, Avitrol, or any other methods that are legal. Not all of the methods listed in Appendix B as potentially available to WS would be legally available for use by resource owners or land managers.

Mammal permits - The resource owner or land manager may choose to apply for their own kill permit from the VDGIF to lethally remove raccoons by trapping or shooting. A landowner will need to apply for a VDGIF permit to trap or shoot opossums only if he/she hires an agent to conduct lethal management activities. Otherwise, the landowner may kill opossums himself/herself without a permit. Landowners may have red foxes killed on their property at any time by anyone without a VDGIF issued permit.

Actions implemented by Wildlife Services

PM control activities by WS would be provided in Virginia, when requested, on private property or public facilities and lands where a need has been documented and upon completion of an *Agreement for Control* between WS and the property owner or manager. WS uses an IWDM approach where nonlethal or lethal methods are applied sequentially or simultaneously, depending on the target species and which methods are practical and effective. Lethal methods used by WS would include shooting; live capture (traps, snares, nets, etc.) followed by euthanasia; denning; effigies; M-44's; gas cartridges; DRC-1339; and Avitrol. Nonlethal methods used by WS may include habitat alteration; exclusion such as wire barriers and fences; deterrents; harassment; effigies; other scaring devices; lasers; and Measurol. All management activities, including disposal requirements, would comply with appropriate Federal, State, and Local laws.

Migratory Bird Permits - To address the anticipated needs of resource owners and land managers with gull damage issues in the coastal areas of Virginia, WS would submit an application for a one-year migratory bird depredation permit to the USFWS estimating the maximum number of gulls and their eggs of each species to be taken by WS as part of an IWDM approach to reduce gull predation on native bird species. No USFWS permit is required to non-lethally harass migratory bird species or to destroy nests that do not have eggs. No USFWS migratory bird permit (50 CFR 21.43) or Virginia state issued permit is required to take crows or grackles, or their eggs to protect native bird species. The USFWS would conduct an independent review of the application, and if acceptable, issue a migratory bird permit to WS as allowed under the depredation permit regulations to take gulls and their eggs. As appropriate, WS could request an amendment of their permit to increase the number of gulls or eggs that would need to be removed to address unpredicted and emerging gull damages/conflicts. Each year, WS would submit an application for renewal of their permit to the USFWS. Through the use of Adaptive Management principles, Virginia breeding gull population management objectives, management actions in the previous year, and anticipated damages and conflicts in the next year, WS would adjust numbers of gulls to meet anticipated needs to resolve gull predation on native bird species. The USFWS would review this application annually, and as appropriate, would issue migratory bird permits to WS as allowed by MBTA regulations. All alterations in the number of gulls or eggs to be removed by WS will be reviewed against the impacts analyzed in this EA.

Mammal permits - Federal wildlife agencies and local government agencies are exempt from VDGIF permit requirements to lethally take state regulated wildlife species in Virginia (VAC 10-30-50).

3.1.2 Alternative 2 - Nonlethal PM Only By WS - Under this alternative, only nonlethal direct control activities and technical assistance would be provided by WS to resolve predator damage on native bird species (Table 14).

Actions implemented by resource owner or property manager

Resource owners and land managers requesting assistance from WS would be provided only with information regarding the use of effective and practical nonlethal methods. The nonlethal methods recommended by WS would follow those identified in Alternative 1. Resource owners and land managers may choose to implement WS' nonlethal recommendations on their own, implement lethal methods or other methods not recommended by WS, use contractual services of private businesses, use volunteer services of private organizations, use nonlethal contractual services of WS, or take no action. In situations where nonlethal methods were impractical or ineffective to alleviate damages, WS would refer requests for information regarding lethal information to VDGIF, USFWS, local animal control agencies, or private businesses or organizations. Not all of the methods listed in Appendix B as potentially available to WS would be legally available for use by resource owners or land managers.

Resource owners and land managers frustrated by lack of WS assistance with the full range of PM techniques (including the use of lethal methods) may try methods not recommended by WS (e.g., illegal poisons, not follow EPA regulations on pesticide labels). In some cases, resource owners or land managers may misuse some methods or use some methods in excess of what is necessary (USDA 1997, White et al. 1989, USFWS 2001, USFDA 2003)

Migratory Bird Permits - Under this alternative, resource owners and land managers may be limited to using nonlethal methods only on gulls as they may be unable to obtain the necessary USFWS permits for use of lethal methods. The USFWS requires professional wildlife damage recommendations on individual damage situations before they issue a migratory bird depredation permit to take gulls and their eggs. The USFWS does not have the mandate or resources available to conduct wildlife damage management work. State agencies (i.e., VDGIF) with responsibilities for migratory birds would likely have to provide this information to the USFWS if migratory bird depredation permits are to be issued for gulls under this alternative. If the appropriate information were provided to the USFWS, following the agency's review of a complete application package for a depredation permit from a property owner or manager to lethally remove gulls or their eggs, the USFWS could issue a migratory bird permit to protect native bird species from gull predation. The USFWS migratory bird permit issuance procedures would follow those described in Alternative 1 (under property owner or manager). Resource owners or land managers could conduct PM using any method authorized by the USFWS, including shooting, egg oiling or destruction, Avitrol or any other methods that are legal. Not all of the methods listed in Appendix B as potentially available to WS would be legally available for use by resource owners or land managers. If state agencies, businesses, and organizations request removal of gulls and their eggs in greater numbers than are necessary, as they may have less technical knowledge and experience managing wildlife damage than WS, the USFWS may subsequently authorize more take than is necessary to alleviate gull damages and conflicts.

Mammal permits - The resource owner or land manager may choose to apply for their own kill permit from the VDGIF to lethally remove raccoons by trapping or shooting. A landowner will need to apply for a VDGIF permit to trap or shoot opossums only if he/she hires an agent to conduct lethal management activities. Otherwise, the landowner may kill opossums himself/herself without a permit. Landowners may have red foxes killed on their property at any time by anyone without a VDGIF issued permit.

Actions implemented by Wildlife Services

PM assistance would be provided by WS in Virginia, when requested, on private or public facilities and lands where a need has been documented and upon completion of an *Agreement for Control* between WS and the property owner or manager. This assistance would be limited to nonlethal methods. The nonlethal methods used or recommended by WS would be identical to those identified in Alternative 1. WS would not need to apply for a depredation permit from the USFWS because no lethal methods would be used. No permits are required from the USFWS or VDGIF to implement nonlethal PM methods.

3.1.3 Alternative 3 - Technical Assistance Only - This alternative would be limited to technical assistance only from WS and would not allow for WS operational PM to protect native birds from predation on coastal areas in

Virginia (Table 14).

Actions implemented by resource owners and land managers

Resource owners and land managers requesting technical assistance from WS would receive information regarding the use of effective and practical nonlethal and lethal methods. The nonlethal and lethal methods recommended by WS would be identical to those identified in Alternative 1 (Actions implemented by resource owner or land manager). Resource owners and land managers may choose to implement WS' recommendations, use contractual services of private businesses, use volunteer services of private organizations, or take no action. In situations where nonlethal methods are ineffective or impractical, WS would be able to advise the resource owner or property manager of appropriate lethal methods to supplement nonlethal methods.

Resource owners and land managers frustrated by their inability to alleviate damages to acceptable levels may try methods not recommended by WS (e.g., illegal poisons, not follow EPA regulations on pesticide labels). In some cases, resource owners or land managers may misuse some methods or use some methods in excess of what is necessary (USDA 1997, White et al. 1989, USFWS 2001, USFDA 2003).

Resource owner and land managers permitted take of migratory birds and mammals protected by state law would be the same as described under Alternative 1 (Actions implemented by resource owner or land manager)

Actions implemented by Wildlife Services

WS would only provide technical assistance and assist resource owners and land managers with Migratory Bird Depredation Reports required by the USFWS for issuance of migratory bird permits to manage predation associated with gulls. WS would not provide any operational assistance under this alternative.

3.1.4 Alternative 4 - Lethal PM Only By WS - Under this alternative, only lethal technical assistance and operational control services would be provided by WS to protect native birds from predation on coastal areas in Virginia (Table 14).

Actions implemented by resource owners and land managers

Resource owners and land managers requesting assistance from WS would only be provided with information regarding effective and practical lethal methods. Lethal methods recommended by WS would be identical to those identified in Alternative 1 (Actions implemented by resource owner or land manager). WS would refer requests for information regarding nonlethal methods to VDGIF, USFWS, local animal control agencies, or private businesses or organizations. Resource owners and land managers may choose to implement WS lethal recommendations, implement nonlethal methods or other methods not recommended by WS, use contractual services of private businesses, use volunteer services of private organizations, use lethal contractual services of WS or take no action. In situations where nonlethal methods were impractical or ineffective, WS would be available to provide recommendation for effective and practical lethal methods.

Resource owner and land manager permitted take of migratory birds and mammals protected by state law would be the same as described under Alternative 1 (Actions implemented by resource owner or land manager).

Actions implemented by Wildlife Services

PM assistance would be provided by WS in Virginia, when requested, on private or public facilities and lands where a need has been documented and upon completion of an *Agreement for Control* between WS and the property owner or land manager. This assistance would be limited to lethal methods. The lethal methods used or recommended by WS would be identical to those identified in Alternative 1.

Wildlife Services permitted take of migratory birds and mammals protected by state law would be the same as described under Alternative 1 (Actions implemented by Wildlife Services).

3.1.5 Alternative 5 - No Federal WS PM - This alternative would eliminate WS involvement in PM to protect

native birds from predation on coastal areas in Virginia (Table 14). WS would not provide direct operational or technical assistance.

Actions implemented by resource owners and land managers

Resource owners and land managers would have to conduct PM without WS involvement. WS would refer all requests for PM assistance to VDGIF, USFWS, local animal control agencies, or private businesses or organizations. Nonlethal and lethal methods that could be potentially used would be identical to those identified in Alternative 1 (Actions implemented by resource owner or land manager). Resource owners and land managers may choose to implement any lethal or nonlethal method available to them, use contractual services of private businesses, use volunteer services of private organizations, or take no action. In situations where PM methods are ineffective or impractical, WS would not be able to advise the resource owner or property manager of appropriate PM methods to use to resolve the specific conflict.

Resource owners and land managers frustrated by lack of WS assistance may try methods that are inappropriate (e.g., illegal poisons, not follow EPA regulations on pesticide labels). In some cases, resource owners or land managers may misuse some methods or use some methods in excess of what is necessary (USDA 1997, White et al. 1989, USFWS 2001, USFDA 2003).

Resource owner and land manager permitted take of migratory birds and mammals protected by state law would be the same as described under Alternative 2 (Actions implemented by resource owner or land manager).

Actions implemented by Wildlife Services

Wildlife Services would not provide any PM assistance under this alternative.

Table 14. Actions that could be taken under each alternative.

Actions	Alt. 1 IWDM PM (Proposed Action/ No Action	Alt. 2 Nonlethal Only by WS	Alt. 3 Technical Assistance (TA) Only	Alt. 4 Lethal Only by WS	Alt. 5 No Federal WS PM Program
WS provides technical assistance on nonlethal methods	X	X	X		
WS provides technical assistance on lethal methods	X		X	X	
WS provides nonlethal operational assistance	X	X			
WS provides lethal operational assistance & USFWS issues permit to WS	X			X	
Property owner able to use nonlethal techniques	X	X	X	Dependent on property owner's ability to find information on nonlethal PM techniques	Dependent on property owner's ability to find information on nonlethal PM techniques
Property owner able to use lethal techniques and & USFWS issues permit to property owner	X	Dependent on State's ability to provide permit recommendations to USFWS	X	X	Dependent on State's ability to provide permit recommendations to USFWS

3.2 PM STRATEGIES AND METHODOLOGIES AVAILABLE IN VIRGINIA

The strategies and methodologies described below include those that could be used or recommended under Alternatives 1, 2, 3 and 4. Alternative 5 would terminate both WS technical assistance and operational PM by WS. Appendix B is a more thorough description of the methods that could be used or recommended.

3.2.1 Integrated Wildlife Damage Management (IWDM).

The most effective approach to resolving wildlife damage is to integrate the use of several methods simultaneously or sequentially. The philosophy behind IWDM is to implement the best combination of effective management methods in a cost-effective[2] manner while minimizing the potentially harmful effects on humans, target and nontarget species, and the environment. IWDM may incorporate cultural practices (i.e., animal husbandry), habitat modification (i.e., removing roost trees), animal behavior modification (i.e., scaring, tactile repellents), removal of individual offending animals, local population reduction, or any combination of these, depending on the circumstances of the specific damage problem.

3.2.2 The IWDM Strategies That WS Employs.

3.2.2.1 Technical Assistance Recommendations.

"Technical assistance" as used herein is information, demonstrations, and advice on available and appropriate wildlife damage management methods. The implementation of damage management actions is the responsibility of the requester. In some cases, WS loans or sells supplies or materials that are of limited availability for non-WS entities to use. Technical assistance may be provided following a personal or telephone consultation, or during an on-site visit with the requester. Generally, several management strategies are described to the requester for short and long-term solutions to damage problems; these strategies are based on the level of risk, need, and the practicality of their application.

Under APHIS NEPA Implementing regulations and specific guidance for the WS program, WS technical assistance is categorically excluded from the need to prepare an EA or EIS. However, it is discussed in this EA because it is an important component of the IWDM approach to resolving wildlife damage problems.

3.2.2.2 Migratory Bird Depredation Permit

Migratory bird depredation permits (50 Code of Federal Regulations [CFR] 21.41) may be issued by the USFWS to landowners and government agencies to lethally remove migratory birds and their eggs to protect native bird species. The migratory bird depredation permit process is the responsibility of the USFWS. The process involves two federal (USFWS and WS) and one state agency (VDGIF) in Virginia. Permit applications are available from USFWS or WS.

Landowners, land managers, or public officials may contact WS for technical assistance to alleviate damage involving migratory birds. WS will consult with the landowner, land manager, or public official about strategies and methods to alleviate migratory bird damage. WS may recommend lethal methods be used to alleviate the damage. The landowner, land manager, or public official may then decide to apply for a USFWS permit to use a lethal method to resolve the migratory bird problem.

The permit applicant must complete a Migratory Bird Depredation Permit application, review 50 CFR, Parts 10, 13, and 21, and pay a processing fee (currently $50 for individuals and $100 for businesses) to the USFWS. Government agencies are exempt from the processing fee. As part of the application process, WS will then complete a migratory bird damage project report. This report describes the resources harmed, the type of damage, migratory bird species and number involved, type of assistance provided, damage abatement methods tried and recommended, other information, and WS recommendation whether a permit

2. The cost of management may sometimes be secondary because of overriding environmental, legal, human health and safety, animal welfare, or other concerns.

should be issued and the number of birds, nests with eggs, or eggs to be taken. The USFWS reviews the permit application and WS report. The USFWS then makes a decision to issue a permit or deny the issuance of the permit.

If the USFWS decides to issue the permit, the permit is sent to the VDGIF for review. If VDGIF concurs, then USFWS issues the permit to the applicant. The permit may be valid for up to one year. Permits are renewable by reapplying annually.

3.2.2.3 Education

Education is an important element of WS's program activities because wildlife damage management is about finding "balance" or co-existence between the needs of people and needs of wildlife. This is extremely challenging as nature has no balance, but rather, is in continual flux. In addition to the routine dissemination of recommendations and information to individuals or organizations sustaining damage, lectures and demonstrations are provided to farmers, homeowners, and other interested groups. WS frequently cooperates with other agencies in education and public information efforts. Additionally, technical papers are presented at professional meetings and conferences so that WS personnel, other wildlife professionals, and the public are periodically updated on recent developments in damage management technology, laws and regulations, and agency policies.

3.2.2.4 Direct Damage Management Assistance.

This is the conducting or supervision of damage management activities by WS personnel. Direct damage management assistance may be initiated when the problem cannot effectively be resolved through technical assistance alone, and when *Agreements for Control* or other comparable instruments provide for WS direct damage management. The initial investigation defines the nature, history, extent of the problem, species responsible for the damage, and methods that would be available to resolve the problem. Professional skills of WS personnel are often required to effectively resolve problems, especially if the problem is complex.

3.2.3 WS Decision Making.

WS personnel use a thought process for evaluating and responding to damage complaints that is depicted by the WS Decision Model described by Slate et al. (1992) (Figure 10). WS personnel are frequently contacted after requesters have tried or considered nonlethal methods and found them to be impractical, too costly, or inadequate for reducing damage to an acceptable level. WS personnel assess the problem, evaluate the appropriateness and availability (legal and administrative) of strategies and methods based on biological, economic and social considerations. Following this evaluation, the methods deemed to be practical for the situation are developed into a management strategy. After the management strategy has been implemented, monitoring is conducted and evaluation continues to assess the effectiveness of the strategy. If the strategy is effective, the need for further management is ended. In terms of the WS Decision Model (Slate et al. 1992), most damage management efforts consist of continuous feedback between receiving the request and monitoring the results of the damage management strategy. The Decision Model is not a written documented process, but a mental problem-solving process common to most if not all professions.

3.2.4 Decision making by private landowners

The decision maker for private property is the property owner or manager. WS would provide technical assistance to this person and recommendations to reduce damage. Direct management would be provided by WS if requested, funding provided, and the requested direct management was in line with WS recommendations.

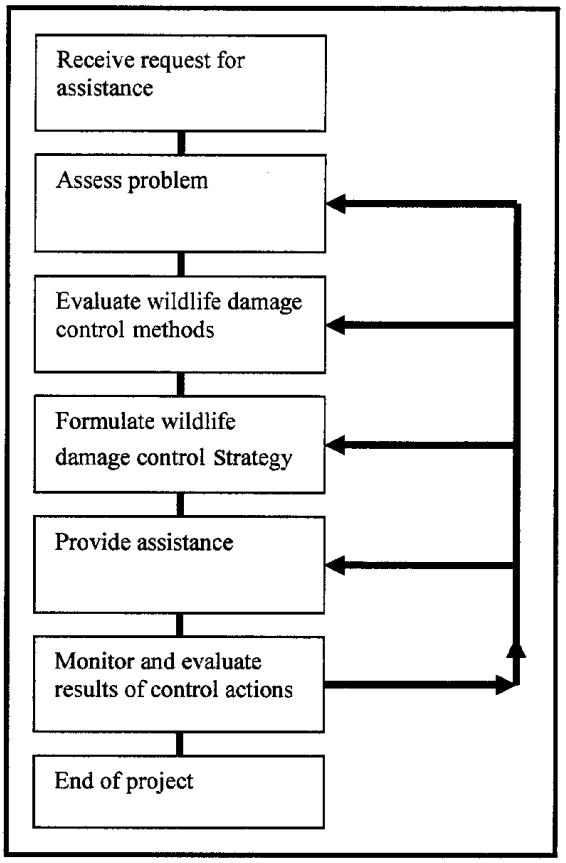


Figure 10. Wildlife Services decision model.

3.2.5 Decision making by public land managers

The decision maker for local, state, or federal property would be the official responsible for or authorized to manage the public land to meet interests, goals and legal mandates for the property. WS would provide technical assistance to this person(s) and recommendations to reduce damage. Direct management would be provided by WS if requested, funding provided, and the requested direct management was in line with WS recommendations.

3.2.6 Predator Management Methods Available for Use under Alternative 1 (Proposed Action/No Action).

(See Appendix B for detailed descriptions of PM Methodologies)

3.2.6.1 Nonlethal Methods (See Appendix B for detailed descriptions)

Property owner or manager practices consist primarily of nonlethal preventive methods such as exclusion, harassment and habitat modification.

Animal behavior modification refers to tactics that alter the behavior of birds to reduce damages. Some but not all of these tactics include:

- Wire barriers to exclude raccoons, opossums, red foxes, gulls, and crows from nests
- Pyrotechnics (to scare birds)
- Distress calls and sound producing devices (to scare birds from areas used for nesting and fledgling)
- Lasers (to scare birds)

- Effigies (to scare gulls or crows from nesting sites and fledgling areas)
- dispersing nearby laughing, herring, great black-backed gull rookeries

Habitat/environmental modification to attract or repel bird species.

Nest destruction is the removal of nesting materials during the construction phase of the nesting cycle.

Mesurol is a chemical registered with the Environmental Protection Agency to repel birds. It has been shown to teach crows to avoid consuming similar looking untreated eggs after an extended time period of aversive conditioning (Dimmick and Nicolaus 1990, Avery and Decker 1994). Mesurol was registered in 2000 to protect threatened and endangered bird eggs preyed upon by crows.

3.2.6.2 Mechanical Management Methods (See Appendix B for detailed descriptions)

Shooting is the practice of selective lethal removal of a target mammal or bird with a shotgun or rifle. Shooting a few individuals from a larger flock can reinforce birds' fear of harassment techniques. Shooting with rifles or shotguns is used to manage raccoon, opossum, red fox, grackle, gull, or crow damage problems when lethal methods are determined to be appropriate. Shooting may involve the use of spotlights, night-vision, decoy dogs, and predator calling. The target species is killed as quickly and humanely as possible. Shooting is an American Veterinary Medical Association (AVMA) and Society of Mammalogist approved method of euthanasia (Beaver et al. 2001) and is sometimes used to euthanize birds and mammals which are captured in live traps.

Foot-hold traps can be utilized to live-capture a variety of mammals. They would be the primary method used to capture red fox. Foot-hold traps would also be used to capture raccoons and opossums. However, other types of traps would most likely be used to capture raccoons and opossums. The use of foot-hold traps also requires more time, expertise, and labor than some methods, but they are indispensable in resolving many depredation problems. Captured red fox, raccoons, and opossums would be euthanized.

Foot-hold traps consist of two opposing steel jaws hinged to a base plate that are held closed by 2 or 4 lever or music wire-coil springs. When the trap is set, the jaws are held open by a triggering device which is a circular or rectangular pan centered between the hinged jaws. The pan must be depressed by the animal's foot for the jaws to be closed shut by the springs. Modifications have occurred to improve animal welfare including adding pan-tension devices to exclude nontarget animals, center swiveling to reduce injuries from twisting, and shock springs in the chain which anchors the trap to reduce lunging injuries. Jaws are without teeth and may have rubber pads attached. Jaws may be offset to keep them from coming together which reduces pressure on the animals foot. Also, the thickness of the jaws may vary to better distribute pressure on the animal's foot. Novak (1987) and Boggess et al.(1990) describe and diagram many types of foot-hold traps used throughout history in North America.

Cage traps, typically constructed of wire mesh or plastic, and are sometimes used or recommended to capture raccoons and opossums. They are comparatively ineffective at catching wary red fox. Cage traps are baited with a fish or sweet type bait to capture raccoons and opossums. Captured raccoons and opossums would be euthanized.

Body gripping (e.g., Conibear) traps are traps designed to cause the quick death of the animal that activates the trap. The appropriate size trap would be used for raccoons and opossums (generally Conibear 160 or 220) and are used near aquatic habitats. Body gripping traps can be placed in modified 3 or 5-gallon buckets baited with fish or sweet baits. Also, traps would be placed in travel corridors located in dense vegetation used by raccoons and opossums. A raccoon is captured as it travels through the trap and activates the triggering mechanism. Safety hazards and risks to humans are usually related to setting, placing, checking, or removing the traps. Size 160 or 220 conibear traps can only be used by federal or local agencies due to a recent interpretation of regulation 4 VAC 15-40-200 and 4 VAC 15-30-50. Landowners and agents would be limited to using 120 size conibear traps (M. Fies, furbearer biologist, VDGIF, personal communication, January 20, 2005).

Specialized raccoon foot traps are traps designed specifically to capture raccoons. These traps (e.g. Coon Cuffs, Little Griz) are baited, specialized foot traps that are placed into the ground. The trap consists of a small box or tube measuring about 3 – 3 1/2 inches square. There is a small hole about 1 ¼ inches in diameter that a raccoon places its paw into to grab the fish or sweet bait. The specialized trap captures the raccoon's foot when it pulls a lever holding the food. These traps are highly selective and humane for capturing raccoons and opossums. Captured raccoons and opossums would be euthanized.

Snares are generally made of small diameter wire cable (e.g., 5/64 inch diameter) with a locking mechanism which holds the snare closed after an animal pulls the snare closed with its foot or body. They weigh only a few ounces and usually are not as affected by inclement weather as are other types of traps. Snares are generally placed to capture the target animal during its normal movement patterns. Snares for red foxes preying on native birds generally are set in travel corridors in dense vegetation. Snares can be set to catch an animal by the neck, which is generally lethal to fox, but not dogs. Infrequently, snares are also set in trails capture a fox by the foot or leg. When used in this manner, they can be useful live capture devices. Raccoons, opossums and red fox captured in snares would be euthanized.

Hunting dogs are sometimes trained and used to hunt for raccoon or red fox. Trained dogs are used primarily to find red fox and raccoons and to pursue or tree problem animals. Dogs could be essential to the successful location of red fox or raccoon sign (tracks, hair, or droppings).

Denning is the practice of finding red fox dens and lethally removing the young, adults, or both to stop an ongoing predation problem or prevent future depredation. Red fox predation on wildlife often increase in the spring and early summer due to the increased food requirements associated with feeding and rearing litters of pups. Pups are typically euthanized in the den using a registered gas fumigant cartridge (see discussion of Large Gas Cartridge under *Chemical Management Methods* and Appendix B).

Rocket or cannon nets would be used to capture gulls, grackles or crows. These nets use 3 or 4 rockets propelled by a smokeless/black powder charge that propels a large net (e.g. 45 feet x 60 feet) over a baited site used by the birds. A cannon net uses mortar projectiles to propel a net up and over birds which have been baited to a particular site. Under special circumstances birds can be captured with a rocket or cannon net at sites where they loaf.

Egg destruction is a method used to reduce production at gull colonies.

Cervical dislocation is an American Veterinary Medical Association (AVMA) approved euthanasia method which is sometimes used to euthanize birds which are captured in live traps (Beaver et al. 2001).

Sport hunting and regulated trapping can be of a PM strategy to reduce local raccoon, opossum or red fox populations on coastal islands.

3.2.6.3 Chemical Management Methods (See Appendix B for detailed descriptions)

Predacides are chemical methods registered with the Environmental Protection Agency to lethally remove mammalian predators causing damage. These products are designed to remove specific predators. The PM program would use Large Gas Cartridges and M-44's to remove red fox that prey on native birds.

Avicides are chemical methods registered with the Environmental Protection Agency to lethally remove birds causing damage. The PM program would use DRC-1339 or Avitrol to take crows, grackles or gulls.

Carbon dioxide (CO_2) gas is an (AVMA) and Ornithological Council approved euthanasia method which is sometimes used to euthanize birds which are captured in live traps and when relocation is not a feasible option (Beaver et al. 2001). Live birds are placed in a container or chamber into which CO_2 gas is released. The birds quickly expire after inhaling the gas.

3.2.7 Alternative 2 - Nonlethal PM Only

This alternative would require that WS only utilize nonlethal methods (3.2.6.1) in addressing predation on native bird populations, including nonlethal technical assistance recommendations. Land managers or owners, state agency personnel, or others could conduct PM activities including the use of traps, snares, shooting, and any lethal or nonlethal methods they deem effective. These individuals, government agencies, and others would be prohibited from using M-44's, DRC-1339, and Measurol as these chemicals are restricted to use by WS employees.

3.2.8 Alternative 3 – Technical Assistance Only

This alternative would require that WS only recommend nonlethal or lethal methods in addressing predation on native bird populations. WS would provide recommendations to the USFWS regarding the issuance of permits to resource owners to allow them to take gulls by lethal methods. Land managers and owners, state agency personnel, or others could conduct PM activities including the use of traps, snares, shooting, and any lethal or nonlethal methods they deem effective. These individuals, government agencies, and others would be prohibited from using M-44's, DRC-1339, and Measurol as these chemicals are restricted to use by WS employees.

3.2.9 Alternative 4 - Lethal PM Only

This alternative would require that WS only utilize lethal management methods (3.2.6.2 and 3.2.6.3) in addressing predation on native bird populations, including lethal technical assistance recommendations. WS would provide recommendations to the USFWS regarding the issuance of permits to resource owners to allow them to take gulls by lethal methods. Private landowners, federal land managers, state agency personnel, or others could conduct PM activities including the use of traps, shooting, and any lethal or nonlethal methods they deem effective. These individuals, government agencies, and others would be prohibited from using M-44's, DRC-1339, and Measurol as these chemicals are restricted to use by WS employees.

3.2.10 Alternative 5 - No Federal PM

This alternative would consist of no WS involvement in PM in the areas listed under the proposed action in VA. Neither direct operational management assistance nor technical assistance to provide information on nonlethal and/or lethal management techniques would be available from WS. Private landowners, federal land managers, state agency personnel, or others would be left with the option to conduct their own PM activities including the use of traps, shooting, and any lethal or nonlethal methods they deem effective. These individuals, government agencies, and others would be prohibited from using M-44's, DRC-1339, and Measurol as these chemicals are restricted to use by WS employees.

3.3 Alternatives Considered But Not Analyzed in Detail With Rationale

Alternatives considered but not analyzed in detail with rationale reflect alternatives that were considered by the WS program. However, after consideration, the alternative was determined to be unacceptable. An explanation is provided for each alterative considered and why it was determined unacceptable.

3.3.1 Live trap and relocation

Trapping and relocation of problem animals is sometimes proposed as a solution to a wildlife damage problem. However, there are various consequences associated with relocation. Some of the consequences to be considered when relocating problem wildlife include efficacy, cost, feasibility, animal welfare, disease transmission, impacts on other wildlife, and impacts on other persons or landowners (Nielsen 1988, Davidson and Nettles 1992, SCWDS undated).

The success of a relocation effort, however, depends on the potential for the problem individuals to be captured efficiently and the existence of an appropriate relocation site (Nielsen 1988). While relocation may be appropriate in some situations when the problem wildlife species population is low, raccoons, crows, and laughing gulls are relatively abundant native species in much of the suitable habitat in Virginia and relocation is not necessary for the maintenance of viable populations of these animals. Crows are one on the most abundant and widely distributed bird species in Virginia (Sauer et al. 2003). Because of their abundance, it is unlikely that raccoons, crows, or laughing gulls could be captured efficiently or that appropriate relocation sites in Virginia exist. The thousands of

gulls and crows, and hundreds of raccoons that would need to be captured and relocated annually to reduce predation on native nesting birds is cost prohibitive and not feasible over such a broad area as 14 barrier and 17 Chesapeake Bay islands. In addition, relocation of birds is generally ineffective because problem bird species are highly mobile and can easily return to damage sites from long distances or relocation would most likely result in bird damage problems at the new location as has been seen with Canada geese and vultures (Humphrey et al. 2000, Cooper and Keefe 1997, Fairaizl 1992).

Abundant historically absent herring gulls, great black-backed gulls, opossums, and non-native red fox already impact native species and relocating these species will lead to further harm to other species. Thus, there are no appropriate relocation sites for herring gulls, great black-backed gulls, opossums and red foxes in Virginia.

