

Chapter 2



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Wetlands are an important refuge habitat.

Description of the Affected Environment

- Introduction
- Physical Environment
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- Refuge Administration
- Biological Resources
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Introduction

This chapter describes in detail the physical, cultural, socioeconomic, biological and administrative environments of the Wallkill River refuge and its resources directly related to our goals and key issues. It also provides the context for evaluating our management alternatives in chapter 3, “Alternatives Considered, Including the Service-Preferred Alternative.”

Physical Environment

We adapted the following information on landscape formation, physiographic provinces and habitat complexes from “Significant Habitat Complexes of the New York Bight Watershed,” a study by our Coastal Ecosystems Program in Charlestown, R.I. The Wallkill River refuge is located in the Hudson River watershed, which is part of the larger New York Bight watershed (USFWS 1997).

Landscape Formation

The rich, varied physical landscape of the New York Bight watershed contains a number of distinctive regional geomorphic provinces and sections. Their variety arises out of several concurrent and successional events: the combination of complex bedrock and surficial geology and recent glacial history; historical mountain-building and land-uplifting forces; and the dynamic processes of erosion, sedimentation, and chemical and physical weathering on various rock types. That region’s extraordinary physiographic diversity, geological complexity, climate and historical events have contributed directly to its remarkable biological diversity and the current distribution of its fauna and flora.

The work of glaciers and the continental ice sheet during the most recent glacial period, the Pleistocene Epoch, has been one of the most interesting, significant factors in shaping the modern landscape of a substantial portion of the Wallkill River watershed and, indeed, much of North America. Although the Pleistocene began more than a million years ago, and was characterized by a series of at least four major glacial advances (glacial stages) and retreats (interglacial stages), its last glacier, the Wisconsin, most profoundly influenced the landscape of the northern section of this region. The Wisconsin glacier advanced between 70,000 and 100,000 years ago, and only retreated from this region between 10,000 and 15,000 years ago. At its height, it covered the watershed with an ice sheet up to 1.6 kilometers (1.0 mile) thick, although it was considerably thinner along its margins. The retreating glacier deposited on the watershed landscape a layer of unsorted and unconsolidated glacial debris, or glacial till, ranging in size from clay particles to huge boulders. Its retreat left the post-Pleistocene landscape devoid of higher plants and animals. That rock-strewn and polished bedrock surface offered a clean slate for the ecological processes leading to the migration and colonization of modern plant and animal communities.

As the global climate warmed and the glacial front retreated, it left many smaller, recessional moraines and other distinctive glacial landforms—kames, kettles, eskers and drumlins—across the landscape north of its terminal moraine. Water melting from the ice sheet created several large, glacial lakes in the watershed: The most prominent were Glacial Lake Passaic, Glacial Lake Hackensack, Glacial Lake Hudson, and Glacial Lake Albany. They lasted for thousands of years, and their remnants are evident today in lakeshore sand and dune deposits and basins of deep marsh peat and lake sediments. Many smaller lakes and wetlands north of the terminal moraine also were formed from the blockage of preglacial streams by glacial deposits, or were excavated by the ice into the bedrock. Those glacial lakes covered almost the entire Wallkill basin. Their bottoms received extensive deposits of organic matter that is the source of the region’s fertile “black dirt.”

Physiographic Provinces

The 1997 report delineates the New York Bight watershed into physiographic provinces and habitat complexes based on landscape features—geology, landforms, topography, altitude, relief, geological and glacial history, and

hydrology—and associated biological communities and species populations. The province serves as the primary hierarchical landscape unit within which we group and describe the various individual habitat complexes.

Upper Wallkill River Valley Habitat Complex

The Wallkill River refuge lies in the Upper Wallkill River Valley Habitat Complex. The 1997 report describes that habitat complex in a rolling valley in the Appalachian Ridge and Valley physiographic province between the Kittatinny Ridge to the west and the Hudson Highlands to the east. That valley is part of the Great Valley, which extends from Canada to the southern United States. Elevations in the complex range from sea level to 200 meters (650 feet) above sea level. Limestone, dolomites, and shales underlie the valley. Metamorphic, crystalline rocks such as gneisses and schists compose the Highlands. The Kittatinny Ridge is composed of sandstones and conglomerates. The terminal moraine of the Wisconsin glacier crosses the valley well south of the habitat area near the Delaware River. A recessional moraine crosses the valley just south of the habitat complex from Ogdensburg west to Culvers Gap. Glacial lake sediments underlie the major wetlands in the complex, including the Wallkill River bottomlands and the upper Wallkill River between the Highlands and Pimple Hills, Papakating Creek, Crooked Swamp, and Wildcat Brook (USFWS 1997).

Soils

The Wallkill River Valley, previously a mix of wetland types, was cleared and drained during the past century. The valley's fertile Carlisle muck soils were highly desirable for farming. Before that drainage, diverse wetlands supported many nesting and wintering waterfowl. Soil maps from the Sussex County Soil Conservation District and Planning Board indicate that "prime farm land" soils, specifically Washington, Wooster, and Riverhead loams, are scattered throughout the refuge. Unique soils include Carlisle muck and Wallkill silt loam, both very productive, which cover large areas in the refuge boundary.

The following section on soils was adapted from the report "Archeological and Historical Reconnaissance of the Wallkill River National Wildlife Refuge, Sussex County, New Jersey, and Orange County, New York" (Maymon et al. 2002).

"Soil information was extracted from the United States Department of Agriculture Soil Conservation Service (now known as the Natural Resources Conservation Service) county soil surveys for the project area. Table 1 lists the soil series identified in the project area. Soils are discussed here on an association level.

"A total of 52 soil series types were identified within the boundaries of the Wallkill River refuge. Approximately one-third of these soils by count (n=19) and approximately two-thirds of the soils by area are classified as hydric. Hydric soils are somewhat poorly drained to very poorly drained, and may be frequently ponded or flooded. The most common hydric soil series by area found in the Wallkill River refuge are Carlisle muck, Sloan and Wayland silt loam, Wallkill silt loam, and Livingston silty clay loam.

"Prehistoric settlement is not generally expected in areas with hydric soils. Hydric soils in the Wallkill River refuge generally are found below 400 ft. amsl in the floodplain or wetlands of the Wallkill Valley. Hydric soils in the Wallkill Valley generally formed from glacial lake bottom sediments. Those sediments consist of relatively impermeable, thinly layered clay, silt and fine sands.

"Conversely, non-hydric soils identified in the Wallkill River refuge usually lie above 400 ft. amsl. Found in small high spots in the floodplain and along the edges of the river valley, non-hydric soils are usually better predictors

for prehistoric activity. Non-hydric soils in the Wallkill Valley formed in discontinuous glacial till, continuous till, stratified ice contact sediments, and stratified ice marginal sediments. Glacial tills are unstratified and unsorted boulders and gravel in a matrix of mixed sand, silt, and clay. Although these deposits are relatively impermeable, their sandier nature in uplands allows for better drainage. Stratified ice contact and ice marginal sediments consist of stratified sand and gravel. Sediments generally are permeable and thick.”

Contemporary Influences on the Landscape

Much of the valley has been cleared for agriculture and, more recently, is being converted to residential and some commercial development. Dairy or crop farms with corn and hay predominated, although horse farms replaced many of the struggling dairy and crop farms. Abandoned farms are now old-field or early successional shrubland habitat. Gravel, clay, peat, soil and limestone mining all have occurred in the area and still occur to a lesser extent.

Air Quality

National Ambient Air Quality Standards monitor six types of air pollutants (carbon monoxide, nitrogen dioxide, ozone, lead, particulate matter, and sulfur dioxide) known to affect visibility, acid deposition, and human, animal or plant health. Five of those pollutants are factors in the EPA Pollutant Standards Index, a daily measure providing an overall rating of air quality: good, moderate, unhealthy, very unhealthy, or hazardous. The Wallkill River refuge is located in the greater New York metropolitan area. Sussex County, N. J., is not monitored for the Pollutant Standards Index; however, both the New York metropolitan area and the State of New Jersey had a number of unhealthy days in 2002 due to ground-level ozone. The Clean Air Act (1991) designates both New Jersey and New York as non-attainment areas for ozone (smog). On most days, prevailing winds bring air to the refuge from the west and north, but some air pollutants from the New York metropolitan area filter into the region.

Water Quality and Contaminants

The Service’s Division of Environmental Contaminants recently updated in 2005 the contaminants assessment protocol (CAP) for the Wallkill River refuge, which was originally done in 2000. The CAP process is a standardized and comprehensive approach used to assess potential threats posed by environmental contaminants to National Wildlife Refuges as well as other Service lands. The information below is drawn principally from the 2005 updated CAP, which identified several contaminant issues.

As mentioned in chapter 1, the Wallkill River flows north from Sparta, N. J., and passes through Hardyston, Franklin and Hamburg before entering the refuge. The dominant contaminant pathways revealed in the CAP are the Papakating Creek and Wallkill River. Many industrial and mercantile facilities and private residences are located along or close to that creek and the river. The creek and its tributary, Clove Brook, drain the area around Sussex before entering the southwest side of the refuge, then converge into the Wallkill River. Sussex is the largest concentrated population center close to the refuge. All of those factors have the potential to contribute contaminants to the aquatic systems of the refuge.

Point Source Pollution

The effluent of the Sussex County Municipal Utilities Authority wastewater treatment plant is discharged just south (upstream) of the existing refuge boundary. During periods of low river flow and high withdrawal demands, the effluent may be a principal contributor of river water. It is not known how much of the water in the river, particularly during periods of low flow, is effluent; nor is it known what water quality impacts, if any, the discharge has on the water that flows through the Wallkill River refuge. Potential threats to the Wallkill River include treatment plant overflow or failure, illegal discharging of various chemicals, and failing septic systems for homes located near the refuge. These

threats could introduce elevated levels of nutrients or partially treated sewage on the refuge. The chronic input of effluent into the Wallkill River also presents the potential for elevated levels of endocrine-disrupting substances, pharmaceuticals, and other effluent-related compounds.

