

Chapter 2.



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Tufted Titmouse

Affected Environment

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2.1 Introduction

This chapter describes the environmental resources at Patuxent Research Refuge that may be affected through the implementation of the CCP. Except where noted, the resource descriptions and acreage measurements are applicable to the entirety of Patuxent Research Refuge.

Refuge Establishment, Purposes, and Land Acquisition History

On December 16, 1936, President Franklin D. Roosevelt signed Executive Order 7514, which transferred 2,670 acres (1,081 hectares) of land to the U.S. Department of Agriculture to serve “as a wildlife experiment and research refuge” and “to effectuate further the purposes of the Migratory Bird Conservation Act.” The area delineated in the order was located in Anne Arundel and Prince George's Counties, Maryland and was to be known as “the Patuxent Research Refuge.” The location of Patuxent Research Refuge (map 1-1), adjacent to the National Agriculture Research Center at Beltsville, made it an appropriate area, according to Secretary Henry A. Wallace, upon which to conduct “long-time studies on the interrelationships of wildlife with agriculture and forestry.” Secretary Wallace and Dr. Ira N. Gabrielson, Chief of the Biological Survey, envisioned an area where wildlife could be studied in relation to the production of agricultural crops and where lands, poorly suited for agriculture, could be turned back into forests, fields, and meadows to benefit wildlife (Perry 2004) (see tables 2-1 and 2-2 for land acquisition totals).

In 1975, 1,250 acres (506 hectares) of surplus land were transferred from the U.S. Department of Agriculture to Patuxent Research Refuge, giving greater protection to refuge wetlands (Perry 2004).

In 1991, 7,600 acres (3,076 hectares) of land in Anne Arundel County, that were previously part of Fort George G. Meade (Fort Meade), immediately adjacent to the refuge to the north, were transferred to Patuxent Research Refuge as a result of the Military Construction Appropriations Act (U.S. Public Law 101-519). The land had been declared excess by the U.S. Army under the Base Closure and Realignment Act of 1985 (U.S. Public Law 100-526). The transfer was based on the recommendations of a broad-based Fort Meade Coordination Council that had extensively studied the options and voted unanimously for the transfer. The transfer document specified that the intended uses of the property, now called North Tract, were preservation of the land, wildlife research, and compatible public use. In addition, the transfer document stated that the Secretary of the Interior, “Shall provide for the continued use of the property by Federal agencies to the extent such agencies are using it on the date of the enactment of this act.” An additional 500 acres (202 hectares), including three baseball fields, were transferred to the refuge in 1992.

Table 2-1. Land Acquisition History for Patuxent Research Refuge

Acquisition Date	Tract	Acreage	Previous Owner
12/02/1933	4	299.74	Hayden, James R.
01/04/1936	116	242.46	Pickford, Thomas H., et al.
01/10/1936	99	384.22	Kluckhuhn, Fred
02/26/1936	97	588.9	Sparks Jr., Robert W., et al.
03/09/1936	114	383.02	Holst, William H. C.
03/25/1936	125	101.55	The Glatfelter Pulp Wood Co.
04/09/1936	100	89.60	Perkins, Edward, et al.
05/04/1936	177	15.00	Coe, Walker P.C.
05/13/1936	105	78.51	Hance, Jesse Frank
05/19/1936	96	561.43	Hoffman, John P.
05/26/1936	117	108.37	Owens, Eleanor Garner
05/28/1936	112	94.08	Knowles, John W.
06/04/1936	145	404.03	Hopkins, Alice
06/08/1936	123	233.70	Harding, Elizabeth A.
06/11/1936	104	123.88	Knowles, James B.
07/21/1936	120	31.09	Hall, Robert S.
05/17/1938	145	11.87	Hopkins, Alice
03/01/1940	10	7.62	Turner, George H.
03/01/1940	11	2.39	Hanus, Joseph
03/01/1940	12	26.39	Melikin, Louis
03/01/1940	125	28.41	The Glatfelter Pulp Wood Co.
03/01/1940	5	159.09	Anne Arundel County
03/01/1940	6	20.85	Repetti Brothers
03/01/1940	7	55.55	Knight, Harry
03/01/1940	9	131.63	Volkmer, Frank
02/21/1941	14	0.40	Kuhl, Lilly M.
04/18/1963	146	32.40	Potomac Electric Power Co.
07/14/1969	48	64.52	Schaefer, Milton R., et al.
08/13/1969	43	30.26	Harder, Earl S., et al.
10/28/1969	47	11.90	Mitchell, Herman S.
07/03/1970	45	140.23	Schaefer, Millard
07/14/1970	44	25.93	Schaefer, William A.
07/21/1970	50	2.13	Mcmillan, Claude M.
10/01/1970	125	182.38	The Glatfelter Pulp Wood Co.
01/05/1976	131	2.45	Barton
09/30/1991	200	7600.00	Department Of The Army
11/17/1992	200	498.20	Department Of The Army
01/28/1999	178	27.30	Curtis Family Land Trust
03/01/2002	202	21.76	Dose, Jean Hardisty
03/05/2002	203	17.69	Utley, Mildred J.
TOTAL		12,840.93	

Table 2-2. Acres of Patuxent Research Refuge by County

County	Acres
Anne Arundel County	8, 557.4
Prince George's County	4,283.5

Patuxent Research Refuge's legislated purposes include:

- 16 U.S.C. 715d, Migratory Bird Conservation Act: "...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." This purpose is also attached to lands purchased with Migratory Bird Conservation funding.
- Public Law 101-519, 104 Stat. 2247 Defense Base Closure and Realignment Act, November 5, 1990: "... (b) The Secretary of the Interior shall administer the property transferred pursuant to subsection (a) consistent with wildlife conservation purposes and shall provide for the continued use of the property by Federal agencies to the extent such agencies are using it on the date of the enactment of this Act."
- 16 U.S.C. 667b, Transfer ... for wildlife conservation purpose: "...can be utilized for wildlife conservation purposes . . . to the Secretary of the Interior if the real property has particular value in carrying out the national migratory bird management program."
- 16 U.S.C. 1534, Land Acquisition: "to conserve fish, wildlife, and plants, including those which are listed as endangered species or threatened species."

Refuge purposes based on executive orders include:

- Executive Order 11724-Federal Property Council, June 27, 1973: "...recreation, conservation, wildlife preservation, and related scientific and educational activities."

2.2 Physical Environment

Regional Setting

Situated between Baltimore, Maryland and Washington, DC, Patuxent Research Refuge provides 12,841 acres (5,197 hectares) of green space in one of the highest densities of development in the U.S. Located just off of the Baltimore-Washington Parkway, the refuge contributes to nearly 28,000 acres of federally owned land in the area. It has been referred to as "the green lungs" of the greater Washington, DC area. This reference to "green lungs" is due to the vast forested acreage secured by the refuge and adjacent Federal land ownerships. Several Federal facilities share a boundary with, or are in close proximity to, the refuge, including Fort Meade, the Rowley Training Center (U.S. Secret Service), National Aeronautics and Space Administration's Goddard Space Flight Center, the Natural Resources Conservation Service's National Plant Materials Center, and the Beltsville Agriculture Research Center.

The refuge is divided into three areas: (1) Central Tract, which includes the USGS Patuxent Wildlife Research Center (PWRC); (2) South Tract, where the National Wildlife Visitor Center (NWVC) is located; and (3) North Tract. The City of Bowie is located southeast of the refuge on Maryland State Highway 197 (MD 197) and the city of Laurel is located northwest of the refuge. MD 197 bisects the Central and South Tracts.

The Central Tract is the original property established in 1936. The Central Tract consists of 2,670 acres (1081 hectares) located in Prince George's and Anne Arundel Counties, and is bordered on the north by the Patuxent River and on the south by MD 197. The eastern boundary is an area of broken forest and meadows running contiguously along



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Central Tract, Entrance Road to NWVC

property owned by the Washington Suburban Sanitary Commission, Maryland National Capital Parks and Planning Commission, Prince George's County, and a private landowner. The western boundary of the Central Tract is a forested area that abuts the residential Basswood Subdivision of Montpelier Woods and a section of property owned by the Washington Suburban Sanitary Commission.

PWRC, 1 of 17 USGS biological research centers, is a leading international research institute for wildlife and applied environmental research, for transmitting research findings to those responsible for managing the Nation's natural resources, and for providing technical assistance in implementing research findings so as to improve natural resource management. Scientists located at Patuxent Research Refuge are responsible for many important advances in natural resource conservation, especially in such areas as migratory birds, wildlife population analysis, waterfowl harvest, habitat management, wetlands, coastal zone and flood plain management, contaminants, endangered species, urban wildlife, ecosystem management, and management of national parks and national wildlife refuges.

PWRC develops and manages national inventory and monitoring programs. It is responsible for the North American Bird Banding Program and leads the development of many other national avian and non-avian wildlife monitoring programs. PWRC's scientific and technical assistance publications, wildlife data bases, and electronic media are used on a national and international scale for managing biological resources (PWRC Web site: <http://www.pwrc.usgs.gov/aboutus/mission.cfm>; accessed January 2012).

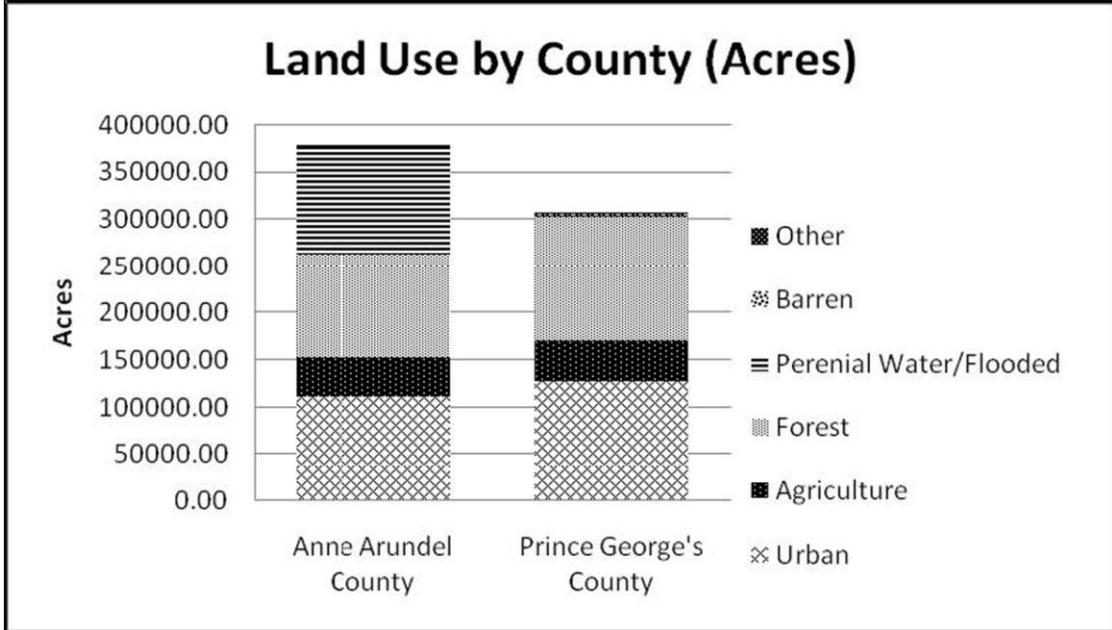
The South Tract, located in Prince George’s County, consists of 2,200 acres (890 hectares) and is bordered by the Sandy Hill Landfill (inactive), the Beltsville Agriculture Research Center, and several residential areas. The South Tract houses the NWVC, located at the end of Scarlet Tanager Loop off of Powder Mill Road, and a small enclave of residences and offices located just off of MD 197. In addition, Cash Lake, a prominent seasonal fishing area, is located on the South Tract.

The North Tract consists of 8,100 acres (3,278 hectares) in Anne Arundel County. It is bounded on the north by Maryland Routes 198 and 32, on the west by the Baltimore-Washington Parkway, on the east by AMTRAK train lines, and on the south by the Patuxent River. Historically, the land was cleared for agriculture and then used by the military for extensive small arms, artillery, and tank training. Many open grassland areas remain, as remnants of old firing ranges, paratrooper training sites, and related administrative areas.

Land Use

Land use for Anne Arundel and Prince George’s Counties is broken down by the following uses: agricultural, forest, urban, barren, perennial water/flooded, and other (figure 2-1). The total land use for the two counties is predominantly split between urban and forest land uses (35 percent each). Other major land uses include perennial water/flooded (17 percent) and agricultural (12 percent) (Vanasse Hangen Brustlin, Inc. 2010).

Figure 2-1. Land Use in Anne Arundel and Prince George’s Counties

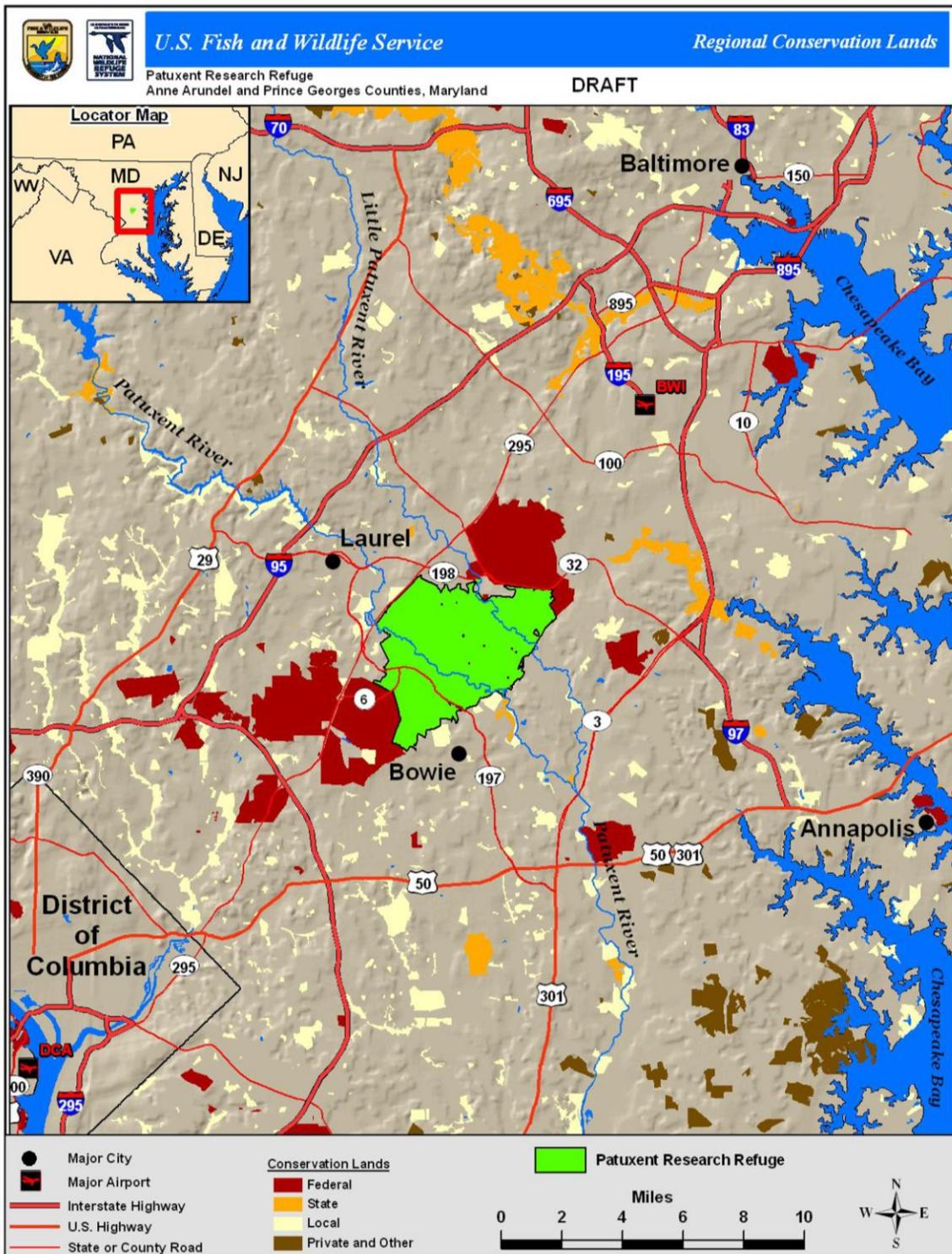


Source: State of Maryland Department of Planning

Regional Protected Lands

A variety of regional parks and protected land are located in Anne Arundel and Prince George’s Counties (map 2-1).

Map 2-1. Regional Conserved Lands around Patuxent Research Refuge



Physiography

The refuge is situated in the coastal plain of central Maryland. The refuge is dominated by the Patuxent and Little Patuxent River drainages, approximately six miles below the fall line, which forms the boundary between the Coastal Plain and the Piedmont Physiographic Provinces. Characterized by gently sloping terrain that is typical of coastal plain, the natural landscape is predominantly forested, with the lowest elevations (near 80 feet or 24 meters above sea level) in river bottomlands. Elevation change is minimal, with the highest elevations being about 240 feet (73 meters) above sea level.

Geology and Soils

The predominant soil type in the area is Beltsville silt loam. Beltsville silt loam is a fine soil that has an underlying clay layer and may also have pockets of small gravel. The soil will not drain well if in a flat landscape and drainage ditches must be used to reduce excess surface water. Gravel and borrow pits are also predominant in the area but are well-suited to wildlife habitat (Dyrlund et al. 2009).

Underlain by unconsolidated deposits of gravel, sand, silt, and clay, the other major soil types at the refuge are the Christiana-Sunnyside-Beltsville association, the Bibb-Tidal marsh association, and the Sassafras-Croom association.

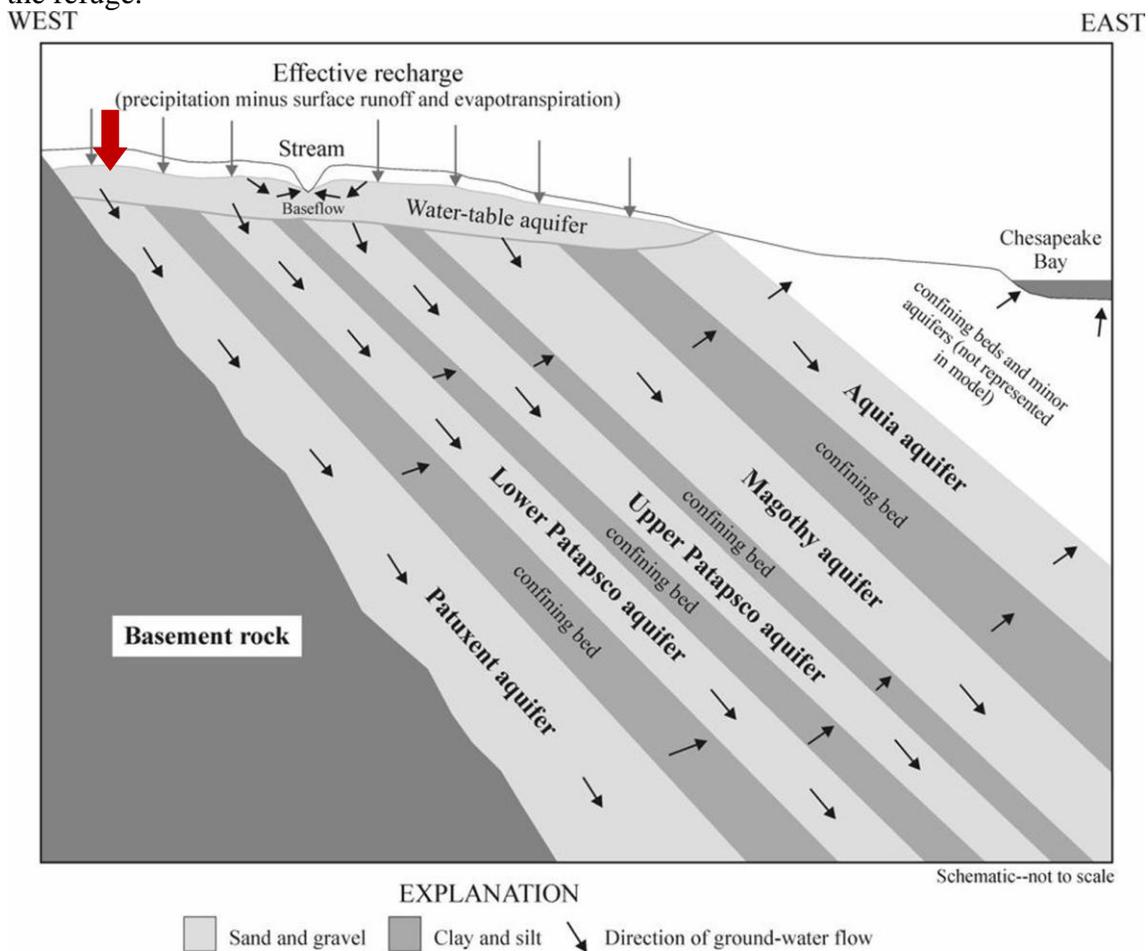
- The Christiana-Sunnyside-Beltsville association is underlain by red clay. The Christiana and Sunnyside soils are well-drained and suitable for deep-rooted vegetation. These soils have generally been put into agricultural production in the region; undisturbed forested areas with these soils are rare. Beltsville soils are less conducive to development and agricultural uses; they contain a restricting subsurface soil layer and consequently have a water table that is parched in wet seasons (Dyrlund et al. 2009).
- The Bibb-Tidal marsh association consist mostly alluvial soils of the flood plains found along the Patuxent River and tributaries. Due to frequent flooding, these riparian soils were generally not cleared for farmland and often support intact wildlife habitat (Dyrlund et al. 2009).
- Sassafras soils are deep and well-drained while Croom soils are shallow and somewhat excessively drained, with a compact to cemented subsoil (Dyrlund et al. 2009).