Many government agencies, professional organizations, and some animal activist organizations oppose relocation for numerous reasons. Translocation of wildlife is discouraged by WS policy (WS Directive 2.501) because of stress to the relocated animal, poor survival rates, and difficulties in adapting to new locations or habitats. (Nielsen 1988). The American Veterinary Medical Association, the National Association of State Public Health Veterinarians, and the Council of State and Territorial Epidemiologists all oppose the relocation of mammals because of the risk of disease transmission, particularly for small mammals (Center for Disease Control 1990). Additionally, the survival of relocated animals is generally very poor due to the stress of relocation, so that in many cases an animal is released only to suffer mortality in a new environment (Craven 1992). Among national animal advocacy groups there appears to be disagreement about relocating wildlife to alleviate damage. The People for the Ethical Treatment of Animals opposes relocation of problem beaver because they believe relocation is cruel (Redmon 1999, 2000). The Humane Society of the United States believes relocation is preferable to death, in some circumstances, but relocation could be stressful and result in suffering or death (Bridgeland et al. 1997).

Relocating wildlife has the potential for transmission of disease between wildlife, livestock, and to human populations (Davidson and Nettles 1992). Raccoons and red fox are vectors for the spread of both rabies and canine distemper. The current rabies epizootic in the eastern United States is tied to relocation and translocation of raccoons from Florida to Virginia in 1978 and 1979 (Jenkins and Winkler 1987). Relocated raccoons and red fox that were exposed to rabies on the mainland and then swim back to the islands may bring rabies, thus infecting native mammal populations.

Distemper is a viral disease that usually is fatal to a high percent of exposed raccoons. Relocation of raccoons from the islands to the mainland may spread distemper and result in an epizootic on the mainland. Such a distemper epizootic occurred in gray fox and raccoons in Florida during 1972 and 1973 from an unknown introduction (Hoff et al. 1974). An additional concern to local health officials about distemper is the symptoms are similar to rabies which is a life threatening fatal disease to humans. Since symptoms of distemper are similar to rabies, local health officials must expend scarce resources monitoring distemper epizootics (Hoff et al. 1974). Also, distemper can spread to domestic and companion animals and can be fatal.

3.3.2 Restore red wolf populations to eastern Virginia to restore balance to the animal community

Red wolves have been introduced to Alligator River National Wildlife Refuge in coastal North Carolina, Bulls Island in South Carolina, St. Vincents Island in Florida, the Great Smoky Mountain National Park, and Horn Island in Mississippi (Phillips et al. 2003, Anonymous 1998, Weller 1996). Red wolves feed on nutria, cottontail rabbits, raccoons, and deer (Phillips et al. 2003, Weller 1996). They caused a dramatic decline in raccoon abundance on Horn Island after their introduction (Esher and Simmons 1993). Locations chosen for red wolves reintroduction sites had abundant prey, no livestock, and no coyotes (Phillips et al. 2003). The red wolf reintroduction in North Carolina was considered successful because the population was legally designated experimental/non-essential which allowed relaxed restriction and regulations on human activity. Hunting and trapping were allowed to continue, a broad education effort was undertaken, and landowners could request that red wolves be removed from their property. Numerous releases of wolves were made over the years, all released and wild born red wolves were radio collared and monitored, and all coyotes were continuously removed from the 1.7 million acre recovery area. It is believed that red wolf reintroduction programs could meet the goals of the recovery plan if the problem of hybridization between red wolves and coyotes can be resolved (Phillips et al. 2003).

Coyotes have been observed on the Eastern Shore of Virginia and on some islands off its coast. The presence of

coyotes complicates and greatly increases the cost of red wolf reintroduction. Also, the impact of red wolves on large colonies of colonial waterbirds is unknown. Finally, it is the decision of the USFWS and not WS on where red wolves will be introduced.

3.3.3 Release the distemper virus among raccoon populations on islands

Canine distemper is a virus that is a principal mortality factor in raccoons and gray foxes (Davidson and Nettles 1997, Hoff et al. 1974, Johnson 1970 cited in Kaufmann 1983). The release of raccoons inoculated with canine distemper on coastal areas and, barrier or Chesapeake Bay islands could result in outbreaks on the islands with resulting high mortality for local raccoon populations. A consequence of releasing raccoons inoculated with distemper would be infected raccoons dispersing to unintended islands or the mainland. Also, some people would question the ethics of releasing a disease that results in suffering. Some agencies are now wondering if distemper, like rabies, is also an exotic virus. Also this disease can spread to domestic animals, such as dogs, creating other concerns.

3.3.4 Distribute single dose toxic baits on islands to remove predatory mammals

Single dose toxic baits have been developed and used to eradicate predatory mammals from islands to protect nesting birds (Tietjen et al. 1988). The Aleutian Canada goose faced extinction after artic fox were introduced to the Aleutian Islands of Alaska with the growth of fox farming and by fur traders in the early 1900's (USFWS 1989, Jones and Byrd 1979). This resulted in the Aleutian Canada goose being listed as an endangered species in 1967 (USFWS 1989). The artic fox were eradicated from the islands when single dose baits consisting of beef tallow, bees wax, and 4 mg of sodium monofluoroacetate were distributed on the island. The removal of the fox allowed the Aleutian Canada goose to recover from a low of less than 800 birds to great than 6,000 birds (USFWS 1989).

Sodium monofluoracetate is considerably more toxic to carnivores and rodents than any other species (Azert 1971). While this product is known to be an effective predacide (Crabtree 1962) we have chosen not to use it because of the administrative and bureaucratic barrier.

3.4 Mitigation and Standard Operating Procedures for Predator Damage Management Techniques

3.4.1 Mitigation in Standard Operating Procedures (SOPs)

Mitigation measures are any features of an action that serve to prevent, reduce, or compensate for impacts that otherwise might result from that action. The current WS program, nationwide and in Virginia, uses many such mitigation measures and these are discussed in detail in Chapter 5 of the FEIS (USDA 1997). Some key mitigating measures pertinent to the proposed action and alternatives that are incorporated into WS's Standard Operating Procedures include:

- The WS Decision Model thought process which is used to identify effective wildlife damage management strategies and their impacts.
- Reasonable and prudent measures or alternatives are identified through consultation with the USFWS and are implemented to avoid impacts to T&E species.
- Research is being conducted to improve PM methods and strategies so as to increase selectivity for target species, to develop effective nonlethal management methods, and to evaluate nontarget hazards and environmental impacts.
- Management actions would be directed toward localized populations or groups of target species and/or individual offending members of those species. Generalized population suppression across the VA, or even across major portions of Virginia, would not be conducted.
- WS uses PM devices and conducts activities for which the risk of hazards to public safety and hazard to the environment have been determined to be low according to a formal risk assessment (USDA 1997, Appendix P). Where such activities are conducted on private lands or other lands of restricted public access, the risk of hazard to the public is even further reduced.

3.4.2 Additional Mitigation Specific to the Issues

The following is a summary of additional mitigation measures that are specific to the issues listed in Chapter 2 of this document.

3.4.2.1 Effects on Target Species Populations of Raccoon, Opossum, Red Fox, Gull, Common Grackle and Crow

- PM activities are directed to resolving bird and mammal damage problems by taking action against individual problem birds and mammals, or local populations or groups, not by attempting to eradicate populations in the entire area or region.
- WS lethal removal is monitored by comparing numbers of birds and mammals killed with overall populations or trends in populations to assure the magnitude of lethal removal is maintained below the level that would cause significant adverse impacts to the viability of native species populations (See Chapter 4).

3.4.2.2 Effects of Predation on Protected Resources - Native Bird Species

- WS biologists and specialist are highly educated, trained, and experienced in identifying causes of wildlife damage (predation) and sign left by wildlife. They use this information to effectively capture, exclude, harass or modify habitat of target species and to avoid non-target species.

3.4.2.3 Effects of Control Methods on Nontarget Species Populations, Including T&E Species

- WS personnel are trained and experienced to select the most appropriate method for managing damaging animals and excluding nontargets.
- WS personnel are trained to identify target species before shooting.
- WS personnel release captured non-target species whenever possible.
- WS personnel use traps and lures designed to capture target species.
- Observations of birds are made prior to implementing control methods to determine if nontarget bird species or T&E species would be at significant risk from PM activities.
- WS has consulted with the USFWS regarding potential impacts of management methods on T&E species, and abides by reasonable and prudent alternatives (RPAs) and/or reasonable and prudent measures (RPMs) established as a result of that consultation. For the full context of the Biological Opinion see the ADC FEIS, Appendix F (USDA 1997). Further consultation on species and methods not covered by or included in that consultation process has determined that the predator damage management program to protect nesting native birds on coastal areas and barrier and Chesapeake Bay islands would not likely adversely affect threatened or endangered species listed in Virginia.
- Avitrol will not be applied on Assateague Island due to concern about endangered Delmarva fox squirrels.
- Avitrol will not be applied when bald eagles are present at a site or within ½ mile of nest sites.

- WS would retrieve dead birds to the extent possible, following treatment with Avitrol.

3.4.2.4 Effects of Control Methods on Human Health and Safety

- WS employees who use firearms to conduct official duties are required to attend an approved firearms safety and use training program within 3 months of their appointment and a refresher course every 2 years afterwards.
- WS employees are trained in the safe use of pyrotechnics and lasers.
- WS employees are certified pesticide applicators by the Virginia Department of Agriculture and Consumer Services, Office of Pesticide Management. Employees are required to be recertified every two years by attending training or testing.

3.4.2.5 Effects on Aesthetic Values of Target and Protected Resources

- Raccoons, opossums, red foxes, gulls, grackles and crows will be euthanized out of public view to the extent possible.

3.4.2.6 Effects on Recreation

- M-44's will be used only from January 7 through May 15 on barrier islands.
- Warning signs will be posted to inform pet owners that snares and traps are set in the area.
- Pets will be excluded from some barrier islands by the landowners or managers.

3.4.2.7 Humaneness and Animal Welfare Concerns of Control Methods Used

- Captured non-target animals would be released unless it is determined by the WS personnel that the animal would not survive.
- Captured animals would be euthanized by methods recommended by the AVMA, Society of Mammalogists, and Ornithological Council (Beaver et al. 2001, Andrews et al. 1993) or the recommendations of a veterinarian.
- Adequate water will be provided to gulls, grackles and crows captured in decoy traps.
- The National Wildlife Research Center continually conducts research to improve selectivity and humaneness of IWDM devices used by WS personnel.

4.0 CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Chapter 4 provides information needed for making informed decisions in selecting the appropriate alternative for meeting the purpose of the proposed action. This chapter analyzes the environmental consequences of each alternative in relation to the issues identified for detailed analysis in Chapter 2. This section analyzes the environmental consequences of each alternative in comparison with the no action alternative to determine if the real or potential impacts would be greater, lesser, or the same. Therefore, the no action alternative serves as the baseline for the analysis and the comparison of expected impacts among the alternatives.

The following resource values within the State are not expected to be significantly impacted by any of the alternatives analyzed: soils, geology, minerals, water quality/quantity, floodplains, wetlands, visual resources, air quality, prime and unique farmlands, aquatic resources, timber, and range. These resources will not be analyzed further.

Cumulative Impacts: Discussed in relationship to each of the potentially affected species analyzed in this chapter.

Irreversible and Irretrievable Commitments of Resources: Other than minor uses of fuels for motor vehicles and other materials, there are no irreversible or irretrievable commitments of resources.

Impacts on sites or resources protected under the National Historic Preservation Act: WS PM actions are not undertakings that could adversely affect historic resources (See Section 1.9.2.4).

4.1 Environmental Consequences for Issues Analyzed in Detail

4.1.1 Effects on Target Species Populations of Raccoon, Opossum, Red Fox, Gull, Common Grackle and Crow

Analysis of this issue is limited to raccoons, opossum, red foxes, gulls, common grackles and crows killed during PM. The analysis for magnitude of impact generally follows the process described in Chapter 4 of USDA (1997). Magnitude is described in USDA (1997) as " . . . *a measure of the number of animals killed in relation to their abundance.*" Magnitude may be determined either quantitatively or qualitatively. Quantitative determinations are based on population estimates, allowable harvest levels, and actual harvest data. Qualitative determinations are based on population trends and harvest data when available. Generally, WS only conducts damage management on species whose population densities are high and usually only after they have caused damage.

WS take is monitored by comparing numbers of animals killed with overall populations or trends in populations to assure the magnitude of take is maintained below the level that would cause significant adverse impacts to the viability of native species populations (USDA 1997, Chapter 4, Fig. 4-1 and Fig. 4-3).

Magnitude is defined as a measure of the number of animals killed in relation to their abundance. In this analysis, magnitude is evaluated first in terms of total harvest or population trend, then in terms of WS program kill. Magnitude is determined either quantitatively or qualitatively. The quantitative method is more rigorous and used when allowable harvest, state population level, and harvest data is available. Qualitative methods are based on state population trends and harvest data or regional population trends and population modeling.

The use of population trends as an index of magnitude is based on the assumption that annual harvests do not exceed allowable harvest levels. State wildlife management agencies act to avoid over-harvests by restricting hunting and trapping to ensure that annual harvests are within allowable harvest levels. The criteria for judging total harvest magnitude on the basis of animal population trends are as follows:

- if the population is increasing, the magnitude is low.
- if the population is stable, the magnitude is moderate.
- if the population is decreasing, the magnitude is high.

The WS kill magnitude is based on the fraction of total harvest attributed to WS. Magnitude ratings for the WS program are based on the following criteria:

- if WS kill is less than or equal to 33 percent of the total harvest, the magnitude is considered low.
- if WS kill is greater than 33 percent but less than or equal to 66 percent of the total harvest, the magnitude is considered moderate if the total harvest rating is high, or the magnitude is considered low if the total harvest rating is moderate.
- if WS kill is greater than 66 percent of the total harvest, the magnitude is considered equivalent to the total harvest rating.

Breeding Bird Surveys. Bird populations can be monitored by using data from the Breeding Bird Surveys (BBS). The BBS is a large-scale inventory of North American birds coordinated by the U.S. Geological Survey, Patuxent Wildlife Research Center (Sauer et al 2004). The BBS is a combined set of over 3,700 roadside survey routes primarily covering the continental United States and southern Canada. The BBS was started in 1966, and routes are surveyed in June by experienced birders. The stated primary objective of the BBS has been to generate an estimate of population change for all breeding birds. Populations of birds tend to fluctuate, especially locally, as a result of variable annual local habitat and climatic conditions. Trends can be determined using different population equations, and statistically tested to determine if a trend is significant.

Estimates of population trends from BBS data are derived primarily from route-regression analysis (Geissler and Sauer 1990) and are dependent upon a variety of assumptions (Link and Sauer 1998). The statistical significance of a trend for a given species is reflected in the calculated P-value (i.e., the probability of obtaining the observed data or more extreme data given that a hypothesis of no change is true). The level of statistical significance (e.g, 0.01, 0.05, 0.10, etc.) can vary and is often set by those conducting the analysis. Often BBS or other geographically large survey (e.g., Christmas Bird Count, Breeding Plot Survey) data is not statistically significant at the local level because of relatively smaller sample size (i.e., fewer routes surveyed), more routes with zero observations of a particular bird species which results in larger statistical variance, and low P-values set for statistical significance. The BBS has a statistical level of significance set at $P<0.01$.

The BBS data is best used to monitor population trends. However, the average number of birds per route (relative abundance) can be used to theoretically estimate the population size (relative abundance/10 mi^2 x 42,326 mi^2 (total land/water area in Virginia). To use these population estimates the following assumptions would need to be accepted.

1. All birds within a quarter mile of the observer are seen at all stops on a BBS route; this assumption is faulty because observers often cannot see a quarter mile in radius at all stops due to obstructions such as hills, trees, and brush and because some bird species can be very elusive. Therefore, the number of birds seen per route would provide a conservative estimate of the population.
2. The chosen survey routes are totally random and are fully representative of available habitats. When BBS routes are established, survey rules allow the observers to make stops for surveys based on better quality habitat or convenient parking areas, even though the survey sites are supposed to be spaced a half-mile apart. Therefore, if survey areas had stops with excellent food availability, the count survey could be biased. This would tend to overestimate the population. However, if these sites were not on a route at all, the population could be underestimated.
3. Birds are equally distributed throughout the survey area and routes were randomly selected. Routes are randomly picked throughout the Commonwealth, but are placed on the nearest available road. Therefore, the starting point is picked for accessibility by vehicle. However a variety of habitat types are

typically covered since most BBS routes are selected because they are "off the beaten path" to allow observers to hear birds without interruption from vehicular noise.

Christmas Bird Counts. The National Audubon Society (NAS) conducts nationwide bird surveys in December to early January (the NAS Christmas Counts). The Christmas Bird Count (CBC) reflects the number of birds frequenting the commonwealth during the winter months. The CBC data does not provide a population estimate, but can be used as an indicator of trends in the population. Researchers have found that population trends reflected in CBC data tend to correlate well with those from censuses taken by more stringent means (National Audubon Society 2004).

Alternative 1. - IWDM PM Program (Proposed Action/No Action)

Raccoons

The VDGIF, as the agency with management responsibility for wildlife in Virginia, has classified the raccoon as a furbearer. Raccoons are a furbearer species (§ 29.1-517, 4 VAC §§15-210-30 and -51, pursuant to §§29.1-100) legally hunted and trapped in Virginia. They also may be killed by landowners or their agents on their land after obtaining a VDGIF issued permit (§29.1-517). Raccoons may cause damage to agricultural crops, property, threats to human health or safety, or T&E species.

Absolute raccoon population densities are difficult or impossible to determine because of the difficulty in knowing what percentage of the population has been counted or estimated and the additional difficulty of knowing how large an area the raccoons are using (Sanderson 1987). Due to their adaptability, raccoon densities are greater in urban areas than in rural areas. Relative raccoon population densities have been variously inferred by take of animals per unit area. For instance, Twichell and Dill (1949) reported removing 100 raccoons from tree dens in a 41 ha (101 acres) waterfowl refuge area, while Yeager and Rennels (1943) studied raccoons on 881 ha (2,177 acres) in Illinois and reported trapping 35-40 raccoons in 1938-39, 170 in 1939-40, and 60 in 1940-41. Slate (1980) estimated 1 raccoon/7.8 ha (19.3 acres) in New Jersey in predominantly agricultural land on the inner coastal plain. Raccoon densities of 100 per sq. mile (1 raccoon per 6.4 acres) can be attained around abundant food sources (Kern 2002). Kennedy et al. (1991) estimated 13 raccoons per 100 ha (1 raccoon per 19 acres) of lowland forest in Tennessee.

No population estimates were available for raccoons in Virginia. Therefore the best available information was used to estimate minimum statewide population size for raccoons. The state of Virginia is approximately 42,326 square miles (U.S. Census Bureau 1999). Using the assumption that raccoon densities across the state average 50 per sq. mile, a conservative (minimum) statewide raccoon population could be estimated at approximately 2,116,300 raccoons.

Raccoon populations are stable across the state (R. Farrar, VDGIF, pers. commun.). The number of raccoons killed by landowners and other citizens for depredation purposes is unknown and not measured by any survey. Hunters killed 111,368 raccoons statewide in 2001-2002 season (R. Farrar, VDGIF, pers. commun.) WS lethally removed 171 raccoons in FY 2003 as part of WS damage management programs (e.g., property, protecting T&E species protection), which is only 0.15% of the number of raccoons taken by hunters. WS's lethal management of raccoons would be expected to be no more than approximately 500 animals in any one year under the proposed action, which is only 0.45% of the number of raccoons taken by hunters and therefore would be considered a low magnitude of impact.

Since WS has no authority or control over legal hunting and trapping or other mortality of raccoons in the state, the *status quo* for raccoon populations and human-caused raccoon mortality in Virginia is almost the same with or without the involvement of the federal program. This is further demonstrated by the likelihood that some of the raccoons killed by WS would be killed by resource owners and land mangers anyway since they were depredating animals. As the analysis indicates WS lethal removal of raccoons would be minor compared to sport and other depredation lethal removal allowed by the VDGIF.

Based on the above information, VDGIF oversight, and WS limited lethal take of raccoons in Virginia, WS should have minimal effects on local or statewide raccoon populations.

Opossum

The VDGIF, as the agency with management responsibility for wildlife in Virginia, has classified the opossum as a furbearer. Opossums are a furbearer species (§ 29.1-517, 4 VAC §§15-160-10, and -30 pursuant to §§29.1-100) legally hunted and trapped in Virginia. They may be killed by landowners on their land at anytime without a VDGIF issued permit (§29.1-517) and by tenants or agents when they have a VDGIF issued permit.

Opossums use a home range consisting of 4-20 ha. (10-50 acres) in size (Jackson 1994, Seidensticker, et al. 1987). Opossums live for only 1-2 years, with as few as 8% of a population of these animals surviving into the second year in a Virginia study conducted by Seidensticker, et al. (1987). In this 5 year study, it was also observed that there was a wide variation in opossum numbers, in what was considered excellent habitat for the species. These variations were observed seasonally and in different years. However, the mean density during the study was 3.9/km^2 (10.1/ mi^2). This was comparable to other opossum population densities in similar habitats in Virginia.

No population estimates were available for opossums in Virginia. Therefore the best available information was used to estimate minimum statewide population size for opossums. The state of Virginia is approximately 42,326 square miles (U.S. Census Bureau 1999). Using the assumption that opossum densities across the state average 10.1 per sq. mile, a conservative (minimum) statewide opossum population could be estimated at approximately 427,493 opossums.

Opossum populations are stable across the state based on the 2003 Virginia Bowhunter Survey (M. Fies, VDGIF, pers. commun., February 23, 2005). The number of opossums killed by landowners and other citizens for depredation purposes is unknown and not measured by any survey. The number of opossums harvested by hunters is unknown since hunters were not surveyed for opossum harvest. However, fur trappers sold 1,804 opossums during the 2003-2004 fur trapping season (M. Fies, VDGIF unpub. data). Statewide, WS killed 110 opossums in FY 2003 as part of WS damage management programs (e.g., property, protecting T&E species protection), which is only 6% of the number of opossums sold by fur trappers. WS's lethal management of opossums would be expected to be no more than approximately 50 animals in any one year under the proposed action, which is only 4.6% of the number of opossums sold by fur trappers and therefore would be considered a low magnitude of impact.

Since WS has no authority or control over legal hunting and trapping or other mortality of opossums in the state, the *status quo* for opossum populations and human-caused opossum mortality in Virginia is almost the same with or without the involvement of the federal program. This is further demonstrated by the likelihood that some of the opossums killed by WS would be killed by resource owners and land mangers anyway since they were depredating animals. As the analysis indicates WS lethal removal of opossums would be minor compared to sport and other depredation lethal removal allowed by the VDGIF.

Based on the above information, VDGIF oversight, and WS limited lethal take of opossums in Virginia, WS should have minimal effects on local or statewide opossum populations.

Red fox

The VDGIF, as the agency with management responsibility for wildlife in Virginia, has classified the red fox as a furbearer. Red fox are a furbearer species (§ 29.1-516, 4 VAC §§15-110-10, -20, -40, and -80 pursuant to §§29.1-100) and legally hunted and trapped in Virginia. Also, a landowner may kill or have killed foxes at anytime on their land without a VDGIF issued permit (4 VAC §§15-110-80). Foxes may be

killed at any time by owners or tenants of any land when they are doing damage to livestock or poultry (§§29.1-516). There are few restrictions on depredation harvest. However, there are many restrictions on sport harvest.

The density of red fox populations is difficult to determine because of the animals secretive and elusive nature. Estimates are prone to error even in open prairie areas with good visibility. Methods used to estimate numbers have included aerial surveys, questionnaires to rural residents and mail carriers, scent post surveys, intensive ground searches, and indices derived from hunting and trapping harvest (Voigt 1987). In Great Britain, where food is superabundant in many urban areas, densities as high as 30 foxes / km^2 (78 / mi^2) have been reported (Harris 1977, MacDonald and Newdick 1982, Harris and Rayner 1986), while in southern Ontario, densities of about 1 fox per square kilometer (2.6 / mi^2) occur during spring. In small areas of the best habitat, 3 times as many foxes have been observed (Voigt 1987). However, these densities rarely occur extensively because of the dispersion of unsuitable habitat, high mortality, or the presence of competition such as coyotes (Voigt and Earle 1983). Cyclical changes in fox numbers occur routinely and complicate density estimates as well as management. These cycles can occur because of changes in prey availability, or disease outbreaks among red foxes. For fox populations to remain relatively stable, mortality and reproduction must balance approximately. Home ranges for red foxes in the eastern U. S. are usually from 500 - 2,000 ha. (1,250 – 5,000 acres) in rural settings such as farmland (Voigt and Tinline 1980), but such sizes may not apply among fox populations in urban settings.

No population estimates were available for red foxes in Virginia. Therefore the best available information was used to estimate minimum statewide population size for red fox. There are over 19.8 million acres of rural land in Virginia, with approximately 2.9 million acres considered cropland (U.S. Census Bureau 1999). Using the assumption that 50% of the rural lands throughout the state have sufficient habitat to support red fox, foxes are only found in rural habitat, red fox densities are 1 fox per 250 acres, a conservative statewide red fox population could be estimated at over 39,600 foxes.

Red fox populations are stable across the state (VDGIF unpubl. data). Even though there are few restrictions on depredation harvest and many restrictions on sport harvest, the red fox sport harvest has been approximately stable each year. However, when combined with hunter effort the red fox harvest has decreased since 1993 (R. Farrar, VDGIF, pers. commun.). The number of red fox killed by landowners and other citizens for depredation purposes is unknown and not measured by any survey. Hunters killed 18,692 red fox statewide during the 2001-2002 season (R. Farrar, VDGIF, pers. commun.). WS lethally removed 103 red fox in FY 2003 as part of WS damage management programs (e.g., airports, protecting T&E species, livestock protection), which is only 0.6% of the number of red fox taken by hunters. WS's lethal management of red fox would be expected to be no more than approximately 50 animals in any one year under the proposed action, which is only 0.3% of the number of red fox taken by hunters and therefore would be considered a low magnitude of impact.

Since WS has no authority or control over legal hunting and trapping or other mortality of red fox in the state, the *status quo* for red fox populations and human-caused red fox mortality in Virginia is almost the same with or without the involvement of the federal program. This is further demonstrated by the likelihood that some of the red fox killed by WS would be killed by resource owners and land managers anyway since they were depredating animals. As the analysis indicates WS lethal removal of red fox would be minor compared to sport and other depredation take allowed by the VDGIF.

Dispersal serves to equalize fox densities over large areas. Annual harvests in localized areas in 1 or more years will likely have little impact on the overall population in subsequent years, but may reduce localized predation (Allen and Sargeant 1993). Phillips (1970) stated that fox populations are resilient and for fox control (by trapping) to be successful, pressure on the population must be almost continuous. Phillips (1970) and Voigt (1987) also concluded that habitat destruction affects fox populations to a greater extent than short-term over-harvest.

Based on the above information, VDGIF oversight, and WS limited lethal take of red fox in Virginia, WS should have minimal effects on local or statewide red fox populations.

Gulls

Three species of gull breed in Virginia: laughing gull, herring gull, and great black-backed gull. Herring and great black-backed gulls have expanded their range south from the Canadian Maritimes over the last 100 years (Good 1998, (Erwin and Korschgen 1979, Watts and Byrd 1998). In Virginia, laughing gulls have greatly increased in abundance since the 1970s (Table 15). These gull species have expanded their range and abundance because of human activities (Drury 1973, Erwin 1979, Erwin 1979a). These activities have made food more available as a result of landfills, shopping centers and restaurants, mari-culture facilities, and agricultural areas which have resulted in increased survival and reproduction of gulls.

Members of the Avian Partnership Council established a baseline year of 1984 for managing gull populations in Virginia to reduce predation and nest site competition with historic native ground nesting colonial waterbirds and shorebirds (M. Erwin, USGS, pers. commun. August 5, 2004). Moreover, the Mid-Atlantic New England Maritimes Working Group (MANEM) recognizes the need for local laughing, herring, and greater black back gull population management in the Mid-Atlantic Region (www.waterbirdconservation.org). This year allowed populations of gulls historically present (laughing gulls) and absent (herring and greater black back gulls) and other birds to possibly co-exist, allowed analyses of trend data (Bart et al. 2004), and reduced predation on threatened and endangered birds and birds of special management concern. The Avian Partnership Council consists of state and federal wildlife and natural resource management agencies, environmental and birding organizations, and researchers and academics from colleges in Virginia. Impacts to the population from the proposed program will be measured against the baseline year (Table 15) on an annual basis. The portion of the adult gull breeding population exceeding the baseline year could be subsequently removed. Currently the difference from the baseline year is 936 great black-backed gull pairs, 1,535 herring gull pairs, and 12,936 laughing gull pairs (Table 15).

Colonial waterbirds are surveyed annually on the Virginia barrier islands (Williams et al. 2000), were surveyed in 1993 and 2003 in the entire coastal plain of Virginia (Watts 2004), and are indexed by the Breeding Bird Survey each year (Sauer et al. 2004). The colonial waterbird surveys record only breeding adult gulls and not immature gulls (i.e., herring and great black-backed gulls less than 4 years of age and laughing gulls less than 3 years of age). According to Dolbeer (1998) the number of non-breeding gulls (sub-adults and non-breeding adults) is estimated to equal about 50% of the nesting population.

Table 15. Estimate of nesting pairs and (number of colonies) of gulls in Virginia.

Species[A]	1977[B]	1984-85[C]	1993[D]	1998	2003[D]	Difference from baseline year (pairs)
GBBG	22 (2)	148 (8)	514 (26)	369*	1,084 (31)	936
HEGU	2,624 (10)	2,986 (18)	8,801 (35)	4,653*	4,521 (38)	1,535
LAGU	31,197 (28)	32,017 (xx)	45,387 (110)	43,784*	44,953 (60)	12,936

A. GBBG = great black-backed gull, HEGU = herring gull, LAGU = laughing gull.
B. Data from Erwin 1979.
C. Data from Andrews 1990.
D. Data from Watts and Byrd. 1998.
*. Barrier islands only.

Under the proposed program, WS and the USFWS would monitor lethal removal of gulls and nests/eggs annually to maintain a breeding gull population in Virginia at or above the 1984 baseline year (Table 15). Gull population would be monitored each year on the barrier islands by The Nature Conservancy; every ten years (e.g,, 1993, 2003) on the coastal plain by the College of William and Mary through funding received

from the VDGIF, Virginia Department of Environmental Quality, The Nature Conservancy, and the Center for Conservation Biology. Gull populations on the seaside would be monitored every 5 years (e.g., 1998) which is coordinated by The Nature Conservancy.