Sediment zinc concentrations reported in a 1997 U.S. Fish & Wildlife Service Technical Assistance Report (USFWS 1997a) exceeded the State's Severe Effects Levels (SEL) at several sampling stations in the Wallkill River within the refuge. The likelihood was considered high that adverse effects would be observed among sediment-dwelling benthic organisms. Zinc mining near the refuge ceased in 1986. We expect the additional zinc loading from former mines to be minimal.

Non point-source pollution

Evaluated non-point source pollution in the Wallkill River watershed in general shows a shift from agricultural sources to those resulting from increasing urbanization. In the upper Wallkill River, deleterious effects of both urbanization and agricultural activities are on the rise. Increasing construction and urban surface run-off have resulted in sediment loading and storm water contamination, respectively. Local officials have stressed the need for storm water management, such as the use of large detention ponds in the region. In addition, agricultural run-off from crop production, pasturelands, confined animal operations, and a former zinc mine are all suspected of adversely affecting water quality and promoting eutrophic conditions in the Wallkill River. Other important non-point-source contaminants include the runoff from roadways, which can potentially introduce petroleum-related polycyclic aromatic hydrocarbons, and residential pesticide applications. The historical, widespread application of pesticides for mosquito control and agricultural production has introduced many persistent organochlorines into areas on and around the refuge.

The accidental, inadvertent, or illegal dumping of household or industrial wastes into the watersheds associated with the refuge is a conspicuous, indisputable contaminants threat. Spent containers of household or industrial products (e.g., cleaning agents, paints, solvents, motor oil) have been observed routinely discarded in stream drainages, on private lands, and along roadways or across refuge property. Those containers, when compromised by environmental factors, will release any residual product onto the soils and into surface waters, establishing a pathway for entry into the refuge.

Pursuant to state Water Quality Standards and the purposes of the refuge established by Congress, the Service petitioned the New Jersey Department of Environmental Protection (NJDEP) to upgrade the Category 2 anti-degradation designation of the Wallkill River to Category 1, which would forbid the degradation of its water quality. As an alternative, the state funded the development of the Wallkill River Watershed Plan, mentioned in chapter 1. The refuge works closely with the Wallkill Watershed Management Group, the organization created as a result of the watershed plan, to sample and monitor water quality in the river. Through 1997, the river was monitored near Sussex, just below the confluence with Papakating Creek, and near Unionville, N.Y.

According to the Draft Initial Surface Water Quality Characterization and Assessment Report for Wallkill Watershed Management Area (NJDEP 2000), phosphorus levels met state water quality criterion of 0.1 mg/l between 1995 and 1997. Total phosphorus in bottom sediments was 430 mg/kg in the Wallkill River at Sussex and dropped to 42 mg/kg in the Wallkill River near Unionville between 1990 and 1994. This drop may be due to the large wetland area acting as a phosphorus sink. Nitrate levels are very low at both monitoring locations (about 1 ppm), but were rising slightly between 1986 and 1995 in the Wallkill near

Unionville (+0.039 mg/l per year). These data indicate very good water quality with respect to total phosphorus and total nitrate.

The Draft Report shows fecal coliform levels were elevated at both monitoring locations, indicating poor water quality with respect to fecal coliform bacteria. As with many areas in the state, elevated fecal coliform in the Wallkill River impairs its use for swimming.

The Draft Report also reveals that water quality in the Papakating Creek, a major tributary of the Wallkill River, is very good for most parameters. However, testing between 1986 and 1997 indicates marginal water quality with respect to total phosphorus, and poor water quality with respect to fecal coliform bacteria.

Cultural Resources

An historical and archeological reconnaissance of the Wallkill River valley and its environs (R. Christopher Goodwin & Associates, Inc., 2002) provides detailed information on the area's cultural resources. Archival research and interviews gathered available materials about the history, prehistory, and previous historical and archeological investigations on or near the refuge. The review of the archeological site files in both New Jersey and New York identified 63 archeological sites either inside or within 3.2 km (2.0 mi.) of the refuge. Of those, 25 lie within the refuge boundary. They represent both prehistoric and historic periods, and include structural remains as well as buried archeological deposits.

Prehistoric Resources

According to the above-mentioned historical and archeological reconnaissance, quarry sites appear within the Wallkill River valley above 420 feet above sea level, where the Allentown Dolomite Formation tends to outcrop. This area also appears to contain a wealth of rock shelter sites. Three rock shelters are known to exist within the boundary of the Wallkill River refuge. Other camp and resource procurement sites are located mainly at or near 400 ft above sea level. Each of the three rock shelter sites within the project area allegedly contained fluted Paleo-Indian points. Review of collections from several unregistered sites located outside the Wallkill River refuge suggests that open-air sites in the valley also might contain Paleo-Indian components. Additionally, most of the collections from sites within the Wallkill River refuge contain projectile points typical of the Late Archaic Period. Farmers plowing the fields along the Wallkill River regularly found artifacts, primarily arrowheads.

Early Historical Land Use

The reconnaissance report also indicated early land uses within the Wallkill River valley. As the report states:



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Farming was, and is, an important part of the regional economy.

“In its natural state, the Wallkill River valley presented the earliest settlers with nearly 40 square miles of flat, virtually untillable land bisected by a sluggish, sinuous stream. The glacial moraine at Denton, New York, held spring freshets and runoff and kept the Wallkill meadows perpetually swampy. Therefore, the Wallkill bottomlands were developed only marginally, if at all, during the seventeenth and eighteenth centuries. The few roads of the period skirted the edges of the swamplands, and farm complexes would have been constructed on dry ground, either on the “islands” of remnant glacial till or on the toe slopes of the ridges that defined the limits of the Wallkill Valley.

“Although they knew that these river bottomlands potentially were very fertile, eighteenth century owners of these so-called ‘Drowned Lands’ did not possess sufficiently powerful technology to drain them successfully

and render them cultivable. The most frequent use was to provide forage for livestock, and landowners rented out grazing rights; the kinds of archeological signatures left by such land use would be minimal, at best. Because the sluggish river also provided a perfect habitat for eels at spawning time and eels were a popular eighteenth century food item, an eel fishery also developed relatively early along the Wallkill and its major tributaries.... Eels trapped in the many weirs constructed within these waterways were packed in brine and shipped to urban markets, thus providing area residents with an additional source of income.

“The implications of these land use patterns are that, except for the eel weirs within unmodified sections of the Wallkill River itself, few if any archeological resources representing the earliest periods of historic occupation are likely to be encountered within the bottomlands of the refuge. Archeological sites from this period may be found, rarely, on the ‘islands’ of glacial till and toe slope margins of the Valley. These areas also are high potential locations for prehistoric activity.”

Socioeconomic Setting

County Populations (New Jersey 2005 and New York 2005):

Development is occurring at a rapid rate in northern New Jersey. In 2006, Sussex County, N. J. had a population of 153,130 (<http://quickfacts.census.gov/qfd/>). This represents a 6 percent increase from 2005. For comparison, the State of New Jersey had an overall 3.6 percent increase in population. The recent passage of the Highlands Water Protection and Planning Act (Highlands Act) will afford additional protection for areas that lie within the designated Preservation Area. It is still too early to predict how the Highlands Act will affect municipal land use and land preservation within the Skylands Landscape Region. However, the Highlands Act will result in additional protection for critical wildlife habitat in areas that lie within the Preservation Area. In the short-term, this will be accomplished through strict limitations on impervious cover; limitations on development on steep slopes, in forested areas, within 300-foot buffers of all water bodies, and in flood areas; and implementation of Category 1 water quality protections on all Highlands waters.

Orange County, N.Y. had a population of 372,893 as of 2005 (<http://quickfacts.census.gov/qfd/>), an increase of 9.1 percent from 2000. According to the New York State Comprehensive Wildlife Conservation Strategy (CWCS 2006), between 2000 and 2015, the greatest increase in human population in New York State will be in the lower Hudson River corridor; specifically, in the increasingly suburban Orange County (13 percent increase by 2015).

Below is a list of towns within the refuge’s current acquisition boundary. Next to each town name is its state (New Jersey or New York) and its population in 2004, which we obtained from <http://www.census.gov/>.

Frankford Township, N. J.	5,660
Hardyston Township, N. J.	7,591
Vernon Township, N. J.	25,553
Wantage Township, N. J.	11,315
Town of Warwick, N.Y.	32,596
Village of Warwick, N.Y.	6,590
Town of Minisink, N.Y.	4,193
Sussex Borough, N. J.	2,186

Principal Industries

Sussex County is a bedroom community experiencing a rapid rate of residential development. The number one industry for the area is outdoor recreation, mainly in the form of downhill and cross-country skiing, mountain biking, hiking, sailing, canoeing, kayaking and birding. Recreational facilities such as water parks and golf courses also provide all-season revenue to municipalities. Agriculture contributes to the local economy as well, but farming overall has declined in importance. Residential growth has outpaced business growth. The area lies within commuting distance of New York City and Bergen and Morris Counties in New Jersey. Because tourism and agriculture constitute most of the economic base, 60 percent of the area's workforce commutes to work outside the county. The manufacturing and technology sectors contribute only minimally to the local economy, due to the lack of major transportation facilities and access.

Many people living in Sussex County worry that residential development will increase at an even more rapid pace because of the Highlands Act. With development limited to the east by the Highlands Act and to the west by the presence of state-protected lands, the Wallkill River valley is the only large area of unprotected land in northern New Jersey that potentially can be developed.

