Chapter 3: Refuge Environment

Seney National Wildlife Refuge

Introduction

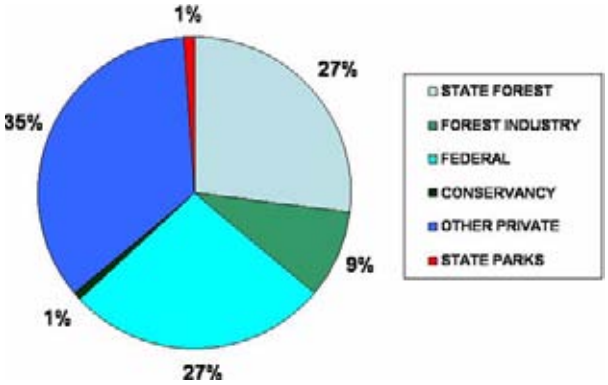
Seney NWR is located in Schoolcraft County in Michigan's eastern Upper Peninsula (U.P.) equidistant from Lakes Superior and Michigan. The Refuge encompasses 95,238 acres; the Seney Wilderness Area, where the Strangmoor Bog National Natural Landmark is located, covers 25,150 acres or 26 percent of the Refuge. The Refuge is removed from major population centers; the three nearest major communities are each more than 80 miles away.

Before its establishment, the forests and soils of the Seney area were exploited to a considerable degree starting in the late 1800s. Early timber cutting favored the best stands of white pine, followed by "high-grading" in the red pine and northern hardwood stands. Slash fires fueled by logging debris occurred repeatedly in the region after the "Great Cutover", with most areas burning time and time again. As the amount of sawtimber diminished, efforts were shifted to cutting of poles, posts, ties and pulp. Following this extensive logging, an attempt was made to settle lands on which forests had been degraded and develop farming communities.

By 1912, drainage of the Seney Swamp was under way. However, poor drainage of peat soils, poor soil fertility and a short growing season made the farming venture a disaster. Many lands were tax-reverted to the State of Michigan by the early 1930s.

Seney NWR was established in 1935 by Executive Order under the Migratory Bird Conservation Act for the protection and production of migratory birds and other wildlife.

Figure 4: Land Ownership in the Eastern Upper Peninsula of Michigan (MDNR)



Climate

The climate of Seney NWR is considerably lacustrine-influenced by its close proximity to Lakes Superior and Michigan. The most common spring through early fall winds are from the southwest to northwest, and average approximately 10 m.p.h. Average daily humidity during spring and fall varies from 50 to 60 percent. Temperature extremes range from approximately minus 35 degrees Fahrenheit to 98 degrees Fahrenheit. Precipitation occurs throughout the year, with June being the wettest month and March the driest on average. Average annual precipitation is approximately 32 inches and average annual snowfall is approximately 123 inches. During spring and summer months, onshore breezes cause frequent afternoon thunderstorms. Lightning strikes are common during such storms. Growing season evaporation averages 25 inches. It is expected that only during 5 percent of the time will drought indices (e.g., Keetch-Byram Drought Index) reach extreme severity levels. The growing season averages 119 days.

Seney NWR. USFWS photo.

Climate Change Impacts

The U.S. Department of the Interior issued an order in January 2001 requiring federal agencies under its direction that have land management responsibilities to consider potential climate change impacts as part of long range planning endeavors.

The increase of carbon dioxide within the Earth's atmosphere has been linked to the gradual rise in surface temperature commonly referred to as global warming. In relation to comprehensive conservation planning for national wildlife refuges, carbon sequestration constitutes the primary climate-related impact that refuges can affect in a small way. The U.S. Department of Energy's "Carbon Sequestration Research and Development" defines carbon sequestration as "...the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere."

Vegetated land is a tremendous factor in carbon sequestration. Terrestrial biomes of all sorts – grasslands, forests, wetlands, tundra, and desert – are effective both in preventing carbon emission and acting as a biological "scrubber" of atmospheric carbon dioxide. The Department of Energy report's conclusions noted that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere.

Conserving natural habitat for wildlife is the heart of any long-range plan for national wildlife refuges. The actions proposed in this CCP would conserve or restore land and habitat, and would thus retain existing carbon sequestration on the Refuge. This in turn contributes positively to efforts to mitigate human-induced global climate change.

One Service activity in particular – prescribed burning – releases carbon dioxide directly to the atmosphere from the biomass consumed during combustion. However, there is actually no net loss of carbon, since new vegetation quickly germinates and sprouts to replace the burned-up biomass and sequesters or assimilates an approximately equal amount of carbon as was lost to the air (Dai et al. 2006). Overall, there should be little or no net change in the amount of carbon sequestered at the Refuge from any of the proposed management alternatives.

Several impacts of climate change have been identified that may need to be considered and addressed in the future:

- Habitat available for cold water fish such as trout and salmon in lakes and streams could be reduced.
- Forests may change, with some species shifting their range northward or dying out, and other trees moving in to take their place.
- Ducks and other waterfowl could lose breeding habitat due to stronger and more frequent droughts.
- Changes in the timing of migration and nesting could put some birds out of sync with the life cycles of their prey species.
- Animal and insect species historically found farther south may colonize new areas to the north as winter climatic conditions moderate.

The managers and resource specialists on the Refuge need to be aware of the possibility of change due to global warming. When feasible, documenting long-term vegetation, species, and hydrologic changes should become a part of research and monitoring programs on the Refuge. Adjustments in Refuge management direction may be necessary over the course of time to adapt to a changing climate.

The following paragraphs are excerpts from the 2000 report, Climate Change Impacts on the United States: The Potential Consequences of Climate Vari-

ability and Change, produced by the National Assessment Synthesis Team, an advisory committee chartered under the Federal Advisory Committee Act to help the U.S. Global Change Research Program fulfill its mandate under the Global Change Research Act of 1990. These excerpts are from the section of the report focused upon the eight-state Midwest Region.

Observed Climate Trends: Over the 20th century, the northern portion of the Midwest, including the upper Great Lakes, has warmed by almost 4 degrees Fahrenheit (2 degrees Celsius), while the southern portion, along the Ohio River valley, has cooled by about 1 degree Fahrenheit (0.5 degrees Celsius). Annual precipitation has increased, with many of the changes quite substantial, including as much as 10 to 20 percent increases over the 20th century. Much of the precipitation has resulted from an increased rise in the number of days with heavy and very heavy precipitation events. There have been moderate to very large increases in the number of days with excessive moisture in the eastern portion of the basin.

Scenarios of Future Climate: During the 21st century, models project that temperatures will increase throughout the Midwest, and at a greater rate than has been observed in the 20th century. Even over the northern portion of the region, where warming has been the largest, an accelerated warming trend is projected for the 21st century, with temperatures increasing by 5 to 10 degrees Fahrenheit (3 to 6 degrees Celsius). The average minimum temperature is likely to increase as much as 1 to 2 degrees Fahrenheit (0.5 to 1 degrees Celsius) more than the maximum temperature. Precipitation is likely to continue its upward trend, at a slightly accelerated rate; 10 to 30 percent increases are projected across much of the region. Despite the increases in precipitation, increases in temperature and other meteorological factors are likely to lead to a substantial increase in evaporation, causing a soil moisture deficit, reduction in lake and river levels, and more drought-like conditions in much of the region. In addition, increases in the proportion of precipitation coming from heavy and extreme precipitation are very likely.

Midwest Key Issues

Reduction in Lake and River Levels

Water levels, supply, quality, and water-based transportation and recreation are all climate-sensitive issues affecting the region. Despite the projected increase in precipitation, increased evaporation due to higher summer air temperatures is likely to lead to reduced levels in the Great Lakes. Of 12 models used to assess this question, 11 suggest significant decreases in lake levels while one suggests a small increase. The total range of the 11 models' projections is less than a 1-foot increase to more than a 5-foot decrease. A 5-foot reduction would lead to a 20 to 40 percent reduction in outflow to the St. Lawrence Seaway. Lower lake levels cause reduced hydropower generation downstream, with reductions of up to 15 percent by 2050. An increase in demand for water across the region at the same time as net flows decrease is of particular concern. There is a possibility of increased national and international tension related to increased pressure for water diversions from the Lakes as demands for water increase. For smaller lakes and rivers, reduced flows are likely to cause water quality issues to become more acute. In addition, the projected increase in very heavy precipitation events will likely lead to increased flash flooding and worsen agricultural and other non-point source pollution as more frequent heavy rains wash pollutants into rivers and lakes. Lower water levels are likely to make water-based transportation more difficult with increases in the costs of navigation of 5 to 40 percent. Some of this increase will likely be offset as reduced ice cover extends the navigation season. Shoreline damage due to high lake levels is likely to decrease 40 to 80 percent due to reduced water levels.

Adaptations: A reduction in lake and river levels would require adaptations such as re-engineering of ship docks and locks for transportation and recreation. If flows decrease while demand increases, international commissions focusing on Great Lakes water issues are likely to become even more important in the future. Improved forecasts and warnings of extreme precipitation events could help reduce some related impacts.

Agricultural Shifts

Agriculture is of vital importance to the Midwest region, the nation and the world. It has exhibited a capacity to adapt to moderate differences in growing season climate, and it is likely that agriculture would be able to continue to adapt. With an increase in the length of the growing season, double cropping, the practice of planting a second crop after the first is harvested, is likely to become more prevalent. The CO2 fertilization effect is likely to enhance plant growth and contribute to generally higher

yields. The largest increases are projected to occur in the northern areas of the region, where crop yields are currently temperature limited. However, yields are not likely to increase in all parts of the region. For example, in the southern portions of Indiana and Illinois, corn yields are likely to decline, with 10-20 percent decreases projected in some locations. Consumers are likely to pay lower prices due to generally increased yields, while most producers are likely to suffer reduced profits due to declining prices. Increased use of pesticides and herbicides are very likely to be required and to present new challenges.

Adaptations: Plant breeding programs can use skilled climate predictions to aid in breeding new varieties for the new growing conditions. Farmers can then choose varieties that are better attuned to the expected climate. It is likely that plant breeders will need to use all the tools of plant breeding, including genetic engineering, in adapting to climate change. Changing planting and harvest dates and planting densities, and using integrated pest management, conservation tillage, and new farm technologies are additional options. There is also the potential for shifting or expanding the area where certain crops are grown if climate conditions become more favorable. Weather conditions during the growing season are the primary factor in year-to-year differences in corn and soybean yields. Droughts and floods result in large yield reductions; severe droughts, like the drought of 1988, cause yield reductions of over 30 percent. Reliable seasonal forecasts are likely to help farmers adjust their practices from year to year to respond to such events.