Population trend data were obtained using Breeding Bird Survey (BBS) data from the U.S. Geological Survey (USGS), Patuxent Wildlife Research Center (Sauer et al. 2004). BBS data represents the best information currently available for monitoring trends in many bird species. In Region 5 of the USFWS, trends calculated from the BBS indicate a rate of increase during the recent period of 1980-2003, with laughing gulls increasing annually at 3.1% (P=0.02). In Region 5 of the USFWS, trends calculated from the BBS indicate a rate of decrease during the recent period of 1980-2003, with great black-backed gulls decreasing annually at 5.2% (P=0.01). In Region 5 of the USFWS, trends calculated from the BBS indicate a stable rate during the recent period of 1980-2003, with herring gulls decreasing annually at 0.4% (P=0.80). The estimated trends for individual states from 1980 to 2003 also show annual increases of 1.0% for laughing gulls and 5.9% for herring gulls in Virginia (Sauer et al. 2004). Watts (2004) showed a 110% increase in great black-backed gulls in Virginia from 1993 – 2003 and a 4,827% increase since 1977 (Erwin 1979 & 1979a). There are too few great black-backed gulls in Virginia for the BBS to calculate trends. Region 5 is comprised of 13 states and the District of Columbia in the Mid-Atlantic and New England region.

Virginia Christmas Bird Count data from 1966-2003 shows an increasing trend for wintering populations great black-backed gulls, and a relatively stable trend for wintering populations of herring gulls and laughing gulls throughout the state (National Audubon Society 2004).

Gulls are protected by the USFWS under the MBTA. The USFWS, as the agency with migratory bird management responsibility, could impose restrictions on depredation harvest as needed to assure cumulative take does not adversely affect the continued viability of populations. This should assure that cumulative impacts on great black-backed gull, herring gull, and laughing gull populations would have no significant adverse impact on the quality of the human environment. In 2003 the USFWS authorized the take of 375 great black-backed gulls in Virginia, while 23 birds were reported taken by permits; 2,905 herring gulls in Virginia, while 333 birds were reported taken by permits; 3,135 laughing gulls in Virginia, while 626 birds were reported taken by permits; (L. Gore, USFWS, pers. commun. March 1, 2005). In calendar year 2003, statewide, WS lethally removed 6 great black-backed gulls, 125 herring gulls, and 241 laughing gulls to protect aviation safety, human safety, and property in VA. No nests or eggs were destroyed. No gulls were taken by WS to protect natural resources in 2003 or 2004. The USFWS in VA lethally removed 19 great black-backed gulls, 86 herring gulls, 171 laughing gulls, and 5 ring-billed gulls in 2003 to protect piping plovers, a federally listed threatened species, on National Wildlife Refuges. Lethal removal by WS and USFWS included adult and sub-adult gulls. Lethal removal by WS may have included birds wintering in Virginia from other states. Analysis of this level of take indicates breeding populations of all three species of gulls are still above the 1984 baseline year (Table 15).

Based on the above information, USFWS oversight, and WS limited lethal take of gulls in Virginia, WS should not adversely affect local, statewide, regional or continental great black-backed, herring, and laughing gull populations.

Common Grackles

The common grackle occupies a range that includes Canada and the United States east of the Rockies (Peterson 1980). This bird inhabits croplands, fields, parks, lawns, and open woodland (Bull and Farrand 1977). The grackle has an extremely varied diet, which includes insects, crayfish, frogs, other small aquatic life, mice, nestling birds, eggs, sprouting and ripened grains, seeds, and fruits (Bull and Farrand 1997; Peterson 1980). These birds form large flocks during migration and in winter roosts and often form breeding colonies. Common grackles usually nest in tall evergreens and have clutch size of five eggs.

Common grackles are considered to be part of the blackbird species group described in USDA (1997) and are estimated to represent 22% of this group (Meanley and Royall 1976). Precise counts of blackbird populations do not exist, but one estimate placed the United States summer population of the blackbird group at over 1 billion (USDA 1997) and the winter population at 500 million (Royall 1977). Natural mortality in blackbird populations is between 50% and 65% of the population each year, regardless of human-caused control operations (USDA 1997). The annual population of blackbirds in the eastern U.S. is at least 232 million (Meanley and Royall 1976, Johnson and Glahn 1994). Therefore the estimated natural mortality of the blackbird group in the eastern U.S should be between 116 and 140 million birds annually.

Dolbeer et al. (1995) showed that WS kills of 3.6% of the wintering population had no effect on breeding populations the following spring. Dolbeer et al. (1976) constructed a population model which indicated that a reduction of 14.8% of the wintering blackbird population would reduce the spring breeding population by 20% and that a 56.2% reduction in the wintering blackbird population would reduce spring breeding populations by only 33%. Given the density-dependent relationships in a blackbird population (i.e. decreased mortality and increased fecundity of surviving birds) a much higher number would likely have to be killed in order to impact the regional breeding population.

The USFWS has established a Depredation Order (50 CFR 21.43) for blackbirds, whereby no Federal permit is required to remove blackbirds if they are committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. The USFWS, as the agency with management responsibility, could impose restrictions on depredation harvest as needed to assure cumulative take does not adversely affect the continued viability of populations. This should assure that cumulative impacts on blackbird populations would have no significant adverse impact on the quality of the human environment.

Breeding Bird Survey trend data from 1966-2003 indicate that common grackle populations have decreased at an annual rate of -1.9%, -1.3%, and -2.0% throughout Virginia, the United States, and Region 5 of the USFWS, respectively (Sauer et al. 2004). With a relative abundance of 76.40, a total Virginia summer grackle population could be estimated at approximately 323,370 birds. Virginia Christmas Bird Count data from 1966-2003 shows a relatively stable population trend for wintering populations of grackles throughout the state (National Audubon Society 2004).

The number of common grackles killed by farmers and other citizens is unknown and not measured by any survey. Statewide, WS killed 17 grackles in FY 2003 to alleviate damage. WS's lethal management of common grackles would be expected to be no more than approximately 100 birds in any one year under the Proposed Action.

Based on the above information, USFWS oversight, and WS anticipated lethal take of common grackles in Virginia, WS should have minimal effects on local, statewide, regional or continental populations.

Crows

American and fish crows are popular game bird hunted in Virginia. They are also a pest species that causes damages to property, crops, and natural resources; and threats to human health and safety (USDA 2000). American crows have a wide range and are extremely abundant, being found in most of the United States (National Audubon Society 2000) and in Virginia. They are found in both urban and rural environments and oftentimes form large communal roosts in cities. In the U.S., some crow roosts may reach a half-million birds (National Audubon Society, 2000). Historically, crow populations have benefited from agricultural development because of grains available as a food supply.

Fish crows are found in mostly coastal areas of Virginia (Clapp and Banks 1991). They may be found in urban or rural environments.

VDGIF provided hunter harvest data (Table 16), but was unable to provide any definitive estimates of population sizes for purposes of the following analyses on impacts to the population. Therefore, WS used the best available information to produce reasonable estimates. Crow populations in Virginia are considered increasing based on trends in breeding bird surveys according to the USGS, Patuxent Wildlife Research Center (Sauer et al. 2004). VDGIF, the state authority responsible for monitoring and managing crows in Virginia believes crows are increasing and are an under-utilized resource by legal hunters (B. Ellis, VDGIF, pers. commun.). Breeding Bird Survey trend data from 1966-2003 indicate that American crow populations have increased at an annual rate of 0.9%, 1.3%, and 1.2% throughout Virginia, the United States, and Region 5 of the USFWS, respectively (Sauer et al. 2004). With a relative abundance of 57.02, a total Virginia summer American crow population could be estimated at approximately 241,343 birds. Breeding Bird Survey trend data from 1966-2003 indicate that fish crow populations have increased at an annual rate of 3.9%, 1.1%, and 3.2% throughout Virginia, the United States, and Region 5 of the USFWS, respectively (Sauer et al. 2004). With a relative abundance of 1.08, a total Virginia summer fish crow population could be estimated at approximately 4,571 birds. Also, the breeding bird survey reported Virginia had the highest relative abundance of American crows among all 50 states (Sauer et al. 2004).

Virginia Christmas Bird Count data from 1966-2003 shows a relatively stable trend for wintering populations of American crows and fish crows throughout the state (National Audubon Society 2004).

Table 16. The estimated number of crows legally killed by hunters during regulated hunting seasons in Virginia. The Virginia Department of Game and Inland Fisheries measures hunter harvest through surveys.

Year	Hunter harvest
1993 - 1994	201,549
1994 - 1995	321,133
1995 - 1996	291,277
1996 - 1997	203,961
1997 - 1998	285,513
1998 - 1999	258,422
2001 – 2002	251,167

The USFWS has established a Depredation Order (50 CFR 21.43) for crows, whereby no Federal permit is required to remove crows if they are committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. The USFWS, as the agency with management responsibility, could impose restrictions on depredation harvest as needed to assure cumulative take does not adversely affect the continued viability of populations. This should assure that cumulative impacts on crow populations would have no significant adverse impact on the quality of the human environment.

The number of crows killed by farmers and other citizens is unknown and not measured by any survey. The mean number of crows harvested by hunters from 1993 - 1999 was 260,309 birds (Table 16). Statewide, WS killed 480 crows in FY 2003 to alleviate damage, which is only 0.18% of the number of crows harvested by hunters. WS's lethal management of crows would be expected to be no more than approximately 200 birds in any one year under the proposed action, which is only 0.08% of the number of crows taken by hunters and therefore would be considered a low magnitude of impact.

Since WS has no authority or control over sport or other harvest or mortality of crows in the state, the *status quo* for crow populations and human-caused crow mortality in Virginia is almost the same with or without the involvement of the federal program. This is further suggested by the likelihood that some of the crows killed by WS would be killed by resource owners and land mangers anyway since they were depredating animals. As the analysis indicates WS lethal removal of crows would be minor compared to

sport and other depredation take.

Based on the above information, USFWS oversight, and WS anticipated lethal take of crows in Virginia, WS should have minimal effects on local, statewide, regional or continental populations.

Alternative 2 - Nonlethal PM Only by WS

Under this alternative, WS would not lethally remove any target species because no lethal methods would be used by WS. Only nonlethal technical assistance recommendations and direct control activities would be implemented by WS. Although WS lethal removal of target bird and mammal species would not occur, it is likely that without WS conducting some level of lethal PM activities, resource owners and land managers PM efforts could increase, stay the same, decrease, or cease, leading to the same or potentially lesser cumulative impacts on target species populations than those of the proposed program alternative. For the same reasons shown in the population impacts analysis in section 4.1.1.1, it is unlikely that target mammal or bird populations would be impacted significantly by implementation of this alternative. .

Alternative 3 – Technical Assistance Only

Under this alternative, WS would have no direct impact on any target species because WS would only provide technical information and recommendations. It is likely that without WS conducting some level of lethal PM activities, resource owners and land managers PM efforts would increase, stay the same, decrease or cease, leading to the same or potentially lesser cumulative impacts on target species populations than those of the proposed program alternative. For the same reasons shown in the population impacts analysis in section 4.1.1.1, it is unlikely that target mammal or bird populations would be impacted significantly by implementation of this alternative.

Alternative 4 - Lethal PM Only by WS

Under this alternative, WS would likely have a greater impact on target bird species populations than Alternative 1 since WS would only be able to recommend and implement lethal control methods. WS would be unable to use or recommend any effective or practical nonlethal methods. It is likely that a minor increase in the number of gulls, crows and grackles and the same number of raccoons, opossum, and red foxes would likely have to be removed lethally to achieve the same results as the proposed action. For the same reasons shown in the population impacts analysis in section 4.1.1.1, it is unlikely that target bird or mammal populations would be impacted significantly by implementation of this alternative.

Alternative 5 - No Federal WS PM

Under this alternative, WS would have no impact on target species populations. Resource owners and land managers PM efforts to reduce or prevent predation on nesting native birds could increase, stay the same, decrease, or cease leading to the same or potentially lesser cumulative impacts on target species populations than those of the proposed program alternative. For the same reasons shown in the population impacts analysis in section 4.1.1.1 it is unlikely that target mammal or bird populations would be impacted significantly by implementation of this alternative.

4.1.2 Effects of Predation on Protected Resources – Native Bird Species.

Alternative 1 - IWDM PM Program (Proposed Action/No Action)

The most ecologically and economically sound methods of predator control remain the selective removal of individuals or groups of predators (Mason 2001). This alternative would be more effective than any of the other alternatives in reducing or minimizing predation on native bird species. An IWDM PM program, a combination of lethal and nonlethal means, has the greatest potential of successfully reducing predation on

native bird species. All PM methods could possibly be implemented and recommended by WS. This alternative would give WS the option to implement lethal management and would enhance WS effectiveness and ability to address a broader range of predation problems. Repopulation of sites where lethal management methods were used would undoubtedly take place as long as suitable habitat exists in that area. However, the use of lethal management would reduce the number of damaging birds and mammals thereby enhancing the effectiveness of non-lethal methods. This alternative would be more effective than Alternatives 2, 3, and 5.

The application of lethal or non-lethal methods may cause gulls nesting on one island to abandon it for another island. Colonial waterbirds, shore birds, and black ducks nesting on the island recently colonized by gulls may incur higher predation rates. These higher predation rates would be dependent on the number of gulls colonizing the island, available nesting and escape cover for other birds, and whether the recent colonization by gulls was followed up with management actions to reduce predation. This result may be preferable if total predation losses are less to bird species of management concern.

Beneficial Impacts on Nontarget and T&E Species.

Nesting native birds and T & E species (piping plovers, Wilson plovers) would have more eggs hatched and fledglings surviving under this alternative than alternatives 2, 3 and 5. These islands were historically used for nesting and were abandoned because of mammalian predation. Now some of these islands would be re-colonized by nesting native birds. The impacts on T & E species would be the same for alternatives 1 and 4. These impacts would be beneficial.

Piping plovers incubating eggs within an enclosure have benefited from less avian predation (USFWS 2000). Most plover nests with enclosures appear to have nest success with at least one egg hatching. Mammalian and avian predator removal efforts were conducted during the same time, thus, masking the actual benefit of enclosures.

Alternative 2 – Non-lethal PM Only by WS

Under this alternative, WS would be restricted to implementing and recommending only nonlethal methods. The overall conclusion after reviewing nonlethal and lethal control strategies for managing predation to livestock, big game, and other wildlife species is there are few effective and practical nonlethal control methods available (Mason 2001). The success or failure of the use of nonlethal methods can be quite variable. This alternative would rely primarily on frightening or displacing wildlife from one location to another. If nonlethal methods did not reduce or eliminate the wildlife damage, no other WS options would be available. Resource owners and land mangers would then be required to develop and implement their own lethal program. Predation on native bird species could increase under this alternative if nonlethal techniques were ineffective and resource owners and land managers did not implement their own lethal PM program. The success of this non-WS program would be dependent upon the expertise of the personnel involved and therefore could be less effective than a WS IWDM PM program. Therefore, predation of native bird species could be greater than the proposed action. Overall impacts would be similar to Alternative 3.

Islands historically used for nesting by native birds would not be re-colonized because the predators would remain. Colonial waterbird and shorebird populations would continue to decline.

A review of non-lethal predator management options by Dueser et al. (2001) revealed that such non-lethal procedures are either unethical (e.g. trapping and relocation), technically infeasible (reproductive inhibitor, aversive conditioning), or technically challenging and expensive in this windy, wet, and salty maritime environment (e.g. barrier fencing). Also, the scope of the work among thousands of acres of barrier and Chesapeake Bay islands demonstrates that non-lethal management of raccoon and red fox predation is fiscally impossible and does not stop predation from occurring on native bird species attempting to nest on

the barrier islands.

The application of non-lethal methods may cause gulls nesting on one island to abandon it for another island. Colonial waterbirds, shore birds, and black ducks nesting on the island recently colonized by gulls may incur higher predation rates. These higher predation rates would be dependent on the number of gulls colonizing the island, available nesting and escape cover for other birds, and whether the recent colonization by gulls was followed up with management actions to reduce predation. This result may be preferable if total predation losses are less to bird species of management concern.

Alternative 3 – Technical Assistance Only

With WS technical assistance but no direct management, resource owners and land managers requesting PM would either take no action, which means conflicts and damage would likely continue or increase in each situation as bird and mammal numbers are maintained or increased, or implement WS recommendations for nonlethal and lethal control methods. The success of this program would be dependent upon the expertise of the personnel involved and therefore could be less effective than a WS IWDM PM program. Individuals or entities that implement PM methods may not have the experience necessary to efficiently and effectively conduct the actions. Therefore, predation of native bird species could be greater than the proposed action.

Populations of colonial waterbirds, shorebirds and black ducks would continue to decline.

Alternative 4 - Lethal PM Only by WS

Under this alternative, only lethal PM activities would be implemented or recommended to resolve predation on native bird species. Due to safety considerations all lethal PM methods may not be available for use in all situations. In those areas where lethal PM could not be conducted predator damage would not be reduced. In these situations, WS would not be able to recommend or use nonlethal methods that would otherwise be available under the proposed action. If resource owners and land managers did not implement their own nonlethal program in this particular situation, predation would continue to occur.

Islands historically used for nesting by native birds may be recolonized once predation stops. The impacts to nesting birds on barrier or Chesapeake Bay islands would be beneficial and populations of colonial waterbirds, shorebirds and black ducks would be expected to increase.

The application of lethal methods may cause gulls nesting on one island to abandon it for another island. Colonial waterbirds, shore birds, and black ducks nesting on the island recently colonized by gulls may incur higher predation rates. These higher predation rates would be dependent on the number of gulls colonizing the island, available nesting and escape cover for other birds, and whether the recent colonization by gulls was followed up with management actions to reduce predation. This result may be preferable if total predation losses are less to bird species of management concern.

Alternative 5 – No Federal WS PM

With no WS assistance, resource owners and land managers would either take no action, which means predation on native bird species would likely continue or increase in each situation as predator numbers are maintained or increased, or individuals will implement their own nonlethal and lethal control methods. Predation on native bird species could be greater under this alternative than the proposed action dependent upon the skills and abilities of the person implementing PM control methods. Efforts to reduce or prevent predation could result in less experienced persons implementing control methods. This could result in a greater potential for predation on native bird species to continue or possibly increase above current levels.

There would be a negative impact on T&E species (e.g., piping plovers, Wilson's plovers, gull-billed terns)

by no WS PM activities from this alternative.

4.1.3 Effects of Control Methods on Nontarget Wildlife Species Populations, including Threatened and Endangered Species.

Alternative 1 - IWDM PM Program (Proposed Action/No Action)

Adverse Impacts on Nontarget (non-T&E) Species. Direct impacts on nontarget species occur when WS program personnel inadvertently kill, injure, or harass animals that are not target species. In general, these impacts result from the use of methods that are not completely selective for target species. Non-target migratory bird species and other non-target wildlife species are usually not affected by WS's management methods, except for the occasional scaring from harassment devices. In these cases, migratory birds and other affected non-target wildlife may temporarily leave the immediate vicinity of scaring, but would most likely return after conclusion of the action.

Nontarget animals may be scared by harassment programs to disperse grackles, gulls or crows. These other birds may seek cover or flee during the harassment program (e.g., lasers, pyrotechnics, sirens, propane cannons). The impact will be short term as the birds would return to their normal activities once the harassment effort ends. Harassment efforts would discontinue or not occur if harassment methods were thought to disturb or disrupt nesting of native bird populations this program seeks to restore. Harassment efforts would not occur where threatened or endangered birds where nesting if harassment methods were thought to disturb or harm nesting efforts.

WS has incidentally removed 5 rice rats and one turkey vulture in body gripping traps during PM activities conducted on coastal areas in Virginia. One deer and one Canada goose were captured in snares and one river otter was captured in a foothold trap during PM activities conducted on coastal areas in Virginia. All 3 animals were released unharmed. Although it is possible that some non-target birds may be unknowingly killed by use of DRC-1339 for bird control, the method of application is designed to minimize or eliminate that risk. For example, DRC-1339 treated bait is only applied after a period of pre-baiting with untreated bait material and when non-target birds are not observed coming to feed at the site. WS take of non-target species during PM activities is expected to be extremely low to non-existent.

WS personnel are experienced and trained in wildlife identification, and to select the most appropriate methods for taking targeted animals and excluding nontarget species. Shooting is virtually 100% selective for the target species; therefore no adverse impacts are anticipated from use of this method. Any non-target species captured in a live trap or net would be released unharmed on site. No adverse impacts from the use of registered pesticides and repellents are anticipated. Based on a thorough Risk Assessment, APHIS concluded that, when WS program chemical methods are used in accordance with label directions, they are highly selective to target individuals or populations, and such use has negligible effects on the environment (USDA 1997).

While every precaution is taken to safeguard against taking nontarget species, changes in local flight patterns and other unanticipated events can result in the incidental take of unintended species. These occurrences are rare in Virginia, and should not affect the overall populations of any species under the proposed program.

T&E Species Impacts. Special efforts are made to avoid jeopardizing T&E species through biological evaluations of the potential effects and the establishment of special restrictions or mitigation measures.

Federally Listed Species. WS has obtained the list of federally listed T&E species for the state of Virginia. WS has consulted with the USFWS under Section 7 of the ESA concerning potential impacts of PM methods on T&E species and has obtained a Biological Opinion. For the full context of the Biological Opinion, see Appendix F of the ADC Final EIS (USDA 1997, Appendix F). Additionally, the USFWS

concluded the proposed action will not adversely affect federally listed species or designated critical habitat (Letter to Wildlife Services from K. Mayne, Fish and Wildlife Service, March 11, 2005).

T&E species that are federally listed (or proposed for listing) for the Commonwealth of Virginia are:

Gray bat, Indiana bat, Virginia big-eared bat, Cumberland bean, purple bean, green blossom pearlymussel, slender chub, spotfin chub, Cumberlandian combshell, duskytail darter, bald eagle, fanshell, Lee County cave isopod, Madison Cave Isopod, Roanoke logperch, yellowfin madtom, Appalachian monkeyface, Cumberland monkeyface, pink mucket, oyster mussel, birdwing pearlymussel, crackling pearlymussel, dromedary pearlymussel, littlewing pearlymussel, finerayed pigtoe, rough pigtoe, shiny pigtoe, piping plover, eastern puma, rough rabbitsfoot, tan riffleshell, Shenandoah salamander, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, Virginia fringed mountain snail, James spineymussel, Delmarva peninsula fox squirrel, Virginia northern flying squirrel, shortnose sturgeon, roseate tern, northeastern beach tiger beetle, bog turtle, dwarf wedgemussel, finback whale, humpback whale, right whale, red-cockaded woodpecker, sensitive joint-vetch, shale barren rock-cress, Virginia round leaf birch, small anthered bittercress, smooth coneflower, Virginia sneezeweed, swamp pink, Peter's Mountain mallow, small whorled pogonia, eastern prairie fringed orchid, Michaux's sumac, northeastern bulrush, Virginia spiraea, seabeach amaranth, shale barren rock-cress, and harperella.

WS PM activities on the coastal areas of Virginia would not adversely affect Gray bat, Indiana bat, Virginia big-eared bat, Cumberland bean, slender chub, bald eagle, yellowfin madtom, Appalachian monkeyface, Cumberland monkeyface, pink mucket,birdwing pearlymussel, finerayed pigtoe, rough pigtoe, shiny pigtoe, piping plover, eastern puma, tan riffleshell, green sea turtle, hawksbill sea turtle, Kemp's ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, Delmarva peninsula fox squirrel, Virginia northern flying squirrel, shortnose sturgeon, roseate tern, swamp pink, and small whorled pogonia. This determination is based on the conclusions made by the USFWS during their 1992 programmatic consultation of WS activities and subsequent Biological Opinion (USDA 1997, Appendix F). The proposed WS PM would have major beneficial impacts to piping plovers and loggerhead seaturtles. In addition, WS has determined that the use of PM methods will have no effect on those T&E species not included in the 1992 BO or their critical habitats. Also, WS has determined that the use of Measurol and lasers will not likely adversely affect any listed T&E species. Measurol treated eggs would not be placed in locations where threatened or endangered species may eat the treated eggs. Therefore, WS has determined that the proposed WS PM program will not likely adversely affect any federally listed T&E species.

Additionally, as stated in the 1992 BO, the USFWS has determined that the only bird damage management method that might adversely affect the bald eagle was above ground use of strychnine treated bait for "nuisance birds." Strychnine is no longer registered for above ground use and would not be used by WS in the State. DRC-1339 poses no primary hazard to eagles because eagles do not eat grain or other bait materials on which this chemical might be applied during PM activities, and further, because eagles are highly resistant to DRC-1339 - up to 100 mg doses were force fed to captive golden eagles with no mortality or adverse effects noted other than regurgitation and head-shaking (Larsen and Dietrich 1970). Secondary hazards to raptors from DRC-1339 and Avitrol are low to nonexistent (see Appendix B). Therefore, WS PM in Virginia is not likely to adversely affect bald eagles.

State Listed Species. WS has obtained and reviewed the list of Virginia State listed T&E species and has determined that the proposed WS PM program will not adversely affect any of the species listed in Virginia. The VDGIF concurs with this determination (R. Boettcher, VDGIF, pers. commun. February 25, 2005).

Mitigation measures to avoid T&E impacts were described in Chapter 3 (section 3.4). Those measures and characteristics should assure there would be no jeopardy to T&E species or adverse impacts on mammalian or non-T&E bird scavengers from the proposed action.

Alternative 2 - Nonlethal PM Only by WS

Under this alternative, WS lethal removal of nontarget animals would be less than that of the proposed action because no lethal management actions would be taken by WS. Impacts from WS use of nonlethal methods (i.e harassment, repellents, etc) would be similar to the proposed action.

However, resource owners and land managers whose predation on native bird populations were not effectively resolved by WS nonlethal management methods and recommendations would likely resort to lethal methods that are available to them. This could result in less experienced persons implementing control methods and could lead to greater take of nontarget wildlife than the proposed action. For example, shooting by persons not proficient at wildlife identification could lead to killing of nontarget birds and mammals. It is hypothetically possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal use of chemical toxicants which could lead to unknown effects on local nontarget species populations, including T&E species (USDA 1997, White et al. 1989, USFWS 2001, USFDA 2003). Hazards to raptors, including bald eagles and falcons, could therefore be greater under this alternative if chemicals that are less selective or that cause secondary poisoning are used by frustrated individuals.

Alternative 3 – Technical Assistance Only

Under this alternative, WS impacts on nontarget animals would be less than that of the proposed action because no direct management actions would be taken by WS. Technical assistance or self-help information would be provided upon request. Although technical support might lead to more selective use of control methods than that which might occur under Alternative 5, resource owners and land managers efforts to reduce or prevent predation could still result in less experienced persons implementing control methods, leading to greater take of non-target wildlife than under the proposed action. It is hypothetically possible that, similar to Alternative 2 and 5, frustration caused by the inability to reduce damage and associated losses could lead to illegal use of chemical toxicants which could lead to unknown effects on local non-target species populations, including some T&E species (USDA 1997, White et al. 1989, USFWS 2001, USFDA 2003). Hazards to raptors, including bald eagles, could therefore be greater under this alternative if chemicals that are less selective or that cause secondary poisoning are used by frustrated individuals.

Alternative 4 - Lethal PM Only by WS

Under this alternative, impacts from WS use of nonlethal methods (i.e harassment, repellents, etc) would be less than that of the proposed action because no nonlethal management actions would be taken by WS. Impacts from WS use of lethal methods would be similar to the proposed action.

Although technical support might lead to more selective use of lethal management methods than that which might occur under Alternative 2 and 5, resource owners and land managers efforts to reduce or prevent predation could still result in less experienced persons implementing management methods, leading to greater take of nontarget wildlife than under the proposed action. It is hypothetically possible that, similar to Alternative 2 and 5, frustration caused by the inability to reduce damage and associated losses could lead to illegal use of chemical toxicants which could lead to unknown effects on local non-target species populations, including some T&E species (USDA 1997, White et al. 1989, USFWS 2001, USFDA 2003). Hazards to raptors, including bald eagles, could therefore be greater under this alternative if chemicals that are less selective or that cause secondary poisoning are used by frustrated individuals.

Alternative 5 - No Federal WS PM

Alternative 5 would not allow any WS PM in Virginia. There would be no impact on nontarget or T&E

species by WS PM activities from this alternative. However, resource owners and land managers efforts to reduce or prevent predation on native birds could increase which could result in less experienced persons implementing management methods and could lead to greater take of nontarget wildlife than under the proposed action. For example, shooting by persons not proficient at wildlife identification could lead to killing of nontarget birds and mammals. It is hypothetically possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal use of chemical toxicants which could lead to unknown effects on local nontarget species populations, including T&E species (USDA 1997, White et al. 1989, USFWS 2001, USFDA 2003). Hazards to raptors, including bald eagles and falcons, could therefore be greater under this alternative if chemicals that are less selective or that cause secondary poisoning are used by frustrated individuals.

4.1.4 Effects of Control Methods on Human Health and Safety

Alternative 1 - IWDM PM Program (Proposed Action/No Action)

PM methods that might raise safety concerns include shooting with firearms, harassment with pyrotechnics and lasers, animal traps, and the application of avicides and predicides. A formal risk assessment of WS's operational management methods (except lasers) found that risks to human safety were low (USDA 1997, Appendix P). Therefore, no significant impacts on human safety from WS's use of these methods are expected. Upon request, technical advice would be provided in the safe and proper use of PM devices to resource owners and land managers. This would likely reduce human safety risks somewhat when WS's advice is utilized.

Firearms and pyrotechnics - Firearms are only used by WS personnel who are experienced in handling and using them. WS personnel receive safety training on a periodic basis to keep them aware of safety concerns. The VA WS program has had no accidents involving the use of firearms or pyrotechnics in which any person was harmed.
Some members of the public may be concerned about the safety of shooting gulls, grackles or crows with shotguns because they have concerns that shot may fall on people using remote beaches or islands. Their concern would be about people being struck and injured from shot. WS employees would visually check the area for the presence of people before shooting birds. Lead and steel bird shot used to shoot gulls, grackles or crows loses its velocity quickly and therefore loses its energy to cause harm. The small bird shot used would fall with a force similar to rain and is unlikely to cause any harm (O'Connor 1978).

Firearm use is a very sensitive topic and a public concern because of safety issues relating to the public and misuse. To ensure safe use and awareness, WS employees who use firearms to conduct official duties are required to attend an approved firearms safety and use training program within 3 months of their appointment and a refresher course every 2 years afterwards (WS Directive 2.615). WS employees who carry firearms as a condition of employment are required to sign a form certifying that they meet the criteria as stated in the *Lautenberg Amendment* which prohibits firearm possession by anyone who has been convicted of a misdemeanor crime of domestic violence.

Lasers - WS employees have been using lasers designed for harassing birds since 2001. Lasers are available with a power of 5 mW (moderate power) and 68 mW (low power). The difference between the lasers is beam intensity and diameter (Glahn et al. 2000). The lasers do not appear to present any detectable ocular hazards to cormorants but do present human safety concerns (Glahn et al. 2000). Both the Desman and Dissuader laser devices which would be used by WS to disperse birds are classified as Class-IIIB lasers (OSHA 1991). Lasers in lower ranges of Class-IIIB do not produce hazardous diffuse reflection unless someone intentionally stares at the laser closer to the diffuser (Glahn and Blackwell undated). The Dissuader is eye safe at the aperture for 1/4 second exposure (Dennis et al. 1999). The lasers can cause temporary flash blindness, afterimage, and glare in people (Glahn and Blackwell, undated). Dennis et al. (1999) report the Dissuader as an excellent glare source at night for tagging people. It is recommended that lasers not be pointed at people (Glahn et al. 2000). These lasers cost $5,700 to $7,500

each and this may be a disadvantage (Glahn et al. 2000). A modified Avian Dissuader™ became available in 2001 for $850.