Valuating the Contribution of the Refuge to the Local Economy

National wildlife refuges provide many benefits to local economies. The Trust for Public Land's "Economic Benefits of Parks and Open Spaces" provides examples indicating that property values increase near open spaces. Another document examining these benefits is "Banking on Nature," published by the Service. In 1995, 27.7 million people visited national wildlife refuges. The revenue from those visitors for local businesses was \$401 million, and supported 10,000 jobs (The Trust for Public Land 1999). In 2004, the Banking on Nature report showed that 37 million people visited national wildlife refuges. Revenues rose to \$454 million and these visits helped support the employment of about 24,000 people. Refuges provide space for natural lands to perform such valuable natural services as the filtration of pollutants from soil and water, which otherwise would have to be done technologically at great expense.

Tourism also increases when refuges provide opportunities for recreational use, which brings revenue to local businesses. Visitors to refuges usually buy gas, food and recreational supplies for fishing, hunting, or observing wildlife. They also stay in hotels or campgrounds and participate in other activities such as golf or shopping. Our "National Survey of Fishing, Hunting, and Wildlife Associated Recreation" (2006) found that that 87.5 million U.S. residents 16 years and older participated in wildlife-related recreation – a 6 percent increase from 2001. The number of hunters and anglers fell from 37.8 million in 2001 to 33.9 million in 2006. The most recent survey also showed an 8 percent increase in the number of wildlife-watchers since 2001 but little change in total expenditures for that activity. Those people spent more than \$120 billion in wildlife-related activities, accounting for 1 percent of the national gross domestic product. The 2006 survey revealed that, in New Jersey alone, 2.85 million residents engaged in hunting, fishing, and wildlife-watching activities, spending \$1.5 billion on wildlife-associated recreation (U.S. Department of Interior and U.S. Department of Commerce, 2006).

Visitors to Wallkill River refuge are local residents, day-trippers from the New York City metropolitan area, or overnight guests, primarily on weekends and during hunting seasons. Those visitors spend money at local businesses near the refuge. In 2000, one refuge hunter informed us that he had spent a total of \$170 for fuel, food, hunting equipment, and one night in a local motel, to support one day of hunting on the refuge. Other refuge visitors have come from as far as Connecticut for an afternoon of bird watching. They also purchase food, fuel, and other merchandise from local vendors.

The total numbers of visitors served by the Wallkill River refuge staff has increased dramatically in recent years, reaching more than 30,000 in 1999 after previous highs of around 4,000 in 1997 and 1,000 in 1996. The majority of those visitors (14,400 visitors annually) use nature trails. We issue permits to about 1,200 individuals each year for deer, waterfowl, woodcock and turkey hunting on the refuge.

National wildlife refuges also contribute to local economies through shared revenue payments. Any Service-owned land is not taxable; but, under the provisions of the Refuge Revenue Sharing Act, that municipality or other local unit of government receives an annual refuge revenue sharing payment that often equals or exceeds the amount it would have received in taxes if the land had remained in private ownership. In addition, land in public ownership requires little in the way of services from municipalities, yet it provides valuable recreational opportunities for local residents. Table 2.1 shows revenue sharing payments to the municipalities in which the Wallkill River refuge holds land.

Table 2.1. Wallkill River refuge revenue sharing payments, 1999 to 2005.

Town	2000	2001	2002	2003	2004	2005	2006	Total
Vernon, N.J.	\$32,877	\$33,154	\$60,640	\$58,287	\$58,280	\$51,552	\$56,891	\$351,681
Wantage, N.J.	\$20,028	\$19,330	\$22,079	\$22,065	\$22,062	\$19,515	\$20,398	\$145,477
Hardyston, N.J.	\$1,443	\$1,292	\$1,862	\$1,790	\$1,789	\$1,583	\$362	\$10,121
Warwick N.Y.	\$1,648	\$1,475	\$1,509	\$1,451	\$1,450	\$1,283	\$1,341	\$10,157
Yearly Total	\$55,996	\$55,251	\$86,090	\$83,593	\$83,581	\$73,933	\$78,992	\$517,436

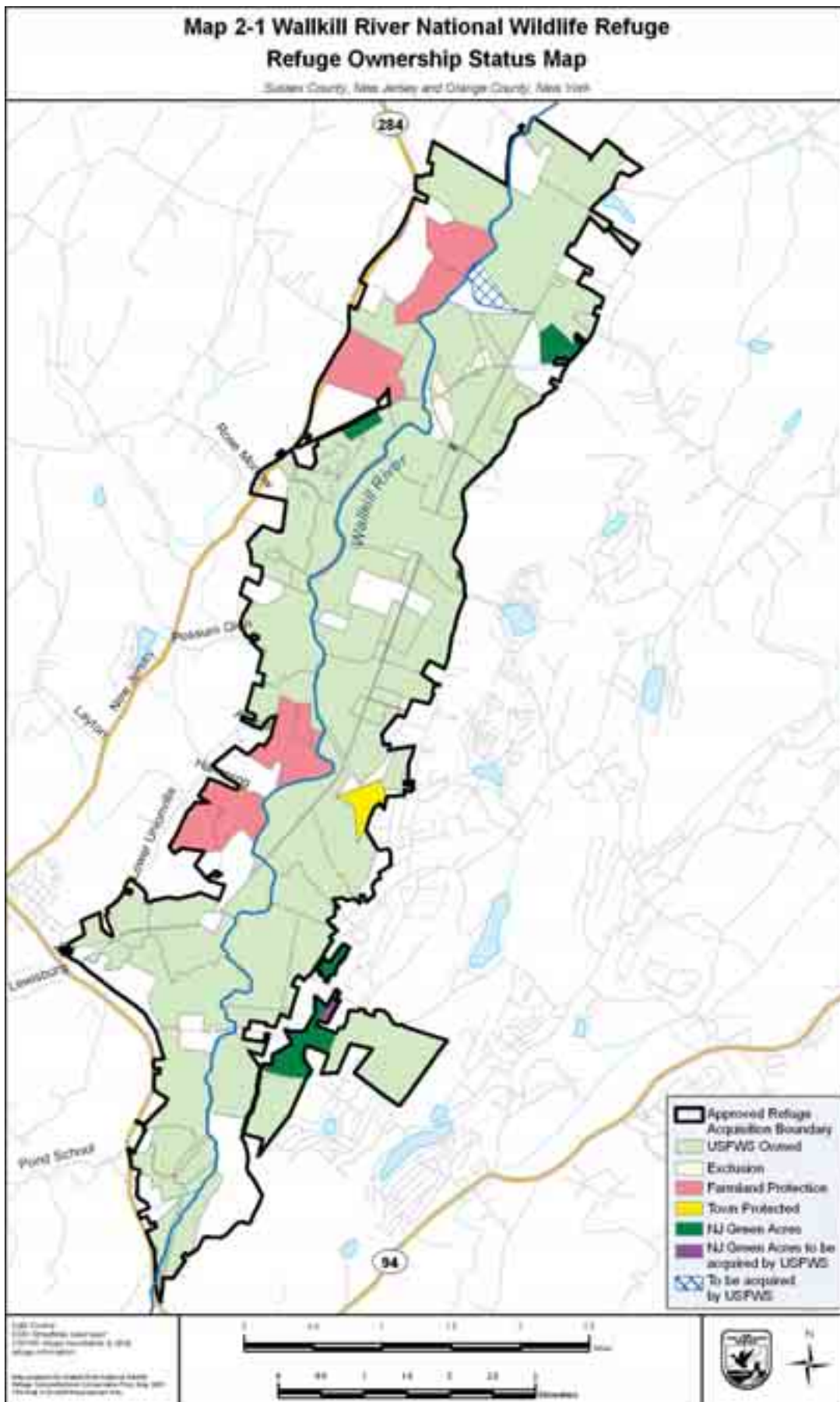
Refuge Administration

Wallkill River Refuge Acquisition History

The Service’s land acquisition policy is to acquire land only from willing sellers at fair market value. Landowners may sell their land to the Service in fee title (outright), or they may sell development rights through a conservation easement. Private landowners in an approved boundary who do not wish to sell retain full control of their property and their rights to use it, in compliance with applicable local, state and federal regulations. The number of willing sellers at most refuges exceeds the availability of funds to purchase the land. This refuge is no exception.

To date, we have acquired 5,106 acres within the approved acquisition boundary. Tables 2.2 and 2.3 provide an annual summary of land acquisition activities and map 2-1 shows the status of refuge ownership. Willing sellers have created a steady history of land acquisition at the refuge. We maintain a waiting list of willing sellers in the approved acquisition boundary. The Sussex County Farmland Protection Program also has protected some of the land in the boundary from development. Those lands, which will remain in private ownership, cannot be developed and must be actively farmed. Other lands within the acquisition boundary are being purchased by the State of New Jersey Green Acres Program, and will be managed by the Service as part of the refuge. When future funds are available, the Service will purchase those lands from Green Acres.

In 2002, the Service purchased a 156-acre inholding at the northern end of the refuge from Mt. Bethel Humus Company, Inc. (also known as Glacial Soil Laboratories), a commercial company that mines and sells topsoil, peat humus and clay. Due to the structure of the real estate agreement, the company retained the mining rights on the land for 10 years from the date of purchase. Once the



mining rights expire in 2012, the Service will assume full management and ownership of the land.

Two natural gas pipelines transect the refuge at its southern end. Tennessee Gas Pipeline and El Paso Company own one pipeline, and NUI Elizabethtown Gas owns the other. The refuge has cooperative agreements with both pipeline owners to allow them to clear brush and vegetation from the right-of-ways on the land covering the pipelines. The refuge has similar agreements with utility companies that maintain power line right-of-ways on the refuge.

Two abandoned rail beds transect the refuge. The former Lehigh-New England railroad bed runs almost the entire length of the refuge, from Sussex Borough north to New York State. A portion of this abandoned rail bed constitutes the Liberty Loop Trail. The former rail bed of the Hanford Branch of the New York, Susquehanna and Western Railroad runs along the southernmost two miles of the refuge and constitutes the Wood Duck Nature Trail. The refuge owns portions of both former rail beds.