Changes in Semi-natural and Natural Ecosystems

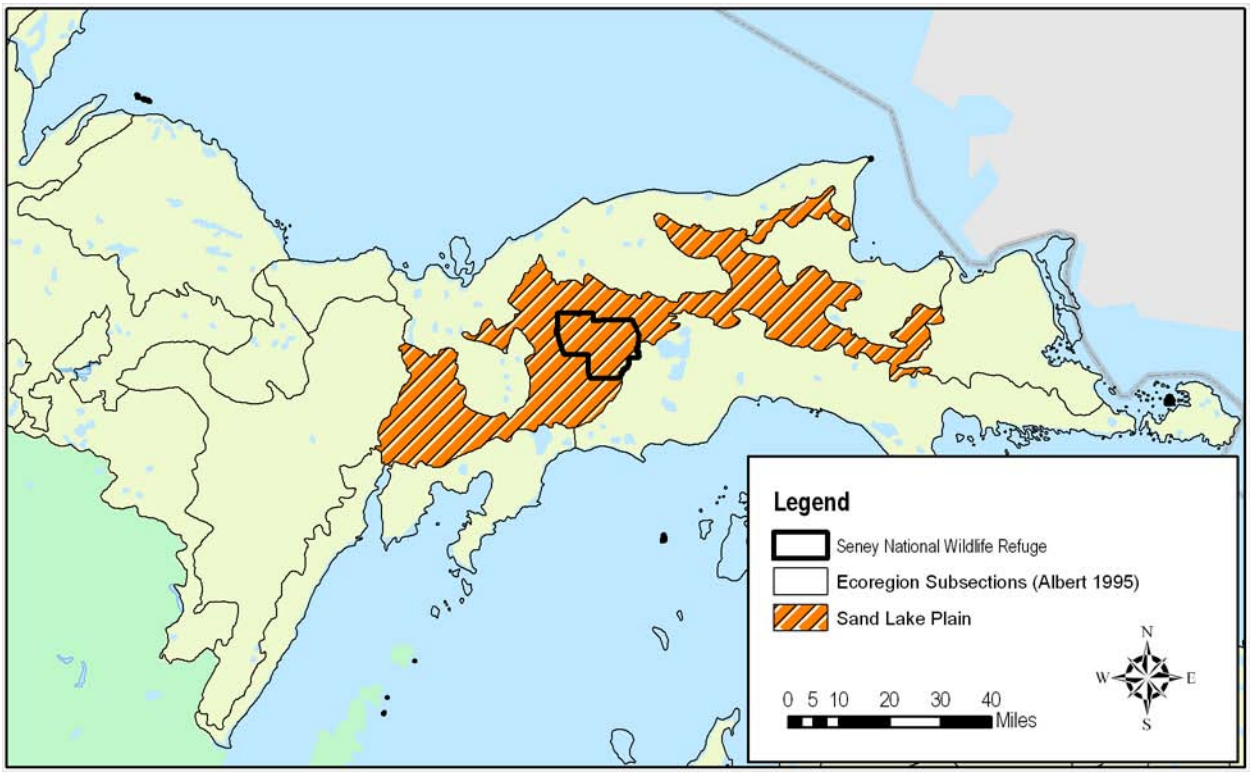
The Upper Midwest has a unique combination of soil and climate that allows for abundant coniferous tree growth. Higher temperatures and increased evaporation will likely reduce boreal forest acreage, and make current forestlands more susceptible to pests and diseases. It is likely that the southern transition zone of the boreal forest will be susceptible to expansion of temperate forests, which in turn will have to compete with other land use pressures. However, warmer weather (coupled with beneficial effects of increased CO2), are likely to lead to an increase in tree growth rates on marginal forestlands that are currently temperature-limited. Most climate models indicate that higher air temperatures will cause greater evaporation and hence reduced soil moisture, a situation conducive to forest fires. As the 21st century progresses, there will be an increased likelihood of greater environmental stress on both deciduous and coniferous trees, making them susceptible to disease and pest infestation, likely resulting in increased tree mortality.

As water temperatures in lakes increase, major changes in freshwater ecosystems will very likely occur, such as a shift from cold water fish species, such as trout, to warmer water species, such as bass and catfish. Warmer water is also likely to create an environment more susceptible to invasions by non-native species. Runoff of excess nutrients (such as nitrogen and phosphorus from fertilizer) into lakes and rivers is likely to increase due to the increase in heavy precipitation events. This, coupled with warmer lake temperatures, is likely to stimulate the growth of algae, depleting the water of oxygen to the detriment of other living things. Declining lake levels are likely to cause large impacts to the current distribution of wetlands. There is a small chance that some wetlands could gradually migrate, but in areas where their migration is limited by the topography, they would disappear. Changes in bird populations and other native wildlife have already been linked to increasing temperatures and more changes are likely in the future. Wildlife populations are particularly susceptible to climate extremes due to the effects of drought on their food sources.

Seney NWR and Climate Change

Climate change is rarely discussed in most management plans because its effects are often assumed to occur more slowly than even the federal planning process. However, for many taxa, recent shifts in phenologic and distribution patterns have been strongly correlated with climate change, and for some species these changes have occurred over a relatively short time frame (Root and Schneider 1995, Stevenson and Bryant 2000, Root et al. 2003). Based on a model assuming a doubling of carbon dioxide, Price (2000) suggests that the distribution patterns of 42 non-game bird species found at the Refuge and in Michigan in general will likely be influenced over an undetermined period of time by climate change: 33 (79 percent) will be extirpated in Michigan, six (14 percent) will experience range expansion, and three (7 percent) will show range contraction. For most species, the influence of climate change is thought to be correlated to changes

Figure 5: Seney Sand Lake Plain



in habitat distribution and abundance. Ongoing research at the Refuge is evaluating how climate change may influence small mammal distribution and abundance patterns (Phil Myers, University of Michigan). Lowland coniferous forests comprised of black spruce, tamarack, and balsam fir are most likely to be affected habitat type at the Refuge since these boreal tree species (especially balsam fir) are near the southern edge of their distribution (Iverson et al. 1999).

Geology and Glaciation

According to the regional landscape classification system of Albert (1995), Seney NWR lies within the Seney Sand Lake Plain (Sub-Subsection VIII.2.1, Figure 5). This unit is characterized by landforms of lacustrine origin with broad, poorly drained embayments containing beach ridges, swales, dunes, and sandbars.

The lands comprising Seney NWR present an area of seemingly little geological variation in comparison with more scenic areas along the shores of Lake Superior and Lake Michigan. Although relatively little topographic relief exists on the Refuge (elevation varies from approximately 803 feet in the northwest to 640 feet in the southeast), the broad, flat lands of the Refuge reflect a subtle, but highly complex, geologic history.

Between 10,000 and 10,500 years ago, the "Valders" pro-glacial lakes in the Superior basin drained southward across the Upper Peninsula. At about the latter date, the Valders ice border was located along the southern shore of Lake Superior allowing meltwater to drain southward across what is now the Refuge. During this period of time, the present land surface appears to have been sculptured. At least two phases of drainage seem to be visible in the surface patterns of the area. The first of these is a broad channel eroded into earlier outwash deposits that carried meltwaters from the area of Long Lake southward through what is now termed the "Strangmoor Bog" (Heinselman 1965). Throughout the length of this channel now occur linear landforms composed of sandy sediments. A second generation of outwash channels is visible as linear peat-filled depressions trending northwest-southeast across Seney NWR. These landforms are now considered unique patterned bog topography

and are prominently visible near Creighton and in the Refuge lands west of the Driggs River (Seney Wilderness Area). Finally, the current natural drainage patterns present a still different orientation and one that transects the above peat-filled channels. In the Seney area, the Driggs River best exhibits this pattern.

Since 10,500 years ago, the Seney area has been a site for marsh development. At present, from 3 to 9 feet of peat blanket most of the area. Among the more conspicuous landforms in the area are parabolic sand dunes, which have spread from northwest to southeast across the Refuge in a disjointed pattern. These landforms indicate arid conditions in the area, which allowed for the disruption of vegetation that had developed upon the surrounding sand and gravel deposits. At the same time, prevailing northwest winds winnowed the exposed fine to medium grained sands from the earlier outwash sediments and gave rise to the present dune topography.

Soils

Within the Seney Sand Lake Plain, 100 to 200 feet of glacial drift generally cover the bedrock. The soils on the Refuge are generally level to somewhat sloping mucks, peats, and sands. The dominant mucks are interspersed with sand ridges and knolls in such an intricate pattern that the two soils have been mapped together as a complex of Carbondale muck and Rubicon sand (dune phase). The muck has accumulated on the wet sandy plain at a depth of 3 to 9 feet. The material is a dark brown, spongy, felt-like muck, which is more decomposed than peat soils and in general contains a higher percentage of mineral matter. The natural drainage is very poor in the mucks and excessive in the sands on the ridges and knolls. This complex covers the majority of the Refuge.

A large area of Dawson and Greenwood peats exists in the central portion of the Refuge. These level, very poorly drained soils are composed of brown or yellow-brown mixed fibrous and woody material. At depth of 1 to 2 feet, raw yellow peat or muck underlies the peat. Very little decomposition has taken place in the areas of yellow peat. The water table is at the surface most of the year. Areas of Carbondale and Tawas mucks interrupt the peats on the Refuge. Wet sands underlie the entire area.

Along the Manistique River Valley, Driggs River, and the other tributaries draining the Refuge, the soils are predominately sands and sandy loams (see Figure 6). These soils are well or excessively drained and lie on slopes that are level to steeply sloping. The soil surface consists of forest litter, underlain by gray sandy loam or fine sandy loam, with coarser sand beneath the loam. Under the former Soil Conservation Service Capability Class system, most of the Refuge would be Class V, wet soils. The wet sandy areas are Class II, VI, and VIII, while the better-drained areas are Class II and III. Only small areas along the Manistique River and along the western border of the Refuge are suitable for farming.

Soils associated with each Forest Management Unit are shown in Appendix J.

According to the habitat typing system of Burger and Kotar (2003), a total of 31 soil types at the Refuge (61 percent) have either primary or secondary habitat types (Table 1 on page 19). Of these, 18 (58 percent) have white pine as a climax species and 13 (42 percent) have maple (sugar or red) as climax species (Appendix J). This system does not (at present) provide primary or secondary successional pathways for wetland soils.

Surface Hydrology

Seney NWR lies within the Manistique River watershed, which encompasses portions of Alger, Delta, Luce, Mackinac, and Schoolcraft Counties. The watershed drains approximately 1,465 square miles before emptying into the northeast corner of Lake Michigan (Madison and Lockwood 2004). General land slopes are approximately 10 feet per mile and southeasterly in direction. Water enters the Refuge from the north-northwest through the following creeks, from west to east: Marsh Creek, Ducey Creek, Walsh Creek, Driggs River, Holland Ditch and Clarks Ditch. Water then flows to the south-southeast to the Manistique River (Figure 7 on page 21 and Table 2 on page 22). The Manistique River then flows into Lake Michigan.

Annual precipitation averages approximately 32 inches per year. This precipitation accounts for approximately 60 percent of the Refuge water intake. The remaining 40 percent of the Refuge water supply comes from the ditches, rivers and creeks. Sheet flow (overland flow) is quite substan-