The Avian Dissuader laser had several new safety features to improve human safety incorporated in 2001. The new safety features include an integral key-lock, trigger "safety", a mechanical safety in the form of a trigger safety pin located on the side of the unit, an audible/visual laser "on" indicator, and a 3-second emission delay for maximum safety.

Traps - Some members of the public may be concerned about the use of foothold and conibear traps or snares and the associated risks of being captured or injured.. Traps are set on barrier islands at a time of year (November – May) when the general public is unlikely to be using the islands. Also, some of the barrier islands are closed to public use, thus it is highly unlikely the general public would come into contact with these traps. Also, the land owner or manager who requested WS assistance would be informed about the traps and would sign an Agreement for Control or other document granting permission to WS to use such devices. Snares close with no force and are unlikely to injure anyone. Addtionally, foothold traps are small and unable to close on shoes worn by people. Conibear traps could injure someone if they put their hand in the trap because there traps are designed to humanely kill wild animals. Finally, signs would be posted warning people that traps are set in the area.

Avicides – WS may use chemicals registered with the Environmental Protection Agency to repel or kill gulls, grackles or crows preying on native bird populations. The chemicals that may be used are Measurol, DRC-1339, and Avitrol.

Measurol is the only repellent chemical method that would be used under the current program alternative. There is some concern among the general public about risks to human health from Measurol. Measurol treated areas will be posted with warning signs at access points to exclude people from treatment areas.

DRC-1339 (3-chloro-p-toluidine hydrochloride) is the primary lethal chemical method that would be used under the current program alternative. There has been some concern expressed by a few members of the public that unknown but significant risks to human health may exist from DRC-1339 used for PM. The Virginia WS program used 0 grams of DRC-1339 for PM activities in FY2003 (Appendix B). Therefore, actual use of this chemical by WS in the State has been low. This chemical is one of the most extensively researched and evaluated pesticides ever developed. Over 30 years of studies have demonstrated the safety and efficacy of this compound. Appendix B provides more detailed information on this chemical and its use in PM. Factors that virtually eliminate any risk of public health problems from use of this chemical are:

- its use is prohibited within 50 feet of standing water and cannot be applied directly to food or feed crops.
- DRC-1339 is highly unstable and degrades rapidly when exposed to sunlight, heat, or ultraviolet radiation. The half-life is about 25 hours, which means that treated bait material generally is nearly 100% broken down within a week.
- it is more than 90% metabolized in target birds within the first few hours after they consume the bait. Therefore, little material is left in bird carcasses that may be found or retrieved by people.
- application rates are extremely low (less than 0.1 lb. of active ingredient per acre) (EPA 1995).
- a human would need to ingest the internal organs of birds found dead from DRC-1339 to have any chance of receiving even a minute amount of the chemical or its metabolites into his/her system. This is highly unlikely to occur.

- The EPA has concluded that, based on mutagenicity studies (the tendency to cause gene mutations in cells), this chemical is not a mutagen or a carcinogen (i.e., cancer-causing agent) (EPA 1995). Regardless, however, the extremely controlled and limited circumstances in which DRC-1339 is used would prevent any exposure of the public to this chemical.

- WS personnel are Virginia certified restricted-use pesticide applicators.

The above analysis indicates that human health risks from DRC-1339 use would be virtually nonexistent under any alternative.

Avitrol (4-Aminopyridine) is another chemical method that might be used by WS in PM. Appendix B provides more detailed information on this chemical. Avitrol is available as a prepared grain bait mixture that is mixed in with clean bait at no greater than a 1:9 treated to untreated mixture. The technical grade chemical is not currently handled by Virginia WS personnel. There has been little use of Avitrol in the Virginia program over previous 10-year period of FY 1993-2003. Only 1.75 pounds of Avitrol corn chops has been used in the 10-year period by WS. Appendix B provides more detailed information on this chemical and its use in PM. In addition to this factor, other factors that virtually eliminate health risks to members of the public from use of this product as an avicide are:

- It is readily broken down or metabolized into removable compounds that are excreted in urine in the target species (ETOXNET 1996). Therefore, little of the chemical remains in killed birds to present a hazard to humans.

- A human would need to ingest the internal organs of birds found dead from Avitrol ingestion to have any chance of receiving even a minute amount of the chemical or its metabolites into his/her system. This is highly unlikely to occur. Furthermore, secondary hazard studies with mammals and birds have shown that there is virtually no hazard of secondary poisoning.

- Although Avitrol has not been specifically tested as a cancer-causing agent, the chemical was found not to be mutagenic in bacterial organisms (EPA 1997) . Therefore, the best scientific information available indicates it is not a carcinogen. Regardless, however, the extremely controlled and limited circumstances in which Avitrol is used would prevent exposure of members of the public to this chemical.

- Treated crows usually die in 10 - 20 minutes. Dead crows would be collected soon after dying.

The above analysis indicates that human health risks from Avitrol use would be virtually nonexistent under any alternative.

Predicides – WS may use chemicals registered with the Environmental Protection Agency to lethally remove red fox preying on native bird populations. The chemicals that may be used are sodium cyanide in M-44 ejectors and Large Gas Cartridges.

The M-44 (sodium cyanide) is the primary lethal chemical method that would be used under the proposed action. There has been some concern expressed by a few members of the public that unknown risks to human health may exist from M-44's. The Virginia WS program used 2.04 lbs. of sodium cyanide for Virginia Cooperative Coyote Damage Control Program activities in FY2003 in western Virginia. Therefore, actual use of this chemical by WS in Virginia is extremely low. This chemical has been extensively researched and evaluated for registration with EPA to reduce canine predation on livestock and T&E species. No WS employee has ever been killed by either M-44's or coyote getters through 50 years of WS use. According to the EPA, Poison Control Center,Toxic Exposure Surveillance System for 1993-1996 there have been more than 400,000 recorded exposures to all sorts of other animal toxicants, however,

there have been no M-44 exposures to the public (email from J. Shivik, NWRC, February 17, 1999). Appendix B provides more detailed information on this chemical and its use in PM programs. Factors that virtually eliminate any risk of public health or safety problems from use of this chemical are:

- follow M-44 label directions including the 26 use restrictions required by EPA and directions in the Predator Management Training Manual (Lowney 1996).
- all employees using M-44's carry amyl nitrate antidote kits
- poison control centers have been notified about use of sodium cyanide in Virginia
- sodium cyanide rapidly breaks down when exposed to the environment.
- sodium cyanide rapidly breaks down when exposed to the environment so persons handling exposed pets or dead animals would receive no exposure.
- sodium cyanide registered by WS has an orange marking dye which may indicate exposure of sodium cyanide if found on clothing, skin, or fur.
- the maximum application rates are extremely low (less than 12 grams per square mile) (EPA 1999).
- a human would need to orally ingest sodium cyanide from the M-44 to die. This would mean biting down on an M-44 embedded in the ground, the head of which is baited with rancid meat paste. The person would then have to pull the M-44 with their teeth to have any chance of receiving this chemical or its metabolites into his/her system. Alternatively, a person would have to place the M-44 in front of their face and pulling the head with their fingers to possible ingest sodium cyanide. Either of these scenarios is highly unlikely to occur.
- M-44's would be used on barrier islands from January 7 through May 15 when public use of barrier islands is unlikely, very low, or non-existent.
- Warning signs would be posted at boat landings or entryways of the barrier islands and within 25 feet of each M-44 unit.
- WS personnel are Virginia certified restricted-use pesticide applicators.

The above analysis indicates that human health risks from M-44 use would be virtually nonexistent under any alternative.

The Large Gas Cartridge is burned to create the carbon monoxide needed to euthanize red fox in their burrows. Applicators must exercise caution to avoid burns to the skin or surrounding vegetation. Appendix B provides more detailed information on this chemical and its current use in predator damage management. The Virginia WS program used 4 Large Gas Cartridges to fumigate red fox dens in 2003 to protect threatened or endangered nesting birds on barrier islands of Virginia. Therefore, actual use of this chemical by WS in Virginia is extremely low. This chemical has been extensively researched and evaluated for registration with EPA to reduce canine predation on livestock and T&E species.

Alternative 2 - Nonlethal PM Only by WS

Alternative 2 would not allow for any lethal methods to be used by WS. WS could only implement nonlethal methods such as repellants, and harassment and exclusion devices and materials. Under this alternative, nonlethal PM methods that might raise safety concerns include shooting with firearms when

used as a harassment technique, pyrotechnics, Measurol and lasers. Impacts from WS use of these methods would be similar to Alternative 1.

Upon request, technical advice would be provided to resource owners and land managers in the safe and proper use of nonlethal management devices, but no assistance would be provided in the use of lethal methods. Although technical support might lead to more selective use of nonlethal management methods by resource owners and land managers than that which might occur under Alternative 4 and 5, hazards to humans could be greater under this alternative if personnel conducting PM activities are poorly or improperly trained.

Alternative 3 – Technical Assistance Only

Under this alternative, WS would not engage in direct operational use of any PM methods. Risks to human safety from WS' use of PM methods would hypothetically be lower than the proposed action alternative, since WS would not be conducting direct control activities.

Although technical support might lead to more selective use of PM methods by resource owners and land managers than that which might occur under Alternative 5, hazards to humans could be greater under this alternative if personnel conducting PM activities are poorly or improperly trained.

Alternative 4 - Lethal PM Only by WS

Alternative 4 would not allow for any nonlethal methods to be used by WS. WS could only implement lethal methods. Under this alternative, lethal PM methods that might raise safety concerns include shooting with firearms, animal traps, and the application of avicides and predicides. Impacts from WS use of these methods would be similar to Alternative 1.

Upon request, technical advice would be provided to resource owners and land managers in the safe and proper use of lethal management devices, but no assistance would be provided in the use of nonlethal methods. Although technical support might lead to more selective use of lethal management methods by resource owners and land managers than that which might occur under Alternative 2 and 5, hazards to humans could be greater under this alternative if personnel conducting PM activities are poorly or improperly trained. .

Alternative 5 - No Federal PM

Under this alternative, WS would not use or recommend any PM methods. Risks to human safety from WS's use of firearms, traps, lasers, pyrotechnics, avicides, and predicides would be alleviated because no such use would occur. However, hazards to humans could be greater under this alternative if personnel conducting PM activities are poorly or improperly trained. WS would not provide assistance to individuals in the safe and proper use of PM devices.

4.1.5 Effects on Recreation

Alternative 1 - IWDM PM Program (Proposed Action/No Action)

Under this alternative, there would be minimal adverse effects on recreation, but major beneficial societal effects as native bird populations are restored. Most PM activities are conducted primarily during the winter and early spring months when few persons are on the islands. Many of the barrier islands are privately owned and access is restricted. Recreational activities such as swimming, sun-bathing, fishing, and other outdoor oriented activities may be harmed by noise disturbances from harassment programs if such activities took place when people are present. Hunting, trapping, and fishing will still occur on most of the islands. Bird watching activities would eventually be enhanced as breeding populations of colonial

waterbirds and shorebirds continue to increase. Black duck hunting opportunities should improve as black duck populations increase due to PM activities. Opportunities for fox, opossum, and raccoon fur trappers are likely to increase because these activities coincide with the goals of landowners and wildlife managers managing native ground nesting bird populations on the barrier islands. Opportunities for fox and raccoon hunters who use dogs may decrease because these activities disturb other wildlife and are somewhat inconsistent with the goals of the landowners and managers. While hunting raccoons with dogs is more efficient than trapping raccoons, the impacts to other wildlife species is an important consideration landowners and wildlife managers will need to weigh.

Alternative 2 – Non-lethal PM Only by WS

Under this alternative, recreational activities, such as bird watching, hunting, fishing, swimming, sun-bathing and other outdoor oriented activities may be harmed by noise disturbances from harassment programs if such activities took place when people are present. Harassment activities could increase above that of the proposed action since lethal management methods would be unavailable for use by WS. Bird watching and black duck hunting opportunities would decline as breeding bird populations continue to decline in those situations were nonlethal methods are ineffective at reducing predation. Hunting, trapping, and fishing will still occur on most of the islands.

Alternative 3 – Technical Assistance Only

Under this alternative, impacts would be expected to be similar to Alternative 2 because without WS operational involvement, the majority of PM activities conducted by resource owners and land managers would likely be nonlethal methods. If resources owners and land managers effectively implemented lethal PM methods, impacts could be similar to the proposed action. The success of this program would be dependent upon the expertise of the personnel involved and therefore could be less effective than a WS IWDM PM program. Individuals or entities that implement PM methods may not have the experience necessary to efficiently and effectively conduct the actions.

Alternative 4 - Lethal PM Only by WS

Under this alternative, impacts would be expected to be similar to Alternative 1.

Alternative 5 – No Federal WS PM

Under this alternative, impacts would be expected to be similar to alternative 2 because without WS operational involvement, the majority of PM activities conducted by resource owners and land managers would likely be nonlethal methods. If resources owners and land managers effectively implemented lethal PM methods, impacts could be similar to the proposed action. The success of this program would be dependent upon the expertise of the personnel involved and therefore could be less effective than a WS IWDM PM program. Individuals or entities that implement PM methods may not have the experience necessary to efficiently and effectively conduct the actions.

4.1.6 Effects on Economics

Alternative 1 - IWDM PM Program (Proposed Action/No Action)

There are many instances in which ecosystem health has been negatively affected by weather, fire, human disturbance, removal of top predators, introduction of exotic flora and fauna, etc. In these circumstances, predators may have major negative impacts on prey species (Hecht and Nickerson 1999). Prey species may become low enough in abundance to draw the attention of resource and land managers, and ultimately, the expenditure of public and private funds to restore these prey species (Bodenchuk et al. 2001).

Predator removal is one of the most cost effective forms of waterfowl management (Garrettson et al. 1996, Lokeman 1984). Bodenchuk et al. (2001) reported benefit:cost ratios for predation management to protect preferred wildlife species as ranging from 2:1 to 22:1. We calculated the extrinsic value of wildlife benefiting from predation management on barrier islands and compared to the cost of predation management. The costs of predation management includes the cost to monitor islands to detect the presence of predators, to monitor nesting and fledgling of management species of concern (shorebirds, colonial waterbirds, and black ducks), and the cost to remove predators.

Extrinsic values can be calculated from hunting license fees, habitat protection and restoration, and non-consumptive used of wildlife (photography, viewing). In addition, wildlife agencies have calculated values of common wildlife species, based on estimates of contributions to the economy by individual animals of the species. These economic values serve as the basis for civil financial penalties assessed as mitigation for illegal poaching or wildlife kills that result from environmental contamination (Bodenchuk et al. 2001).

The extrinsic value of the shorebird, colonial waterbird, and black duck populations is calculated by the number of wildlife viewers multiplied by the average daily expenditure (Table 17, USFWS 2001). Extrinsic values can also include multiplier effects which can contribute to a substantially larger economic effect. Since we did not include multiplier effects, our analysis is conservative and the actual economic impacts are larger.

Values of threatened or endangered species have been judged "incalculable" (*Tennessee Valley Authority vs Hill*, US Supreme Court 1978). Nonetheless, estimates of minimum value can be calculated from the funds expended for restoration (Bodenchuk et al. 2001). Restoration costs could include captive breeding programs, refuge expenditures for the protection of the species, and funds spent by the public on mitigation projects. When these costs are divided by the number of individuals in a population, a conservative cost of these wildlife species can be computed. An alternative and possibly more conservative value of an endangered or threatened species can be calculated from civil penalties assessed by the courts against defendents found having to have killed or harmed these species. We used the value of a threatened species as determined by a federal court case in Virginia where a threatened peregrine falcon was killed.

It is more difficult to calculate the value of a threatened or endangered species which has been reestablished on former occupied habitat. The benefit of restoring a threatened species may be unmeasureable. Piping plovers, a threatened species, has been reestablished on Wallops Island due solely to predator management. This species has been absent from several islands (e.g., Fisherman, Craney) for years due to predation and this loss is equally difficult to put an economic value on.

The cost of predator management includes monitoring for predators, monitoring bird populations, and predator removal activities. In 2004, three federal agencies, two state agencies, and two environmental organizations spent $145,327 to manage colonial waterbird, shorebird, and black duck populations. The extrinsic value of the shorebird, colonial waterbird, and black duck populations was calculated from the number of wildlife viewers at Chincoteague National Wildlife Refuge (NWR) and the annual Eastern Shore Bird Festival. Since the number of wildlife viewers at Fisherman Island NWR, state lands, and private lands is unknown, the true economic value for restoring bird species is likely much greater than the conservative estimates provided in this analysis. The total extrinsic value of the birds was $7,500,551 (Table 17). However a conservative estimate of the share of the bird population that can be attributed to predator management efforts was calculated in intervals of 5%, 10% and 25%. The resulting range of extrinsic values associated with contribution of predator management was $375,027 to $1,500,110 (Table 17). In other words, if predator management efforts were responsible for 5% of the bird population, then the associated extrinsic value of that amount of birds would be $375,027. Similar calculations can be made for the other interval amounts.

The total intrinsic value of shorebirds, colonial waterbirds, and black duck populations on the barrier islands was calculated to be $6,907,500. Using the same interval values for the involvement of predator

management activities, the intrinsic value of the birds ranged from $345,375 to $1,381,500. This can be interpreted in the same manner as above, in that if predator management efforts were responsible for 5% of the bird population, then the associated intrinsic value of that amount of birds would be $345,375. Similar calculations can be made for the other interval amounts.

Summing the extrinsic and intrinsic value of the selected bird species breeding on the barrier islands of Virginia yields the total economic value of $14,408,051 (Table 17 and 18). The total economic value of the birds attributable to predator management efforts ranged from $720,402 to $2,881,610.

A benefit-cost analysis of predator management to enhance breeding bird populations on the barrier islands compares the benefit or total economic value (extrinsic plus intrinsic) of the birds to the total cost of predator management. The cost of predator management was $145,327. The total economic value of birds attributable to predator management efforts ranged from $720,402 to $2,881,610, which results in a range of benefit-cost ratios of 4.6:1 to 19.8:1.

In summary, a conservative economic analysis of the cost:benefit of predator management on the barrier islands to enhance breeding populations of shorebirds, colonial waterbirds, threatened and endangered birds was conducted. The conservative analysis was based on using the intrinsic value of a selective group of birds, and not all bird species present on the islands were included in the analysis. The extrinsic value used was conservative because only bird watchers to Chincoteague NWR and the Eastern Shore Bird Festival were included in the analysis. Bird watchers to Eastern Shore and Fisherman Island NWR and to private lands were excluded from the analysis due to no data. Given the conservative nature of the analysis, a cost:benefit of 1:4.6 to 1:19.8 was realized. A higher cost:benefit could have been realized if more bird species were included in the intrinsic analysis or additional persons or additional bird watching days were included in the extrinsic analysis.

Table 17. Extrinsic value of select shorebird, colonial waterbird, and black duck populations on the barrier islands of the Commonwealth of Virginia.

				Predator management contribution to population and extrinsic value.		
Location	Number of wildlife viewers	Average daily expenditure	Total extrinsic value	5%	10%	20%
Chincoteague National Wildlife Refuge	154,210	$48.17	$7,428,296	$371,415	$742,830	$1,485,659
Eastern Shore Bird Festival[A]	500	$48.17	$72,255	$3,612	$7,226	$14,451
Total	154,710	48.17	$7,500,551	$375,027	$750,056	$1,500,110

A. This is a 3-day festival and most attendees attend all three days. A 1997 economic study reported a total extrinsic value of more than $100,000 to the local economy (R. Rulon, Eastern Shore Chamber of Commerce, pers. commun.).
B. USFWS and USDOC. 2003.

Table 18. Intrinsic value of selected shorebirds, colonial waterbirds, and black duck populations on the barrier islands of the Commonwealth of Virginia.

						Predator management contribution to population and intrinsic value.		
Species	Legal status	Maximum value[A]	Replacement costs[B]	Number of birds in 2003	Total intrinsic value ($)	5%	10%	25%
Piping plover	Federal, threatened	25,000	12,000	228	2,736,000			
Wilson's plover	State threatened	2,000	2,000	62	124,000			
Gull-billed tern	State threatened	2,000	2,000	52	104,000			
Oystercatcher	Migratory bird	2,000	500	546	273,000			
Common tern	Migratory bird	2,000	500	588	294,000			
Royal tern	Migratory bird	2,000	500	2,058	1,029,000			
Least tern	Migratory bird	2,000	500	341	170,500			
Black skimmer	Migratory bird	2,000	500	1,589	794,500			
Brown pelican	Migratory bird	2,000	500	952	476,000			
Black duck	Migratory bird	2,000	500	1,813	906,500			
TOTAL					6,907,500	$345,375	$690,750	$1,381,500

A. Maximum value is maximum criminal or civil penalty allowed by law.
B. Replacement value is calculated from court assessed criminal or civil penalties.

Alternative 2 – Non-lethal PM Only by WS

The impacts of this alternative would be a major adverse impact because it fails to address the predation problem which will result in the continued decline in shorebird, colonial waterbird, and black duck abundance. This alternative would rely primarily on frightening or displacing wildlife from one location to another. If nonlethal methods did not reduce or eliminate the wildlife damage, no other WS options would be available. Resource owners and land mangers would then be required to develop and implement their own lethal program. Predation on native bird species could increase under this alternative if nonlethal techniques were ineffective and resource owners and land managers did not implement their own lethal PM program. The success of this non-WS program would be dependent upon the expertise of the personnel involved and therefore could be less effective than a WS IWDM PM program.

Habitat management has acquisition and annual maintenance and management costs. Costs to plant, seed, mow, or burn can be expensive. Also, one single U.S. Department of Agriculture policy (Conservation Reserve Program [CRP]) has created more bird nesting habitat than state and federal wildlife management agencies have been able to create in 60 years (Garrettson et al. 1996). Only market forces and government policy can affect habitat across the landscape and wildlife management agencies may more effectively use their dollars to improve production on wildlife habitat that currently exists or is created by government incentive programs or policy (Garrettson et al. 1996).

Habitat management to improve ground nesting bird success can include management of dense nesting cover (Duebbert and Lokemoen 1976), fenced nesting cover (Lokemoen et al 1982, Greenwood et al. 1990), nesting islands (Giroux 1981), and rotational grazing (Barker et al. 1990). These approaches produce only a moderate improvement in nesting success at the scale dictated by wildlife funding (Clark and Nudds 1991, McKinnon and Duncan 1999).

The sum effect of non-lethal PM only would be increased costs with continued losses of birds. Benefits that would be accrued through habitat management also benefit predatory birds and mammals. The cost to harass or exclude predatory mammals or birds over a broad geographic area of 31 islands is unrealistic.

The long term cost:benefit ratio would decline as bird numbers decline and rare or threatened and endangered birds disappeared from the islands. There would be negative repercussions to the local economy as fewer people come to view the birds and expend funds for lodging, fuel, food, and other supplies and equipment.

Alternative 3 – Technical Assistance Only

The impacts of this alternative could be as severe as alternative 2 (non-lethal PM only) and alternative 5 (no federal WS PM). With WS technical assistance but no direct management, resource owners and land managers requesting PM would either take no action, which means conflicts and damage would likely continue or increase in each situation as bird and mammal numbers are maintained or increased, or implement WS recommendations for nonlethal and lethal control methods. The success of this program would be dependent upon the expertise of the personnel involved and therefore could be less effective than a WS IWDM PM program. Individuals or entities that implement PM methods may not have the experience necessary to efficiently and effectively conduct the actions. If the landowners and managers can find persons who can effectively conduct PM and funding is available then this alternative could have a minor or moderately beneficial impact. However, there has been difficulty in finding persons and non-federal agencies able and willing to conduct PM. Also, it has been challenging to get private fur trappers to trap abundant furbearers on the mainland due to low fur prices.

The long term cost:benefit could be similar as the nonlethal alternative and the no federal action alternative unless the landowners and managers found a private company or individuals who would effectively and efficiently remove predators from the barrier and Chesapeake Bay islands and coastal areas. Even if a private company or individuals could be found to manage mammalian predators on the islands and coastal areas, the increasing gull population may remain unaddressed thus some bird species would still decline or disappear from the islands and coastal areas which lowers the cost:benefit.

Alternative 4 - Lethal PM Only by WS

Under this alternative, only lethal PM activities would be implemented or recommended to resolve predation on native bird species. Due to safety considerations all lethal PM methods may not be available for use in all situations. In those areas where lethal PM could not be conducted predator damage would not be reduced. In these situations, WS would not be able to recommend or use nonlethal methods that would otherwise be available under the proposed action. If resource owners and land managers did not implement their own nonlethal program in this particular situation, predation would continue to occur.

The cost:benefit would be similar to Alternative 1, Integrated Wildlife Damage Management Predator Management Program .

Alternative 5 – No Federal WS PM

With no WS assistance, resource owners and land managers would either take no action, which means predation on native bird species would likely continue or increase in each situation as predator numbers are maintained or increased, or individuals will implement their own nonlethal and lethal control methods. Predation on native bird species could be greater under this alternative than the proposed action dependent upon the skills and abilities of the person implementing PM control methods. Efforts to reduce or prevent predation could result in less experienced persons implementing control methods. This could result in a greater potential for predation on native bird species to continue or possibly increase above current levels.

The sum effect of no federal WS program would be the continued decline and probable loss of several native ground nesting bird species and populations from the Virginia barrier and Chesapeake Bay islands. This would have negative economic impacts on wildlife watching and its associated economic impacts to local economies. There would also be the loss of black ducks available to waterfowl hunters and they would participate less if a favored duck was unavailable for harvest and/or they perceived wildlife managers were doing little to make black ducks more abundant.

The long term cost:benefit ratio would decline as bird numbers decline and rare or threatened and endangered birds disappeared from the islands. There would be negative repercussions to the local economy as fewer people come to view the birds and expend funds for lodging, fuel, food, and other supplies and equipment.

4.1.7 Effects on Aesthetic Values of Target Species and Protected Resources

Alternative 1 - IWDM PM Program (Proposed Action/No Action)

Some people who routinely view individual birds or mammals such as gulls, crows, grackles, raccoons, opossums, or red foxes would likely be disturbed by removal of such animals under the proposed program. WS is aware of human affectionate bond concerns and has taken it into consideration to mitigate effects.

Some people have expressed opposition to the killing of any raccoons, opossums, red foxes, gulls, grackles or crows during PM activities. Under the proposed program, some lethal management of birds and mammals would occur and these persons would continue to be opposed. However, many persons who voice opposition have no direct connection or opportunity to view or enjoy the particular birds or mammals that would be killed by lethal management activities. Lethal management actions would generally be restricted to local sites and to small, unsubstantial percentages of overall populations. Therefore, the species subjected to limited lethal management actions would remain common and abundant and would therefore continue to remain available for viewing by persons with that interest.

Some people do not believe that gulls, grackles or crows; gull rookeries; or crow roosts should even be harassed to stop or reduce damage problems. Some people who enjoy viewing gulls, grackles, crows, raccoon, opossum, or red fox would feel their interests are harmed by nonlethal harassment program. Some people believe raccoons, opossums, red foxes, gulls, grackles or crows fill important ecological roles and therefore should not be harassed or killed. Mitigating that impact, however, is the fact that overall numbers of gulls, grackles or crows in the area are not diminished by a harassment program and people who like to view these species can still do so on State wildlife management areas, National wildlife refuges, National parks, National forests, as well as numerous private property

sites where the owners are not experiencing damage caused by these birds and are tolerant of their presence.

Some people would be pleased with the implementation of the PM program because this program should result in an increase in diversity and numbers of birds available for viewing. There eventually would be an increase in the numbers of black ducks and perhaps increased hunting opportunity. Gulls, grackles and crows are abundant and some of the most common birds seen on the Eastern Shore of Virginia. Some of the bird populations that this program would increase are rare (i.e., piping plovers, Wilson's plovers), in low abundance (i.e., oyster catchers, least terns), or could be in much greater abundance (i.e., black ducks) and their uncommonness increases their aesthetic value to many people over more common species (i.e., laughing gulls, fish crows). Raccoons are exceptionally common on the Eastern Shore of Virginia and most local people see raccoons regularly at night, dead on roadway, or experience raccoon damage to shellfish beds, mobile homes, or gardens. Opossums are commonly seen in yards or walking public roads at night. Red fox are less visible on the Eastern Shore and are rarely seen by local people.

The current program provides more benefits to a larger cross section of the public than those who would be offended because they knew animals were killed. Serving the greater public good outweighs concerns and sensibilities of a very small minority. However, WS is responsive to this minority and will conduct PM activities in a humane and imperceptible manner.

Alternative 2 – Non-lethal PM Only by WS

Under this alternative, WS would not conduct any lethal PM but would still conduct nonlethal PM such as harassment of gulls, crows, grackles, raccoons, opossums, or red foxes that were preying on native birds. Some people who oppose lethal management of wildlife by government but are tolerant of government involvement in nonlethal wildlife damage management would favor this alternative.

Some people believe that gulls, grackles, crows, raccoons, opossums, or red foxes or gull rookeries or crow roosts should not be harassed to stop or reduce damage problems. Some people who enjoy viewing gulls, crows, grackles, raccoons, opossums, or red foxes or believe these animals' ecological role outweighs any harm to people, would feel their interests are harmed by a nonlethal harassment program. Mitigating that impact, however, is the fact that overall numbers of gulls, grackles or crows in the area are not diminished by a harassment program and people who like to view these species can still do so on State wildlife management areas, National wildlife refuges, National parks, National forests, as well as numerous private property sites where the owners are not experiencing damage caused by these birds and are tolerant of their presence.

Persons who have developed affectionate bonds with individual wild birds or mammals would not be affected by WS's activities under this alternative because the individual birds or mammals would not be killed by WS. However, other entities would likely conduct similar PM activities as those that would no longer be conducted by WS which means the impacts would then be similar to the proposed program alternative.

Some people would be pleased with the implementation of the nonlethal PM program because they would erroneously believe this program should result in an increase in diversity and numbers of birds available for viewing. Unless gulls, grackles, crows, opossums, raccoons and red foxes are removed from the coastal islands there will be no increase in native nesting bird abundance on these islands. Some of the bird population that this program would increase are rare (i.e., piping plovers, Wilson's plovers), in low abundance (i.e., oyster catchers, least terns), or could be in much greater abundance (i.e., black ducks) and their uncommonness increases their aesthetic value for many people over more common species (i.e., laughing gulls, fish crows). Unfortunately, a nonlethal program would result in the continued low or decreasing abundance of these bird species and viewing opportunities.