There are also substantial areas of sandy Evesboro soils on the North Tract. No soil surveys have been performed on the central part of the North Tract, because it is composed of a series of firing ranges and training areas formerly controlled by the Department of Defense (DOD) with unexploded ordnance present. Evesboro soils are sandy and well to somewhat excessively drained (Dyrlund et al. 2009).

The refuge overlies the Northern Atlantic Coastal Plain aquifer system. The aquifer is described generally in the USGS groundwater atlas of the U.S. (Trapp and Horn 1997). The Maryland Geological Survey provides more detailed local information on the State's groundwater aquifers. The coastal plain aquifer system is comprised of unconsolidated

gravel, sand, and silt separated by less permeable layers or confining beds. The more permeable sand and gravel deposits are considered aquifers and are used for public water supply (Andreasen 2007). In Anne Arundel County, the aquifers, from shallowest to deepest, are: water-table aquifer, Aquia, Magothy, Patapsco, and Patuxent (figure 2-2). On the refuge, the water-table aquifer includes shallow groundwater adjacent to rivers and wetlands within 30 feet (9 meters) of the ground surface. Water in this aquifer contributes to the water supply of rivers and wetlands on the refuge. Refuge water supply wells tap the Patapsco and Patuxent aquifers, which are about 280 and 500 feet (85 and 152 meters) below ground surface, respectively (Wurster 2010).

Figure 2-2. Conceptual Model of Groundwater Flow in the Coastal Plain Aquifer System in Anne Arundel County (Andreasen 2007). Red arrow identifies approximate location of the refuge.



Climate

The central Maryland climate is characterized by hot, humid summers and relatively mild winters. Weather systems move from west to east and prevailing winds are from the northwest (NRCS 2010). Typical summer months experience warm, moist air moving up from the Gulf of Mexico, while easterly winds bring cooler air over the region. In addition, central Maryland is frequently under a large, high-pressure system known as the

Bermuda high, centered over the Atlantic, bringing a flow of warm, moist air into the State from a southwesterly direction. Typical winter months experience cold, dry air from central Canada that has been moderated by having passed over the Appalachian Mountains. Much of the precipitation in winter is brought in by northeasters, on-shore winds that move ahead of low-pressure systems going northward along the coast. During the cooler months of October through April, prevailing winds are from the northwest (Wildland Fire Associates 2008).

Averages and Records

The yearly average temperature is 55°F (13°C), with an average high temperature of 65°F (18°C) and average low of 44°F (7°C) (NOAA 2004). July is, on average, the hottest month, with an average high temperature of 87°F (31°C). January is, on average, the coldest, with an average high of 41°F (5°C) (NOAA 2004). The highest temperature on record for the region is 105°F (41°C) on August 20, 1983, and the lowest recorded temperature is -15°F (-26°C) on January 18, 1957 (NRCS 2010). The region averages between 180 and 200 frost-free days each year (UMBC 2003).

The area receives on average 42 inches (1067 millimeters) of precipitation per year, with approximately 60 percent of the precipitation falling between April and October (NRCS 2010). Overall precipitation data indicates monthly averages of between 3 inches (76.2 millimeters) and 4 inches (101.6 millimeters) (NOAA 2004). Between 1971 and 2000, the greatest monthly precipitation amounts occurred in September. Precipitation is most variable during the summer months. The average annual snowfall is 18.2 inches (462 millimeters), with January and February being the snowiest months (NOAA 2004). The region averages between 10 and 16 days with at least 1 inch (25 millimeters) of snow cover (NRCS 2010). Also, December 2009 found the area receiving the largest single snowfall in recorded history. The snowiest season on record was the 2009 to 2010 winter with 55.9 inches

(<http://www.erh.noaa.gov/lwx/winter/DC-Winters.htm>; accessed March 2012).



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Flooding at Duvall Bridge

The region's average relative humidity at mid-afternoon is approximately 54 percent, with higher levels of humidity during the night (NRCS 2010). The region experiences sunshine 60 percent of the summer and 50 percent of the winter (NRCS 2010).

Hydrology and Water Quality

The refuge is located within the Patuxent, Little Patuxent and Anacostia River watersheds, which are part of the Chesapeake Bay watershed. Water quality conditions in

the State are monitored and regulated by the Maryland Department of the Environment (MDE) in order to protect, maintain, and improve the quality of surface waters in Maryland, and to ensure compliance with the Federal Clean Water Act. These standards are based on the designated use, water quality criteria to protect designated uses, and anti-degradation criteria for the waterway.

At the heart of the refuge, on the Central Tract and North Tract, lie the channel, tributaries, floodplains, and nontidal wetlands of the Patuxent River. The watersheds of the Patuxent and Little Patuxent Rivers are characterized by rolling hills and gently sloping terrain, with broad valleys and small tributary streams (MDE 2009, Wurster 2010).

Most of the South and Central Tracts are within the watershed of the Tier 2 segment of the Patuxent River; the lack of major development and impervious surfaces ensure that water quality in the adjacent rivers is protected to a certain degree. Tier 2 represents water that is of better quality than that needed for its designated use. Both the Patuxent and Little Patuxent Rivers are designated as impaired in the biological impairments, sediments, nutrients, and metals categories. However, the rivers are not impaired in the toxins and bacteria categories. Just downstream of the refuge, a short segment of the Patuxent River is designated as Tier 2 under Maryland's anti-degradation policy (Vanasse Hangen Brustlin, Inc. 2010).

Section 303(d) of the Clean Water Act requires that each state identify water bodies where water quality standards are not met. MDE develops a list of known, water quality-limited rivers and lakes. Once a water body is listed, MDE either establishes a total maximum daily load for the limiting substances or shows that the water quality standards are being met (MDE 2009, Wurster 2010).

MDE issues national pollutant discharge elimination system permits for any discharges to waters. These permits regulate the quality and quantity of discharges into the receiving waters and are issued to a variety of organizations and businesses, including NWVC. Stormwater and treated wastewater are two examples of discharges regulated under the permit program in Maryland. It is expected that wastewater discharged under these permits will find its way to the Patuxent and Little Patuxent Rivers (Wurster 2010).

The Patuxent and Little Patuxent Rivers are classified as Use I (water contact recreation and aquatic life) and Use I-P (water contact recreation, aquatic life, and public water supply), respectively, by MDE. These classifications are required under section 303(d) of the Clean Water Act and used to determine if the rivers are water-quality impaired. The Patuxent River is considered one of the State's scenic rivers, which is designed to preserve the natural values of the river. Several reports imply the Patuxent and Little Patuxent Rivers are high-priority waters in Maryland (MDE 2007, LimnoTech 2008, MDE 2009, Wurster 2010).

All the largest rivers on the refuge are identified as impaired water bodies in Maryland's 303(d) list. The Patuxent and Little Patuxent Rivers have excessive nutrients and

sediment, while the Little Patuxent may have excessive mercury in its waters. The Little Patuxent, Midway Branch, and Lake Allen are all identified as having impaired aquatic biota populations (Wurster 2010).

The 2010 Chesapeake Bay report card determined the Patuxent River to be of poor overall ecosystem health. For 2010, the Patuxent River region received a D- score, indicating that, since 2009, no improvement in overall health of the region was found. While phytoplankton and benthic communities showed some improvement, overall water quality indicators declined. See Patuxent River report card at: http://www.eco-check.org/reportcard/chesapeake/2010/summaries/patuxent_river/; accessed January 2012).

In addition to the Patuxent River, there are a number of standing-water features on the refuge which are man-made impoundments. Impoundments are of three major designs: dammed ravines, excavated basins, and diked ponds (McGilvery 1997). Although some were created inadvertently when roads were constructed across drainages, many were constructed between the 1930s and 1970s and created to reclaim gravel pits and old agricultural fields, while others were created specifically for waterfowl research and management (Wildland Fire Associates 2008, Wurster 2010).

Major impoundments on the refuge include Lake Allen on the North Tract, and Cash Lake and Lake Redington on the South Tract. Lake Allen, 22.77 acres (9 hectares), was created by the army in 1946 and originally called Soldier Lake. This lake was included as part of the Fort Meade land transfer in 1991, and named Lake Allen in honor of the commanding general who supported the land transfer. Lake Allen currently serves as a year-round fishing area for anglers. Lake Redington is 36.04 acres (15 hectares) and was created in 1943 for waterfowl conservation. It also currently serves as an interpretive feature for seasonal tram tours. Cash Lake is 52.73 acres (21 hectares) and was created in 1938 by the Civilian Conservation Corp for public fishing. It currently serves as the only seasonal fishing site for the South Tract. Its dam is considered a high-hazard, due to MD 197 being immediately downstream from the dam's outfall.



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Cash Lake Fishing Pier

The Patuxent River and Watershed

The Patuxent River is the largest river entirely in the State of Maryland. On the North Tract, over 6 miles (10 kilometers) of the Little Patuxent River lie within the refuge boundary. In several places the Patuxent and Little Patuxent Rivers are braided and thus have multiple shorelines. In addition to these two rivers, the refuge also has over 43 miles (70 kilometers) of streams which feed into the rivers, totaling 68 riparian miles (110 kilometers) (Les Vilchek 2012). The Patuxent River is 115 miles in length and is the longest river contained within the State of Maryland. The Patuxent River drains 612,425 acres of central and southern Maryland, eventually discharging into the Chesapeake Bay north of the mouth of the Potomac River. Three main streams drain into the upper Patuxent River: the Little Patuxent, which drains much of the newly urbanized area of Columbia, Maryland; the Middle Patuxent, which drains agricultural lands in the northern part of its drainage and the outer suburban areas of Columbia in the southern part of its watershed; and the (upper) Patuxent River, which has remained primarily agricultural. Land use in the watershed is mainly forest, with significant urban and agriculture development. Two large metropolitan areas, Baltimore and Washington, border the Patuxent River watershed, which has gone through significant suburban development in the past few decades. Columbia and Laurel have developed along the Interstate 95 corridor, which bisects the upper half of the watershed. The population of the Patuxent River watershed increased by 136 percent between 1970 and 2000 and is projected to grow an additional 22 percent by 2020. Two water supply reservoirs, located upstream of Laurel, Maryland provide water for the Washington, DC metropolitan area.

The watershed also provides important habitat for land and aquatic animals. It supports over 100 fish species and a commercial and recreational blue crab fishery.

The Chesapeake Bay Watershed

The Chesapeake Bay and its tributaries support more than 2,700 plant and animal species, including threatened and endangered species, waterfowl, raptors, neotropical migratory birds, anadromous fish, and commercially important fish and shellfish. Forested uplands are nesting and resting habitat for neotropical migratory birds and coastal wetlands provide valuable wintering grounds for waterfowl. The tributaries within the watershed are spawning grounds for anadromous fish species like striped bass, blueback herring, alewife, American shad, hickory shad, and Atlantic sturgeon. Shallow water areas support submerged aquatic vegetation, underwater plants that provide food and cover for waterfowl, blue crabs and juvenile fish. The open water of the Chesapeake Bay supports striped bass, bluefish, weakfish, American shad, blueback herring, alewife, bay anchovy and Atlantic menhaden. Commercially valuable shellfish, like oysters and clams, live along the bay's bottom. (Chesapeake Bay Coastal Program Web site: <http://www.fws.gov/chesapeakebay/coastpgm.html>; accessed January 2012.)

The Strategy for Protecting and Restoring the Chesapeake Bay Watershed was developed under the Executive Order issued by President Obama in May 2009, which declared the Chesapeake Bay a national treasure and ushered in a new era of shared Federal leadership, action, and accountability. The strategy deepens the Federal commitment to the Chesapeake region, with agencies dedicating unprecedented resources and targeting

actions where they can have the most impact, to ensure that Federal lands and facilities lead by example in environmental stewardship and take a comprehensive, ecosystemwide approach to restoration. Many of the Federal actions will directly support restoration efforts of local governments, nonprofit groups, and citizens, and provide economic benefits across the Chesapeake region. (Executive Order Web site: <http://executiveorder.chesapeakebay.net>; accessed January 2012.)

Air Quality

Air quality conditions in the State of Maryland are monitored and regulated by MDE. Maryland currently operates 26 air monitoring sites around the State and measures ground-level concentrations of criteria pollutants, air toxics, meteorology, visibility, and other research-oriented measurements. The Ambient Air Monitoring Program is responsible for measuring these concentration levels in compliance with the Federal Clean Air Act (Vanasse Hangen Brustlin, Inc. 2010).

An important part of the Clean Air Act is the delineation of National Ambient Air Quality Standards. These standards apply to outdoor air throughout the U.S. and set concentration limits on combustion-related pollutants. Areas that meet the standards are termed attainment areas. Areas that do not meet the standards are termed nonattainment areas.

The refuge falls in the metropolitan Washington, DC and Baltimore regions. These regions are designated as nonattainment areas for ground-level ozone and particulate matter according to Federal health standards. However, the region's ground-level ozone and fine particle pollution levels have continued to show significant improvements since early the 1990s. Carbon dioxide emissions continue to rise and pose a significant air quality challenge for the region (Vanasse Hangen Brustlin, Inc. 2010, MDE Summer 2006 Air Quality Summary).

Contaminants

A number of hazardous substances, unexploded ordnance, and munitions have been associated with the transfer of former military training grounds (North Tract's 8,100 acres) from Fort Meade through the Base Closure and Realignment Act of 1985. Hazardous substances include, but are not limited to, lead, petroleum-based waste, and unexploded ordnance. The refuge has cooperated with the Department of Defense (DOD) in establishing monitoring wells at several locations on the North Tract for continuous, long-term monitoring of ordnance and demolition-related compounds such as cadmium and volatile organic compounds. Groundwater monitoring wells have also been established to monitor contaminants, including trichloroethylene and tetrachloroethylene, potentially moving from Fort Meade sites through underground aquifers underlying refuge property. In general, natural attenuation is an ongoing cleanup strategy for contaminants. An abandoned trap and skeet range may undergo a soil removal action to eliminate lead-contaminated soil. Ordnance is removed as it is encountered in the field by ordnance demolition teams supplied by Fort Meade or other nearby military bases. The U.S. Environmental Protection Agency (EPA) placed Fort Meade on the national priority list in July 1998, after an evaluation of contamination due to past storage and

disposal of hazardous substances at the defense reutilization and marketing office, closed sanitary landfill, clean fill dump (located on the North Tract), and post laundry facility. Contamination at these sites included solvents, pesticides, polychlorinated biphenyls, heavy metals, waste fuels, and waste oils (URS 2010).

A Federal facility agreement was signed in June 2009 to serve as the master plan between DOD, EPA, and the Service, to provide specific timelines and required actions to resolve contaminant issues between Fort Meade and associated Base Closure and Realignment Act properties, including the North Tract of the refuge. The refuge manager is the point of contact for day-to-day issue and implementation of the agreement. This includes four operable units (areas where contaminant issues remain) on the refuge. While the Service has spent minimal funds for documenting contaminants at a few select locations, all cleanup responsibility for contaminants or ordnance related to former military uses remains the responsibility of the DOD in perpetuity. Soils and waterways in a number of locations within North Tract were contaminated with hazardous substances as a result of handling and disposal techniques that were once considered to be acceptable. In addition to hazardous materials being disposed of on the refuge, munitions and unexploded ordnances remain on the transferred land. The Department of the Interior, the Department of Army, and the EPA are actively involved in cleanup efforts. Investigation, cleanup efforts, and unexploded ordnance sweeps continue throughout the North Tract and are expected to continue into the foreseeable future.



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Shooting Range at Patuxent Research Refuge

Prior to the transfer of the North Tract to the refuge in 1991, a portion of the area was used as a trap and skeet range by Fort Meade. This use began in the mid-1970s and continued after the land transfer until 1999. In 1999, the range was closed because PWRC research data indicated that birds using the site were exposed to lead. Due to concerns about contamination from the lead shot, soil samples were analyzed for levels of lead, as well three common impurities found in lead shot—antimony, arsenic, and copper. In 2004, the Service Chesapeake Bay Field Office and the EPA Environmental Response Team compiled an ecological risk assessment for shooting range 17 (Huston and Krest 2004). The primary objective of the assessment was to determine the extent of lead

contamination at the trap and skeet range and the secondary objective was to assess the impact of this contamination on refuge wildlife. The report summarizes findings from soil samples collected from the site in 2003, explains the environmental impacts of the contaminants found, and recommends goals for site remediation. To assess ecological effects on refuge wildlife, the team conducted a soil toxicity test using earthworms, food chain accumulation models, and a lead-shot ingestion probability model. Overall, they found that the site was contaminated with both lead and lead shot, and posed a risk to insectivorous birds, mammals, and gallinaceous birds, which feed primarily on the ground. Fifteen acres of the site exceeded acceptable levels of contamination. The report lists goals for site remediation in terms of acceptable levels of each contaminant. The entire report is available online from the Service Chesapeake Bay Field Office Web site: <http://www.fws.gov/chesapeakebay/pdf/CBFO-C0405.pdf>; accessed January 2012).

Fort Meade Superfund Site

Fort Meade is located northeast of the refuge near Odenton, Maryland and was designated a superfund site in 1998. Several sites on Fort Meade have been added to the national priorities list of serious abandoned hazardous waste sites. Groundwater in the water-table aquifer under the fort is contaminated with carbon tetrachloride, tetrachloroethene, and trichloroethene. Contaminants migrating in the groundwater could discharge into wetlands and streams on the refuge that receive contributions from shallow groundwater. The Department of the Army has installed a network of 12 groundwater monitoring wells on the North Tract to determine if groundwater is also contaminated on the refuge (Wurster 2010).

2.3 Habitat Overview

Background and Landscape Context of the Refuge

About 10,000 acres (4,046 hectares) of the total 12,841 acres (5,197 hectares) are forest of some type. Refuge forests contribute to one of the largest blocks of contiguous forested habitat in the Mid-Atlantic Coastal Plain. Other habitat types include grasslands/old fields, emergent freshwater marshes, shrub and early succession forest communities, and constructed impoundments. The refuge provides habitat for at least 38 mammal species, 55 amphibians and reptiles, 25 orders of insects, 248 bird species, and 55 species of fish (Vanasse Hangen Brustlin, Inc. 2010, Hotchkiss and Stewart 1979, refuge data on file).