Figure 6: Soils of Seney NWR

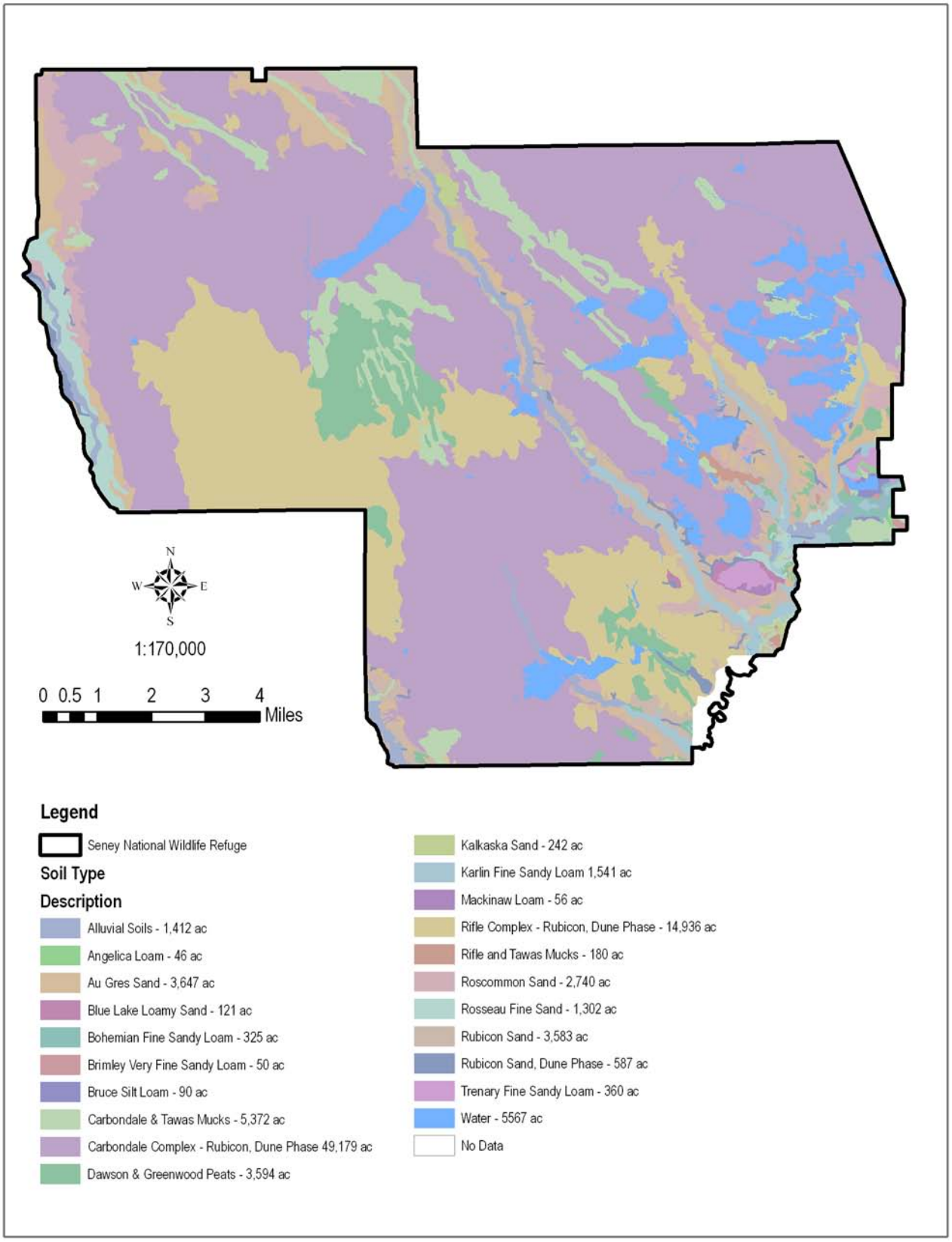


Table 1: Ranked Order of Acres of Soils at Seney NWR

Soil Name	Approximate Acreage	Percent of Refuge	Primary/Secondary Habitat Types[1]
Markey Mucky Peat	43,751	46	None/None
Deford-AuGres-Rubicon Complex, Deep Water Table, 0-15% Slopes	7,392	8	None/PArV
Water	5,977	6	-
Loxley-Carbondale Complex	5,908	6	None/None
Neconish-Kinross-Wainola Complex, 0-6% Slopes	3,549	4	PVE/None
Deford Muck	3,327	3	None/None
Dawson-Greenwood-Loxley Peats	3,279	3	None/None
Markey-Deford Mucks, Drained	1,951	2	None/None
Rousseau-Neconish-Spot Complex, 0-25% Slopes	1,882	2	PVE/None
Histosols and Aquents, Ponded	1,639	2	None/None
Kinross-AuGres-Rubicon Complex, Deep Water Table, 0-15% Slopes	1,501	2	None/PArV
Carbondale-Lupton-Tawas Mucks	1,452	2	None/None
Deford-AuSable-Tawas Mucks	1,316	1	None/None
Pelkie (Occassionally Flooded)-Deford (Frequently Flooded) Complex, 0-6% Slopes	1,302	1	None/None
Proper Fine Sand, 0-6% Slopes	1,266	1	PVE/None
Rousseau-Proper-Deford Complex, 0-25% Slopes	1,189	1	PVE/None
Meehan-Deford-Seney Complex, 0-3% Slopes	1,057	1	PArVAa/None
Finch-Spot Complex, 0-3% Slopes	888	1	PArVAa/None
Duck-Rubicon, 0-15% Slopes	827	1	PArVAa/PArV
Clemons-Deford Complex, Very Rarely Flooded, 0-15% Slopes	738	1	None/None
Rousseau Fine Sand, 15-35% Slopes	600	1	PVE/PArV
Markey-Deford Mucks, Drained	548	1	None/None
Rousseau Fine Sand, 6-15% Slopes	430	0	PVE/PArV
Graveraet Very Fine Sandy Loam, 1-6% Slopes	410	0	AFOAs/AFPo
Hendrie-Anninias Complex, 0-3% Slopes	278	0	None/None
AuGres Sand, 0-3% Slopes	247	0	PArVAa/None
Kinross Muck	237	0	None/None
Liminga Fine Sand, 15-35% Slopes	224	0	ATFD/None
Cathro and Lupton Mucks	212	0	None/None
Rubicon Sand, 15-35% Slopes	204	0	PArV/PVE
Rousseau Fine Sand, 0-6% Slopes	187	0	PVE/PArV
Noseum Fine Sandy Loam, 0-4% Slopes	181	0	ATFD/None

Table 1: Ranked Order of Acres of Soils at Seney NWR (Continued)

Soil Name	Approximate Acreage	Percent of Refuge	Primary/Secondary Habitat Types[1]
AuGres-Deford Complex, 0-3% Slopes	178	0	PArVAa/None
Rubicon Sand, 6-15% Slopes	133	0	PArV/PVE
Hiawatha Fine Sandy Loam, 0-6% Slopes	130	0	ATFD/None
McMillan-Greylock Complex, 1-6% Slopes	127	0	AFPo/AFOAs
Hiawatha-Rubicon Complex, 0-15% Slopes	122	0	PArVAa/PArV
Rubicon-Deford Complex, 0-35% Slopes	114	0	PArV/None
Brevort-Iosco Complex, 0-3% Slopes	110	0	None/None
Halfaday Sand, 0-6% Slopes	110	0	ATFD/None
Pelkie-Moquah-Arnheim Complex, 0-6% Slopes	95	0	AFPo/None
Duck Fine Sandy Loam, 0-4% Slopes	83	0	ATFD/None
Rubicon Sand, Deep Water Table, 0-6% Slopes	58	0	PArV/None
Paquin Sand, 0-3% Slopes	38	0	ATFD/None
Minocqua Muck	38	0	None/None
Dawson-Kinross Mucks	38	0	None/None
Spot Peat	32	0	None/None
Kalkaska Sand, 6-15% Slopes	32	0	ATFD/None
McMillan-Greylock Complex, 6-15% Slopes	10	0	AFPo/AFOAs
McMillan-Stutts Complex, 15-35% Slopes	7	0	AFPo/ATFD
Angelica Muck	4	0	None/None
Total	95,406	100	-

1. *Habitat types:* ***AFOAs*** *= Acer saccharum – Fagus grandifolia/Osmorhiza claytoni – Arisaema atrorubens;* ***AFPo*** *= Acer saccharum - Fagus grandifolia/Polygonatum pubescens;* ***ATFD*** *= Acer saccharum – Tsuga canadensis – Fagus grandifolia/ Dryopteris spinulosa;* ***PArV*** *= Pinus strobus – Acer rubrum/Vaccinium angustifolium;* ***PArVAa*** *= Pinus strobus – Acer rubrum/Vaccinium angustifolium-Aralia nudicaulis;* ***PVE*** *= Pinus strobus/Vaccinium angustifolium-Epigaea repens*

tial each spring as a result of winter snow and ice stores melting. Ground water is discharged into the peat and streams and flows under streambeds as hyporheic flow. Peak flows through the Refuge marsh and water system normally occur during spring. Snowmelt, frozen ground, and rain can combine to create destructive floods, although such events are rare. Stream flow data for water entering the Refuge is limited to early U.S. Geological Survey gauging station data for the period 1939-50 (Table 2 on page 22). Recent stream flow data (1999 -2000) is available for the western half of the Refuge from Marsh Creek east to Driggs River. Overall the discharges are relatively low due to the large amount of wetland and depression storage located in the watershed.

Seney NWR includes 27 man-made pools, with water control capability on 21 pools. Along with associated potholes, beaver ponds, and ditches, the 27 pools account for approximately 7,456 surface acres of impounded water, or 7.8 percent of the total Refuge acreage.

Figure 7: Surface Hydrology of the Seney NWR

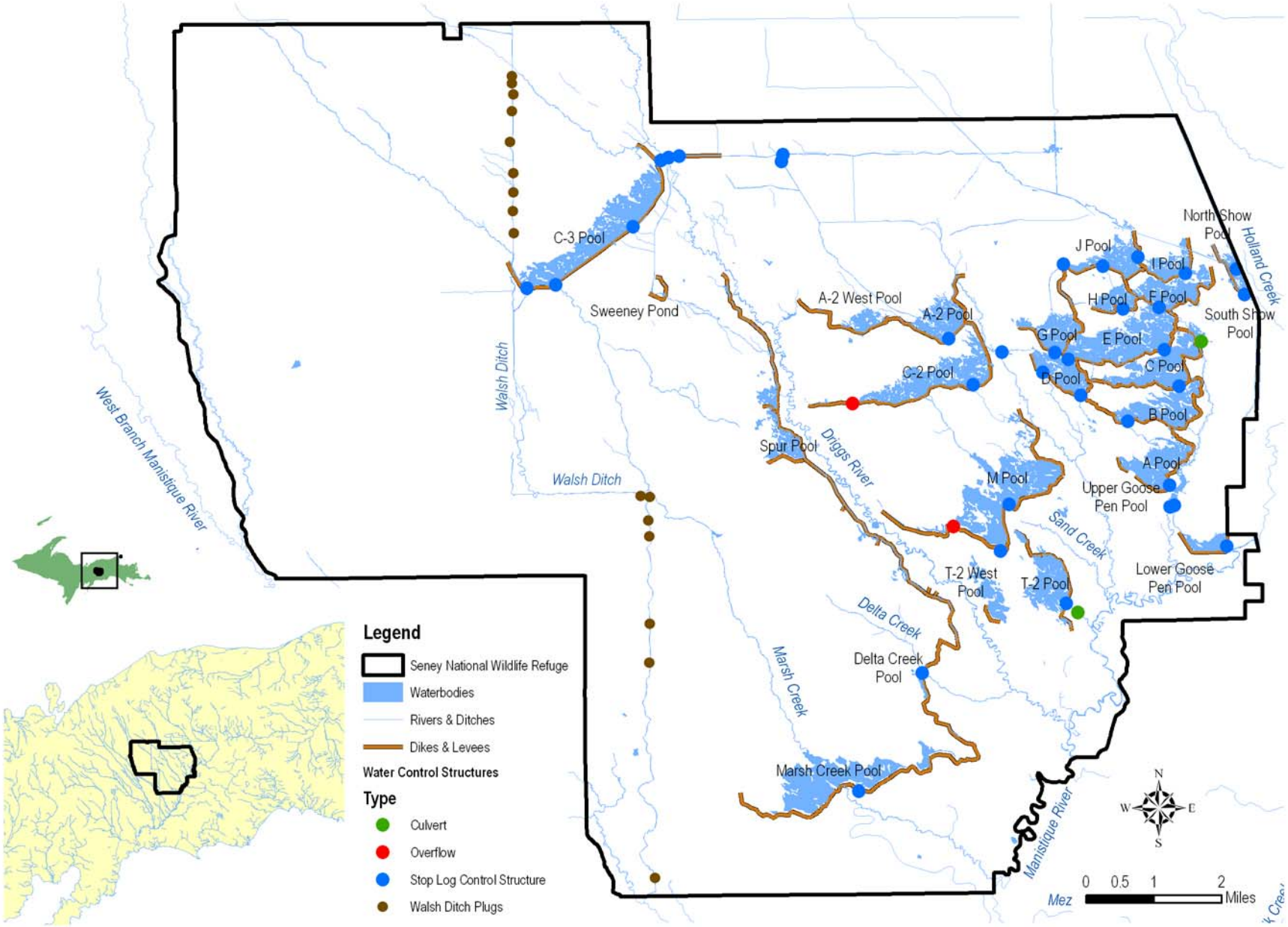


Table 2: Average Peak Inflow of Water into Seney NWR

Flowage	Drainage Area (acres)[1]	Inflow (cubic feet/second)
Marsh Creek[2]	12,800	122
Walsh Ditch	7,680	156
Driggs River	44,800	512
Holland Ditch	8,320	128
Clark Ditch	5,120	98

1. *Drainage area north of the Refuge.*
2. *Includes Ducey Creek drainage.*

Historically much of the land in and near what is now Seney NWR in Michigan's eastern Upper Peninsula was an expansive, ground-water-supported sedge fen. In support of agricultural development, the largest wetland drainage project in Michigan's history was begun in 1912 (Wilcox et al. 2006). The Walsh Ditch was constructed to redirect Walsh and Marsh Creeks and to lower the water tables. Despite this effort, agriculture proved unsustainable and was soon abandoned. The unintended consequences of the wetland drainage project were far reaching and will be discussed in another section of the document.