Our land acquisition funds mainly come from the following two sources, neither of which comes from general tax revenues: the Land and Water Conservation Fund, appropriated annually by Congress; and the Migratory Bird Conservation Fund, which is replenished through the sale of federal duck stamps to conservationists and migratory waterfowl hunters and the federal excise tax on firearms and ammunition. Some funding also comes to the Service through North American Wetlands Conservation Act (NAWCA) grants. Annual expenditures for land acquisition at the refuge average between \$1 million and \$1.5 million. That level of funding is insufficient to purchase land from all the willing sellers in the approved refuge acquisition boundary. In fact, some lands in the boundary have been sold and developed since the refuge was established.

Table 2.2. Summary of annual land acquisition for the Wallkill River refuge.

Year	Number of Tracts/ Ownerships Acquired	Total Acreage
1992	13/8	1086.73
1993	3/3	487.56
1994	6/5	894.10
1995	5/4	225.53
1996	4/4	243.82
1997	12/6	541.07
1998	6/4	383.75
1999	2/2	391.91
2000	7/4	320.90
2001	1/1	1.01
2002	3/3	226.15
2003	0	0
2004	0	0
2005	3/2	90.52
2006	5/2	213.08
Total	65/45	5,106.13

Table 2.3. Summary of annual land acquisition by municipality for the Wallkill River refuge. Acreage numbers differ from table 2.2 above because the numbers below are rounded to the nearest whole number.*

Year	Hardyston N.J. (acres)	Vernon N.J. (acres)	Wantage N.J. (acres)	Warwick N.Y. (acres)
1992	112	663	312	0
1993	0	136	352	0
1994	0	599	148	147
1995	0	226	0	0
1996	0	112	131	0
1997	75	406	60	0
1998	0	197	187	0
1999	0	0	392	0
2000	0	212.20	180.70	0
2001	0	1.01	0	0
2002	0	144.62	76.25	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	90.52	0	0
2006	55.13	157.95	0	0
Total	187	2,696	1,839	147

**The Service owns all acreage in fee simple. Acreage is approximate, as it derives from these three sources of accuracy: (1) land deeds (2) surveys or (3) GIS digitizing. For ease of presentation, the maps throughout this document do not show Service ownership of the Wallkill River bottom, or the well-access easement on the refuge. However, all summaries of refuge acres include that ownership.*

Operating Budget

Table 2.4 presents the budget for the refuge over the past five fiscal years. Budget code 1261 is for refuge operations (salaries, utilities) and budget code 1262 is for refuge maintenance. Budget codes 1263 (Visitor Services) and 1264 (Law Enforcement) were created in FY06 to improve our tracking of funds.

Table 2.4. Wallkill River refuge budgets from fiscal years 2003 to 2007.

Code	FY 03	FY 04	FY 05	FY06	FY07
1261	\$471,106	\$635,513	\$394,500	\$200,098	\$233,142
1262	\$1,047,624	\$84,100	\$398,839	\$88,194	\$198,556
1263				\$79,438	\$58,914
1264				\$4,926	\$4,926
*Other	\$106,976	\$216,315	\$174,078	299,139	\$350,326
Total	\$1,625,706	\$935,928	\$967,417	\$671,795	\$845,864

**Funds in the "Other" category can be carried over from year to year; therefore, they do not necessarily represent new funds.*

Funds in the "Other" category are used for one-time projects such as demolishing, constructing, or rehabilitating refuge buildings, replacing refuge vehicles, or building impoundments. Funds in this category can be carried over from year to year and therefore do not necessarily represent new funds.

Wallkill River Refuge Staffing

Due to the current fiscal climate, the Wallkill River refuge was complexed with Great Swamp National Wildlife Refuge in 2004 to save money by sharing resources. As part of a regional workforce plan, when staffing positions at the Wallkill River refuge became vacant, the Service did not refill those positions. Subsequently, we have eliminated every position except for the biologist position from the refuge’s staffing chart. Instead, Great Swamp refuge will provide as much help as it can to maintain the refuge.

Table 2.5 below shows staffing levels over the last five years. Years that display a decimal reflect part-time employees, employees that left during the year, or student trainees.

Table 2.5. Wallkill River refuge staffing between FY 02 and FY 07.

	FY 02	FY 03	FY 04	FY 05	FY 06	FY07
Funded FTEs*	7.0	7.0	8.2	3.0	2.0	2.0
Approved FTEs	7.0	7.0	8.2	6.0	1.0	1.0

**FTE = full-time employee equivalent*

Facilities and Maintenance

In January 1999, the refuge opened its permanent headquarters at 1547 County Route 565 in Vernon Township, New Jersey. The office, a renovated 5,000-square-foot farmhouse, was built around 1850. It provides office space for refuge staff and volunteers, a conference room/library, and serves as the official visitor contact station for the public. Parking for 41 vehicles is available, as are public restrooms, which are accessible daily. Also on the site is a maintenance complex. In 2006, a manure shed was demolished, and future plans call for demolishing a pole barn. The rehabilitation of the entrance driveway and parking facilities was completed in 2001. In 2005, the refuge added a 30-x35-foot environmental education outdoor pavilion.

Environmental education activities and large public meetings have been held at the Owens Station Environmental Education Center, 119 Owens Station Road in Vernon Township, N. J. That building, which can hold 150 people, was formerly used for indoor soccer. Because the building lacks air conditioning and heating, it has only been used in the spring, summer and fall. It was re-sided in 2003, but budget shortfalls have delayed the installation of a heating and air conditioning system. Other buildings on the refuge include three single-dwelling houses ranging from one to five bedrooms, which are occupied by refuge staff or serve as volunteer housing.

Equipment and staffing to maintain these structures is significantly lacking. Maintenance staff and equipment are also needed to support the refuge habitat management and visitor services programs. In fact, our existing maintenance workload precludes our undertaking any new, non-emergency projects.

Relationship with the New Jersey Department of Environmental Protection and New York State Department of Environmental Conservation

The Wallkill River refuge enjoys significant positive relationships with several divisions in the New Jersey Department of Environmental Protection. Of utmost importance is our relationship with the **New Jersey Division of Fish and Wildlife**. That agency manages the resident fish and wildlife population in the State of New Jersey, including the administration of annual hunting and fishing seasons, the enforcement of conservation laws off-refuge, and the identification and protection of state-listed threatened or endangered species. The refuge has worked closely with the Division of Fish and Wildlife in the development of this draft CCP. The refuge also works closely with the Division in managing our deer

hunting program, expanding our hunt program to other seasons, inventorying and managing bog turtles on and near the refuge, and in organizing special events. In fact, the establishment of the Wallkill River refuge came about because of that Division's strong support for protecting the wetlands and other natural resources in the Wallkill River Valley.

The **New Jersey Division of Parks and Forestry** manages state lands for public recreation near the Wallkill River refuge, and owns an easement on the part of the Appalachian Trail that runs through the refuge. They also manage an extensive, multiple-use rail-trail system, and are expanding that system to include lands directly south of the refuge. We have worked together to identify areas of natural resource significance that should be protected in the Wallkill River Valley for the benefit of New Jersey residents and visitors.

The **New Jersey Green Acres Program** is purchasing lands within and around the acquisition boundary of the Wallkill River refuge from willing sellers. We will manage lands within the acquisition boundary as part of the refuge, while the Division of Parks and Forestry will manage some of the others. The partnership with Green Acres is saving hundreds of acres of valuable wildlife habitat from development, and protecting the ecological value of the refuge and surrounding lands.

The **New Jersey Forest Fire Service** assists the Wallkill River refuge fire staff with prescribed burns on the refuge. We conduct joint training and have a formal agreement to assist each other on wildfires that occur on or near the refuge.

The **New Jersey Division of Watershed Management** manages funds and provides guidance and structure on the development and implementation of watershed plans. Those plans are designed to maintain and/or improve water quality in open bodies of water, including the Wallkill River. The Division is also working on projects to control stream bank erosion that not only will improve water quality, but also will ease public access for boaters (canoes and kayaks) and anglers on the Wallkill River.

The **New York State Department of Environmental Conservation** has assisted the Wallkill River refuge with information about endangered species, biodiversity, and fishery resources, and has worked in conjunction with the refuge to increase the protection of endangered species and important migratory bird habitat adjacent to the refuge.

Partnerships

Our staff are proud of the many and varied refuge partnerships that have developed. Those partnerships are making important contributions to refuge goals and objectives. A brief description of the most significant partnerships at the Wallkill River refuge follows.

The **National Park Service, Delaware Water Gap National Recreation Area** provides law enforcement support to the refuge by providing a 24-hour dispatch. This has proven to be an invaluable assistance in our efforts to protect natural resources from illegal activities and unauthorized uses of the refuge. In addition, we are entering a cooperative agreement with the National Park Service for the exchange of law enforcement services. We also have jointly conducted fire training, and may be collaborating on natural resource management issues, particularly invasive species, in the future.

The **Trust for Public Land (TPL)** provides critical assistance for land acquisition. They have been able to work with landowners directly and often in a

timelier manner than the Service. The direct efforts of the TPL have protected nearly 1,500 acres on 10 properties as part of the refuge. Additional acquisitions are in the planning stages at this time.

Ducks Unlimited and the **National Fish and Wildlife Foundation** provide invaluable assistance with funds and engineering support. One completed project was to restore a 335-acre former sod farm on the refuge to a wetland management unit that provides habitat for migrating waterfowl and shorebirds. Additional projects are being considered.

The North Jersey Chapter of the **Ruffed Grouse Society** is working to restore aspen groves and other scrub-shrub habitat for the benefit of the American woodcock and the ruffed grouse.