To facilitate the development of management objectives and alternatives for key habitats and to communicate these to the public, refuge habitats are classified below in very broad terms, which produced 12 different habitat classifications or cover types. Major dividers in habitat types are upland versus wetland, and impoundment versus naturally occurring wetlands.

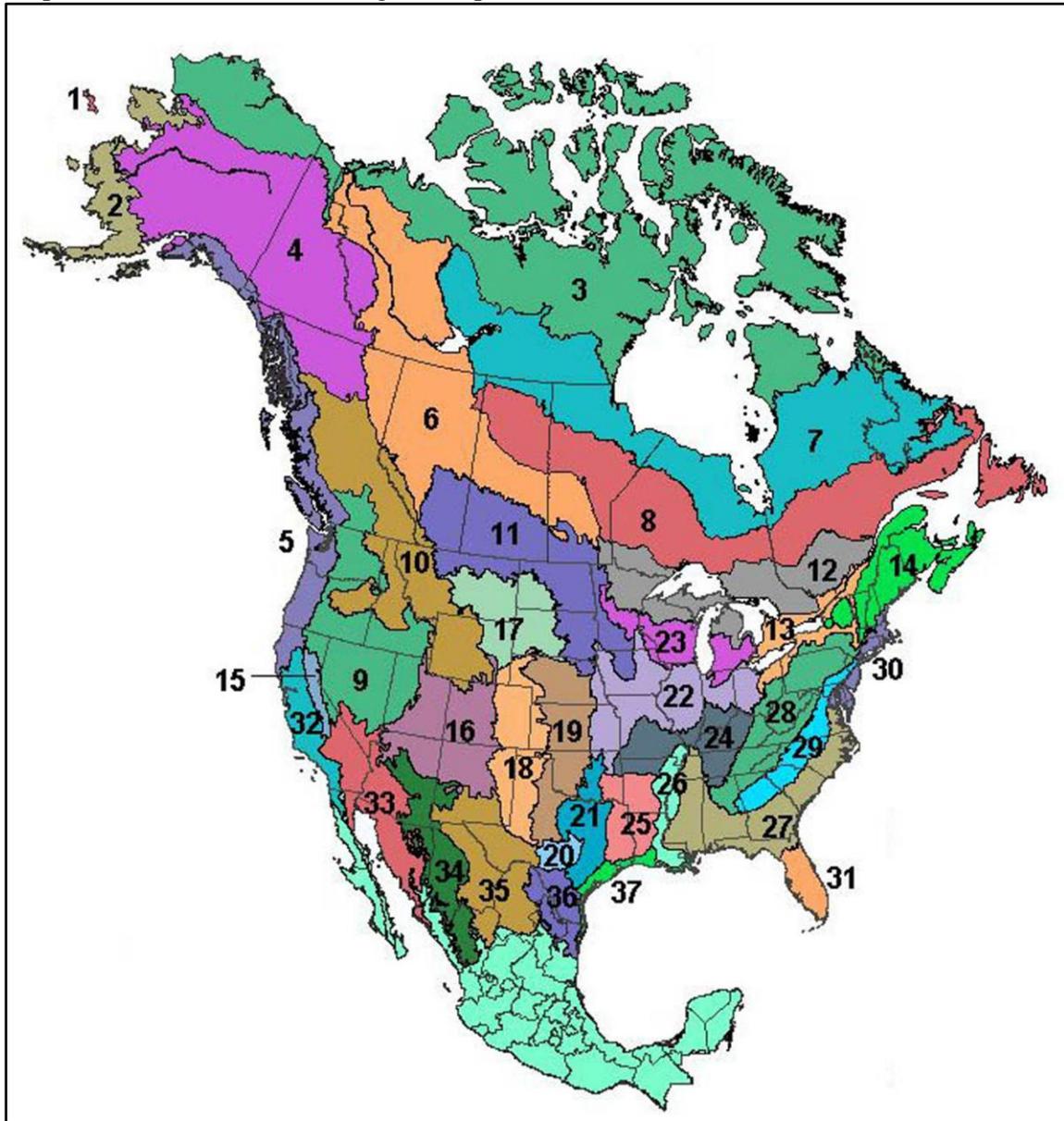
- The general habitat or land cover types for uplands are forest (deciduous, pine, or mixed), oak-pine savannah, shrub-early succession forest, grassland-old field, and administrative-developed.

- The general habitat types for wetlands are floodplain forest and swamp, river and stream, depression forest and shrub wetlands, and emergent wetlands.
- Some wetlands are impoundments and have various cover types, which include open water, emergent, and shrub and forested wetlands (the latter includes managed green-tree reservoirs).

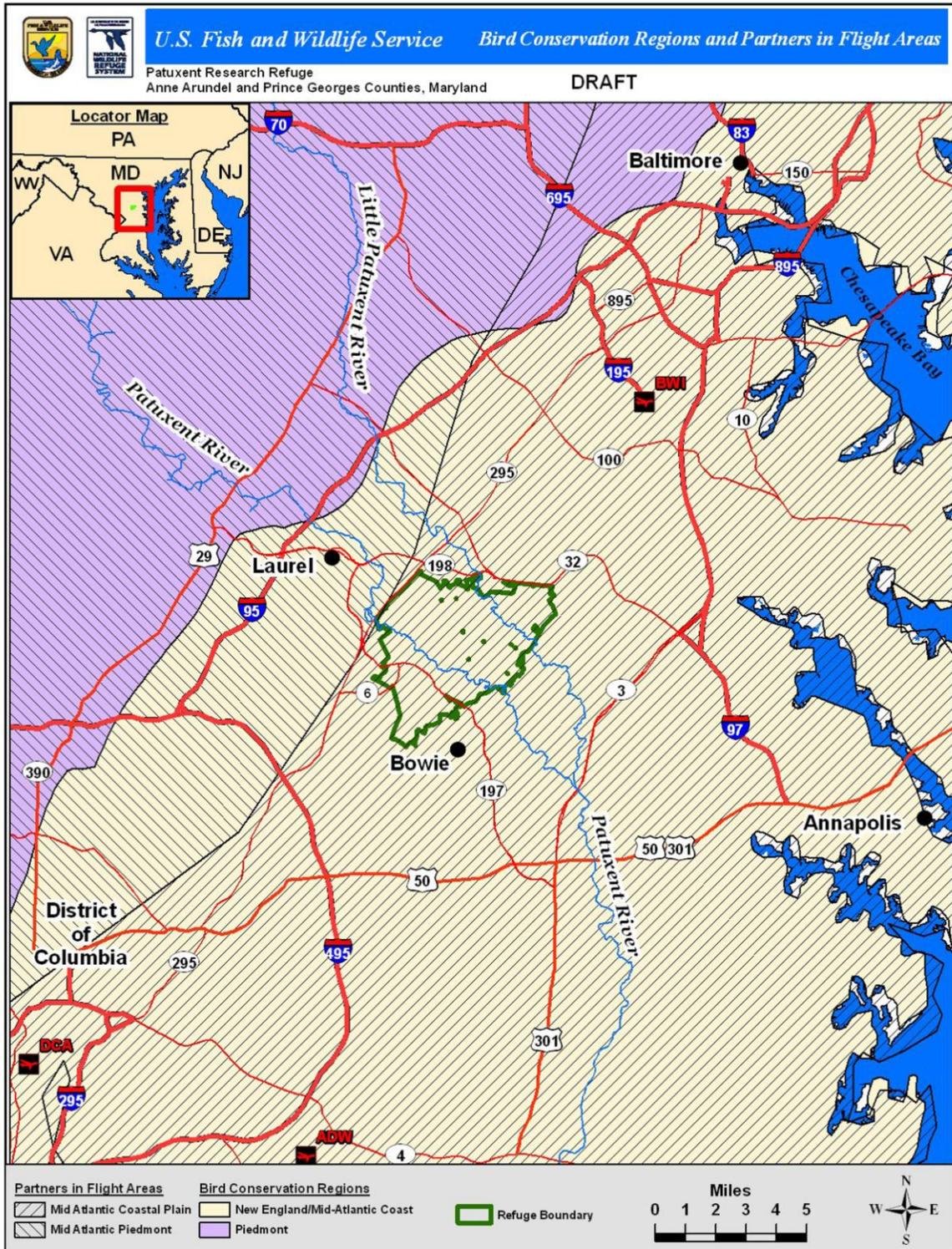
These broad, general habitat types were further classified at much finer scales to identify cohesive natural or altered plant communities. The refuge is located in the Chesapeake Bay Lowlands Ecoregion (Region 60), which encompasses primarily lowlands between the fall line and the Atlantic Coast. Within ecoregions, vegetation communities are characterized and distinctly identified using the National Vegetation Classification System (NVCS). The system was developed by NatureServe, a consortium of Federal and academic partners, and is the Federal standard used for mapping refuge vegetation. The methodology is based on groups of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates (e.g., soils), and/or environmental gradients (e.g., drainage, elevation, climate). A given vegetation classification typically manifests itself in the landscape at tens to thousands of acres and will persist for 50 or more years (Comer et al. 2003). NVCS is based on a relatively fixed hierarchy of floristic units, a measurement of a plant community based on the dominant species in the canopy, including associations and alliances, which are the recommended levels to apply to refuge mapping projects. An association is the most basic floristic vegetation classification unit within the NVCS. It is a plant community of definite floristic composition, a defined range of species composition, diagnostic species, uniform habitat conditions, and physiognomy. An alliance is a group of associations that share floristic characteristics, but is more compositionally and structurally variable, more geographically widespread, and occupies a broader set of habitat conditions (ESA 2004). Additional information on NatureServe, the ecoregions, NVCS, and mapping standards is available online at: www.esa.org; accessed January 2012.

The habitat descriptions below are also important for deriving the priority bird species lists for each habitat type. Map 2-2 shows bird conservation regions (BCRs), ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues. The BCR system was developed by the North American Bird Conservation Initiative, a coalition of government agencies, private organizations, and bird initiatives, to standardize and coordinate bird conservation efforts and planning and is the standard used by most refuges in the Refuge System. Patuxent Research Refuge lies within BCR 30, the Mid-Atlantic Coastal Plain; however, the refuge is very close to BCR 29, which includes the piedmont. Map 2-3 below shows a close up view of the proximity of the refuge to this BCR. For more information about BCRs or BCR 30, see: http://www.acjv.org/BCR_30/BCR30_June_23_2008_final.pdf; accessed January 2012. For more information about North American Bird Conservation Initiative, see: <http://www.nabci-us.org/about.htm>; accessed January 2012.

Map 2-2. Bird Conservation Region Map (NABCI)



Map 2-3. View of Patuxent Research Refuge within BCR 30 and proximity to BCR 29 (Source: Atlantic Coast Joint Venture)



Upland forest is the predominant habitat type found on the refuge. This habitat type is composed primarily of oaks, such as white (*Quercus alba*), northern red (*Quercus rubra*), and southern red oak (*Quercus falcate*). Other species include Virginia pine (*Pinus virginiana*), pitch pine (*Pinus rigida*), red maple (*Acer rubrum*), American beech (*Fagus grandifolia*), hackberry (*Celtis occidentalis*), cherry (*Prunus* spp.), walnut (*Juglans nigra*), hickories (*Carya* spp.), and sweetgum (*Liquidambar styraciflua*). Several alliances are included in the upland forests, such as chestnut oak-red oak-mountain laurel, beech-red/white oak-tulip poplar, or white oak-southern red oak-hickory alliances.

The next most predominant habitat type is bottomland or floodplain hardwood forest characterized by river birch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), sycamore (*Plantanus occidentalis*), pin oak (*Quercus palustris*), swamp white oak (*Quercus bicolor*), willow oak (*Quercus sphellos*), black oak (*Quercus velutina*), red maple, black gum (*Nyssa sylvatica*), sweetgum, yellow poplar (*Liriodendron tulipifera*), bald cypress (*Taxodium distichum*), American elm (*Ulmus Americana*), sweetbay magnolia (*Magnolia virginiana*), and includes several alliances.

Information about big tree species on the refuge can be obtained at:
<http://www.pwrc.usgs.gov/history/herbarium/bigtree.htm>; accessed January 2012.

Much of the land that is now forested is a result of gradual reforestation as lands were retired from agricultural use. Distribution of various species has changed significantly through this process. A notable change has been the invasion of cleared and cut-over areas by conifers. Virginia pine, pitch pine, and loblolly pine (*Pinus taeda*) dominate many of the drier areas. However, it is possible that this is a reversion to a pine-barren community of pitch pine that once ranged from southern New Jersey across northern Delaware and across northern/central Maryland. Early succession species such as tulip poplar (*Liriodendron tulipifera*), red maple, and sweetgum, have invaded more mesic to wet sites. Total plant species for the refuge were assembled from historical data (Hotchkiss and Stewart 1979), recent updates by USGS biologists (Perry and Bond 2011), and new collections in 2011 by volunteer William Harms, which provided 18 new species. The refuge has 985 total plant species including 554 herbs/forbs, 209 graminoids, 165 trees/shrubs, 65 sedges, and 39 vines.

Habitat Types-Uplands

Administrative/Developed

This includes buildings, facilities, parking lots, roads, yards or lawns adjacent to buildings, and any areas that are kept mowed for administrative or maintenance purposes.

Grasslands/Old Fields

This classification represents priority habitats that are being managed for grassland or old field-dependent species of conservation concern. There are many scattered sites throughout the refuge that are in grass cover, but because of their small size (less than 25 acres or 10 hectares), linear or narrow configuration, and closed-canopy setting, would not be appropriate for the investment of resources required to manage as grassland habitat and thus are not defined as grasslands. Old fields are essentially grasslands that have

advanced somewhat in natural succession and contain scattered young trees and a substantial forb component. Refuge grasslands result from continued mowing of past agricultural lands, arrest the natural succession to forest. Some of the open areas are in old field stage, trending toward shrub or early succession forest. Open fields undergoing early succession toward forest are characterized by exotic tall meadow fescue (*Festuca arundinacea*) and *Sericea lespedeza*, which dominates in many areas. Other invasives include mile-a-minute (*Persicaria perfoliata*), Bradford pear (*Pyrus calleryana*), and autumn olive (*Elaeagnus umbellata*). Dense monocultural stands of sweetgum and black locust (*Robinia pseudoacacia*) are encroaching and reducing open acreage in many meadow areas. Other common native species include broomsedge (*Andropogon virginicus*), blackberry species (*Rubus* spp.), goldenrods (*Solidago* spp.), ragweed (*Ambrosia altissima*), many species of asters or composites, Queen Anne's lace (*Daucus carota*), yarrow (*Achillea millefolium*), and a variety of panic grasses (*Panicum* spp.) (Wildland Fire Associates 2008, staff).

The potential for refuge grasslands to support conservation bird species depends on size and configuration. For the majority of grasslands and old fields on the refuge, this would include generalist species more tolerant of woody encroachment and small, linear sizes, such as the field sparrow (*Spizella pusilla*), eastern towhee (*Pipilo erythrophthalmus*), prairie warbler (*Dendroica discolor*), eastern kingbird (*Tyrannus tyrannus*), brown thrasher (*Toxostoma rufum*), orchard oriole (*Icterus spurius*), and indigo bunting (*Passerina cyanea*). Grasshopper sparrow (*Ammodramus savannarum*) and eastern meadowlark (*Sturnella magna*), area-sensitive, grassland-obligate species, generally nest only in the largest field on the North Tract, but have occasionally been observed in other



USFWS

Refuge Grassland

fields on the refuge. American woodcock (*Scolopax minor*) will use the open grasslands for aerial displays in late winter and spring. Grasslands and old fields adjacent to hardwood forest are attractive to box turtles (*Terrapene carolinus*) and are an essential arrangement for forest bats of conservation concern, such as eastern red bat (*Lasurus borealis*), little brown myotis (*Myotis lucifugus*), and tri-colored bat (*Perimyotis subflavus*).

Currently there are 95 mowed fields, approximately 535 acres (217 hectares) on the refuge. Twenty-three of the fields are located on the South Tract and range from less than 0.1 to 5.1 acres and average 1.2 acres (.5 hectares); the 61 Central Tract fields range from 0.3 to 21.5 acres and average 5.5 acres (2.2 hectares); and the 11 North Tract fields range from 3.3 to 90.9 acres and average 31.3 acres (12.7 hectares) (Haglen 2010).

Oak-Pine Savannahs

On the North Tract, there are some areas of fire-influenced barrens or deep sand, well-drained soils now dominated by young, thick scrub growth of Virginia pine or pitch pine, and several species of oaks, such as scrub oak (*Quercus ilicifolia*), post (*Quercus stellata*), willow, sand hickory (*Carya pallid*), and blackjack oak (*Quercus marilandica*). These areas are located primarily along the Patuxent River and may represent a remnant pine barren or savannah. Understory species include little bluestem (*Schizachyrium scoparium*) and Opuntia cactus (Drs. Mathew Perry and Charles Davis, personal communication). Prescribed fire will be considered for use as a management tool to help perpetuate these rare communities (Wildland Fire Associates 2008). Current acreage is about 132 (53 hectares), but this is an estimate based on sandy soils, not vegetation.

Shrub and Early Successional Forests

Shrub and small trees dominate this transitional habitat type that may persist in either an upland or floodplain (palustrine) setting for up to 20 years depending on site potential. Species composition varies, depending on location and the species composition of adjacent habitats. The refuge contains relatively small proportions of this habitat type. Sweetgum, maple, black cherry (*Prunus serotina*), oaks, and tulip poplar tend to be the most common tree species to dominate the scattered pockets and fringe areas of early succession forest. Nonnative invasive species such as Bradford pear, autumn olive, and Chinese lespedeza (*Lespedeza cuneata*) are problematic where old fields abut forest. Most of the acreage of shrub habitat (approximately 223 acres/90 hectares) is located in the two powerline right-of-ways, where it is likely to be maintained.

Upland Deciduous, Pine, and Mixed Forests

Deciduous forests contain a variety of hardwood species depending on the age and hydrology of the forest. Mature climax species for this area would be dominated by oaks, such as white, chestnut (*Quercus prinus*), southern and northern red (*Quercus rubra*), and, on drier sites, post, scrub, blackjack, and willow. Hickories, such as mockernut (*Carya tomentosa*) and bitternut (*Carya cordiformis*), share the canopy in mature, climax forests. But since most of these forests have been logged (oaks, hickories, and walnut were much sought-after) and fire has not been present on the landscape, non-fire adapted species are also common, such as beech (*Fagus grandifolia*), maple, tulip poplar, and sweetgum. Common mid-story and small trees in these forests include dogwood (*Cornus* spp.), hornbeam (*Carpinus* spp.), pawpaw (*Asimina triloba*), spicebush (*Lindera benzoin*), mountain laurel (*Kalmia latifolia*), arrowwood (*Viburnum dentatum*), and sassafras (*Sassafras albidum*). On very dry soils one finds heath communities comprised of blueberries and huckleberries (*Vaccinium* spp.), and wild azalea (*Rhododendron canadense*). Such forests may also contain perched vernal pools (these are vernal pools that lie in a depression in an otherwise elevated upland area, are fed by sheet flow, and have a tendency to dry out). Large blocks of unfragmented, undisturbed deciduous forest also benefit amphibians that depend on forested vernal pools such as wood frog (*Lithobates sylvatica*), spotted salamander (*Ambystoma maculatum*), box turtles, and other forest-dependent reptiles such as hog-nosed snake (*Heterodon platirhinos*).