Archeological and Cultural Values

Cultural resources are: "those parts of the physical environment (natural and built) that have cultural value to some kind of sociocultural group....[and] those non-material human institutions." Schoolcraft County contains four properties on the National Register of Historic Places. On the Refuge there are 40 recorded cultural resource sites, three of which have been determined ineligible for the National Register. These sites include the several buildings in the Refuge Headquarters area, structures constructed by the Civilian Conservation Corps, logging camps, cabins, a farm, a ditch, and other types. No prehistoric sites have been identified on the Refuge. Five Indian tribes have an interest in Schoolcraft County and may be concerned about traditional cultural properties and sacred sites if any exist on the Refuge. During a "Master Planning" process in 1976, Commonwealth Associates, Inc. identified areas along the Manistique River as having the best potential for such sites. To date no resources have been found at these areas.

Social and Economic Context

Seney NWR is located in northern Schoolcraft County. One of 15 counties in Michigan's Upper Peninsula, it stretches from the shores of Lake Michigan north to within 4 miles of Lake Superior. Its poor soils and cold climate contribute to a low human population and limited economic activities. Only 8,903 people live in the 1,178-square-mile county (7.5 people per square mile). The population decreased slightly between 2000 and 2005.

The two nearest towns, Germfask and Seney, host 491 and 108 people, respectively. The closest towns with a population greater that 2,000 people are Manistique, Munising and Newberry, all of which are 40 miles away from the Refuge. The racial makeup of the county is 89 percent white, 6 percent Native American, 2 percent African American with Asians, Hispanic and other races contributing 3 percent. Interestingly, 16 percent of Upper Peninsula residences claim Finnish ancestry, making it the largest concentration of Finns outside of Europe (Table 3).

The median income for a household in Schoolcraft County was $32,306 in 2005, with about 12 percent of the population living below the poverty line. This compares to $46,291 and 11 percent for the State of Michigan in the same year. In Schoolcraft County, government agencies provide 23 percent of the jobs, followed by service industry at 22 percent, retail at 20 percent, manufacturing at 10 percent and construction at 7 percent. Much of the area is forested and attracts summer recreationists who enjoy hunting, hiking, camping and fishing. In the winter, snowmobiling is a big attraction. (U.S. Census Bureau 2005).

Seney NWR was one of the sample Refuges investigated in a national study of the economic benefits to local communities of national wildlife refuge visitation (Laughland and Caudill, 2004). This study found that in 2004 resident and non-resident visitors to Seney NWR spent about $547,300 in the Refuge (Table 4). When this spending had cycled through

Table 3: Socioeconomic Characteristics of Schoolcraft County, Michigan

Characteristic	Schoolcraft County	Michigan
Population, 2005 estimate	8,819	10,120,860
Population, percent change, April 1, 2000 to July 1, 2005	-0.9%	1.8%
Population, 2000	8,903	9,938,444
Land area (square miles)	1,178	56,803
Persons per square mile, 2000	7.6	175
White persons, percent, 2005 (a)	90.0%	81.3%
Black persons, percent, 2005 (a)	2.0%	14.3%
American Indian and Alaska Native persons, percent, 2005 (a)	5.4%	0.6%
Asian persons, percent, 2005 (a)	0.5%	2.2%
Persons of Hispanic or Latino origin, percent, 2005 (b)	1.0%	3.8%
White persons not Hispanic, percent, 2005	89.2%	77.9%
Foreign born persons, percent, 2000	1.0%	5.3%
Language other than English spoken at home, pct age 5+, 2000	3.0%	8.4%
High school graduates, percent of persons age 25+, 2000	79.4%	83.4%
Bachelor's degree or higher, pct of persons age 25+, 2000	11.3%	21.8%
Persons with a disability, age 5+, 2000	1,695	1,711,231
Households, 2000	3,606	3,785,661
Persons per household, 2000	2.36	2.56
Median household income, 2003	$32,306	$46,291
Per capita money income, 1999	$17,137	$22,168
Persons below poverty, percent, 2003	11.7%	11.0%
Source: US Census Bureau State & County QuickFacts (2005)		

Table 4: Recreation-related Expenditures of Visitors to Seney NWR

Activity	Resident	Non-resident	Total ($ in thousands)
Non-consumptive	$29.0	$442.1	$471.1
Hunting	$11.0	$48.6	$59.6
Fishing	$8.0	$8.6	$16.6
Total	$48.0	$499.3	$547.3
Source: Laughland and Caudill, 2004			

the economy, the Refuge had generated $671,800 in fiscal demand, $235,000 in job income, 11 jobs, and $112,600 in total tax revenue.

Environmental Contaminants

A Contaminant Assessment Process (CAP) was conducted for Seney NWR in 2005. A CAP is an information gathering process and initial assessment of a national wildlife refuge in relation to environmental contaminants.

Past Activities Contamination

During the process, soils, groundwater, and biota were collected from areas where past activities (oiling of roads to control dust and wood treatment of fence posts with pentachlorphenol) occurred. Soils were found to have low concentrations of dioxin-like contaminants. Groundwater results indicated that Refuge impoundments were not compromised by hydrocarbon contamination via shallow groundwater discharge. Overall, contamination resulting from previous activities is not at a level great enough in the soil, water or biota to cause adverse affects to Trust resources.

Wildlife Contamination

The Michigan Department of Community Health has issued a fish consumption advisory for all inland lakes. The advisory applies to all the pools at Seney NWR. The advisory provides guidelines regarding the size and frequency of which fish species can be eaten safely. The advisory states that no one should eat more than one meal a week of rock bass, yellow perch, or black crappie over 9 inches in length or any size largemouth bass, smallmouth bass, walleye, northern pike, or muskellunge. Women of childbearing age and children under age 15 should not eat more than one meal per month of these fish.

In 1999 a study was conducted to better assess the presence of mercury in fish collected from the Refuge. Four species (northern pike, yellow perch, white sucker, and pumpkinseed) were collected for mercury analysis (Best 1999). Results from the study confirmed the consumption advisory.

The lack of fish passage prevents fish from Lake Michigan, which have greater poly-chlorinated biphenyls (PCB) concentrations than inland fish, from being a food source to Refuge wildlife. Mink and river otter on the Refuge were tested in 1995 for mercury and PCB contamination. Results indicated that mercury and PCB concentrations found in the livers were substantially less than concentrations associated with adverse effects (Dansereau et al. 1999). Common Loons, which also feed on fish on the Refuge, are not currently being adversely affected by their exposure to mercury on a population basis (McCormick et al. 2006).

Air Contamination

The National Atmospheric Deposition Program/ National Trends Network (NADP/NTN) is a nationwide network of precipitation monitoring sites. The purpose of the network is to collect data on the chemistry of precipitation for monitoring of geographical and temporal long-term trends. In 2000, Seney NWR became a monitoring site for the NADP/NTN. Precipitation is collected weekly and analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, calcium, magnesium, potassium, and sodium.

In 2003, Seney NWR also became a monitoring site for the Mercury Deposition Network. The objective of the network is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal and annual flux of total mercury in wet deposition. The data is being used to develop information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors.

In many of the national maps, Seney NWR is not located in an area of high deposition of many substances (pH, mercury, noxious oxides, NOx) that are elevated further south and east in the Great Lakes Basin.

Due to its remote location, Seney NWR is not near any point-sources of pollution. Therefore, the Refuge is not at risk from spills or other releases from facilities. Instead, the Refuge is more likely to be impacted from air pollution that may originate from other industrialized areas of the Great Lakes basin and beyond.

Table 5: Ranked Order of Pre-European Settlement Cover Types of Seney NWR by Acres[1] and Percent of Total

Cover Type	Acres	Percent (%) of Total
Muskeg-Bog	64,678	68.1
Mixed Conifer Swamp	11,699	12.3
White Pine-Red Pine	5,354	5.6
Jack Pine-Red Pine	4,462	4.7
Hemlock-White Pine	2,479	2.6
Beech-Sugar Maple-Hemlock	1,785	1.9
Spruce Fir-Cedar	1,719	1.8
Hemlock-Yellow Birch	859	0.9
Shrub Swamp-Emergent Marsh	661	0.7
Aspen-Birch	595	0.6
Lake or River	264	0.3
Mixed Hardwood Swamp	165	0.2
Black Ash	132	0.1
Cedar Swamp	66	0.07
Sugar Maple-Hemlock	33	0.03
Total	94,851	99.9

1. *Above information derived from pre-European cover type layer supplied by the Michigan Department of Natural Resources (MDNR). This information is based on General Land Office Notes (see Comer et al. 1995). Refuge boundary GIS layer does not correspond exactly to present-day ownership size of 95,238.*

Natural Resources

Habitats

Historic Vegetation

The plant species that presently dominate Seney NWR are primarily the result of two major events: (1) species migration in response to climate change after the retreat of the Wisconsin glacier, and (2) human intervention during the last two centuries (Zhang et al. 2000). General Land Office notes depict the Seney area prior to European settlement as consisting of a mosaic of upland and wetland cover types (Table 5, Comer et al. 1995). The scrub-shrub matrix was interspersed by herbaceous species such as *Carex* and deciduous and coniferous forests of red and white pine, black spruce, balsam fir, American beech, eastern hemlock, sugar maple, and yellow birch (Figure 8).

In the eastern Upper Peninsula of Michigan, mixed-conifer forests comprised approximately 38 percent of the pre-European landscape (Zhang et al. 2000). The distribution of these forests across the landscape was regulated primarily by the interaction of topography, soil moisture, and fire. Generally speaking, wildfires tended to burn more erratically and less frequently on ice-contact landforms than on dry, sandy outwash plains. As a result, many areas of the Refuge were historically dominated by large, interspersed mature red pine and eastern white pine (Vogl 1970, Whitney 1986).

Prior to Refuge establishment, the forests and soils of the Seney area and surrounding Schoolcraft County were exploited to a considerable degree. Early timber cutting favored the best stands of white pine, followed by "high-grading" in the red pine and hardwood-eastern hemlock stands (Karamanski 1989). Slash fires fueled by logging debris occurred repeatedly, with most areas burning on numerous occasions. As sawtimber diminished, efforts were shifted to cutting of poles, posts, ties, and pulp. At this time, an attempt was made to settle cut-over lands and develop farming communities.

On excessively drained to well-drained ice-contact landforms with higher water-holding capacity and nutrient levels than outwash barrens, mixed-pine stands dominated by red pine and eastern white pine were common historically at Seney NWR, with jack pine, aspen, and other early successional hardwood species as typical associates (Comer et al. 1995). These mixed-conifer forests existed on primarily linear outwash channels and "pine islands" interspersed among a matrix of lowland swamp forests or patterned fens (Silbernagel et al. 1997). Now, it is estimated that less than 1 percent of the primary white and red pine forests exist in the regional landscape and much of the Refuge forests too have been structurally and compositionally altered due to past management actions (Frehlich and Reich 1996, Thompson et al. 2006, Drobyshev et al. In Press).