Alternative 3 – Technical Assistance Only

Under this alternative, only technical assistance or self-help information would be provided upon request. Some persons would still be opposed to PM even though the federal government's only involvement would be providing information, education or training to others. Lethal management and nonlethal management would still occur by non-federal agencies and private persons which means the impacts would then be similar to the proposed program alternative.

Alternative 4 – Lethal PM Only by WS

Under this alternative, only lethal PM activities would be implemented or recommend by WS Some people who routinely view individual birds or mammals such as gulls, crows, grackles, raccoons, opossums, or red foxes would likely be disturbed by removal of such animals under this alternative . WS is aware of similar concerns and has taken it into consideration in some cases to mitigate effects.

Some people have expressed opposition to the killing of any raccoons, opossums, red foxes, gulls, grackles, or crows during PM activities. Under this alternative, lethal management of birds and mammals would occur and these persons would continue to be opposed. However, many persons who voice opposition have no direct connection or opportunity to view or enjoy the particular birds or mammals that would be killed by lethal management activities. Lethal management actions would generally be restricted to local sites and to small, unsubstantial percentages of overall populations. Therefore, the species subjected to limited lethal management actions would remain common and abundant and would therefore continue to remain available for viewing by persons with that interest.

Some people believe raccoons, red foxes, opossums, grackles, gulls, or crows fill important ecological roles and therefore should not be killed. Mitigating that impact, however, is the fact that overall numbers of these bird and mammal species in the area are not diminished by a lethal program and people who like to view these species can still do so on State wildlife management areas, National wildlife refuges, National parks, National forests, as well as numerous private property sites where the owners are not experiencing damage from gulls, crows, grackles, raccoons, opossums, or red foxes gulls, crows, grackles, raccoons, opossums, or red foxes and are tolerant of their presence.

Some people would be pleased with the implementation of the PM program because this program should result in an increase in diversity and numbers of birds available for viewing. There eventually would be an increase in the numbers of black ducks and perhaps increased hunting opportunity. Gulls, grackles and crows are abundant and some of the most common birds seen on the Eastern Shore of Virginia. Some of the bird populations that this program would increase are rare (i.e., piping plovers, Wilson's plovers), in low abundance (i.e., oyster catchers, least terns), or could be in much greater abundance (i.e., black ducks) and their uncommonness increases their aesthetic value to many people over more common species (i.e., laughing gulls, fish crows). Raccoons are exceptionally common on the Eastern Shore of Virginia and most local people see raccoons regularly at night, dead on roadway, or experience raccoon damage to shellfish beds, mobile homes, or gardens. Opossums are commonly seen in yards or walking public roads at night. Red fox are less visible on the Eastern Shore of Virginia and are rarely, if ever, seen by local people.

Alternative 5 – No Federal WS PM

Under this alternative, WS would not conduct any lethal or nonlethal PM program to prevent gulls, crows, grackles, raccoons, opossums, or red foxes from preying on native bird species. Some people who oppose modern wildlife management would favor this alternative even though native birds would continue to decline in abundance. Other people and organizations would see this as a dereliction of responsibility by the federal and state wildlife management agencies that manage wildlife in public trust.

Persons who have developed affectionate bonds with individual wild birds or mammals would be pleased that no activities would be taken under this alternative by WS. However, resource managers and land owners would likely conduct similar PM activities as those that would no longer be conducted by WS.

Unless gulls, grackles, crows, opossums, raccoons and red foxes are removed from the coastal islands there will be no increase in native nesting bird abundance on these islands. Some of the bird populations that this program would attempt to increase are rare (i.e., piping plovers, Wilson's plovers), in low abundance (i.e., oyster catchers, least terns), or could be in much greater abundance (i.e., black ducks) and their uncommonness increases their aesthetic value for many people over more common species (i.e., laughing gulls, fish crows). Unfortunately, employing no federal program would result in the continued low or decreasing abundance of these bird species and viewing opportunities.

The impacts of this alternative would be most harmful to restoring native bird populations that nest on coastal

islands. The implementation of this alternative may lead to the demise of some native bird species from Virginia, thus the permanent loss of aesthetic value.

4.1.8 Humaneness and Animal Welfare Concerns of Methods Used

Alternative 1 - IWDM PM Program (Proposed Action/No Action)

Under this alternative, methods viewed by some persons as inhumane would be used in PM by WS. These methods would include trapping, snaring, shooting, gas cartridges, M-44's, avicides (e.g. DRC-1339, Avitrol), repellents (e.g. Measurol), pyrotechnics, lasers, electronic harassment, modified electric fencing around nests, effigies, and live trapping followed by euthanasia. WS biologists and specialists are professionals and are concerned about animal welfare. They use their knowledge and experience to select and use the most humane methods practical to achieve program goals.

Shooting, when performed by experienced professionals, usually results in a quick death for target animals and is essentially 100% selective for that species or individual. Occasionally, however, some birds and mammals are initially wounded and must be shot a second time or must be caught by hand and then dispatched or euthanized. Some persons would view shooting as inhumane.

Some people would view methods used to trap birds and mammals as inhumane. WS uses the most humane animal traps available to effectively capture animals targeted for removal. WS considers and implements available Best Management Practices for Mammal Traps when these recommendations are practical and effective.

Occasionally, birds and mammals captured alive by foot hold traps, by snares, by hand or with nets would be euthanized. The most common methods of euthanization for birds would be by cervical dislocation and CO_2 gas which are both AVMA-approved euthanasia methods (Beaver et al. 2001). Mammals would be euthanized by a gunshot to the head. Euthanasia methods used by WS on mammals and birds are approved by the Society of Mammalogists and the Ornithological Council. Most people would view AVMA-approved euthanization methods as humane.

Euthanasia means a death that occurs with a minimum of pain and distress (Beaver et al. 2001). Since many methods of euthanasia for wild or feral animals have not been studied, one must rely on clinical signs to determine if death occurred with a minimum of pain and distress (Rowsell et al. 1979). Animals killed with DRC-1339 appear to die humanely as there is no crying out, flopping, exaggerated movements, or any other calls or movements that would indicate distress. Avitrol appears to be humane based on scientific evidence that the bird's central nervous system is depressed and the bird cannot feel pain (Rowsell et al. 1979). Also, before the onset of convulsion electroencephalographic changes occur in the brain that are similar to dissociative anesthetics (e.g., Ketamine). This means there are changes in brain wave activity that demonstrate the effect of some pesticides is the same as some anesthetics, therefore some pesticides are humane. However, clinical signs of convulsive seizures will affect public acceptance of this chemical (Rowsell et al. 1979).

Alternative 2 – Non-lethal PM Only by WS

Under this alternative, lethal methods viewed as inhumane by some persons would not be used by WS. Nonlethal methods that some people may view as inhumane would be used by WS. These methods would include pyrotechnics, lasers, electronic harassment, modified electric fencing around nests, repellents (e.g. Measurol) and effigies. Humanness of nonlethal methods used by WS under this alternative would be similar to the proposed action. Overall, people who perceive the use of lethal management methods by WS as inhumane would prefer this alternative to the proposed action. Although WS would not perform any lethal activities under this alternative, other entities would likely conduct PM activities similar to those that would no longer be conducted by WS, resulting in impacts similar to the proposed action alternative.

Alternative 3 – Technical Assistance Only

Under this alternative, WS would provide self-help advice only. Lethal and nonlethal methods viewed as inhumane by some persons would not be used by WS. Resource owners and property managers could use the information

provided by WS or implement their own PM without WS technical assistance. Many of the methods considered inhumane by some individuals and groups might still be used by resource owners and land managers. Overall impacts should be less than Alternative 5 when WS technical advice is requested and followed.

Alternative 4 - Lethal PM Only by WS

Under this alternative, nonlethal methods that some people may view as inhumane would not be used by WS. Lethal methods that some people may view as inhumane would be used by WS. These methods would include trapping, snaring, shooting, gas cartridges, M-44's, avicides (e.g. DRC-1339, Avitrol), and live trapping followed by euthanasia. Overall, persons who view killing of any kind as inhumane would strongly oppose this alternative. Humanness of lethal PM methods used by WS under this alternative would be similar to the proposed action.

Alternative 5 – No Federal WS PM

Under this alternative, lethal and nonlethal PM methods viewed as inhumane by some persons would not be used or recommended by WS. Although WS would not perform any PM activities under this alternative, other entities would likely conduct PM activities similar to those that would no longer be conducted by WS, resulting in impacts similar to the proposed action alternative.

4.2 Cumulative Impacts

Cumulative impacts, as defined by CEQ (40 CFR 1508.7), are impacts to the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts may result from individually minor, but collectively significant, actions taking place over time.

No significant cumulative environmental impacts are expected from any of the 5 alternatives. Under the Proposed Action and Alternative 4, the lethal removal of raccoons, opossums, red foxes, coyotes, grackles, gulls, and crows would not have a significant impact on these overall animal populations in Virginia, or the United States, but some local reductions may occur. This PM program is supported by the VDGIF, which is the agency with responsibility for managing wildlife in the Commonwealth of Virginia. This PM program is supported by the USFWS, which is the agency with responsibility for managing migratory birds and federally threatened and endangered wildlife in the Commonwealth of Virginia and the United States.

Local raccoon, opossum, and red fox reductions would be temporary as these animals would continue to try to re-colonize coastal islands. The effects of predator removal may last only 1-2 years on some islands due to re-colonization by raccoons, opossums and red fox. The effects may be substantially longer on islands further away from the mainland. The program will continue indefinitely until landscape level changes cause raccoon and red fox populations to return to historic levels which were much lower than today. If the predator management program is discontinued, ground nesting bird populations would eventual collapse with only remnant populations scattered across a few islands.

The local reduction in crows, grackles or gulls from harassment programs or lethal methods may not be noticed. However, some people may notice the dispersal of a laughing gull rookery between Wallops and Chincoteague Islands in VA. The dispersal of other gull rookeries, if and when they occur, may be noticed by some people but numerous other opportunities to view gull colonies exist along the Eastern Shore.

No risk to public safety is expected when WS's services are provided and accepted by requesting individuals in Alternatives 1, 2, 3 and 4, since only trained and experienced wildlife biologists/specialists would conduct and recommend PM activities. There is a slight increased risk to public safety when PM activities are conducted by persons that reject WS assistance and recommendations in Alternatives 1, 2, 3 and 4, and when no WS assistance is provided in Alternative 5. In all 5 Alternatives, however, it would not be to the point that the impacts would be significant.

This program would be consistent with local government and state wildlife management objectives to provide increased opportunity to view or interact with wildlife. The PM program's goals would enhance popularity and

success of local bird viewing festivals by providing increased diversity and abundance of more species of birds. This program would enhance populations of black ducks, a popular duck with local and Virginia duck hunters.

The PM program would be expected to enhance income to local economies because more people would be expected to visit the Eastern Shore of Virginia to observe the increased diversity and abundance of birds. There would be an expected increase in sales tax revenue to the state due to increased sales of goods and services by people coming to the Eastern Shore of Virginia to view birds or hunt ducks and geese.

Although some persons will likely be opposed to WS's participation in PM activities to protect native bird populations from raccoon, opossum, red fox, gull, grackle or crow predation, the analysis in this EA indicates that WS Integrated PM program will not result in significant cumulative adverse impacts on the quality of the human environment. Table 17 summarizes the expected impacts of each of the alternatives on each of the issues.

Table 19. Summary of impacts of each alternative for each issue.

Issues/Impacts	Alt. 1 Integrated Wildlife Damage Management PM Program (Proposed Action/No Action)	Alt. 2 Non-lethal PM Only by WS	Alt. 3 Technical assistance only	Alt. 4 Lethal Methods Only by WS	Alt. 5 No Federal WS PM
Effects on Target Species Populations	Low impact on statewide raccoon, opossum, red fox, gull, grackle and crow populations. Local impacts on raccoons, opossums, and red fox would be high.	No impact by WS. Low impact on statewide raccoon, opossum, red fox, gull, grackle or crow populations by resource owners and land managers.	No impact by WS. Low impact on statewide raccoon, opossum, red fox, gull, grackle or crow populations by resource owners and land managers.	Low impact on statewide raccoon, opossum, red fox, gull, grackle and crow populations. Local impacts on raccoons, opossums, and red fox would be high. Impacts on target birds would be greater than Alt. 1.	No impact by WS. Low impact on statewide or local populations of raccoon, opossum, red fox, gull, grackle or crow populations by resource owners and land managers.
Effects of Predation on Protected Resources – Native Bird Species	Populations of shorebirds, colonial waterbirds, and black ducks would increase.	Populations of shorebirds, colonial waterbirds, and black ducks would continue to decline.	Populations of shorebirds, colonial waterbirds, and black ducks would continue to decline.	Populations of shorebirds, colonial waterbirds, and black ducks would increase.	Populations of shorebirds, colonial waterbirds, and black ducks would continue to decline and some may disappear from Virginia.
Effects of Control Methods on Non-target Wildlife Species Populations, including T&E Species	Low impact to nontarget species because methods are highly selective.	Low or no adverse impact to nontarget species. Harassment methods used for extensive periods may disrupt nesting of some birds.	No impact by WS. Variable impact by resorce owners and land managers.	Low impact to nontarget species because methods are highly selective.	No impact by WS. Variable impact by resource owners and land managers.
Effects on Recreation	Low adverse impacts on recreation from methods. Beneficial effects from restored native bird populations.	Low adverse impacts on recreation from methods but higher than alternative 1 and 4 because harassment may last for extended period of time. Native bird populations may continue to decline.	Low adverse impacts on recreation from methods used by resource owners and land mangers. Native bird populations may continue to decline.	Low adverse impacts on recreation from methods. Beneficial effects from restored native bird populations.	Low adverse impacts on recreation from methods used by resource owners and land managers but higher than alternative 1 and 4 because harassment may last for extended period of time. Native bird populations may

					continue to decline.
Effects on Economics	Beneficial impacts on local economies. This Alt. is consistent with eco-tourism goals of local economies.	Would have less beneficial impacts than Alt. 1 and 4. Eventually, impacts would no longer be beneficial. This Alt. is inconsistent with eco-tourism goals of local economies as local bird populations would decline.	Would have less beneficial impacts than Alt. 1 and 4. Eventually, impacts would no longer be beneficial. This Alt. is inconsistent with eco-tourism goals of local economies as local bird populations would decline.	Beneficial impacts on local economies. Impacts will be the same or slightly less than Alt. 1. This Alt. is consistent with eco-tourism goals of local economies.	Impacts would not be beneficial to local economies as some native nesting birds would continue to decline and possibly disappear from Virginia. This Alt. is inconsistent with eco-tourism goals of local economies.
Effects on Aesthetic Values of Target Species and Protected Resources	WS PM does not adversely affect overall target species populations but would reduce local mammal populations. Reduction of mammals would be on islands out of public view. Alt. 1 would have greatest beneficial impacts to enjoying greater diversity and abundance of birds.	WS PM has no effect on target species populations. Impacts of harassment of gull rookeries would offend some people and harassment would be highly visible. Low beneficial impacts to enjoying greater diversity and abundance of birds because native ground nesting birds would likely continue to decline.	WS PM has no effect on target species populations. Variable impact by resource owners and land managers. Low beneficial impacts to enjoying greater diversity and abundance of birds because native ground nesting birds would likely continue to decline.	WS PM does not adversely affect overall target species populations but would reduce local mammal populations. Impacts on target birds would be greater than Alt. 1. Beneficial impacts to enjoying greater diversity and abundance of birds.	WS PM has no effect on target species populations. Variable impact by resource owners and land managers. Some native nesting bird species would decline. Knowledgeable bird enthusiasts would be disappointed and may see state and federal wildlife agencies as neglecting their legislative mandate or authority to manage wildlife in public trust.
Humaneness and Animal Welfare Concerns of Methods Used	Low to moderate effect - methods viewed by some people as inhumane would be used by WS.	Lower effect than Alt. 1 and 3 since only non-lethal methods would be used by WS.	No effect by WS. Impacts by non-WS personnel would be variable.	Low to moderate effect - methods viewed by some people as inhumane would be used by WS.	No effect by WS. Impacts by non-WS personnel would be variable.

5.0 CHAPTER 5 - LIST OF PREPARERS AND PERSONS CONSULTED

5.1 List of Preparers/Reviewers

Martin Lowney	USDA-APHIS-WS
Jennifer Cromwell	USDA-APHIS-WS
Wendy Servoss	USDA-APHIS-WS
David Reinhold	USDA-APHIS-WS

5.2 List of Persons Consulted

Jeff Cooper	VDGIF
Ruth Boettcher	VDGIF
Randy Farrar	VDGIF
Thomas Bidrowski	VDGIF
Gary Costanzo	VDGIF
Michael Fies	VDGIF
John Schroer	USFWS, Chincoteague NWR
Amanda Avery	USFWS, Chincoteague NWR
Pamela Denmon	USFWS, Fisherman Island NWR
Diane Pence	USFWS
Lamar Gore	USFWS
Scott Johnston	USFWS
Michael Erwin	USGS, Biological Survey
Barry Truitt	The Nature Conservancy
Ray Dueser	Utah State University
Dan Cristol	College of William and Mary
Ruth Beck	College of William and Mary
Bryan Watts	College of William and Mary
Nancy Moncrief	Virginia Museum of Natural History
Stephanie Schwiff	USDA-APHIS-WS, National Wildlife Research Center

APPENDIX A

LITERATURE CITED

Akcakaya, H. R., J. L. Atwood, D. Breininger, C. T. Collins, and B. Duncan. 2003. Metapopulation dynamics of the California least tern. J. Wildl. Manage. 67:829-842.

Allen, S. H., and A. B. Sargeant. 1993. Dispersal patterns of red foxes relative to population density. J. Wildl. Manage. 57:526-533.

American Ornithologist Union. 1998. Check-list of North American Birds. 7th Edition. American Ornithologists' Union. Washington, DC.

Anderson, D. W. and J. O. Keith. 1980. The human influence on seabird nesting success: conservation implications. Biol. Conserv. 18:65-80.

Andrews, J.A., B.T. Bennett, J.D. Clark, K.A. Houpt, P.J. Pascoe, G.W. Robinson, and J.R. Boyce. 1993. 1993 Report of the AVMA Panel on Euthanasia. J. American Veterinary Medical Association 202:(2):229-249.

Andrews, R. 1990. Coastal waterbird colonies: Maine to Virginia 1984-85. An update of an atlas based on 1977 data, showing colony location, species, and nesting pairs at both time periods. US Fish and Wildlife Service, Region 5, Newton Corner, MA.

Anonymous. 1999. Foxes threaten plovers in Maine. Page 5 in The Probe. March 1999.

Anonymous. 1998. Red wolf population/location as of: December 1, 1997. Red Wolf Newsletter 10:5.

Anonymous. 1996. Conservation Action Plan for the Avian Communities in the Virginia Barrier Islands system. Barrier Island Avian Partnership. The Nature Conservancy. Nassawadox, VA. 35 pp.

Arhart, D. K. 1972. Some factors that influence the response of European starlings to aversive visual stimuli. M.S. Thesis. Oregon State University, Corvallis.

Armistead, H. T. 1987. Middle Atlantic Coast Region. Am. Birds 41:1418-1422.

Audubon. 2003. West Nile Virus – Effects on Wildlife. www.audubon.org/bird/wnv/

Avery, M. L. and D. G. Decker. 1994. Responses of captive Fish Crows to eggs treated with chemical repellents. J. of Wildl. Manage. 58:261-266.

Avery, M. L., J. S. Humphrey, E. A. Tillman, K. O. Pares, and J. E. Hatcher. 2002. Dispersing vulture roosts on communication towers. J. of Raptor Research 36:44-49

AVMA (American Veterinary Medical Association). 1987. Journal of the American Veterinary Medical Association. Panel Report on the Colloquim on Recognition and Alleviation of Animal Pain an Distress. 191:1186-1189.

Azert. S. P. 1971. A review of sodium monofluoroacetate (Compound 1080), its properties, toxicology, and use in predator and rodent control. Bureau of Sport Fisheries and Wildlife. Special Scientific Report –Wildlife No. 146. Washington, D.C.

Bailey, E. P. 1993. Introduction of foxes to Alaska islands – history, effects on avifauna, and eradication. Resourc. Publ. 193, U. S . Fish and Wildlife Serv. Washington, DC 53 pp.

Bailey, H. H. 1913. The birds of Virginia. J. P. Bell Co., Lynchburg, Virginia. 362 pp.

Ball, I. J., Martin, T. E. , and Ringelman, J. K. 1994. Conservation of nongame birds and waterfowl: conflict or complement?

Trans. N. Am. Wildl. Nat. Resource. Conf. 59:337-347

Ball, I. J., Martin, T. E. , and Ringelman, J. K. 1994. Conservation of nongame birds and waterfowl: conflict or complement? Trans. N. Am. Wildl. Nat. Resource. Conf. 59:337-347

Barker, W. T., K. K. Sedivec, T. A. Messmer, K. F. Higgins, and D. R. Hertel. 1990. Effects of specialized grazing systems on waterfowl production in south-central North Dakota. Trans. of the North American Wid. And Nat. Resourc. Conf. 55:462-474.

Bart, J., K. P. Burnham, E. H. Dunn, C. M. Francis, and C. J. Ralph. 2004. Goals and strategies for estimating trends in landbird abundance. J. Wildl. Manage. 68:611-626.

Beauchamp, W. D., R. R. Kolford, T. D. Nudds, and D. H. Johnson. 1996. Long-term declines in nest success of prairie ducks. J. Wild. Manage. 60:247-257.

Beauchamp, W. D., T. D. Nudds, and R. Clark. 1996. Duck nest success declines with and without predator management. J. Wildl. Manage. 60:258-264.

Beaver, B. V., W. Reed, S. Leary, B. McKiernan, F. Bain, R. Schultz, B. T. Bennett, P. Pascoe, E. Shull, L. C. Cork, R. Francis-Floyd, K. D. Amass, R. Johnson, R. Schmidt, W. Underwood, G. W. Thornton, B. Kohn. 2001. 2000 Report of the AVMA Panel on Euthanasia. JAVMA 218:669-696

Beck, R. A., J. W. Akers, J. W. Via, and B. Williams. 1990. Status and distribution of the least tern in Virginia – 1975-1988. VA J. of Science 41:404-418

Becker, P. H. 1995. Effects of coloniality on gull predation on common tern (Sterna hirundo) chicks. Colonial Waterbirds 18: 11-22.

Belant, J.L. and R.A. Dolbeer. 1993. Population status of nesting laughing gulls in the United States, 1977-1991. American Birds 47(2): 220-224.

Berryman, J. H. 1991. Animal damage management: responsibilities or various agencies and the need for coordination and support. Proc. East. Wildl. Damage Control Conf. 5:12-14.

Besser, J.F., W. C. Royal, and J. W. DeGrazio. 1967. Baiting starlings with DRC-1339 at a cattle feedlot. J. Wildl. Manage. 3:48-51.

Bidrowski, T. and G. Costanzo. 2003. Progress Report: Survey of breeding black ducks on Virginia barrier islands, spring/summer 2003. VA Dept. of Game and Inland Fisheries. Williamsburg.

Bird Barrier America, Inc. 1999. Bird Shock. Pages 22-23 in 2000 Product Catalog. Bird Barrier America, Inc.

Bishop, R. C. 1987. Economic values defined. Pages 24 -33 in D. J. Decker and G. R. Goff, eds. Valuing wildlife: economic and social perspectives. Westview Press, Boulder, CO. 424 p.

Blackwell, B. F., G. E.Bernhardt, R. A. Dolbeer. 2002. Lasers as nonlethal avian repellents. J. Wildl. Manage. 66:250-258

Blanton, E. M., B. U. Constantin, and G. L. Williams. 1992. Efficacy and methodology of urban pigeon control with DRC-1339. Proc. East. Wildl. Damage Cont. Conf. 5:58-62.

Blodget, B. G. and L. Henze. 1992. Use of DRC-1339 to eliminate gulls and re-establish a tern nesting colony in Buzzards Bay, Massachusetts. Proc. East. Wildl. Damage Control Conf. 5:212-215.

Blokpoel, H. and G. D. Tessier. 1992. Control of ring-billed gulls and herring gulls nesting at urban and surburban industrial sites in Ontario, 1987-1990. Proc. East. Wildl. Damage Conf. 5:51-57

Blus, L. J. and C. J. Stafford. 1980. Breeding biology and relation of pollutants to black skimmers and gull-billed terns in South Carolina. US. Fish & Wildlife Ser. Spec. Scient. Rept. – Wildlife, no 230.

Blus, L. J., B. S. Neely, Jr., T. G. Lamont, and B. Mulhern. 1977. Residues or organochlorines and heavy metals in tissues and eggs of Brown Pelicans, 1969-73. Pestic. Monitor. J. 11:40-53.

Bodenchuk, M. J., J. R. Mason, and W. C. Pitt. 2001. Economics of predation management in relation to agriculture, wildlife, and human health and safety. Pages 80-90 *in* Human Conflicts with Wildlife: Economic Considerations. USDA, APHIS, National Wildlife Research Center. Fort Collins, CO. pp 180.

Boettcher, R. 2004. 2004 Virginia piping plover and Wilson's plover breeding summary. 19th Annual Virginia plover survey. Unpub. Report. VA Dept. of Game and Inland Fisheries. Richmond, VA 7 pp.

Boettcher, R. 2003. 2003 Summary of the Virginia plover survey and piping plover breeding season. 18th Annual Virginia plover Survey. unpub. report. VA Dept. of Game and Inland Fisheries. Richmond, VA. 5 pp.

Boettcher, R. 2002. Summary of piping plover breeding activity in Virginia. Unpub. report. VA Dept. of Game and Inland Fisheries. Richmond, VA. 10 pp

Boggess, E.K., G.R. Batcheller, R.G. Linscombe, J.W. Greer, M. Novak, S.B. Linhart, D.W. Erickson, A.W. Tood, D.C. Juve, and D.A. Wade. 1990. Traps, trapping, and furbearer management. Wildl. Soc. Tech. Rev. 90-1. 31pp.

Bomford, M. 1990. Ineffectiveness of a sonic device for deterring European starlings. Wildlife Society Bulletin 18(2):151-156.

Booth, T. W. 1994. Bird dispersal techniques. Pages E-19 to E-23 In Prevention and control of wildlife damage. Edited by S.E. Hygnstrom, R. M. Timm, and G. E. Larson. Univ. of Nebraska.

Brawn, J. D., and S. K. Robinson. 1996. Source-sink population dynamics may complicate interpretation of long-term census data. Ecology 77:3-12.

Bridgeland, W, D. L. Burton, J. W. Grandy, J. Hadidian, G. R. Hodge, D. Pauli, and J. Valenstein. 1997. Wild neighbors: The humane approach to living with wildlife. Fulcrum Pub. Colorado. 253 pp.

Brown , S., C. Hickey, B. Harrington, and R. Gill. 2001. United States Shorebird Conservation Plan. Manoment Center for Conservation Sciences. Manomet, MA. 61 pp.

Brown, S. C., S. Schulte, B. Harrington, B. Winn, J. Bart, and M. Howe. In press. Population size and winter distribution of eastern American oystercatchers. J. Wild. Manage.

Brown, S., R. Gill, L. Gorman, C. Gratto-Trevor, S. Haig, B. Harrington, C. Hunter, R. I. G. Morrision, G. Page, P. Sanzenbacher, s. skagen, and N. Warnock. 2000. National shorebird conservation assessment: Shorebird conservation status, conservation units, population estimates, population targets, and species prioritization. Tech. Report. Res. and Monitoring Working Group, U.S. Shorebird Conservation Plan Manomet Bird Observatory, Manomet, MA.

Buckley, F. G. and P. A. Buckley. 2002. Royal tern. *In* The Birds of North America, No. 108. A. Poole and F. Gill, Eds. Philadelphia. the Academy of Natural Sciences. Washington, D.C. The American Ornithologist Union. 27pp.

Buckley, F. G. and P. A. Buckley. 1972. The breeding ecology of Royal terns, Sterna (Thalasseus) maxima maxima. Ibis 114:344-359.

Bull, J. and J. Farrand, Jr. 1977. The Audubon Society Field Guide to North American Birds, Eastern Region. Alfred A. Knopf, Inc., New York, NY.

Burness, G. P. 1992. Shelters decrease gull predation on chicks at a common tern colony. J. of Field Ornith. 63:186-189.

Butchko, P. H. and M. A. Small. 1992. Developing a strategy of predator control for the protection of the California least tern: a case history. Vertebr. Pest Conf. Proc. 15:29-31.

Butler, J. S., J. Shanahan, and D. J. Decker. 2003. Public attitudes toward wildlife are changing: a trend analysis of New York residents. Wildl. Soc. Bull. 31:1027-1036

CDFG (California Department of Fish and Game). 1991. California department of fish and game. Final environmental document - bear hunting. Sections 265, 365, 366, 367, 367.5. Title 14 Calif. Code of Regs. Calif. Dept. of Fish and Game, State of California, April 25, 1991. 13pp.

Center for Disease Control and Prevention (CDC). 2003. West Nile Virus. www.cdc.gov.ncidod/dvbid/westnile/birds&mammals.htm.

Center for Disease Control. 1990. Morbidity and Mortality Weekly Report. Compendium of Rabies Control. 39, No. RR-4:6.

CEQ (Council for Environmental Quality). 1981. Forty most asked questions concerning CEQ's National Environmental Policy Act regulations. (40 CFR 1500-1508) Fed. Reg. 46(55):18026-18038.

Chodachek, K. D. 2003. Evaluation of repeated removal of mammalian predators on waterfowl nests success and density. Master Thesis. Louisiana State Univ. 25 pp.

Clappr. B. and R. C. Banks. 1991. Nesting seasons, nest sites, and clutch sizes of crows in Virginia. Unpublished dataa. 15 pp.

Clapp, R. B. and P. A. Buckley. 1984. Status and conservation of seabirds in the southeastern United States. Pages 135-155 *In* J. P. Croxall, P. G. H. Evans, and R. W. Schieber, eds. Status and conservation of the world's seabirds. Intl. Council Bird Preserv. Tech. Publ. No. 2. 778 pp.

Clark, K. E. and L. J. Niles. 2000. Northern Atlantic Regional Shorebird Plan, Version 1.0. Unpublished report, Endangered and Nongame Species Program, NJ Division of Fish and Wildlife. Trenton, NJ. 16pp. Available at http://shorebirdplan.fws.gov/RegionalShoreBird/RegionalPlans.htm.

Clark, R. G. and T. D. Nudds. 1991. Habitat patch size and duck nesting success: the crucial experiments have not been performed. Wildl. Soc. Bull. 19:534-543

Clode, D. and D. W. Macdonald. 2002. Invasive predators and the conservation of island birds: the case of American Mink *Mustela vison* and terns *Sterna spp.* in the Western Isles, Scotland. Bird Study 49:118-123.

Code of Federal Regulations (CFR). 1995. Chapter 1 Wildlife and Fisheries. Part 21 Subpart D. P371. Office of the Federal Register. U.S. Government Printing Office. Washington D.C.