Pine forests are generally pure pine stands on dry soils and may be relatively open in the understory, but sometimes contain short stature red-cedar, blueberry, and other acid soil-tolerant species. Pure stands of Virginia and pitch pine are limited on the refuge and generally colonized from previous disturbance. A mix of dry oak-pine forests support the upland chorus frogs, native bee species and regionally rare invertebrates such as darkling beetle species (*Coleoptera: Tenebrionidae* family) and tiger beetles (*Coleoptera: Cicindelidae* family). Several species of native and rare plants were collected from this general area in historic times and are likely to still be found or may readily recolonize from seed bank within the refuge's sandy soils including those in the milkweed, goldenrod, and sunflower families (Droege et al. 2009). Some such species are *Asclepias verticillata*, L., *Desmodium ochroleucum* M.A. Curtis ex Canby, *Heilanthemum bicknellii* Fern., *Lespedeza stuevei* Nutt., *Matelea carolinensis* (Jacq.) Woods., *Rhynchosia tomentosa* L., *Polygala polygama* Walt., and *Schwalbea americana* L.

Mixed forests are composed of many of the same deciduous species described above and include scattered individuals or small stands of pine species native to this area such as pitch pine, Virginia pine, loblolly pine, and some shortleaf pine (*Pinus echinata*), near the northern limits of its range. As with deciduous forest communities, topography and soil moisture, texture, and pH play a large role in the distribution of species, so pockets of heath communities may be present as well as small, acidic seepages and bogs, and vernal pools.

The total area of these combined forest types is about 8,242 acres (3,335 hectares).

Habitat Types-Wetlands

Floodplain: Forests, Swamps, and Shrub Wetlands

These wetland types comprise about 2,018 acres (817 hectares) of refuge property. Floodplain forests can be found within, or adjacent to, the river and stream floodplains and are also called hardwood bottomland forest. They are not permanently flooded, but may have standing water after heavy rain or flood events. Tree species include beech, tulip poplar, black gum, willow oak, red maple, American sycamore, American elm, green ash, and river birch (*Betula nigra*). Bald cypress has been documented on the refuge. Shrubs include spicebush, viburnums, sweet pepperbush (*Clethra alnifolia*), and deciduous holly (*Ilex decidua*).

Swamps are forested wetlands with a mostly closed canopy, possibly dominated by small shrubs, and remain more or less permanently flooded with standing water. Dominant tree species include green ash, red maple, and black gum. Shrub species include speckled alder (*Alnus incana*), winterberry (*Ilex verticillata*), black haw (*Viburnum prunifolium*), and black willow (*Salix nigra*). A complex variety of herbaceous species may comprise the understory, including lizardtail (*Saururus cernuus* L.) and cutgrass (*Leeria oryzides*). There is an estimated 1,946 acres (787 hectares) of floodplain forest and swamps throughout the refuge.

The floodplain shrub wetlands are relatively small, scattered, and generally interspersed with or bordering the forested canopy. The acreage of this type is only about 73 acres (30

hectares). Typical shrub species are less than 20 feet (6 meters) tall and may include alders (*Alnus* spp.), willows (*Salix* spp.), buttonbush (*Cephalanthus occidentalis*), red osier dogwood (*Cornus stolonifera*), spirea (*Spiraea tomentosa*), and young trees of species such as red maple.

Depressional Forest and Shrub Wetlands

Depressional wetlands include the small scattered bogs, seepages, vernal pools, and perennially wet areas that are not in the floodplain. Some are completely in forested and closed canopy and some are in semi-open or open canopy and dominated by shrubs. The depressional forest acreage is about 752 acres (304 hectares), while the open canopy and depressional shrub wetland acres are relatively small, about 6 acres, and tend to be scattered throughout or paralleling upland habitats. Tree and shrub species of these two habitat types largely reflect those found in the floodplain, but with higher dominance of more versatile upland species that can tolerate short periods of flooding or have root access to well-drained soils.

Coastal plain bogs or coastal plain acidic or alkaline seeps are a rare natural plant community type in Maryland characterized by sphagnum mosses, carnivorous plants, sedges, orchids, and insects such as the minute bog beetle (*Microsporus politus* or *Microsporus texanus*) and elfin skimmer (*Nannothemis bella*). A few open habitat sphagnum bogs are documented in powerline right-of-ways. These sites support many species that have become rare in the State (Simmons and Strong 2001).

Magnolia bogs are enlarged springs or seeps that usually form on a slope where a perched water table intersects the ground surface above an impervious clay lens, rock, or soil. These persist in closed-canopy forest environments and are easily identified by the prevalence of native sweetbay magnolia. Sphagnum moss is a dominant groundcover because of the permanently saturated, acidic conditions throughout the bog (pH 4.2 to 5.0) (Simmons and Strong 2001). This habitat type also supports a variety of herbaceous plants that tolerate shade, such as ferns and skunk cabbage. Magnolia bogs have become increasingly rare and those that are surviving have degraded throughout their range because of extensive development of the gravel terraces that surround the bogs, which destroys or severely depletes their water supply (Simmons and Strong 2001). One such bog has been identified on the lower southeast portion of the North Tract.



Water Lily

Emergent Wetlands

The refuge has just over 107 acres (43 hectares) of this open-canopy floodplain habitat type consisting of seasonally flooded herbaceous meadows and permanently flooded wetlands. Some woody shrub communities may also be present. This habitat type occurs

naturally in scattered areas along refuge creek drainages but is also found in the shallower portions of refuge impoundments and lakes as well. Characteristic emergent herbaceous species includes narrow-leaved cattail (*Typha angustifolia* L.), Juncus species, arrow arum (*Peltandra virginica*), wild rice, pickerel weed (*Pontederia cordata* L.), spatterdock (*Nuphar avdenar*), water lily (*Nuphar avdenar*), and duck potato (*Sagittaria lancifolia*). Characteristic shrub vegetation includes species such as wax myrtle (*Myrica cerifera*) (sandy soil edges), buttonbush, groundsel tree (*Baccharis halimifolia*), alder, elderberry (*Sambucus spp.*), winterberry, and hibiscus (*Hibiscus rosa-sinensis*).

Impounded Wetlands

Total acreage of the refuge’s 61 impoundments is between 553 acres and 575 acres (224 hectares and 233 hectares), 4 percent of the refuge area. Impoundments take on various forms and meaning depending on how they were created and their location, typography, and hydrological regime. Some are true impoundments which are excavated, have water control structures, or man-made blockages; others are former gravel pits, natural river oxbows, or were created unintentionally by road beds. Water depth, hydro-period, and context influence vegetation in the impoundment. Some impoundments are open water, wetland shrub, emergent, or forested but for management purposes, these areas are called impoundments. Constructed impoundments were created primarily between 1940 and 1970. This period mirrored the Service’s management emphasis on the restoration of continental waterfowl populations and restoration of abandoned farmland into wildlife habitats. Many of these impoundments were used in early waterfowl research. A number of them are located on the floodplain and may impact floodplain functionality. Almost half of the impoundments lack water control capability (USFWS-HMP).

Current acreages of impoundments according to cover type are as follows: depressional forested wetland, 28 acres (11 hectares); depressional shrub wetland, 0.23 acres (.09 hectares); emergent wetland, 64 acres (26 hectares); floodplain forest and swamp, 57 acres (30 hectares); floodplain shrub wetland, 42 acres (17 hectares); and open water, 363 acres (147 hectares). Table 2-3 lists the areas of open water and their acreages. Depending on situational context and depth, the impoundments may be open water, emergent, shrub, or forested.

Table 2-3. Current Acres of Open Water at Patuxent Research Refuge

Pond	Acres	Pond	Acres	Pond	Acres
Millrace	58	Greentree Reservoir	6.4	Salamander	1.6
Cash Lake	54	Hance 2	6.2	Fire Control Pond	1.6
Knowles 1	43	Wood Duck Pond	5.9	Sundew Pond	1.6
Lake Redington	35	Shaefer Farm Pond	5.8	Bluegill	1.4
Beaver Valley	30	WSSC	5.8	Old Gravel Pit Pond	1.4
Shaefer Lake	24	Uhler 2	5.5	Goose Pond	1.2
Lake Allen	20	Bullfrog	5.0	Peeper Pond	1.0
Knowles 2	19	Telegraph Swamp	4.7	Farm Pond	0.88
Shangri-La	19	Kingfisher	4.5	Gravel Pit Pond	0.86
Knowles 3	16	Telegraph Swamp	4.2	Clay Pit Pond	0.76

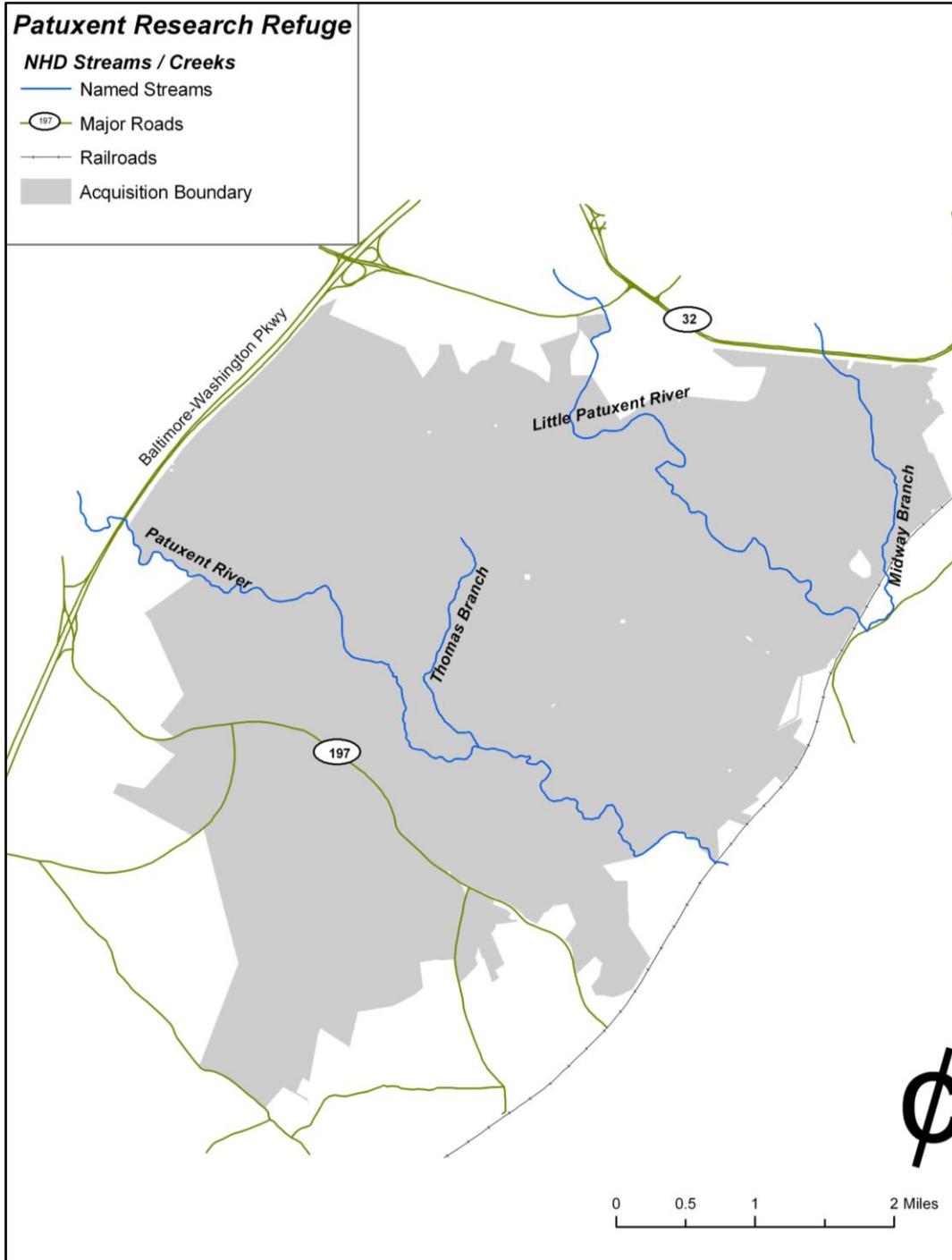
Pond	Acres	Pond	Acres	Pond	Acres
Duvall 1	15	Mabbott Pond	4.1	Bailey Bridge Marsh	0.73
K-Swamp	15	Mallard Pond	4.0	Borrow Pit 2	0.72
Patuxent Marsh	14	Range Pond	3.7	Shaefer Farm Pond	0.72
Wood Duck Pond	13	New Swamp	3.7	Mitigation Pond	0.65
Powerline Swamp	13	New Marsh	3.3	Spillway	0.53
Hobbs Pond	11	Midway Branch	2.9	Rieve's Pond	0.51
Shaefer Farm Pond	9.8	Merganser Pond	2.7	Dragonfly Pond	0.50
Blue Heron	9.2	Cattail Pond	2.7	Borrow Pit 3	0.49
Snowden Pond	8.2	WSSC	2.3	Borrow Pit 1	0.47
Rogue Harbor	8.2	Shaefer Farm Pond	2.2	End. Species Reservoir	0.40
Duvall 2	7.7	Midway	2.1	Treatment Lagoon	0.32
Hance 1	7.5	Shaefer Farm Pond	1.9	Shaefer Farm Pond	0.31
New Marsh	7.1	Treatment Ponds	1.8	Shaefer Farm Pond	0.29
Uhler 1	6.5	Harding Spring Pond	1.7	Fire Trail Pond	0.17

Coastal Plain Streams and Rivers

Silt, sand, small cobble, and gravel are the dominant substrate materials in this habitat, in addition to woody debris and aquatic vegetation, and can be found in the tributaries and small streams traversing the refuge. All stream types (including side channels of the rivers) are included in this habitat type from the national hydrography dataset except the Patuxent and Little Patuxent Rivers proper (L. Vilcheck's personal communication 8/16/2011).

The Patuxent Research Refuge protects approximately 17 miles of the Patuxent, Little Patuxent, Midway Branch, and Thomas Branch Creeks as delineated from the national hydrography dataset and in GIS delineation (Vilchek 2012; map 2-4). The Patuxent River is considered one of the State's scenic rivers, so designated to preserve the natural values of the river. Several reports imply the Patuxent and Little Patuxent Rivers are high priority waters in Maryland (Wurster 2010). The rivers are largely shaded as they course through forested habitats in braided or single run reaches and have a silty or sandy substrate with some pool and riffle sequences and gravel bars. Large woody debris both encumbers migration and provides spawning areas for migratory fish. The Little Patuxent, Midway Branch, and Lake Allen are all identified as having impaired aquatic biota populations. This is corroborated as well by the assessment reports prepared for Anne Arundel County (LimnoTech 2008, Victoria and Markusic 2009). The Patuxent and Little Patuxent suffer from excessive nutrients and sediment, while the Little Patuxent may have excessive mercury in its waters. Sources of impairment point to deficient buffers, bank erosion, and obstructions, but not all sources are from onsite causes (Limnotech 2008, Victoria and Markusic 2009). Land-use changes over the past 300 years have resulted in high sedimentation and silting in the rivers. The upper Patuxent water flow is controlled by the water releases of the Rocky Gorge Reservoir, constructed in 1954. River flow has been reduced since dam construction, which influences sediment transport (Wurster 2010).

Map 2-4. Named Creeks or Streams from the USGS National Hydrography Dataset on and within 0.1 mile of the Patuxent Research Refuge Approved Boundary, Laurel, Maryland (Wurster 2010).



Invasive Species

Invasive plant species of particular concern on the refuge are Chinese lespedeza, mile-a-minute (*Persicaria perfoliata*), Japanese stilt grass (*Microstegium vimineum*), garlic mustard (*Alliaria petiolata*), and spotted knapweed (*Centaurea maculosa*). Some other invasive species are well established or are poised to create challenges in the near future, and will require concerted planning and treatment effort with partners. These include Bradford pear, Japanese honeysuckle (*Lonicera japonica*), autumn olive, Japanese wisteria (*Wisteria floribunda*), tree of heaven (*Ailanthus altissima*), oriental bittersweet (*Celastrus orbiculatus* Thunb.), multiflora rose (*Rosa multiflora*), lesser celandine (*Ranunculus ficaria*), and hydrilla (*Hydrilla verticillata*) in some of the lakes and impoundments. A persistent stand of *phragmites* (*Phragmites australis*) chokes the sewage treatment ponds on the South Tract and several small, scattered stands line ditches and wetland edges.

Invasive animal species of concern include nonnative crayfish, such as virile crayfish (*Orconectes virile*), red swamp crayfish (*Procambarus clarkia*), rusty crayfish (*Orconectes rusticus*), European starlings (*Sturnus vulgaris*), house sparrows (*Passer domesticus*), and feral cats. In some instances it is known how a particular invasive species became established on refuge property; for example, Chinese lespedeza was originally used in agricultural lands to assist with erosion control and as a food source for quail, Bradford pear was introduced as an ornamental species and invasive nonnative crayfish were introduced to Maryland streams as fishing bait.

Natural and Current Role of Fire

Pre-settlement Fires

Both naturally occurring (lightning-caused) fires and fires associated with the activities of Native Americans and European colonists (Patterson and Sassman 1988) have historically influenced vegetation in the eastern U.S. Naturally occurring fire is infrequent in the Northeast (including the Mid-Atlantic); however, human-set fire has historically, dramatically impacted the ecology of the region. Native peoples occupying the Mid-Atlantic from the Pleistocene era until the time of European contact employed fire regularly to improve game habitat, facilitate travel, reduce insect pests, remove cover for potential enemies, and enhance berry production. At the time of European contact, the forest landscape in much of the eastern U.S. contained open stands, shaped by short-interval, low-intensity fires. Grasslands and prairies were common in areas as far east as Ohio, Pennsylvania, and Virginia, primarily as a result of introduced or naturally occurring fire. Open areas had been created and maintained for agricultural use, and as a result of gathering and clearing for firewood. Fire, as applied by Native Americans to eastern ecosystems, largely ended at the time of European settlement. Naturally occurring fires were also suppressed. Subsequent changes in fire regimes had profound ecological effects on forests (Abrams 1996) and grasslands (Tyndall 1992, Latham et al. 1996, Askins 1997) in the eastern U.S. In the absence of periodic fire, landscapes in the east changed rapidly from grasslands to woodlands and dense forests. The absence of fires allowed for the development of dense forest undergrowth. Changes in forest ecology and land-use practices also changed the nature of the fires that occurred. Heavier fuel loadings and a lack of periodic burns to reduce fuel build-up, changed the eastern U.S.

fires from frequent, low-intensity fires to less-frequent, higher-intensity fires. Fire protection and prevention accompanied increasing settlement and urbanization. An end to burning also coincided with conversion of lands for agriculture or residential development, resulting in large-scale fragmentation and loss of habitat. Remaining fire-influenced natural communities have undergone major changes in vegetation structure, including loss of biological richness and invasion by nonnative plants (Vogl 1974, Ladd 1997, Wildland Fire Associates 2008).

Fire Season and Occurrence

Historically, the fire season for the eastern U.S. began in the early spring, before green-up, with the passage of dry, cold fronts. This was followed by a period of nonactivity due to green-up, which continued through much of the summer and then resumed in the fall with the curing of grasses and deciduous vegetation. Weather-related events, primarily drought, have occasionally resulted in breaks in this pattern. Drought and the accumulation of fuels as a result of insect infestation or storm damage are the primary potential contributors to wildfire on the refuge.

Historical documentation of wildfire occurrence on the refuge is minimal. Nevertheless, it is likely that fire historically influenced forest habitats in the Mid-Atlantic (Frost 1998) including areas of the inner coastal plain (Komarek 1968). Frost (1998) estimated that fire frequency in pre-settlement, central Maryland occurred at intervals of every 7 to 12 years. In addition to natural fire occurrence, Tyndall (1992) noted that there is considerable historical evidence of Native American burning in Maryland (Wildland Fire Associates 2008).

2.4 Wildlife

Species of Greatest Conservation Need

The following outlines species of greatest conservation need as listed in the Maryland Wildlife Diversity Conservation Plan.