Figure 8: Historic Landcover of Seney NWR

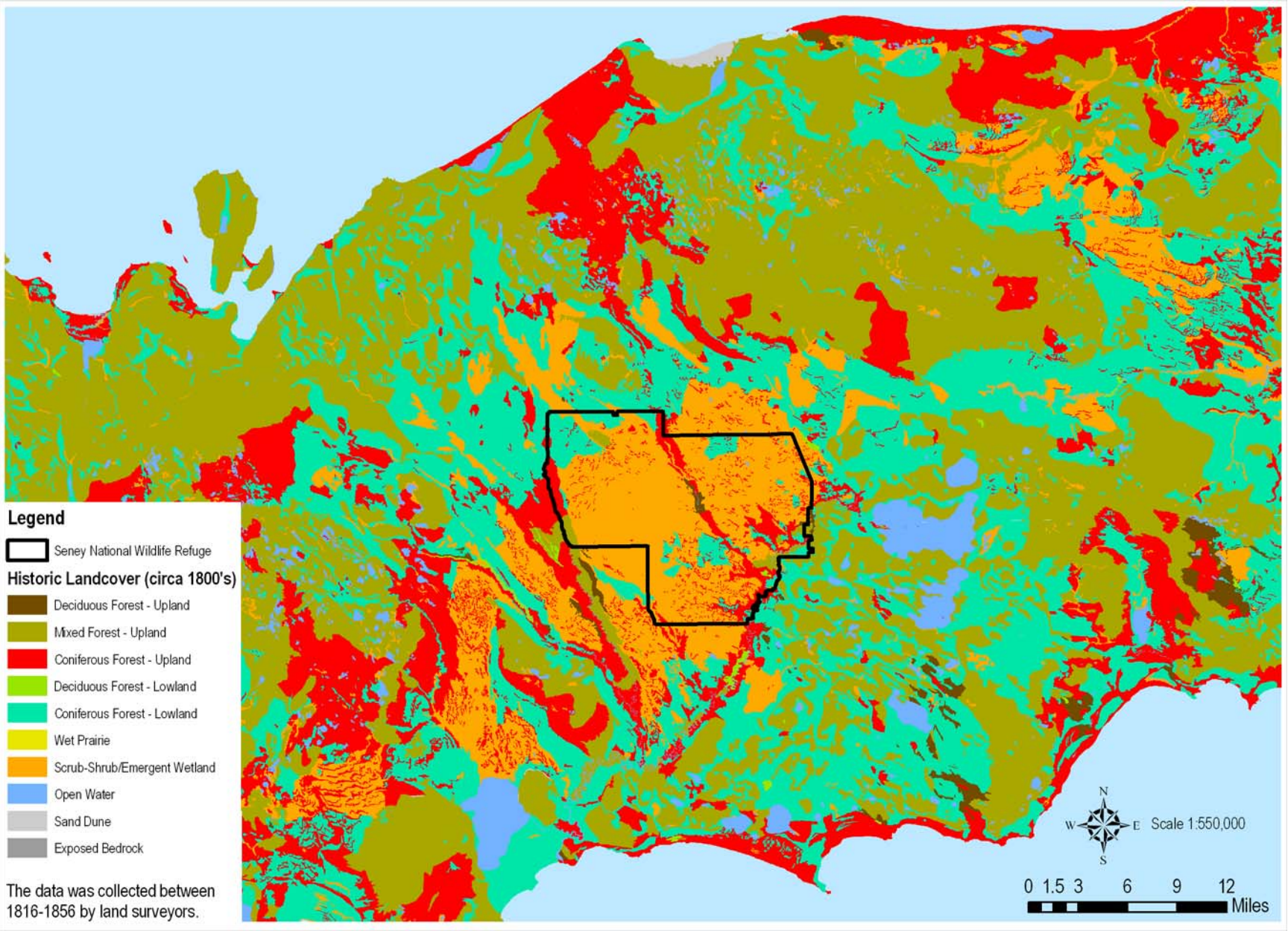


Table 6: Cross-classification of Disturbance by Frequency of Surface and Crown Fire for Common Cover Types, Seney NWR and Surrounding Area[1]

Surface Fires	Crown/Severe Surface Fire			
	Frequent (25-100 yr)	Infrequent (100-500 yr)	Rare (500-1,000 yr)	Very Rare (>1,000 yr)
Very Frequent (<25 yr)	Jack Pine Barrens/ Aspen Parklands	—	—	—
Frequent (25-100 yr)	—	Red-White Oak/Red-White Pine	—	—
Infrequent (>100 yr)	Jack Pine-Black Spruce/Spruce-Fir-Birch	Black Spruce Peatlands	—	Sugar Maple-American Basswoood-Sugar Maple-Eastern Hemlock

1. *Adapted from Frehlich 2002*

Wildfire History

Both biotic and abiotic natural disturbances have historically regulated composition and structure of Refuge forests and other habitats (Frehlich 2002, Drobyshev et al. In Press). Historically, fire occurred frequently in mixed pine-dominated landscapes, with relatively low-intensity surface fires occurring once every 5-40 years (Simard and Blank 1982, Engstrom and Mann 1991, Loope 1991). These low-intensity fires usually created small gaps or left the basic structure of the overstory unaltered while maintaining a relatively open understory. Over time, these disturbances tended to produce a mixed-conifer stand with an uneven age structure (Bergeron et al. 1991, Drobyshev et al. In Press). Under certain conditions (e.g., low fuel moisture, low humidity, high temperatures, and strong winds), these fires sometimes intensified and resulted in a stand-replacing fire. The frequency of stand-replacing fires ranged from 160 years for mixed-conifer stands dominated by jack pine, eastern white pine, and red pine, to 320 years for stands not dominated by jack pine (Zhang et al. 1999, Frehlich 2002, Table 6).

Major native biotic disturbances to forests included jack pine budworm (*Choristoneura pinus*) and spruce budworm (*C. fumiferana*). The eruptive and cyclical nature of the disturbance brought about by these species likely coincided with fire as induced tree mortality altered fuel loading and the connectivity of fuels.

Current Habitat Conditions

At present, the vast majority of areas that were forested during pre-European times in the eastern Upper Peninsula of Michigan are still forested. Relative to most areas in the Midwest, the eastern Upper Peninsula is still comprised of native cover types and has a high degree of ecological integrity. That is, relative to many other parts of the Midwest, the Upper Peninsula of Michigan represents a region where: 1) many ecological processes are intact and within their natural range of variation; 2) for most species their distribution, composition and relative abundance are within their natural range of variation; and 3) the communities found are resilient, or able to recover from severe disturbance events. However, only 13 percent (562,125 acres) of the present landscape of the eastern Upper Peninsula is now dominated by mixed-conifer stands, and the structure of these forests on today's landscape is dramatically different than that on the pre-European landscape (Zhang et al. 2000; Drobyshev et al. In Press).

Based upon General Land Office (GLO) survey records, the mean stem density in the pre-European mixed-conifer forests of the eastern Upper Peninsula was significantly lower than in current mixed-conifer stands. With these presently higher stem densities and corresponding lower stand basal areas, sites that were originally mixed-conifer stands are presently dominated by jack pine and thus differ from their pre-European condition in both composition and structure (Table 7).

Table 7: Acreage, Percent Total Area, and Three Dominant Forest Management Units (FMUs) by Cover Type at Seney NWR[1]

Cover Type (Code Description)	Acres	Percent Total Area	Ranked Order Top Three FMUs (Acres)	Percent in Top Three FMUs
Scrub/Shrub (Lowland)	26,354	27	20 (7720), 4 (2527), 10 (1932)	46
Sedge/Bluejoint Grass	9,385	10	20 (1549), 13 (1301), 14 (1021)	41
Forested Broadleaf/Coniferous Mix (Lowland)	5,915	6	20 (2799), 3 (434), 8 (284)	59
Aspen/Pine	5,855	6	20 (1977), 1 (501), 12 (440)	50
Sphagnum/Leatherleaf	4,162	4	20 (3453), 12 (446), 10 (209)	99
Water	3,928	4	7 (1275), 9 (451), 8 (398)	54
Forested Coniferous Mix (Upland)	3,238	3	17 (476), 20 (394), 9 (258)	35
Tamarack/Spruce	3,156	3	20 (718), 13 (551), 16 (283)	49
Forested Broadleaf/Coniferous Mix (Upland)	3,110	3	20 (844), 17 (428), 9 (297)	51
Mixed Emergents/Grasses/Forbs	2,884	3	11 (480), 7 (344), 13 (322)	40
Forested Coniferous Mix (Lowland)	2,399	2	4 (430), 20 (337), 9 (271)	43
Aspen/Birch/Fir/Spruce (Lowland)	2,305	2	20 (709), 12 (330), 16 (199)	54
Red Pine/Jack Pine	2,098	2	14 (265), 15 (199), 9 (182)	31
Northern Hardwoods/White Pine/Hemlock	1,891	2	20 (803), 18 (261), 17 (221)	68
Aspen (Upland)	1,891	2	20 (859), 12 (383), 17 (144)	73
Aspen (Lowland)	1,681	2	20 (796), 12 (287), 1 (162)	74
Tag Alder	1,634	2	20 (416), 12 (308), 11 (196)	56
Northern Hardwoods (Maple/Beech/Yellow Birch)	1,576	2	20 (534), 17 (460), 18 (263)	80
Black Spruce	1,133	1	19 (147), 16 (143), 13 (133)	37
Jack Pine	1,066	1	15 (182), 16 (162), 17 (127)	44
Red Pine/White Pine	935	1	4 (199), 8 (110), 20 (103)	44
Forested Broadleaf Mix (Upland)	905	1	20 (597), 18 (139), 1 (52)	87
Grass/Ferns	900	1	20 (329), 1 (124), 3 (88)	60
Tamarack	821	1	20 (326), 12 (120), 13 (108)	67
Forested Broadleaf Mix (Lowland)	810	1	1 (271), 20 (266), 2 (125)	82
Red Pine	726	1	1 (203), 20 (115), 18 (83)	55
Willow	711	1	20 (301), 11 (89), 12 (64)	64

Table 7: Acreage, Percent Total Area, and Three Dominant Forest Management Units (FMUs) by Cover Type at Seney NWR[1]

Cover Type (Code Description)	Acres	Percent Total Area	Ranked Order Top Three FMUs (Acres)	Percent in Top Three FMUs
Submergent Vegetation	691	1	19 (175), 8 (145), 9 (130)	65
Aspen/Birch/Fir/Spruce (Upland)	540	1	20 (89), 16 (83), 15 (73)	45
Spruce/Fir	509	1	15 (124), 19 (103), 17 (77)	60
Cattail	493	1	5 (165), 13 (102), 6 (59)	66
Hayfields	402	<1	18 (120), 3 (117), 17 (102)	84
Developed	308	<1	20 (110), 6 (45), 1 (32)	61
Scrub/Shrub (Upland)	255	<1	20 (98), 3 (46), 1 (26)	67
Northern White Cedar (Lowland)	189	<1	18 (108), 1 (32), 10 (31)	90
Rooted-Floating Vegetation	179	<1	6 (67), 7 (51), 9 (19)	77
Hemlock (Upland)	170	<1	20 (119), 1 (35), 15 (9)	96
Hemlock (Lowland)	127	<1	3 (37), 17 (24), 8 (15)	60
White Pine	104	<1	13 (22), 20 (21), 8 (14)	55
Hardwoods (Lowland)	25	<1	20 (7), 18 (6), 9 (4)	71
No Photo Coverage	24	<1	19 (21), 20 (3)	100
Northern White Cedar (Upland)	12	<1	9 (10), 16 (2)	100