The **New Jersey Conservation Foundation** and the **Highlands Coalition** have worked to promote protection of the refuge and other lands within the New Jersey Highlands. The first parcel acquired by the service for the refuge was purchased from the New Jersey Conservation Foundation, who had acquired it for conservation protection before the refuge was even established. Their support for sound land use planning and funding for land acquisition are major assets for the refuge.

The **New Jersey Audubon Society** and the refuge are working together to present opportunities for environmental education to schoolchildren and adults alike on the refuge. Our environmental education initiative will be one of the more exciting and important partnerships on the refuge for the coming years. The New Jersey Audubon Society has also been a major supporter of refuge land acquisition over the years.

The **Wildlife Conservation Society, Metropolitan Conservation Alliance** has identified areas outside the refuge of conservation importance, and has provided training opportunities for local governments near the refuge to learn how to balance economic growth and development with natural resource protection. Their efforts have assisted the refuge by creating a positive and more open municipal mind-set towards natural resource stewardship.

The **Nature Conservancy, New Jersey State Office** has identified the Great Limestone Valley, which includes the refuge area, as one of its conservation focus areas. Our common goal is that this land and its sensitive resources, particularly the bog turtle and associated habitats, be protected through education, stewardship, and acquisition.

The **National Audubon Society, Bergen County Chapter** adopted the refuge through its Audubon Refuge Keepers program. Members of the Bergen County Chapter conduct bird surveys on the refuge. They also are a major supporter of refuge land acquisition.

The **Wallkill River Task Force** is a bi-state, multi-agency organization developed to bring more awareness to the Wallkill River. The task force has proven very successful in raising awareness among local and municipal officials, increasing support for protection of the river, and providing opportunities for the public to access the river. Their support for the river has resulted in increased knowledge and support for the Wallkill River refuge.

The **Wallkill Watershed Coordinator** was created because of the Wallkill River Watershed Plan. The Coordinator provides technical and staff support for various refuge programs including stream bank restoration and public use.

The **Vernon Civic Association** has worked on a number of issues that support the refuge. The most productive to date has been their contributions to the refuge's Centennial Wildlife Garden. Members of the group raised \$2,000 to purchase plants, designed the garden, and plant shrubs that are beneficial to wildlife.

The **Vernon Chamber of Commerce** provides the refuge with a complimentary membership and provides advertising space in its annual community guide. We work together to promote wildlife observation and other nature-based recreation in the refuge area.

Volunteer Program



USFWS

The Friends of Wallkill River Refuges was established in 2006.

Volunteers contribute significantly to the refuge biological, public use and maintenance programs. In fiscal year 2006, 35 refuge volunteers contributed more than 2,000 hours. Their work included wildlife surveys, invasive species identification, bluebird box monitoring and maintenance, trail maintenance, carpentry, computer support, clean-up, visitor services

support and grounds maintenance. Although the refuge volunteer program is active, it is dependent on help from the Friends Group and its growth and utilization is unlikely to improve until we hire a volunteer coordinator.

Friends Program

Friends groups generally are non-profit organizations that work to promote refuges and help them accomplish their missions. Their advocacy extends to local communities and local and state elected officials. The groups operate with a board of directors, and each group establishes its own mission and purpose statements. Often, they become involved in land protection and acquisition, public outreach, environmental education and interpretation, volunteer coordination, and fund-raising for projects. In the summer of 2006, a refuge friends group incorporated, and actively supports the refuge.

Research

Several research projects, studies, and investigations have occurred on the refuge. The respective resource sections of this document also highlight their results. These are some examples of past or present long-term research projects.

- Lamar Gore, Univ. of Massachusetts, breeding grassland bird habitat, 1995-1997. Thesis available, titled "Habitat Preferences and Management Strategies for Grassland Birds on the Wallkill River National Wildlife Refuge."
- Dr. John Smallwood, Montclair State University, has worked with the refuge since 1997 on "An investigation of the behavioral ecology and population dynamics of secondary cavity nesting birds in New Jersey." No final report has been released but annual reports are available.

- Dr. Lance Risley, of William Patterson University, has worked with the refuge to study bat populations and foraging ecology since 1998. A final report entitled “Characterization of trees used as diurnal roosts by forest dwelling bats” was issued in 1999. A final report entitled “Characteristics of day roosts used by female northern long-eared bats (*Myotis septentrionalis*)” was released in 2000. Additional interim reports are available.
- The refuge has collaborated with Professor Bernd Blossey of Cornell University since 1995 to study the use of biological control agents on the eradication of purple loosestrife. The refuge continually receives guidance and consultation advice from Professor Blossey. The refuge has also worked with Professor Blossey on potential biological control agents for *Phragmites*. Interim reports on the effectiveness of biological controls are available.
- The refuge has also worked with Professor Blossey and with Sussex County Mosquito Control on “Toxicity of mosquito larvicides Abate (Temephos), Altosid (Methoprene) and BTI (*Bacillus thuringiensis* var *israelensis*) on leaf-eating beetles (*Galerucella* spp.) used to control purple loosestrife (*Lythrum salicaria*)”.
- Starting around 2002, the refuge has worked with a SUNY Stonybrook graduate student who is researching inflorescence in Canada thistle. The research has been completed, but whether a report exists is unknown.

Special Use Permits

In fiscal year 2006, the refuge issued 15 special use permits, primarily to allow access to closed areas of the refuge. Examples include permits for mosquito-spraying and biological studies. Livestock grazing and haying are other examples described in more detail below.

Cooperative Farming

Since 1992, we have issued permits to local farmers to mow or hay selected grasslands. Grasslands must be periodically mowed to control weeds and the regrowth of trees and shrubs. This arrangement benefits the refuge by reducing our grassland mowing workload and provides participating farmers with supplemental hay. Mowing and haying are not allowed until July 15, after the nesting season for grassland-dependent migratory birds. Table 2.6 shows the number of permits issued for haying/mowing and grazing over the last five years.

Table 2.6. The number (and acres) of special use permits issued for haying/mowing and grazing between 2001 and 2005.

Special Use Permit	2001	2002	2003	2004	2005
Haying/mowing	5 (376 acres)	5 (476 acres)	5 (460 acres)	5 (484 acres)	5 (514 acres)
Grazing	1 (17 acres)	1 (17 acres)	1 (17 acres)	1 (17 acres)	1 (17 acres)

Biological Resources

Vegetation and Habitat Types

Table 2.7 summarizes 20 land use and cover types and their percent cover on land within the current acquisition boundary. Table 2.8 provides the number of acres of each habitat type. For a complete list of plant species on the refuge, visit the refuge website www.fws.gov/northeast/walkkillriver/.

Table 2.7. Land use/land cover types within the Wallkill River refuge acquisition boundary.

Land Use/Land Cover Types	Percent Cover
Residential	10.0 %
Commercial & Services	1.0 %
Industrial	1.0 %
Recreational Land	1.0 %
Cropland & Pasture	14.0 %
Orchards, vineyards, horticulture	0.5 %
Other Agricultural	2.0 %
Deciduous Forest	15.0 %
Coniferous Forest	5.0 %
Conifer/Deciduous Forest	6.0 %
Deciduous/Conifer Forest	3.0 %
Brush land/Shrub land	2.0 %
Streams & Canals	6.0 %
Natural Lakes	0.5 %
Artificial Lakes & Reservoirs	1.0 %
Deciduous Wooded Wetlands	13.5 %
Brush Dominant & Bog Wetlands	8.0 %
Herbaceous Wetlands	9.0 %
Extractive Mining	1.0 %
Altered Lands	0.5 %

The fact that the refuge lies along a riparian corridor dictates refuge vegetation patterns. A typical riparian corridor consists of a mosaic of wet meadows, mixed bottomland hardwood forest, and higher elevations of wetland types surrounded by smaller tributaries of the main river. Freshwater marshes adjacent to the river contain plant communities of sedges, rushes and cattail. Low-lying forests contain red maple swamps with a mix of other hardwood trees and underbrush of spicebush with some exotics, dominated species such as garlic mustard. The hillsides contain fens for bog turtle habitat.

Table 2.8. Habitat types and acreage within the Wallkill River refuge acquisition boundary.

Habitat Type	Acreage*
Grassland	632
Scrub-shrub	999
Forested Wetland	2,098
Non-Forested Wetland	1,216
Forested Upland	1,560
Cropland and Pastureland	406
Open Water	27
Other	148
Total	7,086

*The acreage includes all lands – acquired and unacquired.

Wetlands

Forested wetland, emergent marsh, open water, wet meadow, scrub-shrub wetland, and calcareous fen are the major wetland habitats at the refuge. Most of its forested wetlands are bottomland hardwood forests dominated by red maple along the Wallkill River. The Atlantic white-cedar swamp, considered a globally endangered ecosystem by The Nature Conservancy, is a small but significant type of forested wetland. Wetland forests dominated by Atlantic white cedar (*Chamaecyparis thyoides*) were once widespread along the eastern seaboard. However, the range of this habitat type has contracted significantly from hydrologic alteration, coastal development, and harvesting without regeneration. Important plants in the refuge Atlantic white-cedar swamp include black spruce (*Picea mariana*) and highbush blueberry. Sphagnum mosses (*Sphagnum* spp.) also characterize this swamp.

Emergent marsh and open water species include pondweeds, spatterdocks (*Nuphar* spp.), and duckweeds (*Lemna* spp.). Reed canary grass (*Phalaris arundinacea*) dominates wet meadows. Other common wet meadow plants are swamp milkweed (*Asclepias incarnata*), joe-pye-weeds (*Eupatorium* spp.), common reed, purple loosestrife, and cattail. Scrub-shrub wetland habitats are a successional stage leading to forested wetland. Dominant shrubs include silky dogwood (*Cornus amomum*), multiflora rose (*Rosa multiflora*), and spicebush. Trees include red maple, black willow (*Salix nigra*), and American elm. Sensitive fern, tussock sedge (*Carex stricta*), purple loosestrife, and skunk cabbage are common herbaceous plants. Calcareous fens develop in areas of calcium-rich groundwater discharge and yield a unique assemblage of plants. The continuous groundwater seepage and open vegetation are important habitat characteristics that make these sites suitable for the federal-listed threatened bog turtle.