Fifty-four species of invertebrates, birds, reptiles and amphibians listed as species of greatest conservation need are found in the refuge’s floodplain forests. Twenty-eight are priority bird species listed in either the BCR 30 or PIF 44 implementation plans. Forty-one species of invertebrates, birds, reptiles and amphibians listed as species of greatest conservation need are found in the refuge’s upland forests. Twenty-one are priority bird species listed in either the BCR 30 or PIF 44 implementation plans.

Nine species of birds listed as species of greatest conservation need are found in the refuge’s shrub habitats. Six are priority bird species listed in either the BCR 30 or PIF 44 implementation plans.

Table 2-4. Species of Greatest Conservation Need by Habitat Type

Habitat Type	Invertebrates	Birds	Amphibians and Reptiles	Mammals	Total
Grasslands	0	14	0	1	15

Habitat Type	Invertebrates	Birds	Amphibians and Reptiles	Mammals	Total
Floodplain	24	27	3	0	54
Upland	1	39	1	0	41
Shrub/Scrub	0	9	0	0	9
Streams/Rivers	22	4	3	0	29
Savannah	0	1	0	0	1
Emergent Wetlands	8	6	0	0	14
Impounded Wetlands	22	21	0	0	43

Invertebrates

Since the establishment of the refuge Central Tract, at least 1,222 species of invertebrates in 131 families have been identified on the refuge. At least 1,171 species of arthropods in 114 families and about 29 species of aquatic invertebrates have been identified.

At least 115 species of Odonata (86 species of dragonflies and 29 species of damselflies) in 10 families have been documented on the refuge. Fifty-three of these possess a global or State ranking in Maryland's natural heritage program. State-listed endangered and threatened species include Martha's pennant (*Celithemis martha*), slender baskettail (*Epithea costalis*), robust baskettail (*Epithea spinosa*), little blue dragonlet (*Erythrodiplax miniscula*), elfin skimmer, southern sprite (*Nehalennia integricollis*), Appalachian snaketail (*Ophiogomphus incurvatus incurvatus*), spadderdock darner (*Rhinoaeschna mutata*), treetop emerald (*Somatochlora provocans*), green-striped darner (*Aeshna verticalis*), double-ringed pennant (*Celithemis verna*), arrowhead spiketail (*Cordulegaster oblique*), taper-tailed darner (*Gomphaeschna antilope*), rapids clubtail (*Gomphus quadricolor*), sable clubtail (*Gomphus rogersi*), Selys' sunfly (*Helocordulia selysii*), yellow-sided skimmer (*Libellula flavida*), sphagnum sprite (*Nehalennia graclis*), fine-lined emerald (*Somatochlora filosa*), and Laura's clubtail (*Stylurus laurae*) (Orr 1996).

There are 85 species of butterflies that have been documented on the refuge and there are also 19 potential species that may be found on the refuge. Nine species that had once been considered potential species have been documented on the refuge and include two subspecies of spring azure (*Celastrina ladon ladon* and *C. ladon neglecta*), hackberry emperor (*Asterocampa celtis*), Baltimore checkerspot (*Euphydryas phaeton*), compton tortoiseshell (*Nymphalis vaualbum*), confused cloudywing (*Thorybes confuses*), Delaware skipper (*Anatrytone logan*), hobomok skipper (*Poanes hobomok*), long dash (*Polites mystic*), and whirlabout (*Polites vibex*) (Martin 2001, 1996). The Baltimore checkerspot is a State-listed rare and imperiled species and, although documented in the past, its continued presence is uncertain. The abundance of moth species is reflective of the heavy forest cover with at least 264 species recorded in 20 families (Ferguson 1992, 1994, 1996).

Native bees and wasps are important pollinators and warrant conservation attention. At least 155 bee species and 23 wasp species are documented (Droege personal communication). About 18 regionally rare native bees are likely or suspected to occur in the sandy soils of the oak-pine savannah restoration area, based on discoveries in similar habitat types found locally (Droege et al. 2009).

Beetles are well-represented on the refuge, with 333 species in 19 families. Some rare darkling beetles in the Tenebrionid family have been observed in sandy soil areas of the North Tract, as well as several species of tiger beetles (Droege et al. 2009; refuge data on file).

Spiders total about 19 species and include wolf spiders (*Hogna aspersa*), orb weavers (*Araneus* spp.), and nursery web (*Pisaurina mira*) spiders. At least 83 species of flies, midges, and gnats, and two species of mosquitoes have been identified (Patuxent Research Refuge Master Species List 2012, refuge data on file).



Emerald Tiger Beetle

USFWS

Amphibians and Reptiles

Refuge-wide, there are 53 documented species of reptiles and amphibians on the refuge; 17 snakes, 5 lizards, 8 turtles, 13 frogs and toads, and 10 salamander species. For a complete list of known amphibian and reptile species, please refer to the refuge species list (Hotchkiss and Stewart 1979, E. Grant 2011 personal communication).

The status of populations of vernal-pool breeding amphibians is the focus of a long-term monitoring program, initiated in its current form in 2004. Each spring, 65 vernal pools are visited to determine the occupancy of wood frog and spotted salamander egg masses. Egg masses of wood frogs and spotted salamanders are easily distinguished due to the time of deposition, gross morphology, and because they have high detection probabilities (Crouch and Paton 2000, Grant et al. 2005). Anuran call count surveys have been conducted since the early 2000s (E. Grant 2011 personal communication).

Stream salamanders were sampled in 2003 to 2004 on the refuge, though the number of sites and visits were too small for formal analysis. Species detected during these and others surveys include northern two-lined salamander (*Eurycea bislineata*), long-tailed salamander (*E. longicauda*), and northern dusky salamander (*Desmognathus fuscus*) (E. Grant 2011 personal communication).

Based on data from amphibian occupancy trends on Patuxent Research Refuge from 2004 to 2010, wood frog occupancy declined in 2008 to 2009, but rebounded to near the regional average in recent years, while spotted salamander occupancy closely tracks the regional average. The recommendation is to continue monitoring existing vernal pool sites (Grant 2011 refuge files). Approximately 43 percent of amphibian species are in decline, with one in three species in threat of extinction. Emerging infectious diseases are

partly responsible for some of these declines such as chytridiomycosis (chytrid) and amphibian ranaviral disease, the latter accounting for the majority of the die-offs. The extent to which these diseases affect amphibians on study refuges is still being determined. Samples taken on the refuge in 2011 during multiple, refugewide die-off events are being analyzed. Sampling will continue at all occupied vernal pools 30 and 60 days after breeding activity (Grant 2011).

Other amphibian species encountered on the refuge include northern cricket frog (*Acris crepitans*), gray treefrog (*Hyla versicolor*), pickerel frog (*Lithobates palustris*), southern leopard frog (*Lithobates sphenoccephalus*), green frog (*Lithobates clamitans*), American bullfrog (*Lithobates catesbeiana*), American toad (*Anaryxus americanus*), Fowler's toad (*Anaryxus fowleri*), spring peeper (*Pseudacris crucifer*), upland chorus frog (*Pseudacris feriarum*), marbled salamander (*Ambystoma opacum*), four-toed salamander (*Hemidactylium scutatum*), and eastern newt (*Notophthalmus viridescens*) (E. Grant 2011 personal communication).

Birds

Since refuge establishment, over 270 species of birds have been recorded on the refuge. However, with the closure of a nearby landfill in the past decade, approximately 27 species of gulls and shorebirds have disappeared, bringing the most current total to 248 species of birds in 48 families. Of these, there are a few that are extremely rare or may no longer be present, such as Henslow's sparrow (*Ammodramus henslowii*) and cerulean warbler (*Dendroica cerulean*). Increasing forest fragmentation in the area due to escalating urban development in central Maryland and northern Virginia has negatively impacted many populations of neotropical migratory birds. The refuge is one of the largest forested areas in the Mid-Atlantic region and provides critical breeding habitat and an important nesting area for these species (refuge bird data, USGS bird data on file, Wildland Fire Associates 2008).



Ohio DNR

Cerulean Warbler

To develop a list of bird species and priority birds for the CCP habitat goals and objectives, observations from breeding bird surveys, Christmas bird counts, spring and fall mist netting operations, integrated waterbird monitoring and management, long-term waterbird surveys, and evening woodcock and whip-poor-will surveys are used. We then consulted the list of priority birds provided in the BCR 30 plan and the species of greatest conservation need identified in the Maryland State wildlife action plan. In this way, a subset of priority bird species for the refuge could be identified. Some of the birds associated with each habitat type may not be breeders, but use the refuge during winter or migration. It is expected that the refuge's proximity to BCR 29 may result in birds from that region occasionally occurring on the refuge. For refuge planning purposes, we used only BCR 30. Please refer to the complete bird species list for the refuge in appendix A.

Fish

The refuge is home to at least 55 species of fish in 12 families. The majority of species found are those inhabiting bottomland pools and impoundments, rather than clear-running water and include species such as bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), catfish (*Ictalurus nebulosus*), black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), chain pickerel (*Esox niger*), shad (*Alosa sapidissima*), carp (*Cyprinus carpio*), and yellow perch (*Perca flavescens*) (Hotchkiss and Stewart 1979, USFWS 1989, MD DNR 1995, Freeman 1997). Blueback herring (*Alosa aestivalis*) have not been discovered on the refuge but they are documented upstream in Howard County (Richards 1994). This anadromous fish would have had to swim through the refuge at some point to get to the Howard County portion of the Patuxent River; the same holds true for hickory shad (*Alosa mediocris*) and white crappie, which occur both up and downstream of the refuge (Fort Meade 1997).

Other species that have been documented in the past include least brook lamprey (*Lampetra aepyptera*), sea lamprey (*Petromyzon marinus*), American eel (*Anguilla rostrata*), alewife (*Alosa pseudoharengus*), eastern mudminnow (*Umbra pygmaea*), redbfin pickerel (*Esox americanus*), rosyside dace (*Clinostomus funduloides*), cutlips minnow (*Exoglossum maxillingua*), silvery minnow (*Hybognathus nuchalis*), river chub (*Nocomis micropogon*), golden shiner (*Notemigonus crysoleucas*), comely shiner (*Notropis amoenus*), satinfin shiner (*Cyprinella analostana*), common shiner (*Notropis cornutus*), spottail shiner (*Notropis hudsonius*), swallowtail shiner (*Notropis procne*), blacknose dace (*Rhinichthys atratulus*), languase dace (*Rhinichthys cataractae*), fallfish (*Semotilus corporalis*), white sucker (*Gatostomus commersoni*), creek chubsucker (*Erimyzon oblongus*), northern hog sucker (*Hypentelium nigricans*), short-head redhorse (*Moxostoma macrolepidotum*), white catfish (*Ictalurus catus*), brown bullhead (*Ameiurus nebulosus*), channel catfish (*Ictalurus punctatus*), tadpole madtom (*Noturus gyrinus*), margined madtom (*Noturus insignis*), mosquito fish (*Gambusia affinis holbrooki*), pirate



Duane Raver/USFWS

Pumpkinseed

perch (*Aphredoderus sayanus*), bluespotted sunfish (*Enneacanthus gloriosus*), redbreast sunfish (*Lepomis auritus*), green sunfish (*Lepomis cyanellus*), pumpkinseed (*Lepomis gibbosus*), warmouth (*Lepomis gulosus*), Johnny darter (*Etheostoma nigrum*), glassy darter (*Etheostoma vitreum*), stripe back darter (*Petclna notogramma*), and shield darter (*Percina peltata*) (Hotchkiss and Stewart 1979, Freeman 1997).

In early November 2011, with the assistance of the Maryland Fisheries Resource Office and Chesapeake Bay Field Office, fish samplings were conducted in the shallow impoundments of the refuge using back-pack shockers. No new species were discovered from previous surveys. Species identified from this survey are listed in table 2-5.

Table 2-5. Fish Species Identified in Shallow Impoundments

Common Name	Scientific Name
Black crappie	<i>Pomoxis nigromaculatus</i>
Bluegill	<i>Lepomis macrochirus</i>
Bluespotted sunfish	<i>Enneacanthus gloriosus</i>
Brown bullhead	<i>Ameiurus nebulosus</i>
Eastern mosquitofish	<i>Gambusia holbrooki</i>
Eastern mudminnow	<i>Umbra pygmaea</i>
Green sunfish	<i>Lepomis cyanellus</i>
Largemouth bass	<i>Micropterus salmoides</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Satinfin shiner	<i>Cyprinella analostana</i>
Warmouth	<i>Lepomis gulosus</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
American eel	<i>Anguilla rostrata</i>
Pickerel spp.	<i>Esox spp.</i>

Mammals

At least 38 species of mammals in 13 families are known to inhabit the refuge (Hotchkiss and Stewart 1979, refuge surveys and unpublished data). Of these, the eastern harvest mouse (*Reithrodontomys humulis*) may no longer be present as it might be locally extirpated. A pilot survey for bats was conducted on the refuge in September 2010; no new species were identified.

While not officially documented, coyotes (*Canis latrans var.*) have been infrequently observed by hunters on the refuge.

Priority Species of Concern in Refuge Habitats

Floodplain Forest and Swamps and Depressional Wetlands

Eastern red bat – Typically occupies forest habitat with canopies 4 to 19 feet (1.5 to 6 meters) above the ground and open underneath for summer roosting.

Little brown bat (*Myotis lucifugus*) – Roosts in trees but forages over water.

Prothonotary warbler (*Protonotaria citrea*) – Inhabits mature deciduous floodplain and riverine and swamp forests (DeGraaf et al. 1980, Christman 1984). This secondary cavity nester (uses existing cavities) is the only cavity-nesting warbler in the western hemisphere. Trees must be mature enough to accommodate suitably sized cavities. This species prefers nest trees in or near standing water. They are present during breeding and migration.

Acadian flycatcher (*Empidonax virescens*) – Typically occupies moist deciduous forests along streams or rivers, often building nests in twigs or branches that overhang the water. This species also occurs within the entire gradient of forested wetlands and is generally associated with closed-canopy forests with an open understory. They are present on the refuge during breeding and migration.

Cerulean warbler – This is a species of high conservation concern and requires extensive mature hardwood forests with a broken, structurally diverse canopy. Coastal plain populations typically use mature hardwoods associated with the floodplain (Lynch 1981, Robbins and Blom 1996). This species nests and forages within the upper portions of the canopy, utilizes some of the largest trees available, and appears to have one of the largest forest area requirements among the priority species (Robbins et al. 1992). They may be present on the refuge during breeding and migration. The refuge does not lie at the core of this species range, but a few cerulean warblers were consistently observed during the breeding season in large, mature trees along the Patuxent River, although not in recent years (J. Fallon 2011 personal communication).

Kentucky warbler (*Geothlypis formosaformosus*) – Prefers moist deciduous forests with a well-developed understory and dense ground cover (McDonald 1998). Breeding Kentucky warblers formerly were scattered through the Patuxent River floodplain, but now are mostly restricted to scattered locations on the North Tract (D. Dawson, personal communication). They are present on the refuge during breeding and migration.

Louisiana waterthrush (*Parkesia motacilla*) – Occupies moist deciduous forests along streams and will also utilize forested wetlands, placing nests along stream banks or amongst the roots of upturned trees. Forages in or along moving water, gleaning insects from the surface of rocks, mud, or water (Hamel 1992, Mattsson et al. 2009). They are present on the refuge during breeding and migration.

Rusty Blackbird – Dave Menke



Rusty blackbird (*Euphagus carolinus*) – Uses forested wetlands and bogs, often wading to feed on aquatic life. This species also flocks with other blackbird species in open fields in winter and is considered to be a rapidly declining species. They are present on the refuge during winter.

Upland Deciduous, Pine, and Mixed Forests and Associated Forested Wetlands

Silver-haired bat (*Lasionycteris noctivagans*) – Migrates through the refuge, seeking out shelter in loose bark, rock crevices, clumps of leaves, tree cavities, and occasionally man-made structures such as sheds and outbuildings.

Eastern spadefoot (*Scaphiopus holbrookii*) – Requires vernal pools for breeding and foraging habitat.

Eastern box turtle (*Terrapene carolina*) – Requires large blocks of unfragmented forest, preferring upland mixed hardwood forest juxtaposed with early succession, grassy openings for basking and foraging on herbaceous vegetation.

Acadian flycatcher – Typically occupies moist deciduous forests along streams or rivers, but also occurs in upland forests. It is generally associated with closed-canopy forests with an open understory. They are present on the refuge during breeding and migration.

Eastern whip-poor-will (*Caprimulgus vociferus*) – Nests in mature deciduous forest, and forages in forest openings, including roadways and powerline right-of-ways, on moth species, especially if the openings are backlit by moonlight (Wilson and Watts 2008). Patuxent is designated as an important bird area as it contains the most significant population of this declining species in Maryland.

Scarlet tanager (*Piranga olivacea*) – Requires a forested patch size of at least 250 contiguous acres (101 hectares). High-suitability forest habitat would be 70 percent forested in a 2,500-acre (1,000-hectare) block (Rosenberg et al. 1999). This species is a mature canopy forager and breeder.

Yellow-throated vireo (*Vireo flavifrons*) – Prefers open forest and forested edge habitat, while requiring large blocks of mature mixed deciduous forest to breed successfully.

Cerulean warbler – This is a species of high conservation concern and requires extensive mature hardwood forests with a broken, structurally diverse canopy. Coastal plain populations typically use mature hardwoods associated with the floodplain (Lynch 1981, Robbins and Blom 1996). This species nests and forages within the upper portions of the canopy, utilizes some of the largest trees available, and appears to have one of the largest forest area requirements among the priority species (Robbins et al. 1992). They may be present on the refuge during breeding and migration. The refuge does not lie at the core of this species' range, but a few cerulean warblers were consistently observed during the breeding season in large, mature trees along the Patuxent River, although not in recent years (J. Fallon 2011 personal communication).

Eastern wood-pewee (*Contopus virens*) – Utilizes the entire gradient of forestlands that occur within the Mid-Atlantic Coastal Plain. Across their entire range, pewees have been shown to reach higher densities within dry, compared to moist, forests (Bond 1957, PIF Bird Conservation Plan - Mid-Atlantic Coastal Plain 40 Robbins et al. 1989, Murray and Stauffer 1995). This species generally prefers forests with a relatively open canopy or forests with canopy gaps (Best and Stauffer 1986) and with relatively low shrub cover (Crawford et al. 1981). Patch size does not appear to be an important factor in habitat selection (Blake and Karr 1987, Robbins et al. 1989). They are present on the refuge during breeding and migration.

Louisiana waterthrush – Occupies moist deciduous forests along streams and will also utilize forested wetlands. The species also requires moderate to sparse vegetation along moving water. They are present on the refuge during breeding and migration.

Wood thrush (*Hylocichla mustelina*) – One of the key indicator species for the entire gradient of upland forests from hardwood-dominated to pine-dominated. They are present on the refuge during breeding and migration, foraging on or near the ground and nesting in small trees or in the lower canopy.



Wood Thrush – Steve Maslowski

Worm-eating warbler (*Helminthos vermivorum*) – Requires dense understory vegetation for breeding. This species is generally associated with dry, well-drained hardwood forests, often with steep slopes (typically more than 20 degrees) (Hall 1983, Greenberg 1987). They are present on the refuge during breeding, mostly on the North Tract, and migration.

Emergent and Shrub Wetlands, and Coastal Plain Bogs

American black duck (*Anas rubripes*) – Nests within a variety of habitats, including uplands near water and freshwater marshes. They are present on the refuge year-round.

Least bittern (*Ixobrychus exilis*) – This is an elusive marsh bird of conservation concern in most Atlantic states. This species is present on the refuge during breeding and winters in the south. It requires freshwater or brackish marshes with tall emergent vegetation dense enough to camouflage its nest. This species' nests are attached to vegetation just above high water level.