1. Cover types are shown in ranked order and are based on U. S. Geological Survey-interpreted 2004 aerial photos.

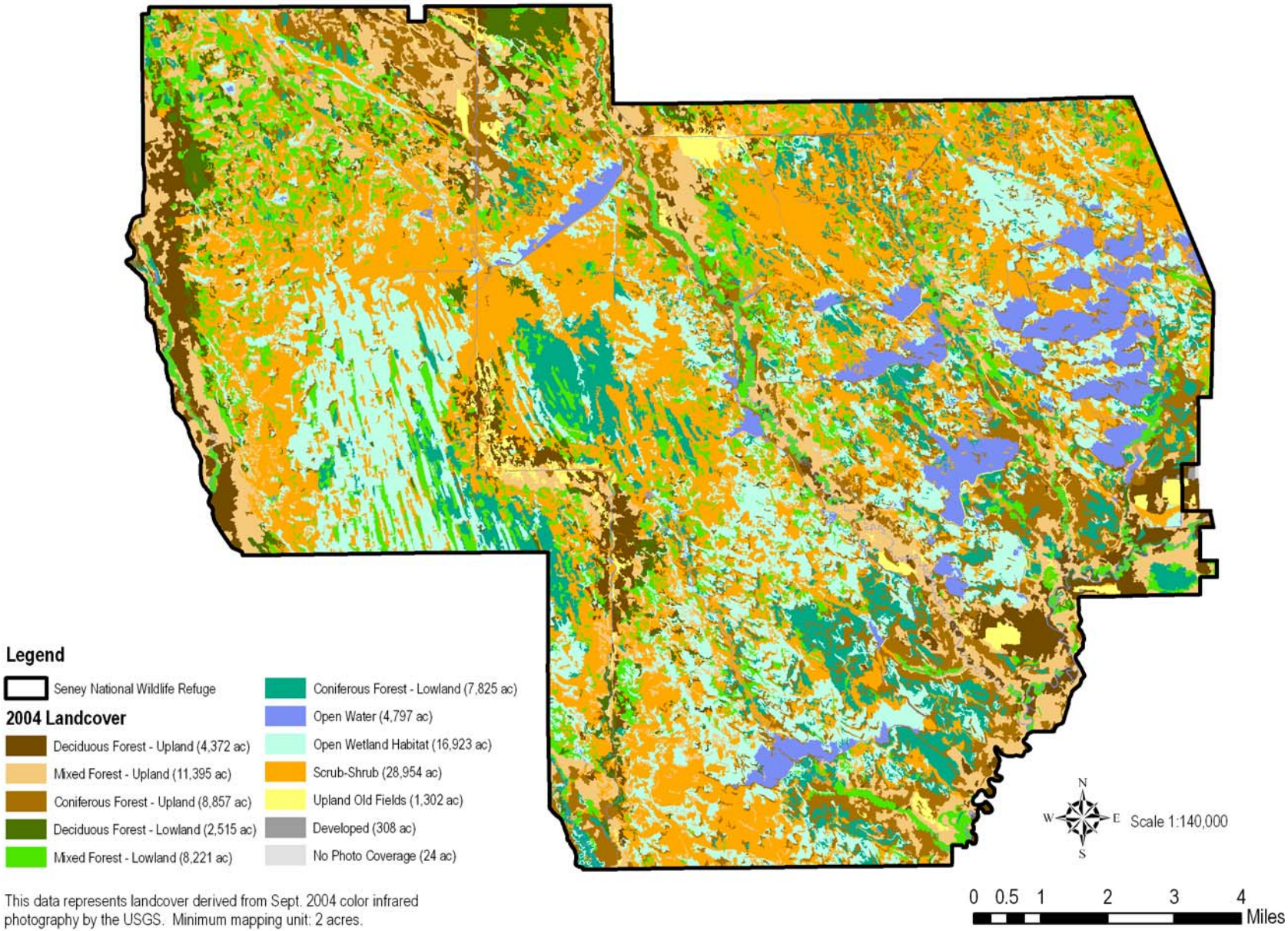
For the purpose of this plan, we combined the resulting 41 vegetative cover types (not including "Developed" and "No Photo Coverage") into 10 habitat types. In ranked order by acreage, these 10 habitat types (Figure 9) are:

- Scrub-Shrub (28,954 acres)
- Open Wetlands (16,617 acres)
- Mixed Forest-Uplands (11,396 acres)
- Coniferous Forest-Uplands (8,857 acres)
- Mixed Forest-Lowlands (8,221 acres)
- Coniferous Forest-Lowlands (7,825 acres)
- Open Water (5,103 acres)
- Deciduous Forest-Uplands (4,372 acres)
- Deciduous Forest-Lowlands (2,515 acres)
- Upland Old Fields and Openland (1,302 acres)

Scrub-Shrub Habitat Type (28,954 acres): This habitat type includes scrub-shrub lowland, tag alder, willow, and scrub shrub upland cover types. This habitat type dominates the Refuge. Common species (and species groups) include alder, red osier dogwood, willow, meadowsweet, current, bedstraw, joe-pye-weed, goldenrod, and marsh fern.

Open Wetland Habitat Type (16,617 acres): This habitat type includes sedge-bluejoint grass, mixed emergents-grasses-forbs, cattail, and sphagnum-leatherleaf cover types. This habitat type contains many different herbaceous species, with composition related to moisture, exposure, and soil conditions.

Figure 9: Current Landcover of Seney NWR (2007)



This data represents landcover derived from Sept. 2004 color infrared photography by the USGS. Minimum mapping unit: 2 acres.

Mixed Forest-Upland Habitat Type (11,396 acres): This habitat type contains aspen-pine, upland forested broadleaf-coniferous mix, northern hardwood-white pine, eastern-hemlock, and aspen-birch-fir-spruce upland cover types. Common overstory species include white pine, red pine, and jack pine, and deciduous species such as red maple, quaking and large-toothed aspen. Understory species include wild raisin, bracken fern, hazels, wild strawberry, princess pine, blueberry, and huckleberry.

Coniferous Forest-Upland Habitat Type (8,857 acres): This habitat type includes upland forested coniferous mix, red pine-jack pine, jack pine, red pine-white pine, red pine, upland spruce-fir; hemlock, white pine, and upland northern white cedar cover types. Understory species include wild raisin, bracken fern, hazels, wild strawberry, princess pine, blueberry, and huckleberry. Lichens, grasses and sedges are also represented, especially in the second growth aspen stands.

Mixed Forest-Lowlands Habitat Type (8,221 acres): includes forested broadleaf-coniferous mix, lowland and aspen-birch-fir-spruce, and other lowland cover types. Overstory species include coniferous species such as black spruce, balsam fir, and tamarack, as well as deciduous species such as black ash, quaking aspen, and red maple.

Coniferous Forest-Lowland Habitat Type (7,825 acres): Habitat includes tamarack-spruce, forested coniferous mix lowland; black spruce; tamarack; northern white cedar, lowland; and hemlock lowland cover types. This habitat type represents a combination of two basic forests types: the spruce-fir or boreal forest, and the northern lowland or swamp conifer forest. White spruce and balsam fir comprise the majority of tree species in the first forest type (with some eastern hemlock), while white cedar, black spruce and tamarack constitute the majority in the second forest type. Typical associates, in this habitat type, include paper birch, red maple, and alder. Common shrubs include round-leafed dogwood, hazel, honeysuckle, thimbleberry, and blueberries. Other understory plants include sweet gale, leatherleaf, bog rosemary, and cranberry. However, when the canopy is closed little understory exists.

Open Water Habitat Type (5,103 acres): Habitat includes water; rooted-floating vegetation; and submergent vegetation cover types. Open water consists of anthropogenic pools and natural stream channels. The pools were created by using dikes and channels to impound water on what was once scrub-shrub and lowland coniferous forest.

Deciduous Forest-Upland Habitat Type (4,372 acres): Habitat includes aspen upland, northern hardwoods (maple-beech-yellow birch), forested broadleaf mix, and other upland cover types. This habitat type is commonly referred to as the broadleaf forest, northern mesic, northern hardwood, or hardwood-hemlock forest, and is comprised of sugar maple, American beech, and yellow birch, with eastern hemlock as an important associate. Other associates include American basswood, black cherry, paper birch, white spruce, white ash, and balsam fir. When the tree canopy closes in, the herbaceous plants disappear. However, in suitable areas, several shrubs (e.g., Canada yew, elderberry, leatherwood, and hazel) and other plants (e.g., partridge berry, bunchberry, twinflower, baneberry, trillium) can occur. This forest type is scattered through the Refuge, usually on the most nutrient rich soils.

Deciduous Forest-Lowland Habitat Type (2,515 acres): Habitat includes aspen lowland, forested broadleaf mix lowland, and hardwoods lowland cover types. This habitat type is comprised of red maple, black and white ash, and American basswood and is scattered through the Refuge, usually next to riparian corridors.

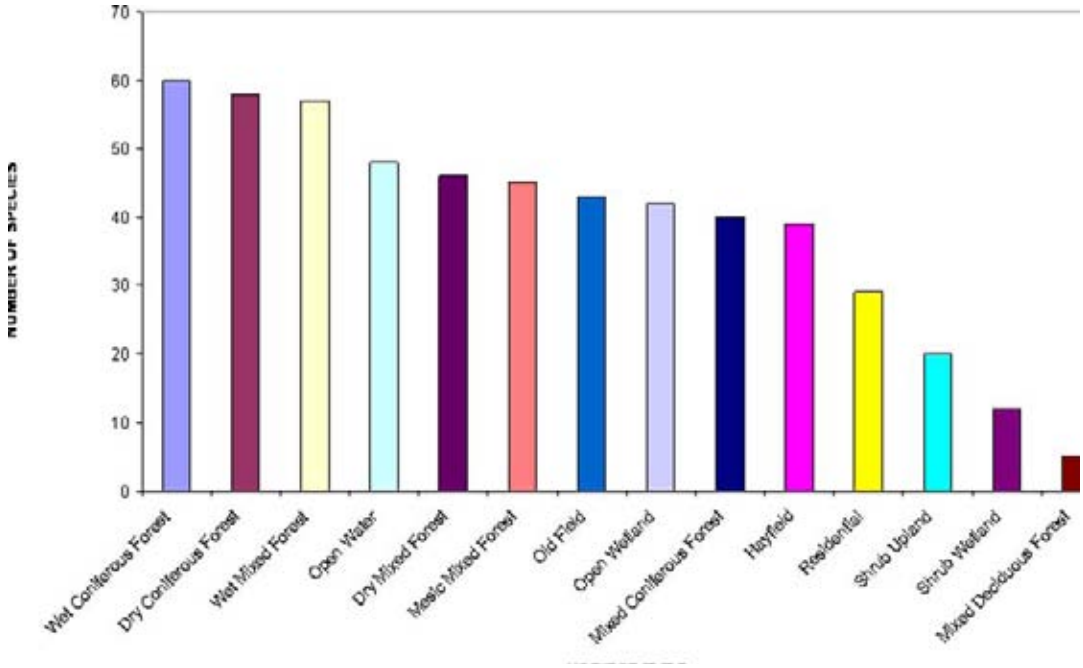
Upland Old Fields and Openland Habitat Type (1,302 acres): This habitat type includes grass-ferns and hayfields cover types. This habitat type consists of primarily anthropogenic habitats created prior to the Refuge establishment in 1935. Many non-native grass species, such as Kentucky bluegrass and several brome species, characterize these areas.

Wildlife

Birds

Relative to pre-European times, it is likely that Seney NWR is presently richer in bird species due to anthropogenic habitats such as Refuge pools and upland old fields and openland. A total of 231 bird species comprise the Refuge's species list of migrants and residents, including breeding and stopover species (Appendix C). It comes as no surprise then that Seney NWR is an Important Bird Area (American Bird Conservancy) and has 46 USFWS R3 Priority Species, 23 of which utilize primarily terrestrial habitats. The Refuge also has

Figure 10: Number of Bird Species Found at Seney NWR by Breeding Habitat[1]



1. *According to Brewer et al. (1991)*

many species that are listed on United States Forest Service and Michigan Department of Natural Resources conservation lists (Table 9 on page 42). Species of high public interest include Common Loon, Bald Eagle, Osprey, Yellow Rail, Sandhill Crane, Trumpeter Swan, Sharp-tailed and Spruce Grouse, Black-backed Woodpecker, Connecticut Warbler, Le Conte's Sparrow, and game species such as American Woodcock and Ruffed Grouse.