Upland Forests

Almost all of the refuge's 1,560 acres of upland forest is second growth. A few older field trees remain within the younger forests. The forest tends to be dominated by a mix of northern hardwoods species (sugar maple, American beech, birch) and an oak-hickory species (northern red oak, shagbark hickory). Hemlock stands tend to congregate around small stream valleys. Together these forests provide habitat for upland songbirds and protect water quality. Slope, aspect, and land use history play a significant role in determining local forest composition. A complete list of plant species on the refuge, including tree species, can be found on the refuge website, www.fws.gov/northeast/wallkillriver/.

Grasslands

Farmers who participate in our cooperative farming program hay and graze approximately 500 acres of cool season grasslands annually. Refuge staff planted a diverse mix of warm season grasses on 57 acres. In addition, 40 acres of old agricultural field were burned in 2002 and 2004. The objective in both projects is to restore natural grassland conditions to support nesting for grassland-dependent birds. Most fields are in the old-field stage of succession, composed of diverse broadleaf plants.

The refuge participated in a region-wide Grassland Breeding Bird Habitat Management Study in 2002. The purpose of the study was to (1) assess the grassland breeding bird use, and vegetation structure or composition of managed grasslands on refuges; (2) evaluate the effects of current grassland management techniques; and (3) assist in our regional contribution to grassland breeding birds. Results from this project, in coordination with the recommendations of the Regional Grassland Bird Working Group, help the refuge concentrate resources for grassland birds where it makes the most sense. This project assisted managers in improving management techniques to create specific grassland vegetation for specific breeding grassland birds.

Shrub/Scrub Habitat

Shrub/scrub habitats are intermediate successional stages between fields and forests. Common shrub species include gray dogwood (*Cornus racemosa*), multiflora rose, eastern red cedar, and staghorn sumac (*Rhus typhina*). Pioneer tree species such as quaking aspen (*Populus tremuloides*) and gray birch (*Betula populifolia*) are also an important component of refuge shrub lands.

Non-Indigenous Invasive Species

Non-indigenous invasive species are a serious threat to native wildlife and habitats at Wallkill River refuge. Exotic plants degrade habitat by converting diverse native plant communities into single-species monocultures. Introduced animals compete directly with native wildlife. In fact, invasive species are one of the most important threats to the Refuge System as a whole.

All refuge habitats and wildlife species are vulnerable to the effects of invasive species. Purple loosestrife and *Phragmites* have taken over many refuge wetlands. Consequently, habitat for the federal-listed threatened bog turtle, migrating waterfowl, and other diverse wetland wildlife has been degraded. Canada thistle is invading refuge grasslands. Shrub lands are becoming dominated by multiflora rose, common buckthorn (*Rhamnus cathartica*), and autumn olive (*Elaeagnus umbellata*). Refuge forests have been invaded by tree-of-heaven (*Ailanthus altissima*), Japanese barberry, and garlic mustard. The introduced mute swan (*Cygnus olor*) competes with native waterfowl and marsh birds for food resources and nesting areas. Further, the feeding activities of these large birds damage wetland ecosystems. Feeding and spawning common carp (*Cyprinus carpio*) kill aquatic plants and increase water turbidity. As a result, refuge waters provide poorer habitat for native fish. Feral cats kill many small mammals, ground-nesting birds, and songbirds.

For the past four years, the refuge has participated in a Regional Invasive Plant Species Inventory and Mapping Initiative. Its purpose is to conduct a basic invasive plant inventory of refuge lands to locate, identify, and map invasive plant species. We will use that information to guide the development of control, monitoring, and evaluation initiatives.

Since 1995, the refuge has used Galerucella beetles and Hylobius weevils to control purple loosestrife (*Lythrum salicaria*). These biological control methods were initiated by Cornell University. In 1999, the refuge assessed eastern hemlock stands for woolly adelgid, and is exploring biological control agents for dealing with them. As mentioned above, the refuge is also exploring the use of biological control agents for *Phragmites*.

Federal-Listed Threatened or Endangered Species and Other Species and Habitats of Special Management Concern

The refuge provides habitat for 73 types of vertebrate and invertebrate wildlife that are state- or federal-listed as endangered, threatened, special concern, or priority species. They received special consideration during our planning process. We derived those species and their status listed in appendix A from the following sources

- Federal List of Endangered and Threatened Wildlife and Plants
- Service Northeast Region (draft) list of Birds of Conservation Concern
- Endangered and Threatened Wildlife of New Jersey
- New Jersey List of Species of Special Concern (pending)
- List of Endangered, Threatened and Special Concern Fish and Wildlife Species of New York State

- Partners In Flight priority species
- North American Bird Conservation Initiative priority species
- North American Wetlands Conservation Act priority
- Region 5 Birds of Concern

Bog Turtle

The Wallkill River refuge is one of only two national wildlife refuges known to be inhabited by the federal-listed threatened bog turtle. Bog turtle populations and potential habitats within the current refuge acquisition boundary are hydrologically and ecologically connected to those within the current refuge (Sciascia and Tesauro 1997). Bog turtles have suffered a 50 percent decline in range and numbers during the last 20 years (USFWS 2001). The refuge preserves open-canopy wetlands that have a mosaic of microhabitats, including dry pockets, saturated areas, and periodically flooded areas that this species requires. One of the highest priorities in refuge operations is the preservation, enhancement, restoration and management of bog turtle habit and the research and monitoring of bog turtle populations.

In 1997, the Service provided funding to the NJDEP Division of Fish and Wildlife Endangered and Nongame Species Program to assess the refuge wetlands and wetlands along its boundary for their suitability as bog turtle habitat. Out of the 54 sites surveyed, 16 were classified as suitable. Of those 16, only three had the presence of bog turtles confirmed (Sciascia and Tesauro 1997).

In 2000, a follow-up survey was conducted to investigate further the potential and known bog turtle sites that previously had been surveyed. The focus of that study was to better assess the population characteristics of sites with bog turtles, describe vegetation types at known and potential sites, and describe any land use or other threats, primarily at sites within the current refuge boundary. Bog turtles were found at only two of the 53 sites surveyed (Bourque 2000).

Between 2002 and 2006, the refuge biologist continued surveys of the one known bog turtle site as well as numerous potential sites within the acquisition boundary. Four turtles were found at one site and marked with radio transmitters. The use of radio telemetry aided in monitoring population trends, detecting signs of recruitment and reproduction, tracking seasonal movements and determining home range.

In 2005 and 2007, Dr. Kurt Buhlmann from the University of Georgia surveyed 15 potential bog turtle sites within the refuge acquisition boundary. No turtles, other than the four at the one known site, were found on any of those sites. Additional turtles were located within the refuge's acquisition boundary, but not on refuge-owned land. After analyzing his data from 2005 and 2007, Dr. Buhlmann will provide the refuge with a freshwater turtle management plan. In addition, he will work with the refuge to analyze further the bog turtle habitats within the refuge and possible bog turtle reintroductions.

Mitchell's Satyr Butterfly

The Service listed Mitchell's satyr butterfly as an endangered species in 1992. Recently, two well-known sites in Sussex and Warren counties had supported the species. The confirmed sites are both fens located in areas of limestone bedrock within the same watershed, similar to habitats used by the federal-listed threatened bog turtle. Although Mitchell's satyr habitats cannot be so neatly classified, certain attributes at each site remain constant. All historical and active

habitats have an herbaceous community, which is dominated by sedges, usually *Carex stricta*, with scattered deciduous and/or coniferous trees, most often *L. laricina* or *Juniperus virginiana* (red cedar). The specific habitat requirements for Mitchell's satyr seem to include structural components as well as the presence of suitable host plants. Butterflies generally use the riparian and floodplain zones for foraging. Females and juveniles will also forage in the canopies of upland trees and over clearings with early successional vegetation (USFWS 1998).

Dwarf Wedgemussel

Potential habitat exists in the Wallkill River for the federal-listed endangered dwarf wedgemussel (*Alasmidonta heterodon*). State biologists conducted surveys for that species in segments of the river running through the refuge in 1999 (Bowers-Altman 2001) and 2001. Those surveys did not detect dwarf wedgemussels or their shells. However, they found numerous stretches of suitable habitat consisting of sandy substrate or sand patches, little to no silt, and slow to moderate current. In addition, the mussel's host fish, the tessellated darter (*Etheostoma olmstedi*), occurs in the river. Further, four freshwater mussel species often associated with dwarf wedgemussel were found. Additional surveys are needed to confirm the presence or absence of this species on the refuge.

Indiana Bat

In 1967, the federal government listed the Indiana bat (*Myotis sodalis*) as endangered, because of documented declines in its numbers at seven major hibernacula in the Midwest. At the time of its listing, it numbered around 883,300. Surveys in 2005 numbered populations at 457,374. Although the population is down by about half of what it was in the 1960s, the 2005 number indicates the population has increased or at least has remained stable in most states' hibernacula in 2004 and 2005, resulting in a 16.7 percent increase overall above 2003 population estimates. The 2005 population number is almost where it was in 1990. At the time that the 2005 population numbers were released, however, surveyors did not have an estimated confidence interval, and some changes in methodology occurred from 2003 to 2005.

Although the Wallkill River refuge has not conducted species-specific surveys, no Indiana bats have been documented at the refuge. In August 2005, however, we learned from our Ecological Services New York Field Office that a hibernaculum of 30,000 Indiana bats was located in Ulster County, 18 miles northeast of the Shawangunk Grasslands refuge. Summer roosting has been documented 9 miles to the north and south of that refuge. The bat's summer focus area—where bats could potentially occur during the summer months (April 1–September 30)—includes the entire Wallkill River refuge. This recent information indicates that the Wallkill River refuge could provide potential roosting and foraging habitat for these bats, since they appear to be in the vicinity. Furthermore, the riparian, forested and upland habitats on the refuge have high potential for supporting, foraging and roosting habitats.