Any plants that are characteristically associated with the open and forested bogs would be targeted for conservation. This includes such species as spatulate-leaved and round-leaved sundew (*Drosera intermedia* and *Drosera rotundifolia*), white-fringed orchid (*Blephariglottis blephariglottis*), and swamp pink (*Hibiscus palustris*). Animals include the minute bog beetle and elfin skimmer, which are two rare species associated with bogs and wetlands. The minute bog beetle is not documented on the refuge, but most live exclusively on sphagnum bogs and seeps and it is expected in coastal plain bogs and marshes of Maryland (MD DNR http://www.dnr.state.md.us/wildlife/Plants_Wildlife/bogs.asp; accessed January 2012).

The elfin skimmer is a small damselfly that favors more open bogs, preying on the insects that specialize on bog plantlife. It has been documented on the refuge (Orr 1996).

Shrub and Early Successional Forests

American woodcock – Utilizes early successional forests for breeding and foraging, and grassy openings near forest edge for territorial display flight. It is considered a species of conservation concern due to its preferred habitat needs and because it is a game species. It feeds on invertebrates, especially earthworms. This species is present on the refuge during breeding and may winter on the refuge as well.

Brown thrasher – Brown thrashers occur in dense woody vegetation associated with shrub thickets, hedgerows, forest edges, or mid-successional forests (Graber et al. 1970, James 1971, Shugart and James 1973, Temple et al. 1979, Stauffer and Best 1980, Faanes 1983). On the refuge, they also use the shrub habitats maintained on the powerline right-of-ways. They are present on the refuge year-round, although generally quite rare in winter.

Eastern towhee – Prefers brush, tangles, thickets along forest edge, and hedgerows. On the refuge, towhees also use the shrub habitats maintained on the powerline right-of-ways. The species is present on the refuge year-round.

Field sparrow – Utilizes successional stages with moderate to substantial intrusion by woody shrubs and saplings (Watts 1999). On the refuge, they also use the shrub habitats maintained on the powerline right-of-ways. This species is present on the refuge year-round.

Gray catbird (*Dumetella carolinensis*) – Prefers brush, tangles, vines, and thickets along forest edges and dense shrub habitat. On the refuge, they predominantly use the shrub habitats maintained on the powerline right-of-ways. It is present on the refuge during the breeding season and migration, and rarely during the winter.

Prairie warbler – Utilizes successional stages with moderate to substantial intrusion by woody shrubs and saplings (Watts 1999). On the refuge, prairie warblers also use the shrub habitats maintained on the powerline right-of-ways. This species is present on the refuge during breeding and migration.



Prairie Warbler – Bill Thompson

Grasslands and Old Field Habitats

Migrating and wintering birds of conservation concern include savannah sparrow (*Passerculus sandwichensis*), swamp sparrow (*Melospiza georgiana*), bobolink (*Dolichonyx oryzivorus*), and dickcissel (*Spiza americana*). Breeding species include yellow-breasted chat (*Icteria virens*), eastern kingbird, and field sparrow.

Coastal Plain River and Stream Habitats

American shad (*Alosa sapidissima*) – Can travel hundreds of miles upstream to spawn. Blockages on spawning rivers by dams and other impediments, degradation of water quality, and overfishing have depleted stocks of American shad. Presently, the Susquehanna, Nanticoke, and Patuxent Rivers are the primary systems that support viable American shad stocks in Maryland. Spawning occurs in areas where the bottom substrate often consists of sand, silt, and muck (MD DNR 2007).

American brook lamprey (*Lampetra appendix*) – Threatened in Maryland and found within slow-moving, warm-water streams with forested edges on the coastal plain (south of I-95) in Maryland. Adults spawn (make a nest in gravel then lay and fertilize eggs) in late March or early April and die soon after. The eggs hatch into larvae, called ammocetes. Lamprey may exist as an ammocete for up to seven years, feeding on algae, before undergoing metamorphosis into its adult form during late summer. Spawning occurs soon after metamorphosis (MD DNR 2010).

Glassy darter – Suitable habitat consists of 1st- to 3rd-order streams with gravel and sand substrates (Killen 1992). This species is excluded from areas when development increases siltation (MD DNR 2005b). Historically, glassy darter ranged from North Carolina to the Patuxent River watershed (Lee et al. 1980).

Triangle floater (*Alasmidonta undulata*) – The triangle floater is a State-endangered freshwater mussel. Freshwater mussels are the most imperiled aquatic taxa in Maryland, and this particular mussel is only known to exist in a handful of locations within seven river basins, including the nearby Patapsco River basin. The triangle floater is commonly found in flowing water, where it occupies a wide range of substrate and flow conditions. Its preferred habitats include low-gradient river reaches with sand and gravel substrates and low to moderate water velocities. It has been found in streams smaller than 16 feet wide (5 meters) and rivers wider than 328 feet (100 meters) (Nedeau 2007). Because they are so sensitive to pollution, their presence in a water body is a good indicator of clean water.

Native crayfish – Spiny-cheeked crayfish (*Oronectes limosus*), once widespread in Atlantic watersheds, is being displaced by the invading rusty crayfish. Spiny-cheeked crayfish inhabit clear streams that are 33 to 328 feet wide (10 to 100 meters) with silt, cobble, gravel, and sand substrates. Individuals are often found in shallow depressions in pools and have rarely been captured where silt is absent from the substrate (see the International Union for Conservation of Nature Red List at: <http://www.iucnredlist.org/apps/redlist/details/153764/0/print#sectionHabitat>; accessed January 2012).

Oak-Pine Savannah

Species would include those that are associated with dry, sandy, well-drained soils and are adapted to relatively poor soils. In this area some rare Tenebrionid beetles (darkling beetle species) have been discovered, as well as several species of native bees and lepidopterans. Bird species that favor early succession forest and shrub described above will be primary beneficiaries of this habitat (Droege et al. 2009).

2.5 Federal and State Threatened and Endangered Species

The Federal list of endangered species includes two plants that may occur on the refuge: sensitive joint vetch (*Aeschynomene virginica*) and sandplain gerardia (*Agalinis acuta*). Sensitive joint vetch is documented in both Prince George's and Anne Arundel Counties and its local distribution range encompasses the refuge (ECOS 2011).

On the State list, there are 29 animal and 151 plant species listed as rare, threatened, or endangered in Prince George's County. Ten of the animal species are threatened or endangered, as are eighty-five plant species for the county (MD DNR 2010).

There are 11 animal and 124 plant species listed by the State of Maryland as rare, threatened, or endangered in Anne Arundel County.

There is a high diversity of dragonflies and damselflies (Odonata) on the refuge, several of which are State-threatened or rare species. At least eight species of these Odonata are listed on Prince George's County list, such as elfin skimmer and sable clubtail (MD DNR 2010). Other State-listed insects that are likely for the refuge include green-patterned tiger beetle (*Cicindela ocellata rectilatera*), red-legged purse spider (*Sphodros rufipes*), and a noctuid moth. Listed amphibians and reptiles include eastern tiger salamander (*Ambystoma tigrinum*), northern map turtle, (*Graptemys geographica*), and red-bellied water snake (*Nerodia erythrogaster*). However, these species have not been documented on the refuge. Mammals include southern pygmy shrew (*Sorex hoyi winnemana*) and eastern harvest mouse. Fish include stripeback (*Percina notogramma*) and glassy darter. Birds include American and least bittern (breeding), and sora (*Porzana Carolina*) (migration) (MD DNR 2010).

The formerly federally listed American bald eagle (*Haliaeetus leucocephalus*) is occasionally observed on the refuge and nests nearby on the Beltsville Agricultural Research Center and further down the Patuxent River.

The complete list of State rare, threatened, or endangered, animal and plant species for Prince George's and Anne Arundel Counties, compiled by the Maryland Wildlife and Heritage Service in 2010 can be found on the Maryland Department of Natural Resources (MD DNR) Web site at: http://www.dnr.state.md.us/wildlife/Plants_Wildlife/espaa.asp; accessed February 2012.

2.6 Special Management Areas

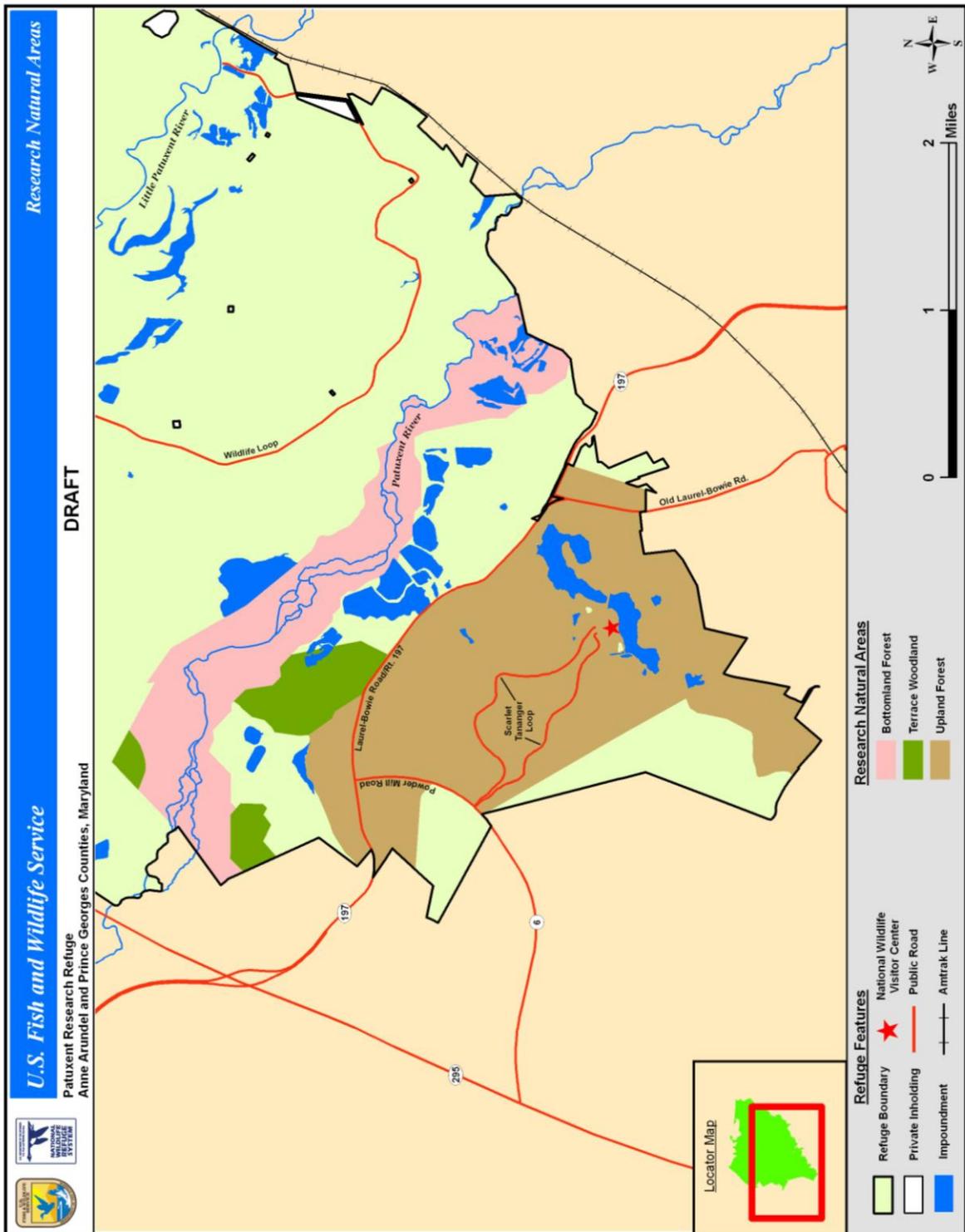
Wilderness

There is no congressionally designated wilderness on the refuge. The refuge has completed a wilderness review (appendix B) as a part of this CCP process.

Research Natural Areas

The Service administratively designates research natural areas, which are part of a national network of reserved areas under various ownerships. While there are no specific restrictions on uses or management of research natural areas, they are intended to serve as examples of significant natural ecosystems, compared with those influenced by man, to provide educational and research areas for scientists, and to serve as gene pools and preserves for rare and endangered species of plants and animals. Research natural areas established at the refuge include bottomland forest (1,000 acres), terrace woodland (250 acres), and upland forest (1,700 acres) (map 2-5).

Map 2-5. Research Natural Areas of Patuxent Research Refuge



2.7 Public Use Resources and Trends

Public Use Facilities

National Wildlife Visitor Center

The NWVC is one of the largest science and environmental education centers operated by the Department. NWVC is designed to provide visitors with knowledge and appreciation of the role of wildlife research and management in preserving natural resources. It features interactive exhibits which focus on global environmental issues, migratory bird studies, habitats, endangered species, the tools and techniques used by scientists, and the role of the Refuge System in wildlife conservation. A viewing pod, with a large picture window overlooking Lake Redington, offers spotting scopes and binoculars for visitors to see waterfowl and other wildlife.



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National Wildlife Visitor Center

A large auditorium and meeting rooms accommodate scientific conferences and meetings, teacher workshops, lectures, and traveling displays. *Wildlife Images*, a bookstore operated by the Friends of Patuxent (a nonprofit cooperating association) offers a variety of conservation gifts, books, and other educational materials. NWVC grounds offer seasonal tram tours, wildlife management demonstration areas, and outdoor education sites for school classes. A schoolyard habitat adjacent to NWVC highlights conservation landscaping practices and provides an additional outdoor learning space. It is open daily from 9 a.m. until 4:30 p.m., Monday to Saturday. Wildlife observation trails are open daily from sunrise to 4:30 p.m. Both the NWVC and grounds are closed on Federal holidays.

Visitor Contact Station

The Visitor Contact Station is located at the entrance to North Tract. All visitors must check in to receive an access pass. Visitors are also provided with an orientation to the refuge, including what activities are allowed, public use opportunities, and relevant seasonal information. A schedule of monthly activities and events is available at NWVC

and online at: <http://www.fws.gov/northeast/patuxent/vcdefault.html>; last accessed March 2012.

Meade Natural Heritage Association Hunting Control Station

The Meade Natural Heritage Association Hunting Control Station is located on Bald Eagle Drive. At the control station, hunters can purchase permits, sign-in and sign-out on hunt visits, and record information on the animals harvested.

North Tract Environmental Education Classroom

At the North Tract, an environmental education classroom is located along Wildlife Loop. Throughout the year, a variety of staff and volunteer-led environmental education and interpretive programs are held here. A schedule of monthly activities and events is available at the Visitor Contact Station and online at:

<http://www.fws.gov/northeast/patuxent/ntedu.html>; accessed January 2012.

Wildlife-dependent Priority Public Uses

The National Wildlife Refuge System Administration Act, as amended, lists six priority public uses on refuges that are to receive enhanced consideration over all other general public uses in planning and management – hunting, fishing, wildlife observation and photography, and environmental education and interpretation. When found compatible, these priority wildlife-dependent recreational uses are to be strongly encouraged (see chapter 1, section on compatibility determinations and findings of appropriateness). All six priority uses are offered at the refuge.

North Tract

The North Tract offers a variety of wildlife-related recreational activities including wildlife observation and photography, fishing, hiking, bicycling, horseback riding, and cross-country skiing. Hunting opportunities include migratory game birds, upland game, white-tailed deer, and a spring wild turkey hunt. North Tract offers over 20 miles of roads and trails, as well as six fishing areas. In 1991, the Service obtained the North Tract from Fort Meade. The Department of the Army formerly used the property for military training and, although it has been swept, unexploded ordnance is still present. All visitors to North Tract must check in at the Visitor Contact Station to receive an access pass and to receive information, including the potential of encountering unexploded ordnance and refuge regulations. The North Tract is open daily, except Federal holidays, from 8 a.m. to 4 p.m. (unless otherwise posted).



Visitor Contact Station

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South Tract

The South Tract is the site of NWVC, hiking trails, and Cash Lake fishing area. Wildlife observation and photography occur on nearly five miles of nature trails and at several wildlife viewing areas. Environmental education and interpretive programs are offered on a regular basis. White-tailed deer hunting is offered seasonally as well. The South Tract is open daily, except Federal holidays, from sunrise to 4:30 p.m. (unless otherwise posted).

Wildlife Conservation Interpretive Tram

Guided electric tram tours, operated by the Friends of Patuxent, are offered seasonally from early spring to late fall. Visitors can purchase tram tickets for a nominal fee at the *Wildlife Images* bookstore in the lobby of NWVC. The tour begins at NWVC and travels through a variety of habitats surrounding Lake Redington. As the tram encounters different habitats, the on-board interpreter discusses each habitat and its wildlife



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inhabitants, how habitats change, and the threats encountered by native plants and wildlife. The tour also describes the refuge's wildlife conservation efforts and the research conducted by the PWRC. The tour concludes at the NWVC with an overview of practical conservation efforts that visitors can pursue to help protect wildlife and their habitats.

Wildlife Conservation Interpretive Tram

Hunting

The refuge's hunting program is administered by a cooperating association, the Meade Natural Heritage Association. The refuge administers the hunt in accordance with the refuge-specific regulations found at 50 CFR 32.39. The refuge provides hunting opportunities for migratory game bird, upland game, white-tailed deer, and spring wild turkey (map 2-6). Hunting is permitted from September through January, based on Maryland State hunting seasons, and in April and May for the spring wild turkey hunt. Hunters can purchase the appropriate refuge hunting permits through the Meade Natural Heritage Association at the North Tract's hunting control station on Bald Eagle Drive. In addition to purchasing a refuge hunting permit, all hunters must possess a valid Maryland State hunting license, verification of completion of a hunter safety course, and Maryland State shooters qualification card. Additional information, such as State and Federal migratory bird hunting and muzzleloader stamps, etc., may be required to participate in certain hunts. All hunters must comply with all State and Federal hunting regulations and laws. Additional information about the refuge hunt is available by phone at 301/317-3825 (301/317-3819 during the hunting season).

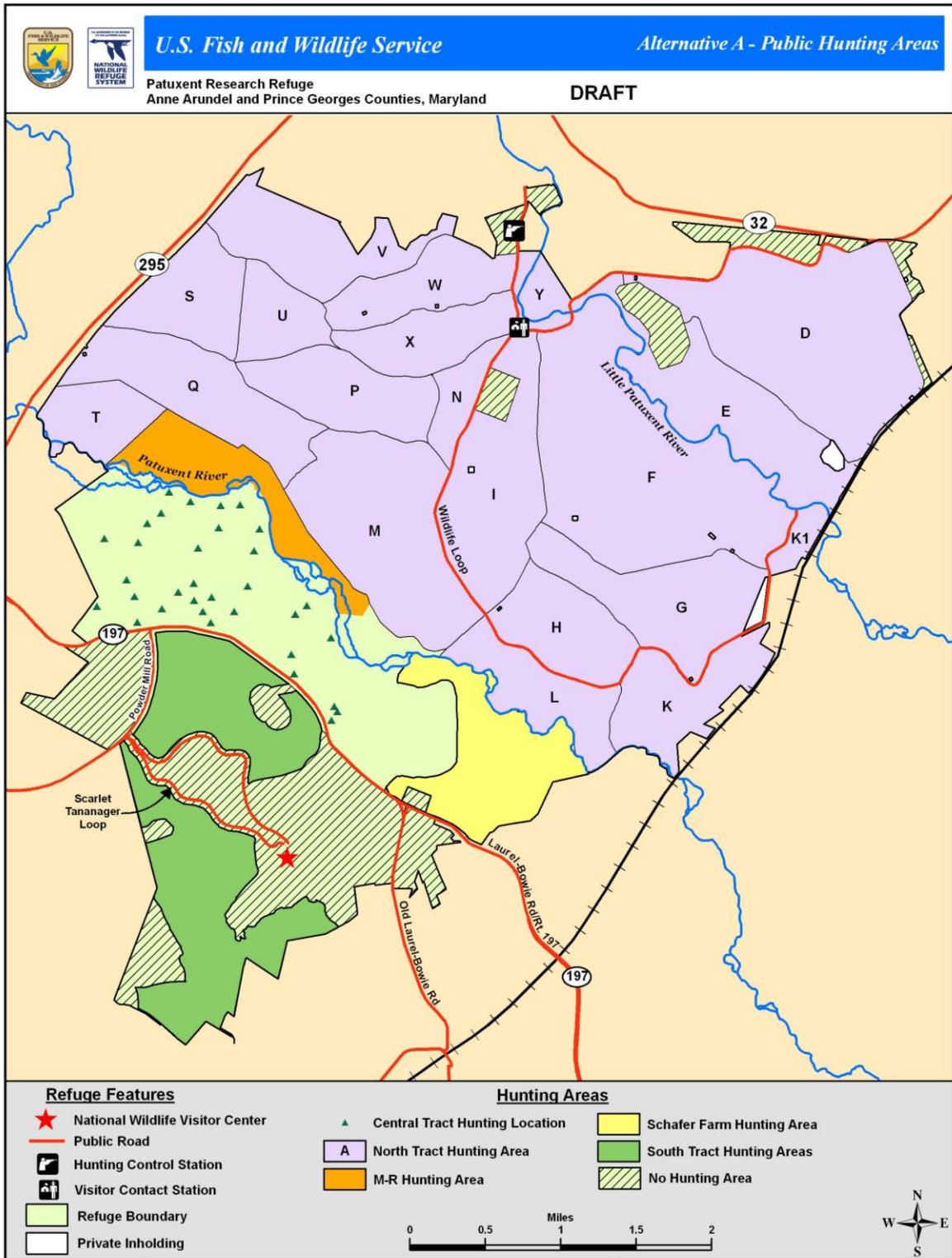
Hunting Opportunities by Refuge Tract

A variety of hunting opportunities are offered on each tract of the refuge (table 2-6). Please read the latest refuge hunting regulations (50 CFR 32.39) and the annual hunt plan for more information on each species, including hunting locations, lottery information, season lengths, and bag limits. Hunting regulations are available onsite and are posted online at: <http://www.fws.gov/northeast/patuxent/MNHA.html>; accessed January 2012.