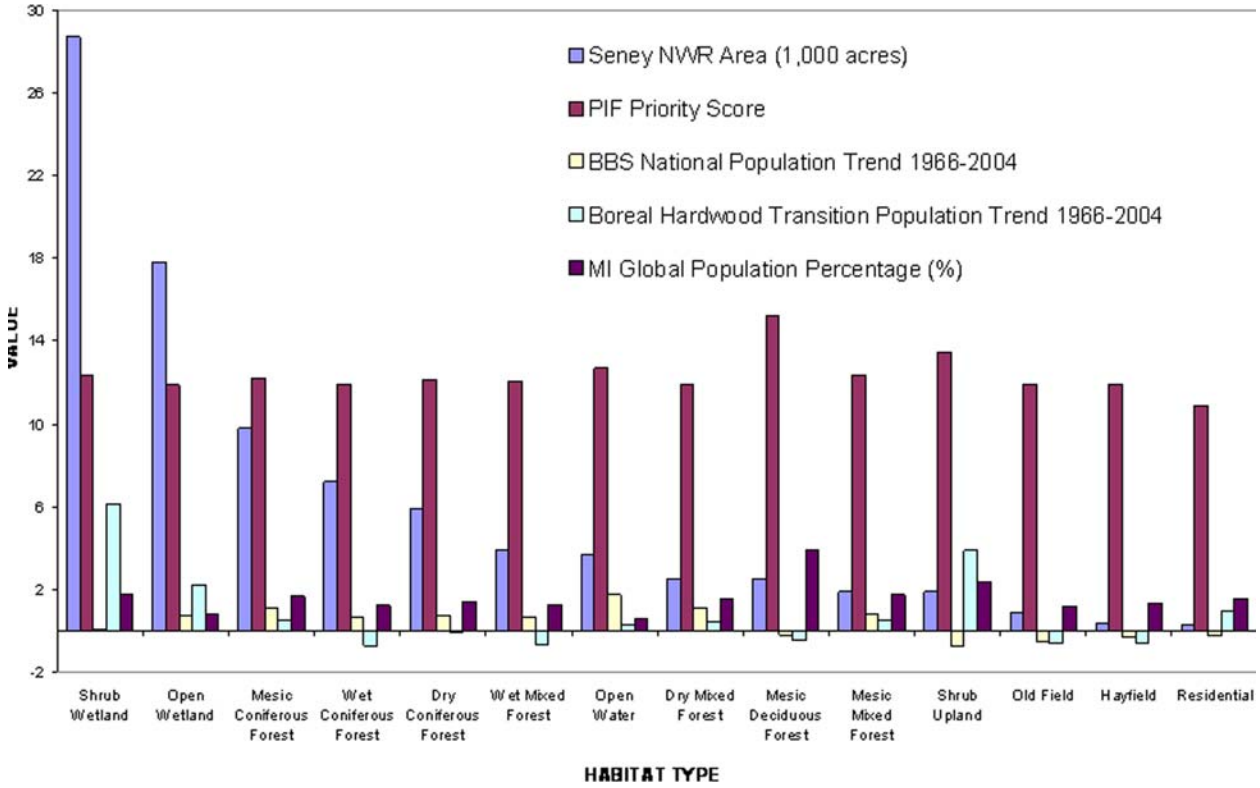
To better assess the Refuge's bird community and help prioritize habitat preservation, conservation, and restoration, Brosnan and Corace (2006) compiled a bird assessment for the Refuge that linked the Refuge's bird species list with (1) preferred breeding habitat types (Brewer et al. 1991) classified per the Refuge's USGS cover type map; (2) nest locations (Ehrlich et al. 1988); (3) global breeding population percentages estimates for Michigan (Rich et al. 2004); (4) Breeding Bird Survey (BBS) regional and national population trends (Sauer et al. 2005); and (5) Partners in Flight (PIF) Midwest conservation priority scores (PIF 2006).

Results indicated that most bird species at Seney NWR are associated with forested habitats. Sixty bird species of Seney NWR breed in wet coniferous forests alone (Figure 10). A significant number of birds also utilize open water and open wetlands for breeding habitat. On a finer spatial scale, there were 13 primary nest location types used by the bird species found on the Refuge. An estimated 40 percent of the Refuge bird species are ground-nesters, with tree, snag, and shrub structures also yielding a higher than average number of species.

A total of 135 species had percent global population scores, and 192 species had information on national population trend data from the BBS survey. A total of 171 bird species had information on regional population trend data within the Boreal Hardwood Transition zone. There were PIF Midwest priority scores for 151 of the bird species. A summary of these scores is shown in Figure 11.

Because of the spatial habitat heterogeneity at Seney NWR, the Refuge should continue to have a high degree of bird diversity, while providing for many species of conservation concern in most existing habitat types. In particular, because Seney NWR has more area in forest habitat types relative to other refuges in the Midwest (and even Lower 48 states), the Refuge has the opportunity to be a leader in forest habitat management for bird conservation.

Figure 11: Average Conservation Value for Bird Species Found at Seney NWR by Habitat Type



Mammals

There are approximately 50 extant mammal species at the Refuge, with other species (e.g., fox squirrel and opossum) likely to colonize the area in future years due to range expansion in light of climate change (Appendix C). Some of the mammals found at the Refuge are listed as USFWS Region 3 Priority Species (e.g., gray wolf), and many other species are listed on United States Forest Service and Michigan Department of Natural Resources conservation lists (Table 9 on page 42). Species of high public interest include gray wolf, fisher, American marten, river otter, beaver, snowshoe hare, and white-tailed deer. Seney NWR's mammal community composition is likely similar to what it was during pre-European times, and thus the predator-prey systems are likely not significantly altered at the Refuge. For instance, the predator-prey relationship that now exists between the small number of gray wolves on the Refuge and the white-tailed deer and beaver they prey upon seems to be in concert, with neither the predator nor the prey species causing considerable ecological concern. Moreover, as a site for the release of individuals, the Refuge has played an integral part, for instance, in the regional restoration of populations of species such as fisher and American marten.

Fish

Seventeen species of fish have been known to occur in the pools on the Refuge. If the Manistique River, the southern boundary of the Refuge, is included the possible total number of fish species present increases to 43. Northern pike, yellow perch, black crappie, brown bullhead, and bluegill are five species of popular game fish in the pool system. Species of fish that are in the rivers and streams within the boundaries of the Refuge include the previous mentioned and walleye, smallmouth

bass, brook trout, and brown trout. The brook trout is listed as a Region 3 Conservation Priority Species.

Seney NWR's fish community composition is likely very different to what it was during pre-European times, primarily due to the large number of non-native salmonids and other species such as sea lamprey. Therefore, unlike the mammal community, the fish predator-prey systems are likely significantly altered at the Refuge.

Reptiles and Amphibians

The herptofauna community at Seney NWR consists of approximately 22 extant species (Appendix C). Although none of these species are listed as USFWS Region 3 Conservation Priority Species, some are listed on United States Forest Service and Michigan Department of Natural Resources conservation lists (Table 9 on page 42). Of special interest in Michigan, for instance, is the Refuge's mink frog population. This species is at its southern range periphery in the Upper Peninsula of Michigan and is not widely distributed in the region.

Resources of Concern

Resources of Concern were identified by literature review and expert opinion. Refuge resources of concern include special areas, habitats, ecosystems, and individual species. Lists of vertebrates occurring on the Refuge and surrounding area and their conservation status according to FWS Region 3, the USFS Regional Forester, and the State of Michigan are shown in Table 9 on page 42.

Ecosystems of Concern

Ecosystems of greatest conservation concern at Seney NWR include patterned fens, rivers, old-growth-virgin deciduous forests, and mature-old growth red and white pine forests (Noss and Scott 1997). A number of specific parcels of land have been set-aside or removed from active management, including the Seney Wilderness Area (1970), the Strangmoor Bog National Natural Landmark (designation date 1973), and a number of Research Natural Areas and Public Use Natural Areas (Figure 12). The five Research Natural Areas are Strangmoor Bog (640 acres), SAF 15 Red Pine (100 acres), SAF 23 Hemlock (50 acres), and SAF 25 Sugar Maple-Beech-Yellow Birch (350 acres). The two Public Use Natural Areas are White Pine (30 acres) and Northern Hardwoods (68 acres).

Black bear. USFWS photo.

Habitat Conservation, Restoration, and Preservation: Forests and Other Terrestrial Ecosystems

Seney NWR contains 20 Forest Management Units (FMUs, Figure 13 on page 36). These long-standing FMUs were devised based upon existing and potential vegetation features, location to access sites, size and shape, as well as management mandates that dictate management strategies to a considerable degree, including Wilderness Area and the designation of other natural areas. Other criteria, such as proximity to human development, were deemed not significant enough to further delineate FMUs.

Forests of Seney NWR have seen dramatic alterations due to exploitation (Verme 1996, Losey 2003), utilitarianism, and "edge management" (Leopold 1933). Now, the proposed philosophy for management of these ecosystems stems from a perspective of landscape (Forman 1995) and disturbance (Frehlich 2002) ecology within a conservation biology context (Hunter 1990, Askins 2000).

Figure 12: Administrative and Visitor Facilities and Natural Areas of Seney NWR

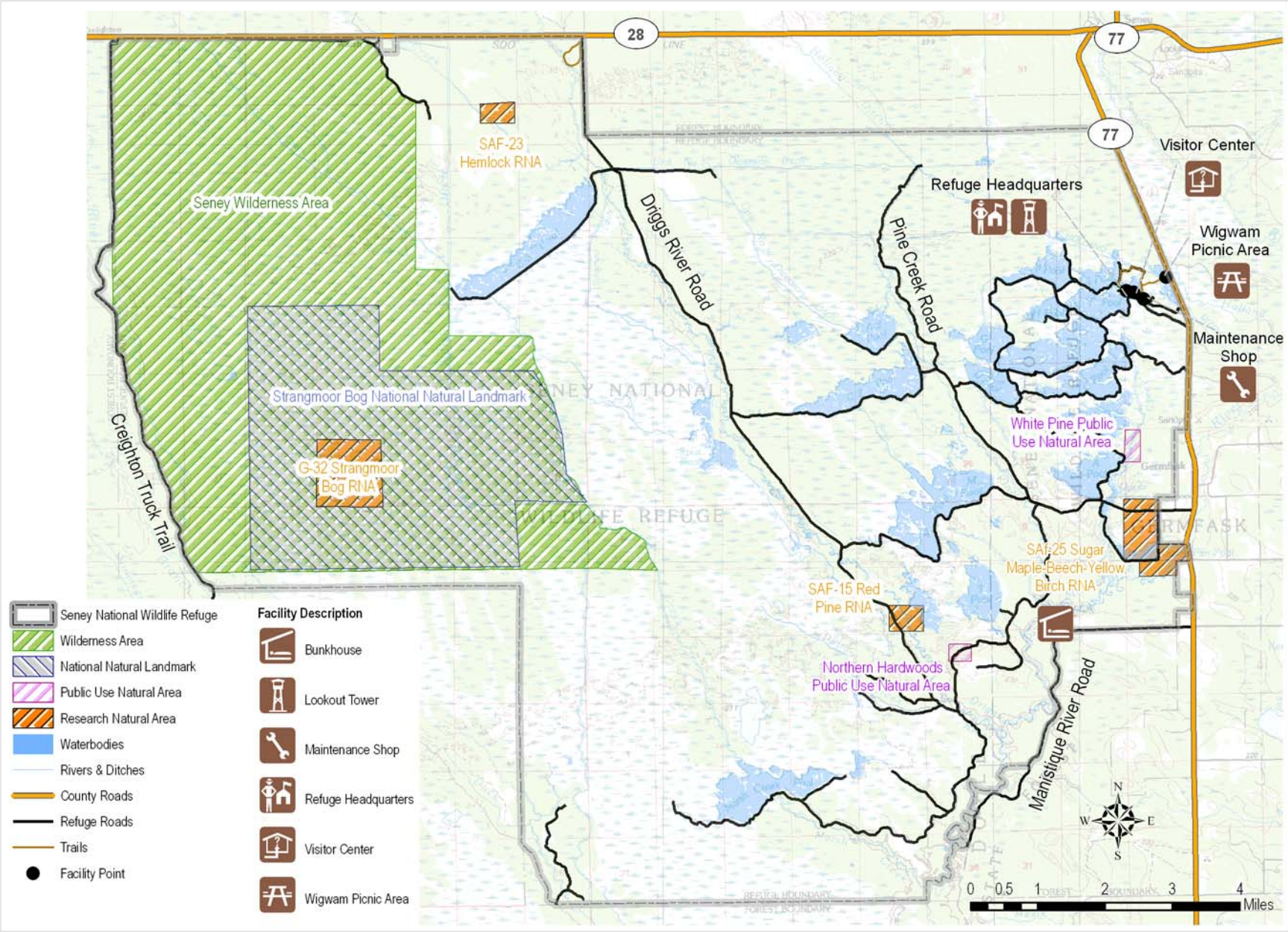


Figure 13: Seney NWR Forest Management Units

Prior to Refuge establishment, forests that contained valuable timber and were accessible either by road or stream were degraded and altered from their pre-European settlement conditions by logging and, in xeric, conifer-dominated areas, resulting wildfires fueled by logging debris (Karamanski 1989, Comer et al. 1995, Verme 1996, Drobyshev et al., In Press). The degree to which these forests were altered from their pre-European settlement condition is thought to be positively correlated to their proximity to roads and/or streams (Corace et al., Ongoing Refuge Research).