Our New York Field Office provided a fact sheet describing habitat requirements for this species. We have included some of its highlights.

- Indiana bats typically hibernate in caves and mines during the winter and roost under bark or in tree crevices in the spring, summer, and fall;
- Their roost habitat is characterized by a live or dead tree, ≥ 5 inches d.b.h., with exfoliating or defoliating bark, or containing cracks or crevices accessible to bats;
- Maternity colonies generally use suitable trees ≥ 9 inches d.b.h.;

- Tree structure appears to be more important than a particular tree species or habitat type;
- Streams, floodplain forests, and impounded water bodies provide preferred foraging habitat, and bats may travel 2-5 miles from roost sites to forage; and,
- Other foraging habitat includes forest canopies, open fields, cropland borders and wooded fencerows; and over farm ponds and pastures, all close to tree cover.

The 2007 Indiana Bat Draft Recovery Plan (USFWS) provides additional descriptions of habitat, natural history, threats, and recommendations for recovery across the species' range. This plan can be accessed at <http://nyfo.fws.gov/es/ibatdraft99.pdf>. We will continue to work with our New York and New Jersey field offices to obtain the latest information on where bats are located, and to assess the implications for our refuge management.

Migratory Birds

More than 225 bird species have been recorded using the refuge. Of those, 122 have been documented as breeding species. The refuge provides habitat especially valuable to migrating waterfowl, wintering raptors, grassland birds, and marsh birds. The refuge is also an important site for wading birds, shorebirds, shrubland-dependent birds, and forest interior songbirds. It also provides nesting, resting, and feeding habitat for numerous birds on lists of rare and declining species. The refuge maintains an annotated bird species checklist, available upon request from the refuge headquarters. For a complete list of all migratory bird species on the refuge, go to the refuge website, www.fws.gov/northeast/walkkillriver/.

Wood Duck banding is one of many ways refuge staff study waterfowl.



USFWS

Waterfowl

The Wallkill River Bottomlands are one of the few large areas of high quality waterfowl habitat remaining in northwest New Jersey. In fact, The North American Waterfowl Management Plan Atlantic Coast Joint Venture identifies the Bottomlands as a priority focus area for waterfowl management in New Jersey (Atlantic Coast Joint Venture 1988). The refuge straddles two major migration corridors for waterfowl moving between eastern Canada and the Atlantic Coast and the Delaware River and Hudson River corridors. Waterfowl use both corridors to stop, rest and feed in the extensive wetlands along the Wallkill River, especially when it floods in the spring. In 2005, the Service completed a project in cooperation with Ducks Unlimited to restore, enhance, and manage 335 acres of seasonal wetlands adjacent to the Liberty Loop Trail.

That project improved habitat for thousands of migrant ducks and geese as well as a wide diversity of other wetland-dependent wildlife.

Nineteen waterfowl species have been recorded on the refuge. Refuge wetlands are particularly important to migratory American black ducks (*Anas rubripes*). Breeding waterfowl include Canada goose, wood duck, American black duck, mallard, hooded merganser, and common merganser.

Table 2.9. Annual maxima of waterfowl at the refuge.

Species	Maximum
Snow goose	175
Canada goose	3,000
Mute swan	40
Wood duck	300
American widgeon	50
American black duck	300
Mallard	1,000
Blue-winged teal	50
Northern pintail	300
Green-winged teal	300
Ring-necked duck	10
Ruddy duck	10
Hooded merganser	50
Common merganser	50

Raptors

Grassland on the refuge provides habitat for significant concentrations of wintering raptors, including northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*B. lagopus*), American kestrel (*Falco sparverius*), and short-eared owl (*Asio flammeus*). The expansive wet meadows near the Liberty Loop Trail are an especially important roosting and foraging site for northern harriers and short-eared owls.

Refuge winter raptor surveys (USFWS 2004, unpublished data) document maxima of 14 northern harriers and 8 short-eared owls. In addition, the refuge red cedar thickets are traditional wintering sites for smaller numbers of long-eared owls (*Asio otus*). Many raptor species nest at the refuge or stop there during migration. In particular, black vultures, osprey, and bald eagles are being spotted with increasing frequency there during migration.

Dr. John Smallwood, from Montclair State University, has been monitoring the use of nesting boxes by American kestrels since March 1997. His project, "An Investigation of the Behavioral Ecology and Population Dynamics of Secondary Cavity Nesting Birds in New Jersey," has resulted in the placement of about 300 nest boxes near grasslands in Sussex and Warren counties, N.J., including 29 boxes located on the refuge. He has found extensive use of the nest boxes by kestrels and other secondary cavity users such as great crested flycatchers, eastern bluebirds, and tree swallows.

Grassland Birds

The refuge is an important nesting area for grassland birds in New Jersey. Grassland-dependent birds have declined more consistently and over a wider

geographic area than any other group of North American birds over the last 30 years (Knopf 1995, Askins 1997, Sauer et al. 1997). The New Jersey Breeding Bird Atlas (Walsh et al. 1999) shows a greater concentration of grassland bird records for the refuge and the Kittatinny Valley than for most other areas of the state. Grassland birds that nest at the refuge include savannah sparrow (*Passerculus sandwichensis*), grasshopper sparrow (*Ammodramus savannarum*), bobolink (*Dolichonyx oryzivorus*), and eastern meadowlark (*Sturnella magna*). Those species also use the 999 acres of refuge grasslands during migration. Grassland dependent birds benefit from our cooperative farming program, which helps maintain large fields of cool season grasses. These birds also benefit from our efforts to restore diverse warm season grasslands on former cornfields.

From 1995 to 1997, Lamar Gore, a former student trainee at the refuge and graduate student at the University of Massachusetts-Amherst, conducted a 3-year study of grassland birds on the refuge. Titled “Habitat Preference and Management Strategies for Grassland Birds on the Wallkill River National Wildlife Refuge,” that research was the first comprehensive evaluation of nesting grassland bird distribution and abundance on the refuge. The report contains recommendations for managing grasslands on the refuge to support nesting grasshopper sparrows, savannah sparrows, and bobolinks. The management of grassland birds should focus on open sites larger than 50 acres.

Refuge staff and volunteers also maintain and monitor approximately 85 bluebird nest boxes near refuge grasslands. Bluebirds occupy about 50 percent of those boxes each year.

Marsh, Wading and Shorebirds

The Kittatinny Valley in which the refuge lays is a stronghold for nesting marsh birds in New Jersey. Many of those are state-listed threatened or special concern species or migratory game birds. Data from the New Jersey Breeding Bird Atlas (Walsh et al. 1999) indicates that disproportionately high numbers of all marsh bird species were recorded in the valley. For example, 37.1 percent of the sora rail records were from this province, although it comprises only 5.3 percent of the state’s land area. These secretive species also rest and feed in emergent marshes on the refuge during migration. The refuge biologist conducts marsh bird callback surveys following established regional protocol.

Many wading birds and shorebirds use the refuge as well. A small great blue heronry is located on the refuge, and the green heron is a common nesting species. Efforts to restore seasonal wetlands adjacent to the Liberty Loop Trail will yield significant benefits for wading birds, and substantially increase opportunities for managing habitat for migrating shorebirds. Killdeer and spotted sandpiper also breed on the refuge. American woodcock (*Scolopax minor*) is a very common breeder and migrant that exploits refuge woodlands, shrub lands, and grasslands. Each year, the refuge biologist conducts woodcock singing ground surveys following established regional protocol.

Shrubland Birds

Birds that nest in shrub lands have suffered the steepest declines in population over the past 30 years of any bird assemblage in the Northeast (Askins 2000). The refuge old fields, thick forest edges, and hedgerows provide nesting and migrating stopover habitat for several declining shrubland species. The refuge is developing a partnership with The Ruffed Grouse Society to help manage shrubland areas for American woodcock and other shrubland-dependent species.

Forest Interior Birds

The refuge preserves many large tracts of unfragmented forest. Consequently, several species of forest interior songbirds nest there. Many of those are

Neotropical migrants (birds that winter in Central and South America) that have shown significant declines in population over recent decades (Terborgh 1989, Askins et al. 1990). The refuge also serves as a migratory stopover site for those songbirds and more than 50 species that breed farther to the north.

Mammals

Approximately 40 mammal species appear on the refuge, which is particularly important regionally in providing habitat for bobcat (*Lynx rufus*; state-listed endangered) and black bear (*Ursus americanus*). Those large mammals require the large, unfragmented patches of habitat the refuge preserves. For a complete list of all mammal species on the refuge, go to its website, www.fws.gov/northeast/walkkillriver/.

White-tailed deer, muskrats, and woodchucks (*Marmota monax*) have substantial impacts on refuge habitats and management activities. Populations of white-tailed deer, which are high on the refuge and in the surrounding areas, have negatively affected the structure and composition of plant communities. Consequently, the habitat for many wildlife species has been degraded. The burrowing of muskrats and woodchucks causes extensive damage to refuge dikes. That damage inhibits our capability to manage water levels in impoundments for wetland wildlife.

Several species of bats also appear on the refuge. Since 1998, Dr. Lance Risley from William Patterson University has studied bat populations and bat foraging ecology on the refuge and at other sites in northern New Jersey. Dr. Risley is conducting that research because, although the ecological value of bats as insectivores is well known, their general ecology is poorly understood. Dr. Risley's research will further define the habitat preferences of bats in northern New Jersey by locating and characterizing daily roosting sites in forest preserves. His research takes place between May and August, and involves capturing bats using mist nets, monitoring high-frequency bat vocalizations, and attaching radio transmitters to pregnant female bats to determine the locations of their roosting sites. The bats are released unharmed each night. Three bat species have been captured: little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), and red bat (*Lasiurus borealis*).