Table 2-6. Hunting Opportunities Offered on each Tract at Patuxent Research Refuge

Tract	Species/Season
South	Deer (bow/crossbow/shotgun)
Central	Deer (bow/crossbow/shotgun) Spring wild turkey (youth/hunters with disabilities/general hunters)
North	Deer (bow/crossbow/muzzleloader/firearms) Youth deer (bow/firearms) Canada goose Mourning dove Duck Junior duck day Rabbit Woodchuck Gray squirrel Spring wild turkey (youth/hunters with disabilities/general hunters)

Map 2-6. Public Hunting Opportunities on Patuxent Research Refuge



Fishing

The North and South Tracts offer recreational fishing opportunities in seven designated fishing areas. Year-round fishing is permitted at the North Tract, while seasonal fishing is available on the South Tract. Common fish species on both tracts include bluegill, largemouth bass, catfish, black and white crappie, pickerel, shad, chub, carp, and yellow perch.

Anglers wishing to fish on the refuge must have a current Maryland nontidal fishing license and a seasonal refuge fishing permit. Refuge fishing permits are free and available at NWVC (starting in June, daily from 9 a.m. to 4 p.m., except Federal holidays) or at the North Tract Visitor Contact Station (daily from 8:30 a.m. to 3:30 p.m., except Federal holidays). The refuge prohibits the use of lead sinkers in all fishing areas and encourages anglers to catch and release all fish species. Anglers are permitted to use non-motorized boats on Cash Lake. Freshwater fishing and boating laws of the State of Maryland apply except as further restricted in refuge regulations.

Cash Lake Fishing Area

Cash Lake, universally accessible, is open for fishing from mid-June to mid-October. Summer hours are 6 a.m. to 8 p.m., while fall hours are 7 a.m. to 6:30 p.m. (unless otherwise posted). Common fish species at Cash Lake include bluegill, largemouth bass, catfish, black and white crappie, pickerel, shad, chub, carp, and yellow perch. Fishing is permitted from the fishing pier and shorelines on both sides of pier to posted signs along the shoreline. Boating is only allowed at Cash Lake to facilitate fishing. Electric motors must be less than four horsepower; gasoline motors are not permitted.

North Tract Fishing Areas

The North Tract offers year-round recreational fishing during the tract's hours of operation. Boats are prohibited on the North Tract. Universally accessible fishing is offered at Lake Allen, New Marsh, and the south side of Bailey Bridge.

- Lake Allen is a 13-acre (5-hectare) lake with shoreline access for fishing.
- Rieve's Pond is a spring-fed pond, open to foot-traffic only, and accessible via Kingfisher Road.
- New Marsh is a 5-acre (2-hectare) wetland complex with three ponds located off of Wildlife Loop.
- Cattail Pond and Bailey Bridge Marsh are located near the southeast corner of Wildlife Loop and offer opportunities to catch panfish and largemouth bass. Anglers are allowed to fish on the south side of Bailey Bridge and downstream only.
- Lower Little Patuxent River is downstream of Bailey Bridge and gives anglers the opportunity to fish the river for smallmouth bass, bluegill, and catfish. Wading is only allowed while fishing in this stretch of the river (approximately 500 yards).

More information on fishing at Patuxent Refuge is available online at: http://www.fws.gov/northeast/patuxent/fishing_refuge.html; accessed January 2012.

Wildlife Observation and Photography

Over 23 miles of trails and roads on the refuge offer extensive and diverse wildlife observation and photography opportunities for hikers, joggers, and cyclists (map 2-7 and 2-8). Visitors in automobiles can enjoy wildlife observation and photography along North Tract's Wildlife Loop and the South Tract's entrance and exit roads. Designated North Tract trails also offer bicycling, horseback riding, and cross-country skiing in order to facilitate observation of the refuge's wildlife. Wildlife-viewing areas on the South Tract and in the NWVC viewing pod offer relaxing opportunities to glimpse and photograph beavers, dragonflies, waterfowl, waterbirds, and other wildlife. A wildlife art show and sale, held each year by the Friends of Patuxent, showcases photography and the arts, while benefitting the PWRC and Patuxent Research Refuge missions. The art show and sale also accommodates the Maryland's black bear conservation stamp contest and the Maryland migratory game bird stamp contest.



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Loop Trail

North Tract Trails and Wildlife Viewing Blinds

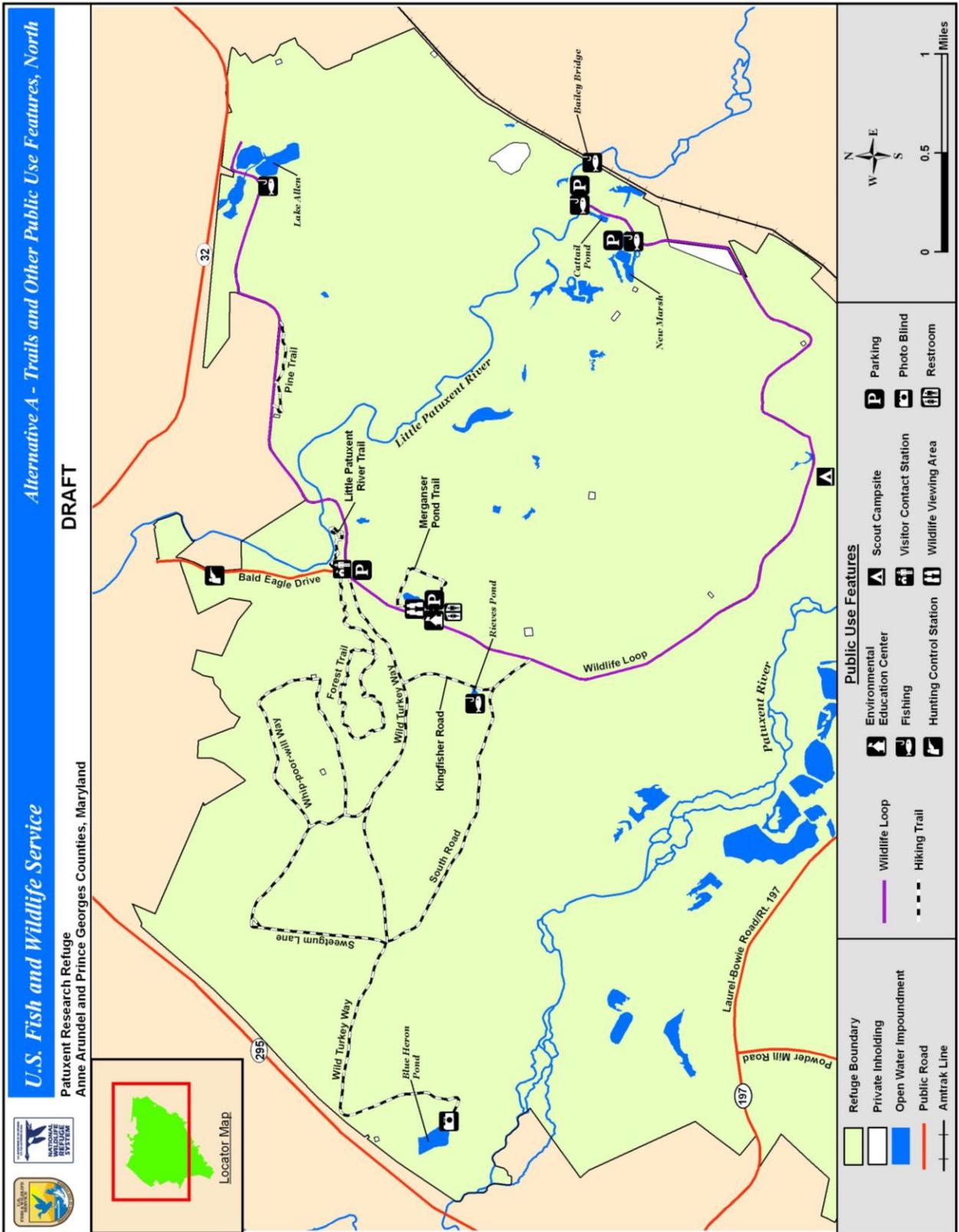
- Wildlife Loop (8 miles) is a paved scenic roadway originating at the Visitor Contact Station, and winding through upland meadow and forest habitat. Automobiles, hiking, bicycling, horseback riding, and cross-country skiing are permitted on the road. The wildlife viewing area, which includes a 35-acre wetland created by the Baltimore Gas and Electric Company, is located on the Wildlife Loop and provides scenic overlooks and opportunities to view wildlife such as waterfowl, shorebirds, raptors, and songbirds. Several wildlife exhibits and spotting scopes are also located at the wildlife viewing area.
- Little Patuxent River Trail (.75 miles) is a hiking-only trail starting at the Visitor Contact Station and meandering through bottomland hardwood forest habitat, with overlooks of the Little Patuxent River.
- Forest Trail (2.5 miles) is a loop-trail originating near the Visitor Contact Station. The hiking-only trail travels through a second-growth hardwood forest.
- Pine Trail (.75 miles) provides wildlife-viewing opportunities for hikers, cross-country skiers, and horseback riders. The trail links Wildlife Loop with the St. Peter's Church Cemetery.

- The Multi-use Trails (total 9.2 miles) allow hiking, bicycling, horseback riding, and cross-country skiing and include South Road, Wild Turkey Way, Sweetgum Lane, Whip-poor-will Way, and Kingfisher Road. These interconnected gravel and dirt roads cross a variety of different habitats in the western portion of North Tract, providing excellent wildlife observation opportunities.
- Blue Heron Pond Blind is an accessible blind located at the end of Wild Turkey Way. This blind overlooks Blue Heron Pond and its surrounding area and provides views of waterfowl, dragonflies, butterflies, and other wildlife.
- Merganser Pond Trail (.87 miles) is a loop trail around Merganser Pond located at the wildlife viewing area. The hiking-only trail travels by a green-tree reservoir, an open meadow, and Merganser Pond.

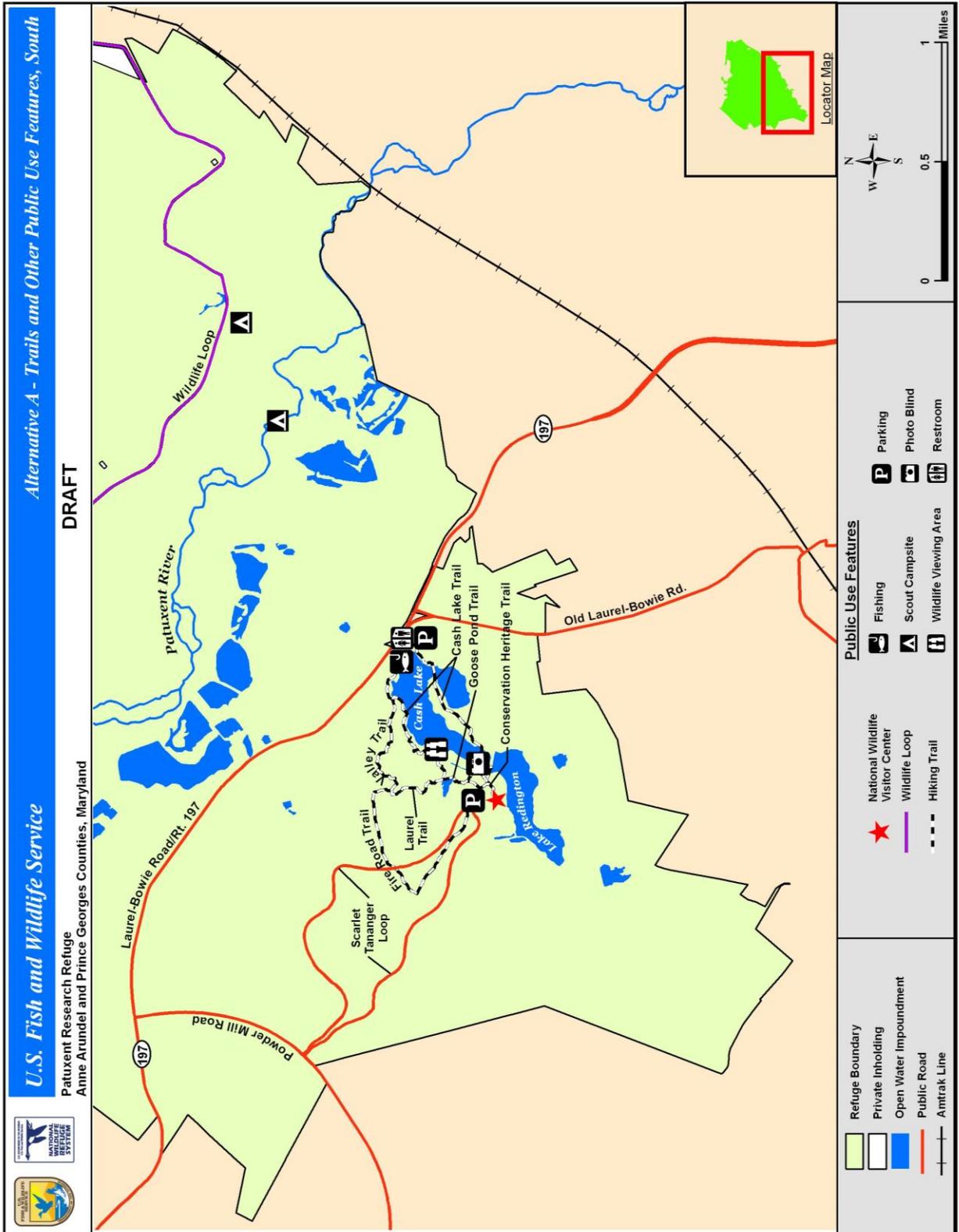
South Tract Trails and Wildlife-viewing Blinds

- Loop Trail (0.3 miles) is an Americans with Disabilities Act (ADA)-accessible paved trail starting at NWVC that offers views of Lake Redington and Cash Lake. The trail runs along a meadow and man-made wetland and provides access to other trails and a boardwalk with an accessible wildlife observation blind. This trail was recently renamed the Conservation Heritage Loop Trail, with several prominent conservationists throughout the nation's history featured on interpretive signs.
- Goose Pond Trail (0.2 miles) connects from the Conservation Heritage Loop Trail and leads to the Cash Lake and Laurel Trails. The trail parallels a forest edge and then wanders through a forested wetland to a pond offering waterfowl viewing. An outdoor environmental area for educational groups is also located along the trail.
- Cash Lake Trail (1.4 miles) begins at the intersection of Goose Pond and Laurel Trail and connects to the Valley Trail. The trail loops around the 53-acre Cash Lake impoundment. On the south side of the lake, floating walkways provide access to a peninsula. An accessible wildlife viewing blind near the impoundment's headwaters offers views of waterbirds and waterfowl. The southern portion of the trail is closed seasonally to prevent disturbance to nesting and wintering waterfowl.
- Valley Trail (0.6 miles) connects the Cash Lake and Laurel Trails. The trail follows a gully through a woodland valley, winding through predominantly oak and beech hardwood forest.
- Fire Road Trail (0.9 miles) begins at the back edge of the NWVC parking lot and leads to the intersection of the Valley and Laurel Trails. The trail follows an old fire road through pine and hardwood forest.
- Laurel Trail (0.4 miles) connects the Goose Pond, Valley, and Fire Road Trails. The mountain laurel-lined trail is dedicated to Chandler S. Robbins, a migratory bird researcher (now retired) at the USGS PWRC.

Map 2-7. Existing Public Use Opportunities, North



Map 2-8. Existing Public Use Opportunities, South



Environmental Education and Interpretation

Staff and volunteers offer guided bird and nature walks, as well as other environmental education programs throughout the year at both the North and South Tracts. A diverse range of educational and interpretive programs, from puppet shows and summer camps for children to birding and plant identification workshops for adults, are offered. The refuge also hosts on and offsite educational programs for teachers and schoolchildren. Several hundred interpretive and educational programs are offered throughout the year, both on and offsite. Announcements of upcoming programs and special events are posted at refuge contact facilities, in local newspapers and on the Web site at:

<http://www.fws.gov/northeast/patuxent/ntedu.html>; accessed January 2012). A monthly announcement listserv is also maintained which reaches approximately 3,400 subscribers.

Non-wildlife-dependent Public Uses

As discussed in chapter 3, we have permitted certain Federal agencies to continue their use of shooting ranges on the North Tract. Other non-wildlife-dependent uses which occur on the refuge include jogging, horseback riding, scout camping, bicycling, cross country skiing, and dog training.

Scout Camping

There are two primitive, seasonal (March 1 to June 30) scout campsites located off Wildlife Loop in the southern portion of North Tract. Based on a nationwide memorandum of agreement, these sites are only for use by the Boy and Girl Scouts of America and 4-H clubs. Both sites are first-come, first-served and equipped with accessible toilets and fire rings.

Horseback Riding

The North Tract allows horseback riding to facilitate wildlife observation on over 18 miles of trails. North Tract trails open to horseback riding include the Wildlife Loop, the multi-use trails, and trails at Lake Allen and Rieve's Pond.

Cross Country Skiing

The North Tract allows cross-country skiing to facilitate wildlife observation on over 18 miles of trails. North Tract trails open to cross-country skiing include the Wildlife Loop, the multi-use trails, and the trails at Lake Allen and Rieve's Pond.

Table 2-7 shows the number of visitors that participated in specific refuge public use activities from 2006 to 2009.