Connolly, G. E. 1988. M-44 sodium cyanide ejectors in the Animal Damage Control program, 1976-1986. Proc. Vertebr. Pest Conf. (A.C. Crabb and R.E. Marsh, eds.), Printed at Univ. Calif., Davis. 13:220-225.

Conover, M. R. 1982. Evaluation of behavioral techniques to reduce wildlife damage. Proc. Wildl.-Livestock Relation. Sym. 10:332-344.

Cooper, J. A. and T. Keefe. 1997. Urban Canada goose management: policies and procedures. Trans. 62nd No. Am. Wildl. and Natural Resour. Conf 62:412-430

Cornell University. 2003. West Nile Virus: Transmission, Infection, & Symptoms. Environmental Risk Analysis Program, Cornell University – Department of Communication & Center for the Environment. http://environmentalrisk.cornell.edu/WNV/Summary2.cfm

Cote, I. M. and W. J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11:395-404.

Cox, R. R. And A. D. Afton. 1994. Portable platforms for setting rocket nets in open-water habitats. J. Field ornithol. 65:551-555.

Crabtree, D. G. 1962. Review of current vertebrate pesticides. In: Proc. Vertebr. Pest Control Conf. 327-362.

Craik, C. 1997. Long-term effects on North American mink *Mustela vison* on seabirds in western Scottland. Bird Study 44:303-309.

Craven, S.R. 1992. Summary of a survey on translocation of urban wildlife. Final report to the NPCA. 10 pp.

Cross, R. R. 1991. Monitoring, management, and research of the piping plover at Chincoteague National Wildlife Refuge. Unpub. report. VA Dept. of Game and Inland Fisheries. Richmond, VA 76 pp.

Cross, R. R. 1989. Monitoring, management, and research of the piping plover at Chincoteague National Wildlife Refuge. Unpub. report. VA Dept. of Game and Inland Fisheries. Richmond, VA 80 pp.

Cunningham, D.J., E.W. Schafer, and L.K. McConnell. 1981. DRC-1339 and DRC-2698 residues in starlings: preliminary evaluation of their effects on secondary hazard potential. Proc. Bird Control Semin. 8:31-37.

Davidson, W. R. and V. F. Nettles. 1997. Field manual of wildlife diseases in the southeastern United States. College of Vet. Medicine, Univ. of Georgia. Athens, GA.

Davidson, W. R. and V. F. Nettles. 1992. Relocation of wildlife: identifying and evaluating disease risks. Trans. of 57th N. A. Wild. and Nat. Res. Conf. 57:466-473

Davis, M. B. 1999. Reproductive success, status, and viability of the Amrican Oystercatcher (*Haematopus palliatus*). Unpub. Master Thesis, North Carolina State Univ., Raleigh, NC.

Davis, M. B., T. R. Simons, M. J. Groom, J. L. Weaver, and J. R. Cordes. 2001. The breeding status of the American oystercatcher on the east coast of North America and breeding success in North Carolina. Waterbirds 24:195-2002.

Decino, T.J., D.J. Cunningham, and E.W. Schafer. 1966. Toxicity of DRC-1339 to starlings. J. Wildl.\ Manage. 30(2):249-253.

Decker, D. J. and G. R. Goff. 1987. Valuing Wildlife: Economic and Social Perspectives. Westview Press. Boulder, Colorado, 424 p.

Decker, D. J. A and K. G. Purdy. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. Wildl. Soc. Bull. 16:53-57

Dennis, J. T., J. T. Harrison, W. E. Wallace, R. J. Thomas and S. R. Cora. 1999. Visual effects assessment of the Dissuader laser illuminator. United States Air Force Research Laboratory Report. AFRL-HE-BR-TR-1999-0179.

DeVos, J. C. and J. L. Smith. 1995. Natural mortality in wildlife populations. Intl. Assoc. of Fish and Wildlife Agencies, Washington, DC. 50 pp.

Dill, H. H. and W. H. Thornberry. 1950. A cannon-projected net trap for capturing waterfowl. J. Wildl. Manage. 14:132-137

Dimmick, C. R. and L. K. Nicolaus. 1990. Efficiency of conditioned aversion in reducing depredation by crows. J. Applied Ecol. 27:200-209.

Dion, N., K. A. Hobson, and S. Lariviere. 1999. Effects of removing duck-nests predators on nesting success of grassland songbirds. Can. J. Zool. 77:1801-1806

Dolbeer, R.A. 1998. Population dynamics: the foundation of wildlife damage management for the 21st century. Proceedings Vertebrate Pest Conference 18: 1-11 (Published by University of California, Davis).

Dolbeer, R.A., C.R. Ingram, and J.L. Seubert. 1976. Modeling as a management tool for assessing the impact of blackbird control measures. Proc. Vertebr. Pest Conf. 7:35-45.

Dolbeer, R.A , D.F. Mott, and J.L. Belant. 1995. Blackbirds and European starlings killed at winter roosts from PA-14 applications, 1974-1992: Implications for regional population management. Proc. East. Wildl. Damage Control Conf.

Dolbeer, R. A., P. P. Woronecki, and R.L. Bruggers. 1986. Reflecting tapes repel blackbirds from millet, sunflowers, and sweet corn. Wildl. Soc. Bull. 14:418-425.

Downing , R. L. 1973. A preliminary nesting survey of least terns and black skimmers in the East. Am. Birds. 27:946-947.

Drury, W. H. 1973. Population changes in New England seabirds. Bird Banding 44:267-313.

Duebbert, H. F. and J. T. Lokemoen. 1976. Duck nesting in fields of undisturbed grass-legume cover. J. of Wildl. Manage. 40:39-49.

Dueser, R. D. , B. R. Truitt, N. D. Moncrief, S. J. Keil, and O. Keiss. 2001. Avian habitat restoration on the Virginia barrier islands: a landscape approach to predation management. Final Project Report to Virginia Coastal Resources Management Program and Virginia Coast Reserve of The Nature Conservancy. 25 pp.

Dueser, R. D., M. A. Graham, G. J. Hennessey, C. McCaffrey, A. W. Niederoda, T. W. Rice, and B. Williams. 1976. Ecosystem description: The Virginia coast Reserve Study. The Nature Conservancy, Arlington, VA 568 pp.

Dueser, R. D., N. D. Moncrief, and B. R. Truitt. 2003. Avian habitat restoration on the Virginia barrier islands. Final Report. The Nature Conservancy. 16pp.

Dueser, R. D., W. C. Brown, G. S. Hogue, C. McCaffrey, S. A. McCuskey, and G. J. Hennessey. 1979. Mammals on the Virginia barrier islands. J. of Mammology 60:425-429.

EPA (U.S. Environmental Protection Agency). 1995. R.E.D. Facts — Starlicide (3-chloro-p-toluidine hydrochloride). USEPA, Prevention, Pesticides and Toxic Substances. EPA-738-F-96-003. 4 p.

EPA (U.S. Environmental Protection Agency). 1997. 4-Aminopyridine. Health Assessment Information. Taken from USEPA IRIS data file No. 504-24-5 (03/01/97) at Internet site http://www.epa.gov/ngispgm3/irisdat/0440.DAT

Eriksen, B., J. Cardoza, J. Pack, and H. Kilpatrick. Undated. Procedures and guidelines for rocket-netting wild turkeys. National Wild Turkey Federation Technical Bulletin No. 1. Nat. Wild Turkey Fed. 8 pp.

Erwin, R. M., D. H. Allen, and D. Jenkins. 2003. Created versus natural coastal islands: Atlantic waterbird populations, habitat choices, and management implications. Estuaries 26:949-955.

Erwin, R. M. 1979. Historical breeding records of colonial seabirds and wading birds, 1900 – 1977, Cape Elizabeth, Maine to Virginia. supplement to final report prepared for U.S. Fish and Wildlife Service, Coastal Ecosystems Project, Newton Corner, Massachusetts.

Erwin, R. M. 1979a. Species interactions in a mixed colony of Common Terns (Sterna hiundo) and Black Skimmers (Rynchops niger). Anim. Behav. 27:1054-1062.

Erwin, R. M. 1979b. Coastal waterbird colonies: Cape Elizabeth, Maine to Virginia. Fish and Wildlife Service, Biological Services Program. FWS/OBS-79/10. 212 pp.

Erwin, R. M. and C. E. Korschgen. 1979. Coastal waterbird colonies: Maine to Virginia, 1977. An atlas showing colony locations and species composition. U.S. Fish and Wildlife Serv. FWS/OBS-79/08.

Erwin, R. M., B. R. Truitt, J. E. Jimenez. 2001. Ground nesting waterbirds and mammalian carnivors in the Virginia barrier island region: running out of options. J. of Coastal Research. 17:292-296.

Esher, R. J. and T. R. Simons. 1993. Red wolf propagation on Horn Island, Mississippi: red wolf ecological studies. Final Report. 36 pp.

ETOXNET (Extension Toxicology Network). 1996. 4-Aminopyridine. Pesticide Information Profiles. Coop. Ext. Offices at Cornell Univ., OR State Univ., Univ. of ID, Univ. of CA-Davis, and the Instit. for Envir. Toxicology, MI State Univ. Information taken from Internet site http://ace.ace.orst.edu/info/extoxnet/pips/4-aminop.htm.

Fairaizl, S. D. 1992. An integrated approach to the management of urban Canada geese depredations. Verteb. Pest. Conf. 15:105-109

Forbes, J.E. M.W. Bedford, W. W. Beck, and B. V. Archuleta. 1995. Dispersal of ring-billed gull nesting colonies in New York state. Proc. Of the Eastern Wildlife Damage Control Conf. 6:120-122.

Gaden, J. S. 1994. Naturally around us. Pages 26 – 28 *In* Virginia Explorer. Virginia Museum of Natural History. Fall. Martinsville, VA.

Gaines, E. P. and M. R. Ryan. 1988. Piping plover habitat use and reproductive success in North Dakota. J. Wildl. Manage. 52:266-273

Gardner, A. L. 1982. Virginia opossums. Pages 3-36 in Wild Mammals of North America. J. A. Chapman and G. A. Feldhamer, eds. John Hopkins Univ. Press. Baltimore. Pp. 1147

Garrettson, P. R. and F. C. Rohwer. 2001. Effects of mammalian predator removal on production of upland-nesting ducks in North Dakota. J. Wildl. Manage. 65:398-405.

Garrettson, P. R., F. C. Rowher, J. M. Zimmer, B. J. Mense, and N. Dion. 1996. Effects of mammalian predator removal on waterfowl and non-game birds in North Dakota. Trans. N. Amer. Wildl. And Natur. Resour. Conf. 61:94-101.

George, R. C. 2002. Reproductive ecology of the American Oystercatcher (Haematopus palliatus) in Georgia. M. Sc. thesis. Univ. of Georgia, Athens.

Geissler, P. H. and J. R. Sauer 1990. Topics in route-regression analysis. Pages 54-57 *In* J. R. Sauer and S. Droege, editors. Survey designs and statistical methods for the estimation of avian population trends. U.S. fish and Wildlife Service, Bioloigcal Report 90(1).

Giroux, J. F. 1981. Use of artificial nesting islands by nesting waterfowl in southeastern Alberta. J. of Wildl. Manage. 45:669-679.

Glahn, J.F. 1982. Use of starlicide to reduce starling damage at livestock feeding operations. Proc. Great Plains Wildl. Damage Control Workshop. 5:273-277.

Glahn, J. F. and B. F. Blackwell, undated. Safety guidelines for using the Desman Laser and Dissuader Laser to disperse double-crested cormorants and other birds. USDA-APHIS-WS, National Wildlife Research Center. Sandusky, OH. 4 pp.

Glahn, J. F. and E. A. Wilson. 1992. Effectiveness of DRC-1339 baiting for reducing blackbird damage to sprouting rice. Proc. East. Wildl. Damage Cont. Conf. 5:117-123.

Glahn, J. F., G. Ellis, P. Fiornelli, and B. Dorr. 2000. Evaluation of low- to moderate-power lasers for dispersing double-crested cormorants from thier night roosts. Proceedings of the Ninth Wildlife Damage Management Conference

9:34-45.

Glahn, J. F., S.K. Timbrook, and D.J. Twedt. 1987. Temporal use patterns of wintering starlings at a southeastern livestock farm: implications for damage control. Proc. East. Wildl. Damage Control Conf. 3:194-203.

Good, T. P. 1998. Great black backed gull (Larus marinus). In The birds of North America, No. 330 (A. Poole and F. Gill, Eds.). The birds of North America, Inc. Philadelphia, PA.

Graves, G. E. and W. F. Andelt. 1987. Prevention and control of woodpecker damage. Service in Action, Colo. St. Univ. Coop. Ext. Serv. Publ. No. 6.516. Ft. Collins, Colo. 2 pp.

Greenwood, R. J., A. B. Sargeant, D. H. Johnson, L. M. Cowardin and T. L. Schaffer. 1987. Mallard nest success and recruitment in prairie Canada. Trans. N. Amer. Wildl. and Natur. Resour. Conf. 52:298-309.

Greenwood, R. J., P. M. Arnold and B. G. McGuire. 1990. Protecting duck nests from mammalian predators with fences, traps, and a toxicant. Wildl. Soc. bull. 18:75-82

Gochfeld, M. and J. Burger. 1994. Black skimmer. *In* The Birds of North America, No. 108. A. Poole and F. Gill, Eds. Philadelphia. the Academy of Natural Sciences. Washington, D.C. The American Ornithologist Union. 28pp.

Gruver, K.S., R.L. Phillips, and E.S. Williams. 1996. Leg injuries to coyotes captured in standard and modified Soft Catch® traps. Proc. 17th Vertebr. Pest Conf. 17: 91-93

Guillemette, M. and P. Brousseau. 2001. Does culling predatory gulls enhance the productivity of breeding common terns? J. of Appliled Ecology 38:1-8.

Handley, C. O. and C. P. Patton. 1947. Wild mammals of Virginia. Richmond: Commission of Game and Inland Fisheries.

Hanlon, C. L., D. E. Hayes, A. N. Hamir, D. E. Snyder, S. Jenkins, C. P. Hable, and C. E. Rupprecht. 1989. Proposed field evaluation of a rabies recombinant vaccine for raccoons (Procyon lotor): site selection, target species characteristics, and placebo baiting trials. J. of Wildl. Disease 25:555-567.

Harris, S. 1977. Distribution, habitat utilization and age structure of a suburban fox (Vulpes vulpes) population. Mammal. Rev. 7:25-39.

Harris, S., and J. M. V. Rayner. 1986. Urban fox (Vulpes vulpes) population estimates and habitat requirements in several British cities. J. Anim. Ecol. 55:575-591.

Hayden, B. P. and J. Hayden. 1994. The land must change to stay the same. Pages 2 – 5 *In* Virginia Explorer. Virginia Museum of Natural History. Fall. Martinsville, VA.

Hecht, A. D. and P. R. Nickerson. 1999. The need for predator management in conservation of some vulnerable species. Endangered Species Update 16:114-118.

Hecht, A., D. Avrin, S. Melvin, J. Nicholls, C. Raithel, and K. Terwilliger. 1996. Piping plover, Atlantic Coast population. Revised recovery plan. U.S. Fish and Wildlife Service. Hadley, MA. 245 pp.

Henke, S. E. and F. C. Bryant. 1999. Effects of coyote removal on the faunal community in western Texas. J. Wildl. Manage. 63:1066-1081

Heske, E. J., S. K. Robinson, and J. D. Brown. 2001. Nest predation and neotropical migrant songbirds: piecing together the fragments. Wildl. Soc. Bull. 29:52-61

Heusmann, H. W. and Bellville, Robert. June 1978. Effects of Nest Removal on Starling Populations. Wilson Bulletin, 90 (2): 287-290.

Hoff, M. J. 1999. Predator trapping on township-sized blocks: does duck nesting success increase. Master Thesis. Louisiana State Univ. 42 pp.

Hoff, G. L., W. J. Bigger, S. J. Proctor, and L. P. Stallings. 1974. Epizootic of canine distemper virus infection among urban raccoons and gray foxes. J. Wildl. Diseases 10:423-428

Holler, N. R. and E. W. Schafer. 1982. Potential secondary hazards of Avitrol baits to sharp-shinned hawks and American kestrels. J. Wildl. Manage. 46:457-462

Howell, A. B. 1911. A comparative study of Cobb's Island, Virginia Auk 28:449-453.

Humphrey, J. S., M. L. Avery, and A. P. McGrane. 2000. Evaluating relocation as a vulture management tool in north Florida. Proc. 19th Vertebr. Pest. Conf.. Univ. of Calif., Davis. 19:49-53

Humphrey, J. S., E. A. Tillman, and M. L. Avery. 2001. Guidelines for using effigies to disperse nuisance vulture roosts. National Wildlife Research Center. Mimeo. July 2001. 2 pp.

Ickes, S. K., J. L. Belant, and R. A. Dolbeer. 1998. Nest disturbance techniques to control nesting by gulls. Wildl. Soc. Bull. 26:269-273.

Jackson, J. J. 1994. Opossums. Pp D59-64 in S.E. Hygnstrom, R.M. Timm and G.E. Larson, Eds., *Prevention and Control of Wildlife Damage.* Univ. Nebr. Coop. Ext., USDA-APHIS-ADC, and Great Plains Agric. Council Wildl. Comm., Lincoln, Nebr

Jenkins, J. R. and W. G. Winkler. 1987. Descriptive epidemiology from an epizootic of raccoon rabies in the middle Atlantic states, 1982-1983. Am. J. Epidemiolo. 126:429-437.

Johnson, A. S. 1970. Biology of the raccoon (Procyon lotor varius) in Alabama. Auburn Univ. Agric. Exp. Stn. Bull 402. 148 pp.

Johnson, D. H., A. B. Sargeant, and R. J. Greenwood. 1989. Importance of individual species of predators in nesting success of ducks in the Canadian Prairie Pothole Region. Can. J. Zoo. 67:291-297.

Johnson, J. J., D. B. Hurlbut, M. L. Avery, and J. C. Rhyans. 1999. Methods for the diagnosis of acute 3-chloro-p-toluidine hydrochloride poisoning in birds and the estimation of secondary hazards to wildlife. Environ. Toxicology and Chemistry. 18:2533-2537

Johnson, R. J. 1994. American crows. Pages E33-40 in S.E. Hyngstrom, R. M. Timm, and G.E. Larson, eds. Prevention and control of wildlife damage. Univ. Of Nebraska. Lincoln, NE.

Johnson, R.J., and J.F. Glahn. 1994. European Starlings. p. E-109 - E-120 in Hygnstrom, S.E., R.M. Timm, and G.E. Larson, Prevention and control of wildlife damage - 1994. Univ. NE Coop. Ext., Instit. o f Ag. and Nat. Res., Univ. of NE-Lincoln, USDA, APHIS, ADC, Great Plains Ag. Council Wildl. Committee.

Jones, R. D. and G. V. Byrd. 1979. Interrelations between seabirds and introduced animals. In: Int. Symp. Conserv. Marine Birds of Northern North Am. U.S.Fish and Wildl. Serv. Wildl. Res. Rep. 11, 221-226.

Kadlec, J.A. 1968. Bird reactions and scaring devices. Append. 1. Fed. Aviation Advis. Circ. 150-5200-9.

Kain, T. 1996. Plover paradise: barrier island nesting surveys. Virginia J. of Science 47:152.

Kamler, J. F. and W. B. Ballard. 2002. A review of native and nonnative red foxes in North America. Wildlife Society Bulletin 30:370-379.

Kaufman, J. H. 1982. Raccoon and allies. Pages 567-585 *In* Wild mammals of North America:biology, management, and economics. Eds. J. A. Chapman and G. A. Feldhamer. John Hopkins Univ. Press. 1147pp.

Keiss, O. 2000. Mammalian predator abundance on the Virginia barrier islands in relation to breeding habitats of colonial birds. Master thesis. Utah State Univ. 98pp.

Kellert, S. R. and J. K. Berry. 1980. Knowledge, affection and basic attitude toward animals in American society. United States Government Printing Service, Washington, DC.

Kennedy, M.L., J.P. Nelson, Jr., F.W. Weckerly, D.W. Sugg, and J.C. Stroh. 1991. An assessment of selected forest factors and lake level in raccoon management. Wildl. Soc. Bull. 19:151-154.

Kern, W.H., Jr. 2002. Raccoons. WEC-34. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Kharitonov, S.P. and Siegel-Causey, D. 1988. Colony formation in seabirds. Current Ornithology, 5, 223-227.

King, K. A. , E. L. Flickinger, and H. H. Hildebrand. 1977. The decline of brown pelicans on the Louisiana and Texas Gulf Coast, Southwest, Nat. 21:417-431.

Kreps, L. B. 1974. Feral pigeon control. Proc. Vertebr. Pest. Conf. 6:257-262.

Kress, S., E. Weinstein, and I. C. T. Nisbet, eds. 1983. The status of tern populations in northeastern United States and adjacent Canada. Colon. Waterbirds 6:84-106

Kruse, C. D., K. F. Higgins, and B. a. Vander Lee. 2001. Influence of predation on piping plovers, *Charadrius melodius,* and Least tern, *Sterna antillarum*, productivity along the Missouri River in South Dakota. The Canadian Field-Naturalist 115:480-486.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. Acosta Cruz, M. Coulter, I. Davison, L. Discson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. rapp, J. Wheeler, and K. Wohl. 2002. Waterbird conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas, Washington, DC. 78 pp.

LaGrange, T. G., J. L. Hansen, R. D. Andrews, A. W. Hancock, and J. M. Kienzler. 1995. Electric fence predator exclosure to enhance duck nesting: a long-term case study in Iowa. Wildl. Soc. Bull. 23:261-266.

Lariviere, S. 2004. Range expansion of raccoons in the Canadian prairies: review of hypotheses. Wildl. Society Bull. 32:955-963.

Larsen, K. H., and J. H. Dietrich. 1970. Reduction of a raven population on lambing grounds with DRC-1339. J. Wildl. Manage. 34:200-204.

Leatherman, S., R. Chalfont, E. Pendleton, T. McCandless, and S. Funderburk. 1995. Vanishing lands: Sea level, society and Chesapeake Bay. Chesapeake Bay Field Office, USFWS, Annapolis MD.

Leopold, A. S. 1933. Game Management. Charles Scribner & Sons. NY, NY. 481 p.

Link, W. A. and Sauer, J. R. 1998. Estimating population change from count data: application to the North American Breeding Bird Survey. Ecological applications 8:258-268.

Linzey, D. W. 1998. The Mammals of Virginia. Mcdonald and Woodward Pub. Co., P.O. Box 10308, Blacksburg, VA 24060.

Lokemoen, J. T. and R. O. Woodward. 1992. Nesting waterfowl and water birds on natural islands in the Dakotas and Montana. Wild. Soc. Bull. 20:163-171.

Lokemoen, J. T., and R. O. Woodward. 1993. An assessment of predator barriers and predator control to enhance duck nest

success on peninsulas. Wildl. Soc. Bull.21:275-282.

Loker, C.A., D. J. Decker, and S. J. Schwager. 1999. Social acceptability of wildlife management actions in suburban areas: 3 cases from New York. Wildl. Soc. Bull. 27:152-159

Longcore, J.R., D.G. McAuley, G.R. Hepp, and J.M. Rhymer. 2000. American Black Duck (Anas rubripes). In The Birds of North America, No. 481 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA. http://bna.birds.cornell.edu/BNA/

Lowney, M. S. 1996. Predator Management Training Manual. Virginia Cooperative Extension. Publication 456-230.

MacDonald, D. W., and M. T. Newdick. 1982. The distribution and ecology of foxes Vulpes vulpes (L.) in urban areas. Pages 123-135 in R. Bornkamm, J. A. Lee, and M. R. D. Seaward, eds. Urban Ecology. Blackwell Sci. Publ., Oxford, U.K.

Martin, T. E. 1992. Breeding productivity considerations: what are the appropriate habitat features for management? Pages 455-473 In J. M. Hagan III and D. W. Johnson, eds. Ecology and conservation of Neotropical migrant landbirds. Smithsonian Institution, Washington, DC

Mason, J. R. 2001. Management alternatives relative to predators. The role of predator control as a tool in game management: Proceedings of a symposium. T. f. Ginnett and S. E. Henke, eds. Texas Ag. Extension Service, San Angelo, TX.

Mason, J. R. 1989. Avoidance of methiocarb-poisoned apples by red-winged blackbirds. J. Wildl. Manage. 53:836-840.

McCaffrey, C. A. and R. D. Dueser. 1990. Preliminary vascular flora for the Virginia barrier islands. Virginia Journal of Science. 41:259-281.

McKillop, I. G. and R. M. Sibly. 1988. Animal behaviour at electric fences and the implications for management. Mammal Rev. 18:91-103.

McKinnon, D. T., and D. C. Duncan. 1999. Effectiveness of dense nesting cover for increasing duck production in Saskatchewan. J. of Wild. Manage. 63:382-389.

Meanley, B. and W. C. Royall. 1976. Nationwide estimates of blackbirds and European starlings. Proc. Bird Control Seminar. 7:39-40.

Megyesi, J. L. 1998. Management for avian nesting diversity on the northern end of South Monomoy Island: 1997 field season report. Environment Cape Code 1:15-37

Messmer, T. A., M. W. Brunson, d. Reiter, and D. G. Hewitt. 1999. United States public attitudes regarding predators and management to enhance avian recruitment. Wildl. Soc. Bull. 27:75-85.

Moncrief, N. D. 1994. In this issue... Page 1 *In* Virginia Explorer. Virginia Museum of Natural History. Fall. Martinsville, VA.

Moncrief, N. D., B. R. Truitt, and R. D. Dueser. 1998. Habitat restoration for nesting shorebirds on the Virginia barrier islands. A proposal to the Virginia Coastal Resources Management Program. 9 pp.

Morbidity and Mortality Weekly Report (MMWR). 2002. Provisional Surveillance Summary of the West Nile Virus Epidemic – United States, January-November 2002. Center for Disease and Surveillance; December 20, 2002. Vol. 51; No. 50.

Mott, D. F. 1985. Dispersing blackbird-starling roosts with helium-filled balloons. Proceedings of the East. Wildlife Damage Conference 2:156-162.

Murray, J. J. 1952. A checklist of the birds of Virginia. Virginia Soc. Of Ornithol.,

National Audubon Society. 2000. Field guide to birds eastern region North America. 2nd ed., 9th printing, J. Bull. Jr. and J. Farrand, Jr., eds. Alfred A. Knopf, Inc., Chanticleer Press, Inc., New York. 796pp.

National Audubon Society. 2004. The Christmas Bird Count Historical Results. www.audubon.org/bird/cbc. August 2004.

National Park Service. 2003. American oystercatcher (*Haematopus palliatus*) monitoring at Cape Lookout National Seashore. 2003 summary report. Harkers Island, NC. 13 pp.

Nelson, H. K. 2001. Impact of predation on avian recruitment: an introduction. Wildl. Soc. Bull. 29:2-5

Nettleship, D. N.; Burger, J. and Gochfeld, M. G. 1994. Seabirds on Islands: threats, case studies, and action plans. Cambridge, England: Birdlife International, 318 p.

Nielsen, L. 1988. Definitions, considerations, and guidelines for translocation of wild animals. Pages 12-49 In Translocation of Wild Animals. Edited by L. Nielsen and R. D. Brown. WI Humane Society, Inc. and Ceaser Kleberg Wildlife Research Instit. 333 p.

Nisbet, I. C. T. 1989. Status and biology of the northeastern population of the roseate tern. U.S. Fish and Wildlife Service, Newton Corner, MA. 74 pp.

Nocera, J. J. and S. W. Kress. 1996. Nocturnal predation on common terns by great black-backed gulls. Colonial Waterbirds 19:277-279.

Nol, E. 1989. Food supply and reproductive performance of the American Oystercatcher in Virginia. Condor 91:429-435.

Nol, E, and R. C. Humphrey. 1994. American Oystercatcher (*Haematopus palliatus*). *In* The Birds of North America. A. Poole and F. Gill, Eds., No. 82. The Academy of Nat. Sciences, Philadelphia, PA; The American Ornithologist's Union, Washington, D.C. 24 pp.

Norton, A. H. 1924. Notes on birds of the Knox Co. region, Pt. 7. Maine Field naturalist 5:1-5.

Novak, M. 1987. Traps and Trap Research. Pages 941-969 in M. Novak, J.A. Baker, M.E. Obbard, and B. Mallock, eds. Wild Furbearer Management and Conservation in North America.

Novick, J. S. 1996. An analysis of human recreational impacts on the reproductive success of American Oystercatchers (*Haematopus palliatus*): Cape Lookout National Seashore, North Carolina. Unpub. Master Thesis, Duke University, Durham, NC.

O'Connell, T. J. and R. A. Beck. 2003. Gull predation limits nesting success of terns and skimmers on the Virginia barrier islands. J. of Field Ornithology 74:66-73.

O'Connor, J. 1978. The shotgun book. Pub. by A. A. Knopf, Inc. New York, NY. 341 pp.

OSHA. 1991. Guidelines for laser safety and assessment. Publication 8-1.7. U. S. Department of Labor, Occupational Health and Safety Administration.

Paradiso, J. L. 1969. Red fox . Pages 134 – 139 in Mammals of Maryland. North American Fauna, No. 66. Bureau of Sport Fisheries and Wildlife. Washington, D.C.

Paradiso, J. L. and R. M. Nowak. 1983. Wolves. Pages 460-474 in Wild Mammals of North America. J. A. Chapman and G. A. Feldhamer, eds. John Hopkins Univ. Press. 1147 pp.

Parnell, J. F., R. M. Erwin, and K. C. Molina. 1995. Gull-billed tern. *In* The Birds of North America, No. 140. A. Poole and

F. Gill, Eds. Philadelphia. the Academy of Natural Sciences. Washington, D.C. The American Ornithologist Union. 20pp.

Parsons, K., and Johnston, S., eds. 2005. Mid-Atlantic/New England/Maritimes Regional Waterbird Plan. Draft unpublished document, Manomet Center For Conservation Sciences, Manomet, Massachusetts.

Patterson, M. E., J. D. Fraser, J. W. Roggenbuck. 1991. Factors affecting piping plover productivity on Assateague Island. J. Wildl. Manage. 55:525-531.

Patton, S.R. 1988. Abundance of gulls at Tampa Bay landfills. Wilson Bulletin 100 :431-442.

Pearson, T. G., C. S. Brimley, and H. H. Brimley. 1942. Birds of North Carolina. Bynum Printing Co., Raleigh, NC.

Perry, M.C., editor. 2002. Black ducks and their Chesapeake Bay habitats: Proceedings of a symposium. U.S. Geological Survey, Biological Resources Discipline Information and Technology Report USGS/BRD/ITR-2002-0005. 44 p.

Peterson, R. T. 1980. A field guide to the birds east of the Rockies. Houghton Mifflin, Boston 384 p.

Pfeifer, W. K., and M. W. Goss. 1982. Guard dogs and gas exploders as coyote depredation control tools in North Dakota. Proc. Vertebr. Pest Conf. 10:55-61.