Reptiles and Amphibians

The mixed topography of the refuge yields a wide variety of habitats for reptiles and amphibians, including vernal pools, calcareous fens, rocky woodland slopes, floodplain swamps, emergent marshes, small rocky streams, and open meadows. Consequently, the refuge supports a great diversity of reptiles and amphibians, including several on federal and state lists of rare and declining species. In fact, few areas in northern New Jersey support such a large concentration of species in need of protection.

The refuge protects habitat in one of only two river drainages in New Jersey occupied by the blue-spotted salamander (*Ambystoma laterale*; state-listed endangered). Other state-listed species on the refuge include eastern mud salamander (*Pseudotriton montanus*), longtail salamander (*Eurycea longicauda*), wood turtle (*Clemmys insculpta*; state-listed threatened), northern spring salamander (*Gyrinophilus porphyriticus*), spotted turtle (*C. guttata*), and eastern box turtle (*Terrapene carolina*; state-listed special concern pending). For a complete list of all reptile and amphibian species on the refuge, go to the refuge website www.fws.gov/northeast/walkkillriver/.

The refuge participates in five herpetological surveys: (1) the Regional anuran call count survey; (2) vernal pool survey; (3) streamside salamander survey; (4) malformed frog surveys, and (5) surveys for the New Jersey Herptile Atlas.

Since 2000, the refuge has participated in the regional anuran call count surveys. These surveys are an effective way to determine species occurrence and abundance, the effects of management activities, and the overall health of the habitat. Starting in 2001, the refuge has assisted the U.S. Geological Survey (USGS) Northeast Amphibian Research and Monitoring Initiative in the long-term monitoring of streamside salamanders and vernal pool breeding amphibians. The objectives of that initiative are to determine the status and trends of amphibians in the Northeast for the ultimate goal of conserving amphibian populations and establishing a long-term monitoring program on Department of Interior lands.

One concern is that pesticides from agricultural operations or from mosquito control may be causing deformities in amphibians in the northern part of the country. In 1997 on two sites, and in 1998 on four sites, the refuge conducted preliminary surveys for frog abnormalities. In 1999, our Chesapeake Bay Field Office conducted a comprehensive survey of four sites. Based on that data, a follow-up survey was conducted in 2000. Its results indicate that, although frogs with abnormalities were found on the refuge, there was not enough evidence to suggest these levels were outside the range of natural variability. The study was concluded in this area (Eaton-Poole and Pickney, 2001).

Fish

The segments of the Wallkill River that run through the refuge are classified as non-trout waters. However, the upper stretches of several tributaries are considered trout maintenance waters (capable of supporting stocked trout). Three river tributaries (Franklin Pond Creek, Sparta Glen Brook, and a tributary to the Wallkill in Ogdensburg) support naturally reproducing populations of brook trout (*Salvelinus fontinalis*). Franklin Pond Creek also supports reproducing brown trout (*Salmo trutta*). For a complete list of all fish species on the refuge, go to the refuge website, www.fws.gov/northeast/wallkillriver/.

Stretches of the river on the refuge support a warm water fishery. The results of a fish survey by our Lake Champlain Fish and Wildlife Resources Office on those stretches is available from the refuge office upon request. A table lists common game and panfish and their relative abundance.

Invertebrates

Most invertebrates are poorly documented on the refuge. However, surveys have been completed for dragonflies and damselflies (*Odonata*), butterflies (*Papilionoidea*), mosquitoes (*Culicidae*), and mussels (*Unionacea*) in the Wallkill River.



Edward Henry/USFWS

Common Wood Nymph is an easy-to-find butterfly on the refuge.

In 2000, Dr. Allen Barlow, a regionally noted entomologist, documented 65 species of dragonflies and damselflies on the refuge. In fact, the refuge supports one of the most diverse Odonate communities in the Northeast. The most significant of these include the first state sightings of midland clubtail (*Gomphus fraternus*) and skillet clubtail (*Gomus ventricosus*). The refuge maintains an annotated damselfly and dragonfly species checklist, available upon request from the refuge headquarters.

The refuge provides habitat for diverse butterfly species. In 2001, the regionally rare Milbert's tortoiseshell (*Nymphalis milberti*) was documented on the refuge. In addition, the North American Butterfly Association (NABA) on July 4, 2001, documented the national high count of 1,737 red admirals (*Vanessa atalanta*). Overall, 32 different butterfly species have been recorded on the refuge. The

counts are conducted by refuge staff and volunteers. The refuge maintains an annotated butterfly species checklist, available upon request from the refuge headquarters.

Annual refuge surveys of mosquitoes were initiated in response to community concerns about the threat of West Nile virus, which was documented in a mosquito trapped in 2001 on the refuge. Twelve species of mosquitoes have been documented. For a complete list of all invertebrate species on the refuge, go to the refuge website, www.fws.gov/northeast/wallkillriver/. These species are the target of control activities on the refuge conducted by the Sussex County Mosquito Control Commission. Mosquito surveillance is typically accomplished through larval dip counts. Larvicides and pupicides are used on a limited basis to control mosquitoes during their most concentrated stages. Typically, Bti is used every year.

Four freshwater mussel species were found during surveys for dwarf wedgemussel in stretches of the Wallkill River that pass through the refuge. The eastern lampmussel is a state-listed threatened species and the creeper is a state special concern species (listing pending).

Public Use

Visitor Numbers

The total number of visits to the refuge in Fiscal Year 2005 was 31,085. Visitor usage has been growing each year as more residents and visitors discover the wildlife-dependent public use opportunities available there.

The refuge has an annual average of 483 deer hunters, 149 migratory bird hunters and 120 turkey hunters. The refuge first opened for migratory bird hunting in 2000.

The Wallkill River is accessible by boat at designated canoe access sites. An estimated 1,500 individuals each year observe wildlife on the Wallkill River by canoe. The refuge is also open for fishing, most of which occurs in spring and summer. An estimated 625 people fished on the refuge in Fiscal Year 2005.

Priority Wildlife— Dependent Public Use

Wallkill River refuge provides hunting, fishing, wildlife observation, wildlife photography, environmental education and interpretation for the public. Wildlife observation is available on the Wood Duck Nature Trail, the Liberty Loop Nature Trail and Dagmar Dale Nature Trail, and by motorized boat, canoe, kayak, or rowboat along the Wallkill River. Fishing and watercraft launch sites are located on the refuge at Oil City Road, Bassett's Bridge and County Route 565. Refuge staff and volunteers occasionally visit local schools, or host scout groups and occasionally lead interpretive walks on the nature trails on the refuge. The refuge is open for fishing along the Wallkill River in accordance with New York and New Jersey fishing regulations, though the refuge does not allow the removal of frogs or turtles. The part of the refuge that lies in New Jersey is also open for all State deer hunting seasons, spring and fall turkey hunting, and all migratory bird hunting except for crows. No hunting is allowed on the part of the refuge in New York State.

The refuge's Wood Duck Nature Trail is a 1.5-mile trail on an abandoned railroad bed. The first 0.6 miles of the trail is hardened to allow barrier-free access. Benches and interpretive signs along the trail facilitate wildlife observation. A new, three-panel information kiosk and five-car parking area are located at the trailhead on Route 565 in Wantage Township. The trail passes through a beaver flowage and wet meadows and ends at the Wallkill River.

The Liberty Loop Nature Trail is a 2.5-mile loop around a grassland/wetland habitat complex. About two-thirds of the Liberty Loop Trail coincides with the Appalachian Trail. The Liberty Loop Trail lacks interpretive signs. In 2001, five benches were added along the trail. A new, six-panel information kiosk and a 10-car parking area are located at the trailhead on Oil City Road in Warwick, New York.

The Dagmar Dale Nature Trail consists of two loops totaling 2.9 miles. The trail traverses deciduous forest and open grasslands before passing by the Wallkill River. The blue trail (north loop) is 1.7 miles long, and the yellow trail (south loop) is 1.2 miles. The trail was officially opened on September 23, 2001, at the Refuge Dedication and Open House. All three trails on the refuge were developed and are enhanced by Eagle Scouts and volunteers, who cleared vegetation, built benches and footbridges and installed interpretive signs.

Fishing and canoe access are provided at several refuge locations. A three-panel kiosk and eight-car parking area is located on the Wallkill River at Bassett's Bridge (Route 642) in Wantage Township. A canoe access area is provided at the Wallkill River on Route 565 in Vernon Township. No parking is currently available at this site, but parking is available at the corner of Route 565 and Scenic Lakes Road, a 5-minute walk from the river.

Access to the manmade farm pond at the refuge office has been provided because of two Eagle Scout projects. A bench on the pond dam and two additional benches in a sycamore grove on the other side of the creek leading from the pond were constructed in the fall of 1999. The sycamore grove could serve as a small outdoor classroom for environmental education. Catch and release fishing at the farm pond is allowed.

A comfort station and 41-car parking lot at refuge headquarters was completed in spring 2001. That facility provides parking for visitors to the refuge office, fishing pond, and Dagmar Dale Nature Trail, and for hunters accessing the land behind the maintenance area.

Last, a six-panel kiosk in the parking area and a small one-panel kiosk are located at the refuge headquarters. It currently provides information for visitors arriving outside normal business hours.

Unauthorized Public Uses

The most pervasive, unauthorized public uses at Wallkill River refuge are dog walking, horseback riding, and all-terrain vehicle use. Those activities are not currently allowed as they are not wildlife-dependent and they interfere with visitors participating in priority, wildlife-dependent public uses. On any given day, one or more of those activities are likely to occur. Refuge law enforcement concentrates on managing our authorized hunting program, providing visitor safety on our trails, and monitoring and enforcing refuge regulations against unauthorized uses.