Table 2-7. Visitation for Refuge Public Use Activities 2006 to 2009

Public Use Activity	Number of Visitors		
	2006-2007	2007-2008	2008-2009
Onsite talks	9,882	7,035	9,796
Offsite talks	2,621	4,577	2,889
Total interpretation	12,503	11,612	12,685
Teachers onsite	1,901	84	215
Teachers offsite	470	2,010	71

Public Use Activity	Number of Visitors		
	2006-2007	2007-2008	2008-2009
Students onsite	6,523	2,515	4,177
Students offsite	782	3,694	1,578
Total environmental education	9,676	8,303	6,041
Facilitated by hiking	18,607	18,957	24,118
Facilitated by auto	59,824	38,991	51,660
Total wildlife observation	78,431	57,948	75,778
Total wildlife photography	16,939	13,356	18,362
Waterfowl hunting	474	375	348
Migratory bird hunting	68	91	43
Upland game hunting	90	207	246
Big game hunting	5,184	4,928	5,119
Total hunting	6,086	5,601	5,756
Total freshwater fishing	4,899	3,136	3,357
Bicycling	3,373	4,413	4,403
Shooting ranges	24,333	22,083	27,180
Baseball fields	1,555	17,014	16,384
Horseback riding	109	120	134
Cross-country skiing	0	0	1
Dog training	5	0	1
Jogging	398	1,499	1,489
Scout camping	219	278	266
Special events	4,841	3,972	4,441
National Wildlife Visitor Center	48,013	25,188	38,095
North Tract Visitor Contact Station	9,477	8,202	7,809
Hunter control station	6,086	5,601	5,756
Total visitor centers	63,576	38,991	51,660
TOTAL VISITATION	223,070	178,045	223,399

2.8 Archaeological and Cultural Values

The Service seeks to preserve and manage the refuge’s cultural and archaeological resources that have contributed to and have the potential to advance our understanding of State, regional, and national prehistory and history. A total of 41 archaeological sites registered with the Maryland Historical Trust and Service are present within the refuge. Prehistoric archaeological resources date from the Early Archaic through Late Woodland periods. Native American archaeological resources dating to other time periods (e.g., Pre-Clovis, Paleo-Indian, Contact periods) may exist within the refuge. Historic sites include occupations dating from the 17th century to the 20th century (Richard Grubb and Associates 2011).

Summary of Prehistoric Archaeological Resources

There are 41 known archaeological sites with prehistoric components within the refuge. Surface collecting of plowed fields and other exposed ground surfaces in the mid-20th

century resulted in the recovery of prehistoric stone artifacts and prehistoric pottery within the refuge. The surface collected artifacts from the Central and North Tracts provided items for a display that was located on the refuge.

The prehistoric archaeological resources within the refuge date from the Early Archaic period to the Late Woodland period. Pre-Clovis and Paleo-Indian artifacts have not been found on the refuge. However, a Clovis point was found by an avocational archaeologist in the general vicinity of the refuge (MacCord n.d.) and Clovis points have been found within the Patuxent River Watershed (Curry 1978, Steponaitis 1980). Prehistoric archaeological resources have been found on a variety of geomorphological settings on the refuge.

Most of the prehistoric resources consist of low density lithic scatters. Several prehistoric sites contain relatively large quantities of artifacts suggesting these sites may not represent short term resource procurement sites. The larger sites are multi-component surface or plowzone sites. Buried occupational surfaces (i.e., buried A-horizon contain cultural material) have not been found in the refuge. Prehistoric features have not been found at any site within the refuge. Most of the prehistoric artifacts have been found in the plow zone or from surface collecting, limiting interpretation of prehistoric activities within the refuge. The stone tools, cores, and debitage indicate that lithic reduction activities were one of the primary onsite activities within the refuge. The recovery of ground stone tools such as adzes and axes from the refuge reflects woodworking or other heavy duty activities. The chipped stone tools were likely used for hunting, cutting, scraping, and other processing activities. Fire-cracked-rock has been found at several refuge sites, which reflects hearth related activities. A drilled gorget fragment from the refuge may be indicative of ritual or other activities. The abundance of ceramics at one site suggests onsite activities included the storage or preparation of food.

The prehistoric sites and artifact assemblage from the refuge provide insights into the types of occupations and activities conducted within the refuge. Extensive excavations (i.e., Phase III data recoveries) and specialized analysis (e.g., residue analysis, micro-wear analysis, ecofact analysis, and radiocarbon dating) have not been conducted within the refuge. Therefore, interpretations of prehistoric lifeways within the refuge are limited. However, archaeological investigations conducted in the vicinity of the refuge provide comparative data and can be used to provide insight into prehistoric lifeways.

In summary, the prehistoric archaeological resources within the refuge reflect over 9,000 years of occupation. A diversity of artifacts and sites has been documented.

Summary of Known and Potential Historic Sites

Most of the historic archaeological resources within the Patuxent Research Refuge are detailed in Pousson (1987) for the Central and South Tracts and within Joseph et al. (1991) for the North Tract. A 2004 report by McGill and Persall also presented information on several cemeteries located within the North Tract.

A history of the Patuxent forks region notes that there were two cemeteries (possibly a family cemetery and a separate slave cemetery) on both the Anderson and Mullikan farms (Dulaney 1948). This suggests that additional burials may be expected beyond the known locations of the Mullikan Cemetery (also known as Cemetery No. 17) and that burials may also be present at the complex known as the Anderson Family Homestead. Additional unknown cemeteries may be associated with the known church sites (Joseph et al. 1991).

Also located within the Refuge is Snowden Hall. The Snowden-family manor house was first built at this location circa 1700. Destroyed by fire, it was rebuilt circa 1812 or 1815 as a one- or a one-and-one-half story brick cottage (Morley 1948; Reed 2002). It was expanded to a full two stories ca. 1856, when then-occupant John Snowden was married. Single-story brick wings were added to the north and south elevations of the building in 1938 when the structure was rehabilitated for use as the Refuge headquarters (Reed 2002). Snowden Hall was damaged during an earthquake in 2011. Refuge staff do not use the building currently.



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Snowden Hall

Not previously discussed in earlier reports is the location of a ford indicated on the 1861 Martenet map that crosses the Patuxent River near what is now the Duvall Bridge (also known as the Griffith's mill bridge). Fords across both the Patuxent and the Little Patuxent Rivers were commonly used, and were established in areas with shallow water and a gravel bottom. "These fords were great mileage savers and were useful for carriages, buggies and people on horseback. Automobiles proved to be a different story" (Dulaney 1948). If present, remains of these fords may be significant; in the case of the Duvall Ford, it may be a contributing element to the Duvall Mill Historic District.

Historic Districts

There are three National Register eligible historic districts identified within the refuge:

- Duvall Mill Historic District, which includes resources significant to the history of Prince George's County and not associated with the development of the refuge.

- Patuxent Research Refuge Historic District, which includes resources significant to the development of the refuge.
- South Tract Forest Service Historic District, which includes resources significant to the development of the Forest Service research area within the Beltsville Agricultural Research Center.

Cemeteries

The North Tract includes 10 Fort Meade inholdings that are historic cemeteries, totaling approximately 3.4 acres. These have headstones dating back to the 1700s, with some as recent as 1969 (Hileman 1998). They include graves and headstones of former landowners and their extended families. Fort Meade is responsible for their management and preservation, although the refuge does minimal cosmetic maintenance, such as fence repair, tree removal, etc., as the public's perception is that the refuge owns these plots.

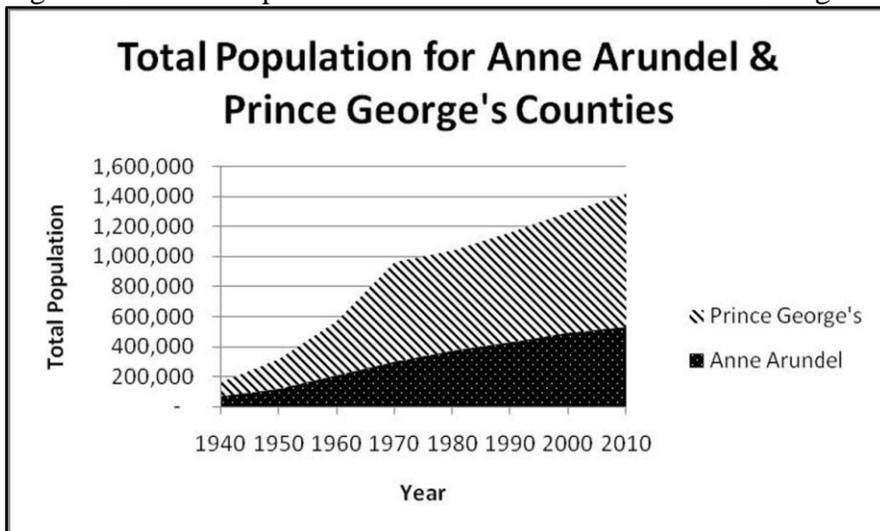
Four of the ten cemeteries were part of the former Fort Meade lands transferred to the refuge in 1991 and 1992. These are the John Penn Cemetery, and three others that are unknown/unmarked. The refuge performs minimal custodial work at the John Penn site.

2.9 Socioeconomic Environment

Demographic Profile

According to U.S. Census, the 2010 populations for Prince George's and Anne Arundel Counties were 863,420 and 537,656. This is a 7.7 percent increase in population for Prince George's County and a 9.8 percent increase in population for Anne Arundel County from 2000 to 2010. This large increase can be attributed to the counties' close proximity to the Washington, DC and Baltimore, Maryland metro areas. Figure 2-3 shows that the combined population for the two counties has grown steadily since 1940, from 157,865 to 1,291,171 in 2000 (Vanasse Hangen Brustlin, Inc. 2010).

Figure 2-3. Total Population for Anne Arundel and Prince George's Counties



An analysis of the population for the two counties broken into age groups shows the 35 to 54 age group to be the largest, comprising 31 percent of the total population. The 5 to 17 and 25 to 34 age groups were the next largest at 19 and 17 percent, respectively (Vanasse Hangen Brustlin 2010).

Socioeconomic and Community Profiles

Households

The 2000 U.S. Census showed that there were 465,404 households in the Anne Arundel and Prince George's Counties. Prince George's County held the largest number of households at 286,650. The average household size for the two localities was 1.67 persons. Of the households, 329,488 or 71 percent were classified as "family." Of those, 36 percent were two-person households, 25 percent were three-person, 21 percent were four-person, and 16 percent were five or more person households. Of the households, 87,126 were considered "non-family," with 79 percent being one-person households.

Migration

In 2000, 54 percent of the population in the two counties lived in the same house in which they lived in 1995. Of the remaining 46 percent of the population, 50 percent moved within the same county, 13 percent had moved from a different county in the same State, 28 percent had moved from a different state, and 3 percent were immigrants.

Education

According to the 2000 U.S. Census, Anne Arundel and Prince Georges Counties have 86 percent and 85 percent of their population, respectively, aged 25 and older who have completed high school (or equivalent).

Employment

Of the population 16 years and over, 29 percent were not in the labor force in 2000. The percent of women not in the labor force was greater than the percent of men (33 percent of women, 25 percent of men). Of the total population aged 16 years and over in the labor force, 93 percent were employed. According to the Maryland Department of Labor, in 2007 Anne Arundel County had an unemployment rate of 3.2 percent while Prince George's County had a higher rate of 4.0 percent. The greatest percentages of employment in the area are in the Federal/State/local government and the trade, transportation, and utilities industries.

Income

According to the Maryland Department of Planning, the weighted average (weighted average was based on relative county population) of median household income for Anne Arundel and Prince George's Counties as reported in 2006 was \$73,900. In comparison, the overall Washington, DC area's median income is \$79,000.

Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low Income Populations, requires Federal agencies to identify and address potential disproportionately high and adverse human health or environmental effects of its

programs, policies, and activities on minority populations and low-income populations (EO 12898). The Presidential memorandum accompanying this Executive Order further directs Federal agencies to improve opportunities for community input and the accessibility of meetings, documents, and notices (CEQ 1997). To facilitate this, Federal agencies should also consider if a significant portion of the affected community is linguistically isolated and provide translated documents and other appropriate outreach materials.

In creating table 2-8, we used the following definitions:

- Minority population includes persons who are members of the following groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.
- Low-income population includes persons living below the poverty line.
- Linguistically isolated population includes persons who identified as speaking English less than “very well.”

Table 2-8. Regional Environmental Justice Characteristics

Environmental Justice Population	Washington, DC/Baltimore, MD	Anne Arundel County, MD	Prince George’s County, MD
Minority Population (as percent of total population)	37.0	20.8	71.9
Linguistically Isolated Population (as percent of total population)	6.8	3.0	7.9
Low-income Population (as percent of total population)	8.3	4.5	7.4

Source: USCB (2010)

Minority Populations

Minority populations represent 52.4 percent of the two counties’ total population combined. However, Prince George’s County has a much higher percentage of minority populations than does Anne Arundel County, 73 percent compared to 18.7 percent (table 2-9).

Table 2-9. Minority Population in Anne Arundel and Prince George’s Counties

County	Minority Population	Percent of Total Population
Anne Arundel County	91,763	18.7
Prince George’s County	584,741	73.0
TOTAL	676,504	52.4

Source: 2000 U.S. Census

Low Income

The low-income population for Anne Arundel and Prince George’s Counties represents 6.7 percent of the two counties’ population. Prince George’s County has a higher

percentage of low-income population than does Anne Arundel, 7.7 percent compared to 5.1 percent (table 2-10).

Table 2-10. Low-income Population in Anne Arundel and Prince George’s Counties

County	Population Below Poverty	Percent of Total Population
Anne Arundel County	24,335	5.1
Prince George’s County	60, 196	7.7
TOTAL	84,531	6.7

Source: 2000 U.S. Census

Real Property

Patuxent Research Refuge owns all real property assets located on the refuge, totaling approximately \$324 million. These assets include office buildings, residences, storage sheds, garages, roads, bridges, dams, dikes, wells, animal colonies, and wastewater treatment systems. Portions of the North Tract are privately owned inholdings consisting of small historic family cemeteries, ranging from one-tenth of an acre to one-quarter of an acre in size, and a 12.6 acre DOD clean fill dump. DOD plans to transfer the property to the refuge once the site is clean. Fort Meade owns and maintains most of the cemeteries.

Current Staff and Budget

The refuge is currently managed by a staff of 23 professionals, including 20 permanent employees and 3 supporting temporary employees. Table 2-11 shows staffing and funding levels from 2007 to 2011.

Table 2-11. Refuge Staffing and Funding Levels

Fiscal Year	Annual Budget	Annual Budget Plus Additional Regionally Funded Projects	Permanent Staff
2007	\$3,912,494	\$4,340,795	20.4
2008	\$3,607,753	\$9,814,249	21.7
2009	\$2,932,935	\$3,069,085	21.4
2010	\$3,969,517	\$8,511,736*	22.4
2011	\$3,512,120	\$3,630,537	21.4

*One-time ARRA funding

The largest portion of funds in the annual budget is salary and benefit costs for refuge staff. Fluctuations in funding reflect appropriations for special projects or new construction. Most of the larger maintenance project-related funding is appropriated and documented via the Service Asset Maintenance Management System (SAMMS). This system is used to identify and appropriate funding for maintenance and construction projects (rehabilitation, repair, and replacement) for existing facilities. SAMMS documents existing asset conditions and helps prioritize the projects that are identified. SAMMS is divided into four major components:

- Property inventories
- Comprehensive condition assessments
- Budget planning
- Management reporting system

Refuge managers use SAMMS as a facility management tool to establish short- and long-term management goals over a multi-year period. Funding for future non-maintenance projects and programs is received largely through the Refuge Operation and Needs System (RONS). This system is used to identify, justify, and prioritize future projects and programs. These projects are formally articulated via an approved CCP for the refuge. If a CCP does not exist for the given refuge, projects identified under RONS must comply with various short- and long-term goals for that refuge as approved by the Service and the Department of the Interior.

Volunteer Program

The refuge has a very active, engaged volunteer program. As of fiscal year 2010, 156 volunteers were recorded, with 106 of those being active volunteers and 50 of those as one-time volunteers. A total of 28,140 volunteers hours were contributed for fiscal year 2010.

2.10 Partnerships

Friends of Patuxent

The Friends of Patuxent Wildlife Research Center and Patuxent Research Refuge, Inc. (Friends) is an all-volunteer nonprofit organization. The Friends were established in 1991 to support the refuge and the USGS PWRC. Through volunteering and fundraising, the Friends help support the refuge's educational programs, exhibits, and outreach and PWRC's research on endangered species, environmental contaminants, and migratory birds. The Friends also seek and administer research grants from concerned foundations, organizations, and individual donors. Their most notable contributions are described below.

- Wildlife Conservation Interpretation Tram is operated by the Friends to help raise funds to support the refuge and PWRC. The interpretive tram runs in a loop from the NWVC from early spring through late fall.
- Wildlife Images Bookstore is operated by the Friends to help raise funds to support the refuge and PWRC. The store is located in the lobby of the NWVC and offers a variety of wildlife-themed books, clothing, posters, and other items.

- The Patuxent Wildlife Art Show and Sale is an annual fundraiser featuring a wide variety of wildlife art on display and for sale. All profits are donated to the refuge and PWRC.
- Adopt-a-Whooper Program allows individuals to “adopt” a whooping crane egg, adult, breeding pair, or brood of chicks. Funds raised are donated to support the PWRC’s research and captive propagation of the federally endangered whooping crane.



Whooping Crane – USFWS

For more information on the Friends group, visit their Web site at: <http://friendsofpatuxent.org/>; accessed January 2012.

Meade Natural Heritage Association

The Meade Natural Heritage Association, established in 1991, is an incorporated, nonprofit organization that is dedicated to the purpose of wildlife conservation, management, and to promote and support outdoor sporting activities. The volunteer staff of the association, in cooperation with refuge officials, manages the hunt program for upland game, waterfowl, and white-tailed deer through a permit system. Hunting is permitted from September through January, based on Maryland State hunting seasons, and in April and May for the spring wild turkey hunt. By using a daily sign-in system, weapon qualifications for deer hunters, hunter education classes, and hunter density limits in each hunting area, association personnel strive to provide the safest and highest quality outdoor experience to the outdoor sportsperson. Coordination of hunting activities, permit sales, and daily sign-in and harvest recording are performed at the hunt control station located at the North Tract.

For more information on the Meade Natural Heritage Association, visit their Web site at: <http://www.mnha.net/>; accessed January 2012.

Both the Friends and the Meade Natural Heritage Association provide support by funding volunteers and purchasing equipment and food during many refuge events and volunteer recognition dinners and picnics, and providing extra volunteer help for our events from their memberships or partners. Both organizations also produce newsletters and maintain active Web sites (Russo et al. 2009).

All Partnerships

The refuge has many partnerships with local, State, and national organizations. Partnerships are an important part of management that allows the refuge to engage and gain support from a number of different groups to receive funding and resources to accomplish refuge goals, while also fostering good community relations. For fiscal year 2010, refuge staff completed 30 partnership projects. Examples of these projects include, but are not limited to:

- Beltsville Agriculture Research Center assisted with invasive species control by supplying equipment and applicators.
- Bass Pro supplied fishing supplies for our kid's fishing day.
- DOD Wounded Warriors program introduced or reintroduced wounded soldiers to fishing.
- Ducks Unlimited helped develop endangered species/mitigation impoundments.



Wounded Military Visitation Day Fishing

2.11 Administrative Facilities

The refuge has an unusually high amount of infrastructure, much of it supporting Federal entities located onsite. It is the work location for the USGS PWRC, which employs approximately 150 people onsite, and the Service Division of Migratory Bird Management, which employs approximately 45 people onsite. An interagency work group has identified approximately \$110 million of new construction, adaptive reuse/modifications of historic-eligible structures, utility upgrades, and demolition of unneeded assets to allow the refuge and research center to meet their respective missions to the fullest extent possible. The facilities modernization program plan details these needs and proposes a phased funding approach. This additional staff necessitates a high amount of infrastructure (offices, animal colonies, labs, mailing facilities, etc.) and impacts refuge assets.

The National Security Agency also operates several shooting ranges on the North Tract of the refuge for various Federal and State law enforcement agencies. The zone of impact from the short and long-distance shooting range is approximately 2,900 acres (1,174 hectares). The range facilities include a Range Control Office, classrooms, practical exercise buildings, a brass recycling room, multiple storage sheds and con ex boxes, and the range facilities themselves (target frames, shooting stations, berms, etc.).