Phillips, R. L. 1996. Evaluation of 3 types of snares for capturing coyotes. Wildl. Soc. Bull. 24:107-110.

Phillips, R. L. 1970. Age ratio of Iowa foxes. J. Wildl. Manage. 34:52-56.

Phillips, R. L., and K. S. Gruver. 1996. Performance of the Paws-I-Trip pan tension device on 3 types of traps. Wildl. Soc. Bull. 24:119-122.

Phillips, M. K., V. G. Henry, and B. T. Kelly. 2003. Restoration of the red wolf. Pages 272-288 in Mech, David L. and Luigi Boitani eds. Wolves: behavior, ecology, and conservation. Univ. of Chicago Press.

Pietz, P. J. and G. L. Krapu. 1994. Effects of predator exclosures design on duck brood movements. Wildl. Soc. Bull. 22:26-33

Pulliam, H. R. 1988. Sources, sinks, and population regulation. American Naturalist 132:757-785

Quinn, J. S. 1989. Black skimmer parental defence against chick predation by gulls. Anim. Behav. 38:534-541.

Rappole, J.H., S.R. Derrickson, and Z. Hubalek. 2000. Migratory birds and the spread of West Nile virus in the Western Hemisphere. Emerging Infectious Diseases 6(4):319-328.

Redmon, J. 1999. Problem gnaws at neighborhood. Richmond Times Dispatch. December 28, 1999.

Redmon, J. 2000. Group urged to seek federal help for beavers. Richmond Times Dispatch. January 6, 2000.

Reynolds, J. C. and S. C. Tapper. 1996. Control of mammalian predators in game management and conservation. Mammal Rev. 26:127-156

Rich, T. D., C. J. Beardmore, H. Berlanga, P.J. Blancher, M.S. W. Bradstreet, G.S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pahsley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T .C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY. 84 pp.

Rolland, C. Danchin, E, and Fraipont, M. 1998. The evolution of coloniality in birds in relation to food, habitat, predation, an life history traits: a comparative analysis. America naturalist, 151:514-529.

Rossbach, R. 1975. Further experiences with the electroacoustic method of driving starlings from their sleeping areas. Emberiza 2(3):176-179.

Rowsell, H. C., J. Ritcey, and F. Cox. 1979. Assessment of humaneness of vertebrate pesticides. Proceeding CALAS. University of Guelph, Ontario.

Royall, W. C. 1977. Blackbird-Starling Roost Survey. Bird Damage Research Report #52. Denver Wildlife Research Center. 54pp.

Samuel, D. E. and B. B. Nelson. 1982. Foxes. Pages 475-490 in J. A. Chapman and G. A. Feldhamer, eds. Wild Mammals of North America. The John Hopkins University Press, 701 West 40th Street, Baltimore, Maryland 21211.

Sanderson, G.C. Raccoons. 1987. Pp. 486-499 in M. Novak, J. A. Baker, M.E. Obbard, B. Mallock, eds., *Wild Furbearer Management and Conservation in North America.* Ministry of Natural Resources, Ontario, Canada. 1150 pp.

Sargeant, A. B. and A. D. Kruse. 1974. Use of small fences to protect ground bird nests from mammalian predators. Prairie Nat. 6:60-63.

Sargeant, A. B., M. A. Sovada, and T. L. Shaffer. 1995. Seasonal predator removal relative to hatch rate of duck nests in waterfowl production areas. Wild. Soc. bull. 23:507-513.

Sargeant, A. B., S. H. Allen, and R. T. Eberhardt. 1984. Red Fox predation on breeding ducks in mid-continent North America. Wildlife Monographs 89:1-41.

Sargeant, A. B., R. J. Greewood, M. A. Sovada, and T. L. Shaffer. 1993. Distribution and abundance of predators that affect duck production-prairie pothole region. Resourc. Publ. 194, U.S. Fish and Wildlife Serv., Washington, D.C. 96 pp.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results, and Analysis 1966 - 2003. Version 200x.2, U.S.G.S. Patuxet Wildlife Research Center, Laurel, MD.

Sauer, J.R., J.E. Hines, and J. Fallon. 2003. The North American breeding bird survey, results and analysis 1996 - 2002. Version 2003.1, USGS Patuxent Wildlife Research Center. Laurel, MD.

Schafer, E. W. 1991. "Bird control chemicals-nature, mode of action and toxicity." pp. 599-610 *in* CRC Handbook of Pest Management in Agriculture Vol. II. CRC Press, Cleveland, OH.

Schafer, E. W., Jr. 1984. Potential primary and secondary hazards of avicides. Proc. Vert. Pest Conf. 11:217-222.

Schafer, E. W., Jr. 1981. Bird control chemicals – nature, modes of action, and toxicity. Pages 129-139 in CRC handbook of pest management in agriculture. Vol. 3. CRC Press, Cleveland, OH.

Schafer, E. W. Jr., R. B. Brunton, and N. F. Lockyer. 1974. Hazards to animals feeding on blackbirds killed with 4-aminopyrine baits. J. Wildl. Manage. 38:424-426.

Schmidt, R. H. 1989. Animal welfare and wildlife management. Trans. N. A. Wildl. And Nat. Res. Conf. 54:468-475

Schmidt, R.H. and R.J. Johnson. 1984. Bird dispersal recordings: an overview. ASTM STP 817. 4:43-65.

Schreiber, R. W. 1979. Reproductive performance of the Eastern brown pelican, Pelecanus occidentalis. Nat. Hist. Mus. Los Angeles Co. Contrib. Sci. no. 317.

Schreiber, R. W. and R. W. Risebrough. 1972. Studies of the brown pelican. Wilson Bull. 84:119-135.

Scott , F. R. and D. A. Cutler. 1970. Middle Atalntic Coast region. Aerm. Birds. 15:455-458

SCWDS. No year. Thoughts about raccoon restocking. Southeastern Cooperative Wildlife Disease Study Group. Athens,

GA. 2 pp.

Seidensticker, J., M. A. O'Connel, and A. J. T. Hohnsingh. 1987. Virginia Opossum. Pp 246-263 in M. Novak, J. A. Baker, M.E. Obbard, B. Mallock, eds., *Wild Furbearer Management and Conservation in North America.* Ministry of Natural Resources, Ontario, Canada. 1150 pp.

Serie, J.R. 2002. The American Black Duck: a Species of International Concern. Pages 2-7 In Perry, M.C., editor. 2002. Black ducks and their Chesapeake Bay habitats: Proceedings of a symposium. U.S. Geological Survey, Biological Resources Discipline Information and Technology Report USGS/BRD/ITR-2002-0005. 44 p.

Shields, M. 2002. Brown pelican. *In* The Birds of North America, No. 609. A. Poole and F. Gill, Eds. Philadelphia. the Academy of Natural Sciences. Washington, D.C. The American Ornithologist Union. 36pp.

Shirota, Y.M. and S. Masake. 1983. Eyespotted balloons are a device to scare gray starlings. Appl. Ent. Zool. 18:545-549.

Slate, D. 1980. A study of New Jersey raccoon populations— determination of the densities, dynamics and incidence of disease in raccoon populations in New Jersey. N.J. Div. Fish, Game, and Wildl., Pittman-Robertson Proj. W-52-R-8, Final Rep. 67pp.

Slate, D.A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Trans. N. A. Wildl. Nat. Res. Conf 57:51-62.

Sovada, M. A., R. M. Anthony, and B. D. J. Bratt. 2001. Predation on waterfowl in artic tundra and prairie breeding areas: a review. Wildl. Soc. Bull. 29:6-15

Sovada, M. A. A. B. Sargeant, and Grier, J. W. 1995. Differential effect of coyotes and red foxes on duck nesting success. J. Wild. Manage. 59:1-9

Stoudt, J. H. 1982. Habitat use and productivity of canvasbacks in southwestern Manitoba, 1961-72. Pec. Sci. Rept. Wildl. 248. U.S. Fish and Wildlife Service. Washington, D.C. 31 pp.

Sullivan, B. D. and J. J. Dinsmore. 1990. Factors affecting egg predation by American crows. J. Wildl. Manage. 54:433-437.

Terwilliger, K. 1994. Birdlife on Virginia's Eastern Shore. Pages 6 – 10 *In* Virginia Explorer. Virginia Museum of Natural History. Fall. Martinsville, VA.

The Nature Conservancy and National Oceanic and Atmospheric Administration (TNC & NOAA). 1996. Conservation action plan for the avian communities in the Virginia barrier island system. 35 pp.

The Nature Conservancy (TNC). 1998. Predator Control Program: Metompkin Island, Virginia Coast Reserve. 5 pp.

Tietjen, H.,F. Deines, and W. Stephensen. 1988. Sodium monofluoroacetate (1080): a study of residues in artic fox muscle tissue. Bull. Environ. Contam. Toxicol. 40:707-710.

Till, J. A., and F. F. Knowlton. 1983. Efficacy of denning in alleviating coyote depredations upon domestic sheep. J. Wildl. Manage. 47(4):1018-1025.

Tillman, E. A., J. S. Humphrey, and M. L. Avery. 2002. Use of vulture carcasses and effigies to reduce vulture damage to property and agriculture. Proc. Vertebrate Pest Conference 20: (in press).

Tobin, M. E., P. P. Woronecki, R. A. Dolbeer, R. L. Bruggers. 1988. Reflecting tape fails to protect ripening blueberries from bird damage. Wildl. Soc. Bull. 16:300-303.

Trottier, G. C., D. C. Duncan, and S. C. Lee. 1994. Electric predator fences delay mallard brood movements to water. Wildl. Soc. Bull. 22:22-26.

Turkowski, F.J., A.R. Armistead, and S.B. Linhart. 1984. Selectivity and effectivesness of pan tension devices for coyote foothold traps. J. Wildl. Manage. 48(3): 700-708.

Twichell, A. R., and H. H. Dill. 1949. One hundred raccoons from one hundred and two acres. *J. Mammal.* 30:130–133.

US Census Bureau. 1999. Statistical Abstract of the United States. U.S. Department of Commerce, Economics and Statistics Administration. Washington DC. 1005pp.

U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Animal Damage Control (ADC) Strategic Plan. 1989. USDA, APHIS, ADC Operational Support Staff, 4700 River Road, Unit 87, Riverdale, MD 20737.

U.S. Department of Agriculture (USDA), (APHIS) Animal and Plant Health Inspection Service, (ADC) Animal Damage Control Program. 1997. Final Environmental Impact Statement. USDA, APHIS, ADC Operational Support Staff, 4700 River Road, Unit 87, Riverdale, MD 20737.

U.S. Department of Agriculture (USDA), (APHIS) Animal and Plant Health Inspection Service, Wildlife Services (WS). Management of crow damage in the Commonwealth of Virginia. Environmental Assessment and Decision and Finding of No Significant Impact. December 2000.

U.S. Department of Agriculture (USDA), (APHIS) Animal and Plant Health Inspection Service, Wildlife Services (WS). Management of coyote, dog, red fox predation on livestock in the Commonwealth of Virginia. Environmental Assessment and Decision and Finding of No Significant Impact. May 2002.

U.S. Fish and Wildlife Service. 2005. Birds of management concern. Unpublished document. Arlington, VA.

U.S. Fish and Wildlife Service. 1992. Draft Environmental Impact Statement for the Chincoteague NWR master plan. Chincoteague, VA. Pp. 261 + appendices

U.S. Fish and Wildlife Service. 2003. Migratory Bird Permit Memorandum: Nest destruction. Washington, D.C. http://www.fws.gov/permits/mbpermits/PoliciesHandbooks/MBPM-2.nest.PDF

U.S. Fish and Wildlife Service. 2003. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 2002. Piping plover monitoring and management summer 2002 report and 2003 plans for beach nesting birds. Unpub. draft report. Chincoteague National Wildlife Refuge, Assateague Island, VA.

U.S. Fish and Wildlife Service. 2001. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 2000. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 1999. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 1998. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 1997. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 1996. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 1995. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 1990. Predator Control Program: Chincoteague National Wildlife Refuge. Unpublished report. Chincoteague, VA.

U.S. Fish and Wildlife Service. 1989. Aleutian Canada goose recovering from near extinction; Fish and Wildlife Service proposes reclassification. Atlanta, GA. 2 pp.

U.S. Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau.. 2003. The 2001 national survey of fishing, hunting, and wildlife-associated recreation: Virginia. 46 pp + appendices.

USFDA (U.S. Food and Drug Administration). 2003. Bird poisoning of Federally protected birds. Office of Criminal Investigations. Enforcement Story 2003. http://www.fda.gov/ora/about/enf_story/ch6/oci.htm

USFWS. 2001. Inside Region 3: Ohio man to pay more than $11,000 for poisoning migratory birds. Volume 4(2):5.

United States Geological Survey (USGS)-National Wildlife Health Center (NWHC). 2003. NWHC West Nile Virus Project. www.nwhc.usgs.gov/research/west_nile.html

Verbeek, N.A.M. 1977. Comparative feeding ecology of herring gulls *Larus argentatus* and lesser black-backed gulls *Larus fiscus*. Ardea 65: 25-42.

Via, J. and D. C. Duffy. 1992. Gull-billed tern. Pages 135-148 *In* Migratory nongame birds of management concern in the northeast. K. J. Schneider and D.M. Pence, eds. U.S. Dept. of Interior, Fish and Wildlife Service. Newton Corner, MA.

Viksne, J. 1997. Predation control: Pages 89-94 *in* J. Viksne: The Bird Lake Engure. Jana Seta, Riga, Latvia.

Virginia Department of Game and Inland Fisheries. No date. A guide to Virginia's wildlife management areas. Richmond, VA. 68 pp.

Voigt, D. R, and R. L. Tinline. 1980. Strategies for analyzing radio tracking data. Pp 387–404 in C. J. Amlaner, Jr., and D. W. Macdonald, eds., *A handbook on biotelemetry and radio tracking*. Pergamon Press, Oxford, U.K.

Voigt, D. R. 1987. Red Fox. Pages 378-392 in M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild Furbearer Management and Conservation in North America. Ministry Nat. Resour., Toronto, Ontario, Canada.

Voigt, D. R., and B. D. Earle. 1983. Avoidance of coyotes by red fox families. J. Wildl. Manage. 47:852-857.

Watts, B. D. 2004. Status and distribution of colonial waterbirds in coastal Virginia: 2003 breeding season. CCBTR-04-06. Center for Conservation Biology, college of William and Mary, Williamsburg, VA. 25 pp.

Watts, B. D. 1999. Mid-Atlantic coastal Plain Bird Conservation Plan (Physiographic Region #44). College of William and Mary. Williamsburg, VA. 77pp.

Watts, B. D. and M. A. Byrd. 1998. Status and distribution of colonial waterbirds in coastal Virginia. Raven 69:20-31

Weller, J. R. 1996. Food habits of the red wolf on Horn Island, Mississippi, and its impact on the small mammal population. Pages 178-186 in the Proc. Def. Wildl. Wolf Conf. Albany, NY.

West, R.R., J.F. Besser and J.W. DeGrazio. 1967. Starling control in livestock feeding areas. Proc. Vertebr. Pest Conf. San Francisco, CA.

West, R.R. and J.F. Besser. 1976. Selection of toxic poultry pellets from cattle rations by starlings. Proc. Bird Control Semin. 7:242-244.

White, D.H., L.E. Hayes, and P.B. Bush. 1989. Case histories of wild birds killed intentionally with famphur in Georgia and West Virginia. Jounal of Wild. Diseases. 25:144-188.

Wildlife Society, The. 1990. Conservation policies of the Wildlife Society. The Wildlife Society. Wash., D.C. 20 p.

Wilke, A. 2004. American oystercatcher productivity monitoring and banding on the Eastern Shore of Virginia: Year 2003 report. Center for Conservation Biology Technical Report Series. CCBTR-04-01. College of William and Mary, Williamsburg, VA. 26pp.

Wilke, A. and R. A. Beck. 2002. Annual surveys of American oystercatchers on the coast of Virginia and reproductive success on Metompkin Island and Fisherman Island. Final Report. The Nature Conservancy. 14pp.

Williams, B. 1989. The first breeding record of the Brown Pelican in Virginia: a chronology. Raven 60:1-3.

Williams, B., B. Akers, M. Beck, R. Beck, and J. Via. 2001. A summary of the twenty-fifth annual beach-nesting and colonial waterbird survey of the Virginia Barrier islands - 1999. The Raven 72:12-15.

Williams, B., B. Akers, M. Beck, R. Beck, and J. Via. 2000. The 1998 colonial and beach-nesting waterbird survey on the Virginia Barrier islands. The Raven 71:42-45.

Williams, B., B. Akers, M. Beck, R. Beck, and J. Via. 1997. The 1997 beach-nesting and colonial waterbird survey of the Virginia barrier islands. Raven 68:105-109.

Williams, B., B. Akers, M. Beck, R. Beck, and J. Via. 1996. The 1996 beach-nesting and colonial waterbird survey of the Virginia barrier islands. Raven 68:85-88.

Williams, B., B. Akers, R. Beck, and J. Via. 1994. A summary of the 1993 beach-nesting and colonial waterbird survey of the Virginia barrier islands. Raven 65:109-113.

Williams, B., B. Akers, R. Beck, and J. Via. 1993. The 1992 colonial and beach-nesting waterbird survey of the Virginia barrier islands. Raven 64:24-29.

Williams, B., R. A. Beck, B. Akers, and J. Via. 1990. Longitudinal surveys of the beach nesting and colonial waterbirds of the Virginia barrier islands. Virginia Journal of Science 41:381-388.

Witmer, G. W., J. L. Bucknall, T. H. Fritts, and D. G. Moreno. 1996. Predator management to protect endangered avian species. Trans. 61st No. Amer. Wildl. And Natur. Resourc. Conf. 61:102-108

Wittenberger, J. F. and Hunt, G. L. 1985. The adaptive significance of coloniality in birds. Pages 1-79 *In* Farner, D. S.; King, J. R. and Parkes, K. C. (eds) *Avian Biology, no. 8.* New Your: Academic Press.

Wolcott, D. L. and T. G. Wolcott. 1999. High mortality of piping plovers on beaches with abundant ghost crabs: correlation, not causation. Wilson Bull. 111:321-329

Yeager, L. E., and R. G. Rennels. 1943. Fur yield and autumn foods of the raccoon in Illinois river bottom lands. *J. Wildl. Manage.* 7:45–60.

Zoellick, B. W., H. M. Ulmschneider, B. S. Cade, and A. W. Stanley. 2004. Isolation of Snake River islands and mammalian predation of waterfowl nests. J. Wildl. Manage. 68:650-662

Appendix B

PREDATOR MANAGEMENT METHODS AVAILABLE FOR USE OR RECOMMENDATION BY THE VIRGINIA WILDLIFE SERVICES PROGRAM

HABITAT MANAGEMENT METHODS

State and federal wildlife and resource managers and property owner practices. These consist primarily of nonlethal preventive methods such as habitat modification. Habitat modification techniques are implemented by the state and federal wildlife and resource managers or private property owners/managers. Resource owners/managers may be encouraged to use these methods, based on the level of risk, need, and professional judgment on their effectiveness and practicality.

Environmental/Habitat modification can be an integral part of PM. Wildlife production and/or presence is directly related to the type, quality, and quantity of suitable habitat. Therefore, habitat can be managed to reduce or eliminate the production or attraction of certain wildlife species or to repel certain animals. In most cases, the resource or property owner is responsible for implementing habitat modifications, and WS only provides advice on the type of modifications that have the best chance of achieving the desired effect. Habitat management is most often a primary component of PM strategies by eliminating crow, grackle and gull nesting, roosting, loafing, or feeding sites; or raccoon and fox denning sites.

There are probably few habitat modifications that could be implemented to reduce raccoon or red fox abundance because these species are highly adaptable generalists. One possible habitat modification that could affect raccoon abundance on some islands is razing abandoned buildings used by raccoons as dens. Other habitat modification such as the elimination of dense vegetation used as raccoon or red fox den sites would be harmful to other wildlife species or affect plant communities on the islands and may lead to erosion of fragile barrier islands.

Bird activity can be greatly reduced at roost sites by removing all the trees or selectively thinning the stand. Roosts often will re-form at traditional sites, and substantial habitat alteration is sometimes the only way to permanently stop such activity at a site (USDA 1997).

MECHANICAL MANAGEMENT METHODS – NONLETHAL

Animal behavior modification refers to tactics that deter or repel predators and thus, reduce predation. These techniques are generally only practical for small areas. Scaring devices such as distress calls, helium filled eye spot balloons, raptor effigies and silhouettes, mirrors, and moving disks can be effective but usually for only a short time before birds and mammals become accustomed and learn to ignore them (Schmidt and Johnson 1984, Bomford 1990, Rossbach 1975, Graves and Andelt 1987, Mott 1985, Shirota and Masake 1983, Conover 1982, Arhart 1972, Pfeifer and Goos 1982). Some but not all methods that are included by this category are:

- Propane exploders
- Pyrotechnics
- Distress calls and sound producing devices
- Repellents
- Scare crows
- Mylar tape
- Eye-spot balloons
- Lasers
- Effigies (taxidermic mounts and carcasses)
- Shooting to harass
- Chase with ATV's or vehicles

Predator-resistant fences are woven wire or smooth wire electric fences. Woven wire fences generally are four-foot tall and may have a barb wire along the bottom of the fence to deter digging under by predators. Electric fences may be less

expensive to erect but red fox, and other wildlife can pass through electric fences (Greenwood et al. 1990). Avian predators can fly over predator resistant or electric fencing. Electric fences must be maintained and tested regularly. Vegetation and fallen branches on the fence drain current, thus reducing efficacy. Also, dry soil conditions prevent grounding, and thus the animal can pass through the fence without being shocked (McKillop and Sibly 1988). Finally, salt water and salt spray corrode and eventually disable electric fencing. Electric fences also make the use of snares very difficult because of the reduced ability to detect where coyotes, red fox, raccoons, and opossums are passing through the fence. Trottier et al. (1994) and Greenwood et al. (1990) found predator resistant fencing can separate broods from their hens. Pietz and Krapu (1994) found predator-resistant fencing delays ducklings getting to water and may result in duckling mortality or separation from the hen. Fences cost $4,500 to enclose a 16.2 hectare area in 1985.

Nest Enclosures are electric or woven wire fencing placed around a nest to deter avian and mammalian predators. Nest enclosures have reduced predation on eggs and incubating hens resulting in a greater percentage nests hatching eggs (Sargeant et al. 1974, Lokemoen et al. 1982, Greenwood et al. 1990). However, nest enclosures only reduce predation on enclosed nests versus unprotected nests, they don't stop nest predation (Sargeant et al. 1974, Greenwood et al. 1990, LaGrange et al. 1995). Harassment of incubating adults by raccoons and fox can result in nest abandonment or predation. Chicks that hatch are still vulnerable to avian and mammalian predation once they leave the enclosure to feed. Nest enclosures failed to stop avian (i.e., fish crow) or mammalian (i.e., red fox) predation on eggs or fledglings, or to stop nest abandonment by piping plovers (USFWS 1991). In fact red fox visitation to nest enclosures increased each year (USFWS 1991).

Temporary fencing is placing temporary electric polytape fence in a nesting or fledgling feeding area to deter predation for a day to a week or more while the immature native birds grow and mature. The temporary fence may need to be moved daily as the birds may move to new areas to meet nutritional needs.

Auditory scaring devices such as propane exploders, pyrotechnics, electronic guards, scare crows, shooting in the air, and audio distress/predator vocalizations are effective in many situations for dispersing damage-causing bird species. These devices are sometimes effective but usually only for a short period of time before birds become accustomed and learn to ignore them (Schmidt and Johnson 1984, Bomford 1990, Booth 1994, Rossbach 1975, Mott 1985, Shirota and Masake 1983, and Arhart 1972). Birds, too, quickly learn to ignore scaring devices if the birds' fear of the methods is not reinforced with other tactics.

Visual scaring techniques such as use of mylar tape (highly reflective surface produces flashes of light that startles birds), eye-spot balloons (the large eyes supposedly give birds a visual cue that a large predator is present), flags, effigies, sometimes are effective in reducing bird damage. Mylar tape has produced mixed results in its effectiveness to frighten birds (Dolbeer et.al. 1986, and Tobin et.al. 1988). Birds quickly learn to ignore visual and other scaring devices if the birds' fear of the methods is not reinforced with other tactics.

Effigies can be used to disperse gulls (Avery et al. 2002, Tillman et al. 2002). Effigies can be dead gulls or taxidermy gulls (Humphrey et al. 2001, Avery et al. 2002, Tillman et al. 2002). Effigies are hung upside down as high a possible in trees or from specially constructed masts to disperse gulls (Humphrey et al. 2001, Tillman et al. 2002). A migratory bird permit is required from the USFWS before a gull may be taken to use as an effigy or to salvage a dead gull (e.g., road kill) to use as an effigy.

Lasers are non-chemical, non-lethal technique recently evaluated by the National Wildlife Research Center to disperse double-crested cormorant roosts (Glahn et al. 2000). For best results and to disperse numerous birds from a roost, the laser is most effectively used in periods of low light, such as after sunset and before sunrise. In the daytime, the laser can also be used during overcast conditions or in shaded areas to move individuals and small numbers of birds, although the effective range of the laser is much diminished. Moving the laser light through the tree branches rather than touching birds with the laser light elicited an avoidance response from cormorants (Glahn et al. 2000). During pen trials with lasers, the cormorants were inconsistent in their response with some birds showing no response to the laser (Glahn et al. 2000). The lack of overt response by cormorants to lasers is not clearly understood, but suggests laser light is not an highly aversive agent (Glahn et al. 2000). Blackwell et al. (2002) tested lasers on several bird species and observed varied results among species. Lasers were ineffective at dispersing starlings and cowbirds (Blackwell et al. (2002)). Lasers were initially effective at dispersing pigeons and mallard ducks but the birds habituated in approximately 5-minutes and 20-minutes, respectively (Blackwell et al. (2002). Canada geese reacted to the laser displaying neophobic avoidance to the approaching laser beam.

Nest destruction is the removal of nesting materials during the construction phase of the nesting cycle. Nest destruction is generally only applied when dealing with a single bird or very few birds. Heusmann and Bellville (1978) reported that nest removal was an effective but time-consuming method because problem bird species are highly mobile and can easily return to damage sites from long distances, or because of high populations. This method poses no imminent danger to pets or the public.

Live traps include:

Live/Decoy traps are used by WS for preventive and corrective bird damage management. Active traps are monitored daily, every other day, or as appropriate, to remove and euthanize or release trapped birds and to replenish bait and water. Bird traps and other live traps, as applied and used by WS, pose no danger to pets or the public and if a pet is accidentally captured in such traps, it can be released unharmed. Live or decoy traps can catch single or multiple birds at one time.

Foot-hold traps can be utilized to live-capture a variety of mammals, but are most often used within Virginia to capture coyotes, feral dogs, and red foxes. Three advantages of the foot-hold trap are: 1) they can be set under a wide variety of conditions, and 2) pan-tension devices can be used to reduce the probability of capturing smaller non-target animals (Turkowski et al. 1984, Phillips and Gruver 1996), and 3) non-target wildlife can be released. Effective trap placement and the use of appropriate lures by trained WS personnel also contribute to the foothold trap's selectivity.

Foot-hold traps are difficult to keep operational during inclement weather and they lack selectivity where non-target species are of a similar or heavier weight than the target species. The use of foot-hold traps also requires more time and labor than some methods, but they are indispensable in resolving many depredation problems.

Foot-hold traps are constantly being modified and tested to improve animal welfare of captured animals. The Best Management Practice (BMP) testing process and research has identified some foot-hold traps that have acceptable capture efficiency and low moderate-severe injury scores. This BMP process is ongoing and traps which meet BMP standards are being published as research is being completed. . Foot-hold traps identified and used in the Virginia program include the use of a Woodstream Victor Number 3 padded-jaw modified with four-coils and reinforced base plate, and bubble-tip welded or turned jaws (Gruver et al. 1996); a Number 3 coil-spring offset with wide rounded-edge jaws (Sterling MJ600); and the J.C. Conner "Jake" padded-jaw trap. A similar steel jawed trap (Number 3 Bridger with laminated jaws and four-coils) tested by Canada passed the BMP process for capture efficiency and animal welfare will be used by WS. As new foot-hold traps are developed, WS may test and use these traps during PM activities.

Specialized raccoon foot traps are traps designed specifically to capture raccoons. These traps (e.g. Coon Cuffs, Little Griz) are baited, specialized foot traps that are placed into the ground. The trap consists of a small box or tube measuring about 3 – 3 1/2 inches square. There is a small hole about 1 ¼ inches in diameter that a raccoon places its paw into to grab the fish or sweet bait. The specialized trap captures the raccoon's foot when it pulls a lever holding the food. These traps are highly selective and humane for capturing raccoons and opossums. Captured raccoons and opossums would be euthanized.

Cage or box traps, typically constructed of wire mesh or plastic, are sometimes used or recommended to capture raccoons and opossums. Cage traps pose minimal risks to humans, pets and non-target wildlife and allow for on-site release or relocation of pets and nontarget animals. Cage traps, however, cannot be used effectively to capture wary predators such as red fox. Active traps are monitored daily to remove and euthanize or release trapped mammals and to replenish bait.

Snares may be used as either lethal or live-capture devices. They are placed wherever an animal moves through a restricted area (e.g., crawl holes under fences, trails through vegetation, etc.) and are easier to keep operational during periods of inclement weather than foot-hold traps. Snares set to catch an animal by the neck are usually nonlethal and a live capture method for most species. Also, snares positioned to capture an animal around the body, leg or foot can be a live-capture method. Careful attention to details when placing snares can result in avoiding nontarget captures.
Virginia WS incorporates *"break-away"* snares that allow larger non-target animals to break the snare and escape

(Phillips 1996).

Rocket or cannon nets are used by WS for preventative and corrective damage management. Rocket and cannon nets are projectile-type net traps comprised of 3 - 5 rockets or cannons and a large net (e.g., 33 x 57 foot with 2-inch square nylon mesh) (Dill and Thornberry 1950, Cox and Afton 1994, Eriksen et al. undated). The net is folded upon itself or set inside a net box (Eriksen et al. undated). The rear of the net is anchored to 5 or 10 pound boat anchors or tied with inner tubes to stakes driven into the ground. The net is folded up upon itself. Bait is placed approximately 15 feet in front of the net. The rockets or projectiles in the cannons are propelled by smokeless powder or black powder charges which are ignited with an electric squib inside the charge. The charges are placed inside the rockets or cannon tubes and tested with a galvanometer for electrical continuity. A spool of at least 200 - 350 feet of 18 or larger gauge wire is unspooled and connected at one end to the charges and at the other end to a blasting machine. When an adequate number of birds are in front of the net, usually less than 25 feet away, the blasting machine is charged and fired. Firing the blasting machine sends an electrical charge down the wire and ignites the charges in the rockets or cannon tubes which discharges the net from the folded position. Birds are caught alive with rare instance of a bird being killed or injured. Captured gulls or crows may be humanely euthanized or released. WS personnel receive training before using rocket or cannon nets.

Hunting dogs are sometimes trained and used to hunt for raccoon or red fox. Trained dogs are used primarily to find red fox and raccoons and to pursue or tree problem animals. Trapping dogs could be essential to the successful location of red fox or raccoon sign (tracks, hair, or droppings).

MECHANICAL MANAGEMENT METHODS – LETHAL

Shooting is more effective as a dispersal technique than as a way to reduce bird densities when large number of birds are present. Normally shooting is conducted with shotguns or rifles. It may be conducted with .22 caliber rifles. Shooting is a very individual specific method and is normally used to remove a single offending bird. However, at times, a few birds could be shot from a flock to make the remainder of the birds more wary and to help reinforce nonlethal methods. Removal of a few gulls, grackles or crows from a local population increases the efficacy of harassment programs and prevents habituation to harassment (Kadlec 1968). Shooting can be relatively expensive because of the staff hours sometimes required (USDA 1997). Shooting with shotguns, or rim and center fire rifles is sometimes used to manage bird damage problems when lethal methods are determined to be appropriate. The birds are killed as quickly and humanely as possible. All firearm safety precautions are followed by WS when conducting PM activities and all laws and regulations governing the lawful use of firearms are strictly complied with.
Raccoons, red fox, and opossums are nocturnal animals. They may be illuminated at night with spotlights or found with thermal imagers, and then shot with rifles or shotguns as they move about the islands or adjacent coastal areas. Raccoons may be shot from denning sites during the day as they sleep. Fox may be called with predator calls imitating injuring animals and shot when they come within rifle or shotgun range.

Firearm use is very sensitive and a public concern because of safety issues relating to the public and misuse. To ensure safe use and awareness, WS employees who use firearms to conduct official duties are required to attend an approved firearms safety and use training program within 3 months of their appointment and a refresher course every 2 years afterwards (WS Directive 2.615). WS employees' who carry firearms as a condition of employment, are required to sign a form certifying that they meet the criteria as stated in the *Lautenberg Amendment* which prohibits firearm possession by anyone who has been convicted of a misdemeanor crime of domestic violence.

Denning is the practice of finding red fox dens and eliminating the young, adults, or both to stop an ongoing predation problem or prevent future depredation. Till and Knowlton (1983) documented denning's cost-effectiveness and high degree of efficacy in resolving predation problems due to coyotes killing lambs in the spring. Red fox predation on wildlife often increases in the spring and early summer due to the increased food requirements associated with feeding and rearing litters of pups. Pups are typically euthanized in the den using a registered gas fumigant cartridge (see discussion of gas cartridge under *Chemical Management Methods*). Red fox dens are occasionally found on barrier islands in Virginia.

Body gripping (e.g., Conibear) traps are traps designed to cause the quick death of the animal that activates the trap. The appropriate size trap would be used for raccoons and opossums (generally Conibear 160 or 220) and are used near aquatic habitats. Body gripping traps can be placed in modified 3 or 5-gallon buckets baited with fish or sweet baits. Also, traps would be placed in travel corridors located in dense vegetation used by raccoons and opossums. A raccoon is captured as it

travels through the trap and activates the triggering mechanism. Safety hazards and risks to humans are usually related to setting, placing, checking, or removing the traps. Size 160 or 220 conibear traps can only be used by federal or local agencies due to a recent interpretation of regulation 4 VAC 15-40-200 and 4 VAC 15-30-50. Landowners and agents would be limited to using 120 size conibear traps (M. Fies, furbearer biologist, VDGIF, personal communication, January 20, 2005).

Egg destruction is a method used to reduce production at gull colonies. Eggs can be crushed or oiled. Eggs are crushed in the nest requiring nesting gulls to expend energy to relay eggs. Egg destruction over several years reduces or eliminates local gull problems by reducing reproduction but does not eliminate ring-billed gull or herring gull colonies or reduce the overall gull population (Ickes et al. 1998, Forbes et al. 1995, Blokpoel and Tessier 1992). However, Ickes et al. (1998) reported nest and egg destruction were more effective at causing ring-billed gulls to abandon some roof top colonies but not herring gulls. The effectiveness of nest and egg destruction resulting in colony abandonment may be increased if habitat alteration and harassment are conducted also (Ickes et al. 1998). Forbes et al. (1995) was able to substantially reduce nesting ring-billed gull colonies by using overhead wire grids and nest and egg destruction simultaneously. However, the ring-billed gulls moved their colony to new sites up to 21 miles away (Forbes et al. 1995).

Sport hunting and regulated trapping can be of a PM strategy to reduce local raccoon, opossum or red fox populations on coastal islands. Although WS does not use sport hunting and regulated trapping, it recommends, where appropriate, sport hunting and regulated trapping to alleviate predator damage. The WS program has recommended to the Virginia Trappers Association in July 2004 that they reduce raccoon and red fox abundance on mainland properties near barrier or Chesapeake Bay islands to reduce the potential for raccoons and red fox to disperse to islands. Hunters and trappers can provide a societal benefit by reducing local wild animal populations which can reduce damage. Raccoons, opossums and red fox are classified as furbearer species in Virginia and may be hunted and trapped. Red foxes, opossums, and raccoons may be hunted November 1 through January 31 with dogs and gun, except in a few counties. Red fox and raccoon may be trapped for fur during the regulated trappings season from November 15 through February 28. A hunting license is required to hunt red fox, opossums and raccoons. A trapping license is required to trap red fox, opossums, and raccoons. There are some exceptions to license requirements for landowners. The VDGIF has specific regulations on license requirements.

Cervical dislocation is sometimes used to euthanize birds which are captured in live traps or nets. The bird is stretched and the neck is hyper-extended and dorsally twisted to separate the first cervical vertebrae from the skull. The AVMA approves this technique as humane method of euthanasia and states that cervical dislocation when properly executed is a humane technique for euthanasia of poultry and other small birds (Beaver et al. 2001). Cervical dislocation is a technique that may induce rapid unconsciousness, does not chemically contaminate tissue, and is rapidly accomplished (Beaver et al. 2001).

CHEMICAL MANAGEMENT METHODS

All chemicals used by WS to protect native bird species, including threatened and endangered wildlife or wildlife species of special concern are registered under the FIFRA and administered by the EPA and VDACS. All WS personnel in Virginia that use pesticides are certified as restricted-use pesticide applicators by the VDACS; the VDACS requires pesticide applicators to adhere to all certification requirements set forth in the FIFRA. Only WS employees can use M-44's, DRC-1339 and Measurol in Virginia. No chemicals are used on public or private lands without authorization from the land management agency or property owner or manager. The chemical methods used and/or available for use in Virginia are:

CHEMICAL MANAGEMENT METHODS – NONLETHAL

Mesurol was recently registered by WS to repel crows and ravens from birds nests of T&E species. It could be used by WS only as a bird repellent to deter predation by crows on eggs of threatened or endangered species. Dimmick and Nicolaus (1990) showed breeding pairs of crows could be conditioned with aversive chemicals to avoid eggs. However, Avery and Decker (1994) observed increased consumption of eggs treated with higher doses of Mesurol by fish crows. Sullivan and Dinsmore (1990) reported bird nests greater than 700 meters from crow nests were relatively safe from crow predation, thus nests beyond 700 meters from active crow nests may not need to be treated.

WS would treat eggs similar in appearance as those eggs of the species needing protection. The active ingredient is injected into eggs which are placed in artificial nests or upon elevated platforms. Upon ingestion, birds develop post-ingestional malaise (Mason 1989) and crows develop an aversion to consuming similar looking eggs (Dimmick and Nicolaus 1990). Repeated exposures may be necessary to develop and maintain aversion to threatened or endangered species eggs as the learning curve for crows can take from 23 days to 3 months (Dimmick and Nicolaus 1990, Avery and Decker 1994).

Measurol, may be used only by WS personnel. Treated areas will be posted with warning signs at access points to exclude people from endangered or threatened species nesting areas. Treated eggs are not placed in locations where threatened or endangered species may eat the treated eggs. Mesurol is highly toxic to birds and mammals and toxic to fish. It is also highly toxic to honey bees.

CHEMICAL MANAGEMENT METHODS - LETHAL

Sodium cyanide in the M-44 device - The M-44 can be used effectively during winter and spring months when foot-hold traps are difficult to keep in operation and M-44s are typically more selective for target canid species. The M-44 is a spring-activated ejector device developed specifically to kill red fox preying on threatened or endangered wildlife and other native wildlife species, and it is registered with the EPA (EPA Reg No. 56228-15). The M-44 consists of a capsule holder wrapped in an absorbent material, an ejector mechanism, a capsule containing about 0.9 grams of a powdered sodium cyanide mixture, a fluorescent marker, and a 6-7 inch hollow stake. To set a M-44, a suitable location is found, the hollow stake is driven into the ground, and the ejector unit is cocked and fastened into the stake by a slip ring. The wrapped capsule holder containing the cyanide capsule is then screwed onto the ejector unit and an attractant is applied to the capsule holder. A canine attracted to the bait will try to bite and pick up the baited capsule holder. When the M-44 capsule holder is pulled, the spring-activated plunger propels sodium cyanide into the animal's mouth, resulting in a quick death. Red fox killed by M-44s present no secondary poisoning risks (USDA 1997 revised, Appendix P, pgs. 269-271). Bilingual (English-Spanish) warning signs are posted at major entries into the area where M-44s are placed, and two bilingual warning signs are placed within 25 feet to warn of each device's presence.

The M-44 is very selective for canids because of the attractants used and because the device is triggered by pulling upward. Connolly (1988), in an analysis of M-44 use by the WS program from 1976-1986, documented about a 95.3% selectivity rate for target species. In Virginia, M-44's have a selectivity rate of 83.5% for target species. Domestic dogs are susceptible to M-44s, and this limits the areas where the devices can be safely used (see SOPs in Chapter 3). In addition, the 26 EPA use restrictions preclude the use of M-44s in areas where they may pose a danger to T&E species.

M-44s are used for corrective and preventive damage management on all land classes where authorized. Only WS personnel may use M-44's in Virginia. WS personnel comply with the EPA label and 26 use restrictions (see USDA 1997 revised, Appendix Q).

The **Large Gas Cartridge** is registered as a fumigant by the EPA (Reg. No. 56228-21) and is used in conjunction with denning operations in Virginia. When ignited, the cartridge burns in the den of an animal and produces large amounts of carbon monoxide, a colorless, odorless, and tasteless, poisonous gas. The combination of oxygen depletion and carbon monoxide exposure kills the animals in the den. Carbon monoxide euthanasia is recognized by the AVMA as an approved and humane method to kill animals (Andrews et al. 1993).

CO_2 is sometimes used to euthanize birds which are captured in live traps and nets. Live birds are placed in a container such as a plastic 5-gallon bucket or chamber and sealed shut. CO_2 gas is released into the bucket or chamber and birds quickly die after inhaling the gas. This method is approved as a euthanizing agent by the American Veterinary Medical Association (Beaver et al. 2001). CO_2 gas is a byproduct of animal respiration, is common in the atmosphere, and is required by plants for photosynthesis. It is used to carbonate beverages for human consumption and is also the gas released by dry ice. The use of CO_2 by WS for euthanasia purposes is exceedingly minor and inconsequential to the amounts used for other purposes by society.

Avitrol is a chemical frightening agent (repellent) that is effective in a single dose when mixed with untreated baits, normally in a 1:9 ratio. Avitrol, however, is not completely nonlethal in that a small portion of the birds are generally killed (Johnson and Glahn 1994). Pre-baiting is usually necessary to achieve effective bait acceptance by the target species. This chemical is registered for use on pigeons, crows, gulls, blackbirds (grackles), starlings, and English sparrows in various situations. Avitrol treated bait is placed in an area where the targeted birds are feeding and usually a few birds will consume a treated bait and become affected by the chemical. The affected birds then broadcast distress vocalizations and display abnormal flying behavior, thereby frightening the remaining flock away.

Avitrol is a restricted use pesticide that can only be sold to certified applicators and is available in several bait formulations

where only a small portion of the individual grains carry the chemical. It can be used during anytime of the year, but is used most often during winter and spring. Any granivorous bird associated with the target species could be affected by Avitrol. Avitrol is water soluble, but laboratory studies demonstrated that Avitrol is strongly absorbed onto soil colloids and has moderately low mobility. Biodegradation is expected to be slow in soil and water, with a half-life ranging from three to 22 months. However, Avitrol may form covalent bonds with humic materials, which may serve to reduce its availability for intake by organisms from water, is non-accumulative in tissues and rapidly metabolized by many species (Schafer 1991).

Avitrol is acutely toxic to avian and mammalian species, however, blackbirds are more sensitive to the chemical and there is little evidence of chronic toxicity. Laboratory studies with predator and scavenger species have shown minimal potential for secondary poisoning, and during field use only magpies and crows appear to have been affected (Schafer 1991). However, a laboratory study by Schafer et al. (1974) showed that magpies exposed to two to 3.2 times the published Lethal Dose (LD_{50}) in contaminated prey for 20 days were not adversely affected and three American kestrels that were fed contaminated blackbirds for seven to 45 days were not adversely affected. Some hazards may occur to predatory species consuming unabsorbed chemical in the GI tract of affected or dead birds (Holler and Shafer 1982, Schafer 1981). A formal Risk Assessment found no probable risk is expected for pets and the public, based on low concentrations and low hazards quotient value for nontarget indicator species tested on this compound (USDA 1997, Appendix P).

DRC-1339 is the principal chemical method that would be used for crow, grackle and gull damage management under the proposed action. For more than 30 years, DRC-1339 has proven to be an effective method of starling, blackbird, gull, and pigeon management at feedlots, dairies, airports, and in urban areas (Megyesi 1998, Nisbet 1989, Blodget and Henze 1992, West et al. 1967, Besser et al. 1967, Decino et al. 1966). Studies continue to document the effectiveness of DRC-1339 in reducing gull abundance to benefit threatened or endangered shorebirds or colonial waterbirds (Megyesi 1998, Nisbet 1989, Blodget and Henze 1992), resolving blackbird/starling problems at feedlots (West and Besser 1976, Glahn 1982, Glahn et al. 1987), dispersing crows roosts in urban/suburban areas (Boyd and Hall 1987), and Blanton et al. (1992) reports that DRC-1339 appears to be a very effective, selective, and safe means of urban pigeon population reduction. Glahn and Wilson (1992) noted that baiting with DRC-1339 is a cost-effective method of reducing damage by blackbirds to sprouting rice.

DRC-1339 is a slow acting avicide that is registered with the EPA for reducing damage from several species of birds, including blackbirds, starlings, pigeons, crows, ravens, magpies, and gulls. DRC-1339 was developed as an avicide because of its differential toxicity to mammals. DRC-1339 is highly toxic to sensitive species but only slightly toxic to non-sensitive birds, predatory birds, and mammals (Johnson et al. 1999, Schafer 1991, 1981). For example, starlings, a highly sensitive species, require a dose of only 0.3 mg/bird to cause death (Royall et al. 1967). Most bird species that are responsible for damage, including starlings, blackbirds, pigeons, crows, magpies, and ravens are highly sensitive to DRC-1339. Many other bird species such as raptors (Schafer 1981), sparrows, and eagles are classified as non-sensitive. Numerous studies show that DRC-1339 poses minimal risk of primary poisoning to nontarget and T&E species (USDA 1997). Secondary poisoning has not been observed with DRC-1339 treated baits, except crows eating gut contents of pigeons (Kreps 1974). During research studies, carcasses of birds which died from DRC-1339 were fed to raptors and scavenger mammals for 30 to 200 days with no symptoms of secondary poisoning observed (Cunningham et al. 1981). This can be attributed to relatively low toxicity to species that might scavenge on blackbirds and starlings killed by DRC-1339 and its tendency to be almost completely metabolized in the target birds which leaves little residue to be ingested by scavengers. Secondary hazards of DRC-1339 are almost nonexistent (Johnson et al. 1999, Schafer 1991, 1984). DRC-1339 acts in a humane manner producing a quiet and apparently painless death.

DRC-1339 is unstable in the environment and degrades rapidly when exposed to sunlight, heat, or ultra violet radiation. DRC-1339 is highly soluble in water but does not hydrolyze and degradation occurs rapidly in water. DRC-1339 tightly binds to soil and has low mobility. The half life is about 25 hours, which means it is nearly 100% broken down within a week, and identified metabolites (i.e., degradation chemicals) have low toxicity. Aquatic and invertebrate toxicity is low (USDA 1997). Appendix P of USDA (1997) contains a thorough risk assessment of DRC-1339 and the reader is referred to that source for a more complete discussion. That assessment concluded that no adverse effects are expected from use of DRC-1339.

DRC 1339 has several EPA Registration Labels (56228-10, 56228-17, 56228-28, 56228-29, and 56228-30) depending on the application or species involved in the bird damage management project. Virginia WS used or supervised the use of an average of 13,540 grams (29.8 pounds) of DRC-1339 per year for the past 3 years (Table B-1).

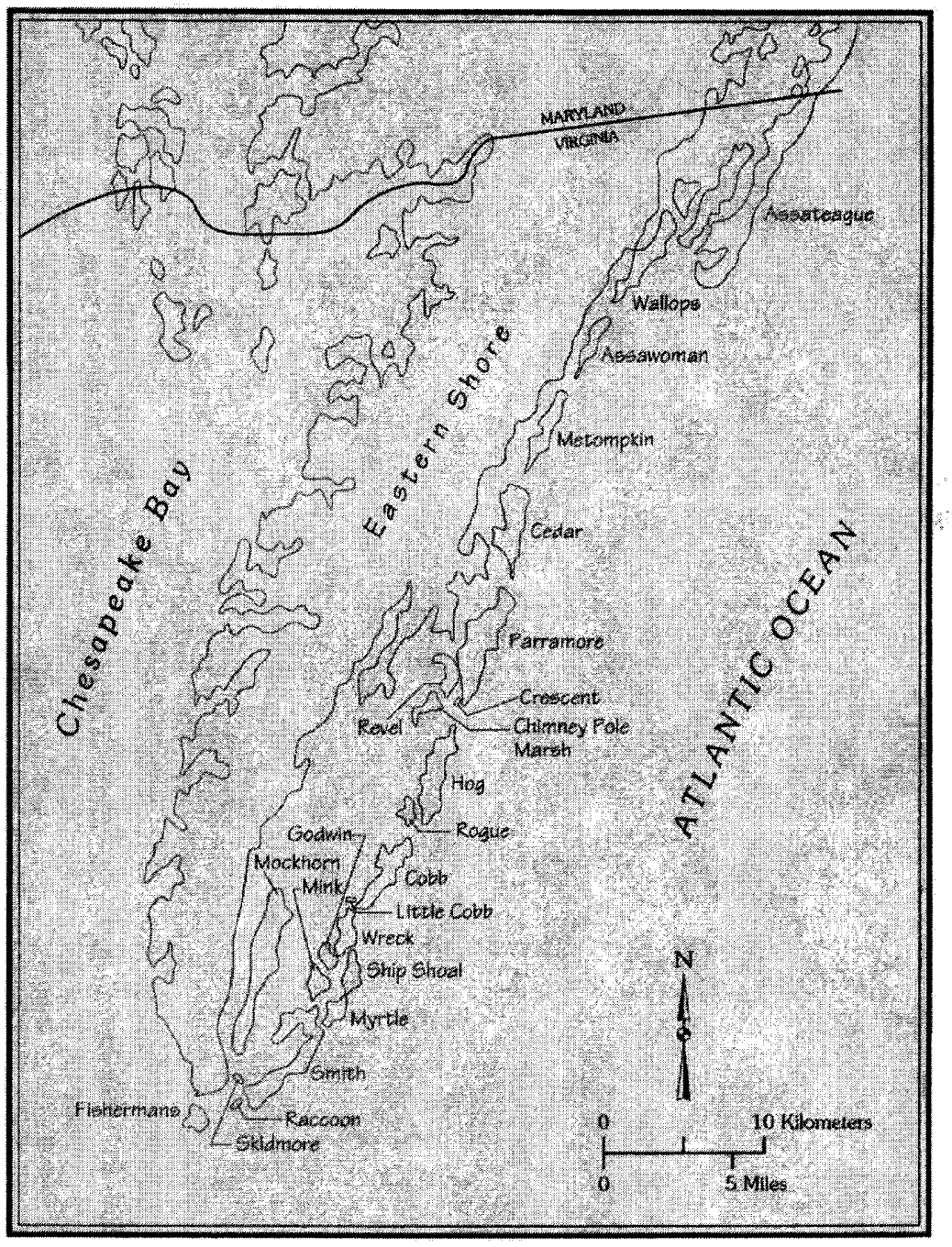
Only WS personnel may use DRC-1339 in Virginia.

Table B-1. DRC-1339 Used by Virginia WS.

FY	EPA Reg.	Species	Quantity Used (grams)
2003	56228-10	Blackbirds/ Starlings	30,901
	56228-28	Pigeons	1,984
	56228-30	Blackbirds, crows	4,835
2002	56228-10	Blackbirds/ Starlings	2,086
	56228-28	Pigeons	226
	56228-30	Blackbirds, crows	224
2001	56228-10	Blackbirds/ Starlings	168
	56228-28	Pigeons	71
	56228-30	Blackbirds, crows	126

APPENDIX C

Map of the barrier islands of Virginia, reprinted with permission from the Virginia Museum of Natural History



Virginia Museum of Natural History

APPENDIX D

Response to Public Comments
on the
Environmental Assessment for the

MANAGEMENT OF PREDATION LOSSES TO NATIVE BIRD POPULATIONS ON THE BARRIER AND CHESAPEAKE BAY ISLANDS AND COASTAL AREAS OF THE COMMONWEALTH OF VIRGINIA

Wildlife Services (WS) received 1 comments letter from the pubic involvement process and review of the pre-decisional environmental assessment (EA). The National Environmental Policy Act (NEPA) requires that proper consideration be given to all reasonable points of view, particularly as they may relate to the issues being considered. In this light, it is important to consider and address concerns or criticisms that may arise. Appendix A is a summary of comments, particularly criticisms and concerns, received from review of the pre-decisional EA, with the corresponding WS responses.
Public involvement under provisions of NEPA is intended to gather substantive information and ideas from the public on proposed federal actions in order to help managers make better decisions. The public involvement process is not counting votes supporting or opposing management actions. While quantitative information is gathered and is important to assessing attitudes, that is only part of the information analyzed.

All responses were reviewed for major issues. Comments addressed a wide range of topics, however, patterns emerged that indicated common points of concern that are summarized below as "*Issues*". These issues and the program's response to each are discussed below.

Issue 1: **Habitat degradation and loss is the cause of bird population declines on the barrier and Chesapeake Bay islands and coastal areas, not predation.**

USDA Wildlife Services response: This issue was address in the EA in section 1.3. The barrier islands have remained isolated, uninhabitated by humans, and relatively little changed except by natural forces (Dueser et al. 1976). The Chesapeake Bay islands are comprised by 17 marsh islands and two large islands. One large Chesapeake Bay island is partially developed but has nesting birds. The other islands are in natural conditions and relatively unaffected by humans. The other coastal area "islands" are mostly man-made sites which have become colonized by numerous birds species and now have large nesting populations of colonial waterbirds and shorebirds. One coastal area, Grandview Beach, does have a lot of human disturbance during the summer. Overall, the analysis is that the islands are mostly in a natural state with adequate habitat and little human disturbance. This lead to an analysis of other factors that may affect bird population size. The data lead to avian and mammalian predation on nesting birds as the cause of populations being unable to increase, with data for piping plovers and American oystercatchers making this point most clearly. Also, colonization of islands by red foxes and raccoons and subsequent declines in nesting bird populations provided strong evidence that predation was the cause of bird population declines.

Issue 2: **Predator management is not a long-term solution to restoring bird populations on the barrier or Chesapeake Bay islands or coastal areas.**

USDA Wildlife Services response: The current faunal community is comprised of unnatural populations of avian and mammalian predators which are negatively impacting native nesting colonial waterbird, shorebird, and black duck populations in coastal Virginia. The impacts of these unnatural predator populations are discussed in Section 1.3 of the EA. These unnatural populations of red fox, raccoons, opossums, crows, and gulls are a result of action by man. The red fox were introduced from Europe. The greater black backed and herring gulls have expanded their populations out of the Canadian Maritimes due to the abundance of man-made foods. Laughing gulls, crows, and raccoons are abundant due to man-made foods and modern agriculture. The eradication of red wolves probably benefits the survival of raccoons. Unless the local ecosystem is altered such that gulls, crows, red fox, raccoons, and opossums decline greatly in abundance, then predator

management will be a required long term management action or we will lose the populations of shorebirds, colonial waterbirds, and black ducks in coastal Virginia.

WS recognizes that a reduction of a local predator population is frequently temporary because immigration from adjacent areas or reproduction replaces the animals removed. While lethal control may only have a temporary short-term effect in many circumstances, this may be the only option available to effectively and efficiently reduce predation to acceptable levels. As described in Section 1.3.5 of the EA, predator management has been shown to be effective in reducing predation rates on bird populations.

Issue 3: **There is no evidence that mammalian or avian predation is causing the population decline in shorebirds, colonial waterbirds, or black ducks in coastal Virginia.**

USDA Wildlife Services response: Wildlife management is a complex science that requires the analysis of many pieces of information in order to make determinations of a population's status and an appropriate response. Determining why native populations of shorebirds, colonial waterbirds, and black ducks declined in coastal Virginia took years of research conducted by many. An analysis of the data makes a convincing case that predation was the cause of these bird population declines. This issue is addressed in Section 1.3 of the EA.

First, researchers considered all possible causes of bird population declines and analyzed those causes. They considered habitat loss and degradation, severe weather events, predation, disease, sea level rise, water quality, and human disturbance. Of these factors, predation was the one that was manageable and data supported the hypothesis that predation was the most likely cause of population decline. This lead to more research that showed relationships with years raccoons and red fox colonized islands and the subsequent decline and sometime eradication of nesting shorebirds, colonial waterbirds, and black ducks. This data is presented in Table 11 of the EA, Section 1.3.3.1 under Piping and Wilson's plover, Section 1.3.3.2 under American Oystercatchers, and Section 1.3.3.4.

The impacts of gulls on gull-billed terns and common terns are presented in the EA in Section 1.3.3.1 under gull-billed terns and Section 1.3.4.4. The increasing abundance of gulls correlates to declines in other species of birds. There is a long history dating to the 1920's showing the impacts of gull abundance on other bird species in other regions of the United States.

Many of the shorebird, colonial waterbird, and black duck populations were recently or are at very low levels. Research on American oystercatchers and piping plovers indicate that predation by raccoons and red fox prevented these species from recovering. Section 1.3.3.1 of the EA under Piping and Wilson's plover and Section 1.3.3.3 of the EA including Table 8 clearly show that removing raccoons and red fox from barrier islands allowed piping plover populations to increase and the number of chicks fledged to increase. Furthermore, similar studies with American oystercatchers showed the removal of red fox and raccoons from barrier islands allowed oystercatchers to produce more chicks.

In summary, the wealth of data showing shorebird, colonial waterbird, and black duck population declines correlates to islands being colonized by raccoons and red fox and/or large increases in gull abundance. Where raccoons and red foxes have been removed from islands piping plovers and American oystercatchers showed increased fecundity and piping plovers increased in population. Also, data from other areas supports the conclusion reached by independent researchers and USDA Wildlife Services that predation is largely responsible for population declines of many bird species nesting on the barrier and Chesapeake Bay islands and coastal areas of Virginia.

Issue 4: **Justification is needed to manage predator abundance in mainland coastal areas to protect birds nesting on islands.**

USDA Wildlife Services response: Raccoons and red foxes colonize an island by emigrating from the mainland or other occupied islands. The commentor acknowledged this in the comment letter and thus is aware of where raccoons and red foxes come from when they colonize an island. Since raccoons and red foxes from the mainland may colonize nearby islands the Wildlife Services program is encouraging local fur trappers to trap raccoons and red foxes on the mainland as a means of reducing predation rates on nearby islands. Also, studies on the scale that predator management must be conducted to be effective was discussed in Section 1.3.6 of the EA. As appropriate, WS will consider management actions on mainland coastal areas when determined necessary. However, at this time Wildlife Services is limiting its activities to the islands

because this is where we can be most effective with the limited resources that are currently available.

Issue 5: **Improvement of nesting habitat would be more effective than predator management at increasing populations of shorebirds, colonial waterbirds, and black ducks.**

USDA Wildlife Services response: We and the landowners and land managers are working to increase bird populations on about 70 linear miles of barrier island. Shorebirds and colonial waterbirds primarily nest in shallow depressions in the sand or sand/shell substrate. There is adequate nesting habitat on the barrier islands. Black ducks nest more in dense forbes and grasses. This habitat type is in short supply on some islands and abundant on other islands. Annual black duck nesting surveys conducted by the Virginia Department of Game and Inland Fisheries indicate much of the available nesting habitat is unused. In summary, there is adequate nesting habitat and the creation of more appears unnecessary.

Issue 6: **Predator management may result in increases of other predator or alternative prey populations and compete for resources with bird species of management concern. These other predators or prey species may negatively impact colonial waterbirds, shorebirds, and black ducks.**

USDA Wildlife Services response: We considered this scenario and determined the removal of introduced, non-native, or historically absent populations of raccoons, red fox, opossums, gulls, and crows was desirable to having few to no shorebirds, colonial waterbirds, or black ducks. The removal of these predators was viewed as working towards restoring a naturally functioning ecosystem. We also considered if other prey species (e.g., rice rats, peregrine falcons, warblers, sparrows, rails, meadow voles, bats, etc.) would become more abundant by reducing or removing predators and thus compete with colonial waterbirds, shorebirds, and black ducks for resources. Wildlife Services concluded that if these historically present prey species are a naturally occurring species on the islands this would most likely be more desirable than the presence of an introduced, non-native, or historically absent predator population.

Issue 7: **It may not be feasible to eradicate all predators from an island if the predator population is large enough.**

USDA Wildlife Services response: Preliminary analysis by one researcher has concluded that Wildlife Services can eradicate red fox from islands (R. Dueser, Utah State Univ., unpub. data). The same researcher found mixed results for eradicating raccoons from islands. On islands with relatively small populations of raccoons Wildlife Services has been successful at eradicating raccoons. On large islands with large populations of raccoons (1 raccoon per 3-6 acres of land) Wildlife Services has been unable to eradicate raccoons due to inadequate resources, but has been able to suppress populations to a more manageable level. This information is factored into which islands Wildlife Services will work each year to be most effective and to make most use of limited resources.

Issue 8: **The EA provides no justification for using lethal methods prior to any attempt to use non-lethal methods.**

USDA Wildlife Services response: As discussed in Section 1.3.5 of the EA, lethal damage management methods are an effective means of reducing predation rates on bird populations. The decision on when, how and what types of methods (lethal and non-lethal methods) to use will be based upon the WS Decision Model described in Section 3.2.3 of the EA.