After Refuge establishment in 1935, forest management objectives were primarily concerned with managing for early successional habitats, such as aspen and jack pine. Consequently, in many (but not all) forest patches, compositional and structural patterns that now exist are considerably different relative to pre-European benchmark conditions. For instance, in many sites that once grew long-lived, later seral stage, red and white pine, past management activities have shifted stand dominance to shorter-lived, earlier seral stage, jack pine with a concomitant loss of structural diversity. Similarly, in northern hardwood stands, salvage logging for utilitarian objectives during the 1970s and the recent arrival of Beech Bark Disease have together decreased the ecological integrity of many of these forests as well, with adverse impacts to many wildlife species (especially neotropical migrant birds) of national, regional, or local concern.

The goal of forest management at the Refuge is to conserve the diversity of cover types and seral stages at the landscape scale, while providing ecosystems, habitats, or seral stages important for species of national, regional, state, or local conservation concern. At the patch scale, management focuses on conserving and restoring historic compositional and structural patterns to forests that were degraded by past human activities. In doing so, the Refuge provides a model for the Forest Bird Conservation Area (FBCA) concept posed by Matteson et al. (In Review).

Forest management at the Refuge should be ecologically-based (Seymour and Hunter 1999), should de-emphasize single-species management (Simberloff 1997), maintain Refuge biodiversity, and strive to conserve and restore nationally, regionally, or locally imperiled ecosystems and habitat types (Holling and Meffe 1996, Lambeck 1997). Management should also increase mean patch size (Crozier and Niemi 2003) across the Refuge, and increase connectivity between similar forests or habitat types. Forest management should also focus on the spatial arrangement of existing forests or habitat types and conserve and restore forest stand structure and composition where and when possible (Askins 2000). For instance, early successional forests (e.g., aspen, jack pine) that now exist on the Refuge boundary (e.g., Forest Management Units 1 to 6) should be conserved so as to produce larger overall patches by linking with similar cover types managed by the primary surrounding land owner, the State of Michigan.

Elsewhere, however, management should be directed at moving succession primarily “forward” and provide near benchmark conditions for later successional red and white pine and northern hardwood forests as near-benchmark examples of these forests are especially imperiled nationally, regionally, and locally (Noss and Scott 1997). Thus, forest management should provide a gradient from earlier successional forest cover types (e.g., aspen and jack pine) at the northern periphery of the Refuge to later successional ecosystems and seral stages within the interior and at the southern portion of the Refuge while maintaining existing stands of late successional forests wherever they are found.

The patch-scale focus of forest management should promote ecological integrity by restoring composition, structure, and processes in altered stands and maintaining these characteristics in relatively unaltered stands. In late successional forests

comprised of red and white pine, eastern hemlock, and northern hardwood-associated tree species, an increased focus should be placed on providing coarse woody debris and standing snags. According to a literature review by Sallabanks and Arnett (2005), of all the characteristics of forest ecosystems that can be altered by management, the size, diversity, and abundance of snags may be the most important factor affecting bird diversity and abundance at the stand scale. Research conducted at the Refuge also indicated that stands with more compositional and structural diversity (including increased coarse woody debris and snags) have more diverse small mammal communities, an important component of ecologically integrity in northern forest ecosystems (Harrington 2006).

Refuge forest patches with pre-European settlement forest conditions contain many large-diameter snags (Drobyshev et al. In Press). However, most forest patches on the Refuge are even-aged and less compositionally or structurally diverse. Except for a few, highly scattered individuals, there are very few snags and cavities present in some areas, except those in near benchmark conditions. Most of the snags that are present are of limited value to many cavity-nesting species (e.g., Wood Duck, Black-backed Woodpecker, Pileated Woodpecker) due to their relatively small diameter. The creation of snags will accomplish several objectives:

- Improve forest stand structural and compositional diversity.
- Increase the patchiness of canopy coverage and thereby enhance age structure of the stands.

White pine stump and jack pine, Seney NWR. USFWS photo.

- Provide nesting sites for cavity-nesting wildlife species.
- Increase woody debris on the forest floor for wildlife such as salamanders and invertebrates.
- Promote ecological processes.
- Provide organic material to soil layers altered by turn-of-the-century wildfires.

Forest management at the Refuge should use all the necessary tools to meet ecologically-based objectives. In most stands, prescribed fire will not move succession forward as it may compound the effects of past wildfires by consuming soil organic matter, and promoting the establishment of jack pine. However, where patches of early successional species such as aspen and jack pine are to be maintained, prescribed fire may be applied, and in some later successional stands in near benchmark condition, prescribed fire here too may be used to maintain existing conditions. Elsewhere, commercial and non-commercial mechanical treatments may be used to move succession forward or maintain existing conditions. In all instances, Michigan Best Management Practices (MDNR) are used to provide the minimum standards for management. In particular, wherever streams, pools, or wetlands exist management should be buffered from the effects of logging activities (the exception is on pool dikes where many of the existing trees should be removed). At a minimum, a 100-foot management buffer on either side of streams and surrounding pools will be used to minimize soil disturbances.

Wetland Management

Seney NWR is blessed with an abundance of water for its pool system (Table 8). As a result, drought and growing season flooding are not extremely important factors influencing water management. This unique and biologically complex pool system was constructed during the late 1930s and early 1940s, making it at least 65-70 years old. The pool system at Seney NWR uses gravity flow to manipulate water levels in all pools. Water enters the north end of the Refuge via rivers, ditches or creeks and flows generally southeast to the Manistique River. General ground slope is southeast at approximately 10 feet per mile. Existing impoundments have been developed by constructing dikes across the general slope to intercept rivers, creek, ditches and overland water flow.

Table 8: Pool Name With Water Control Structures, Initial Flooding Date and Size at Seney NWR

Unit	Pool	Initial Flooding Date	Acreage (Open Water)
1	Show Pools (North and South)	Spring 1937	57
	Upper Goose Pen	Spring 1937	27
	Lower Goose Pen	Spring 1937	93
	A-1	Spring 1937	259
	B-1	Spring 1937	243
	C-1	Spring 1937	302
	D-1	Spring 1937	197
	E-1	Spring 1937	490
	F-1	Fall 1936	258
	G-1	Spring 1937	202
	H-1	Spring 1937	111
	I-1	Spring 1937	129
	J-1	Spring 1937	214
			Unit 1 Total: 2,582
2	A-2	Fall 1939	282
	C-2	Fall 1939	501
	M-2	Spring 1941	863
	T-2 East	Spring 1941	233
			Unit 2 Total: 1,879
3	C-3	Fall 1942	702
	Marsh Creek	Late 1950s	950
	Delta Creek	Late 1950s	50
			Unit 3 Total: 1,702
Total Pool Acreage			6,163

Water Rights: Because of the general land slope of 10 feet per mile and the location of water control structures, upstream landowners are not affected by water management on the Refuge. In the State of Michigan, a land owner of the water course is entitled to have the stream flow by or through his or her property substantially undiminished in quantity and quality. The natural flow of the stream, however, is subject to the privilege of the upstream riparian owner to make "reasonable" use of the water as it flows past or through his or her land. The owner of Seney NWR, the U.S. Fish and Wildlife Service, is a riparian landowner and can make reasonable use of the water passing through the Refuge as long as such use is not to the detriment of lower riparian

owners. Currently, water flows from the Refuge into the Manistique River without any major detriment in quantity to the downstream users.

The Refuge has received a few requests to hold as much water as possible during spring periods of high flow in the Manistique River. These requests were made during flood stage conditions when the Refuge was unable to retain any more water. Water management will, when possible, attempt to reduce discharge into the Manistique River during these times as long as water levels on the Refuge are not high enough to damage dikes or control structures.

Water Supply: Annual average precipitation is approximately 32 inches per year. Precipitation accounts for 60 percent of Refuge water intake. The bundant rainfall is essential to maintaining water evels in the managed pools because all 60 miles of Refuge dikes are constructed of sand and they have high profile seeps and subsequent high water loss. he remaining 40 percent of the Refuge water supply comes from the ditches, rivers, and creeks. Peak lows through the Refuge marsh and water system normally occur during spring. Snowmelt, frozen ground, and rain can combine to create destructive floods, although such events are rare. However during spring run-off daily attention to pool levels and structures is required.

Pool History and Management: Most water level management prior to 1963 consisted of holding the pools at a stable levels throughout the year (Fjetland 1973). Some experimentation with drawdowns occurred when pools levels were lowered to facilitate repair work. As a result, the pools have a variety of management histories. From 1963-1969 the approach was to manage the pools with fluctuating water levels. The general practice was to maintain low level through the winter, raise them in the spring, hold high through the nesting season and then drop the levels through the rest of the summer. In 1970, partly as a result of recommendations by Fjetland (1973), stable level water management resumed until 1983.

F-Pool, Seney NWR. USFWS photo.

The current program is based on water level manipulations and maintenance of approximately 6,163 surface acres within 21 man-made impoundments with water control structures (1993 Long Range Marsh and Water Management Plan). An additional 65,000 wetland acres are maintained naturally by precipitation, surface runoff, or by diversions and ditches associated with the man-made structures. Rotational water level drawdown and flooding management within the 21 pool provides resident and migratory birds with approximately 1,500 acres of moist soil plant production annually. In addition, full and partial draw-downs produce an estimated 2,300 acres of emergent vegetation for nesting and brood habitat.

Each pool is managed for specific wildlife objectives as detailed in the current Annual Water Management Plan. This Plan is used to define detail pool objectives and associated water levels. It takes into account maintenance requirements and the objectives and water levels in adjacent pools' Annual Water Management Plans are guided by Long Range Marsh and Water Management Plan, written in 1993.

During spring and early summer, pools will be filled to the maximum permissible level unless the annual plan specifies otherwise. During late summer, water levels on most pools will be lowered approximately 1 foot to facilitate use of submergent vegetation by staging and migrating waterfowl and to provide some mudflats for use by Sandhill Crane, shorebirds, and Canada Goose. After October 15, impoundment levels will be maintained to accommodate over wintering of fish species and initial spring runoff. All Annual Water Level Management Plans are subject to change given the current environmental conditions.

Once the CCP is completed for Seney NWR, the Long Range Marsh and Water Management Plan will be revised and incorporated into the Seney NWR Habitat Management Plan.

Associated Plans and Initiatives

Michigan's Wildlife Action Plan

In 2005, Michigan's Wildlife Action Plan (WAP) was completed to better manage wildlife species and their habitats of "greatest conservation need" in Michigan. The plan was developed with the support of funding from the State Wildlife Grant Program (SWG) created by Congress in 2001. The goal of the plan is to provide a common strategic framework that will enable Michigan's conservation partners to jointly implement a long-term holistic approach for the conservation of all wildlife species. Members of the partnership include the Michigan Department of Natural Resources, the U.S. Fish and Wildlife Service, the U.S. Forest Service, The Nature Conservancy, Michigan Natural Features Inventory, academics from several Michigan universities, as well as many other agencies and conservation organizations.

The Michigan Wildlife Action Plan:

- Provides an ecological, habitat-based framework to aid in the conservation and management of wildlife;
- Identifies and recommends actions to improve habitat conditions and population status of species with the greatest conservation need (SGCN), which are those species with small or declining populations or other characteristics that make them vulnerable;
- Recommends actions that will help to keep common species common;
- Identifies and prioritizes conservation actions, research and survey needs, and long-term monitoring needed to assess the success of conservation efforts;
- Complements other conservation strategies, funding sources, planning initiatives, and legally mandated activities;
- Incorporates public participation to provide an opportunity for all conservation partners and Michigan residents to influence the future of resource management;
- Provides guidance for use of SWG funds; and
- Provides a clear process for review and revision as necessary to address changing conditions and to integrate new information as it becomes available.

Migratory Bird Conservation Initiatives

Several migratory bird conservation plans have been published over the last decade that can be used to help guide management decisions for refuges. Bird conservation planning efforts have evolved from a largely local, site-based orientation to a more regional, even inter-continental, landscape-oriented perspective (Figure 14). Several trans-national migratory bird conservation initiatives have emerged to help guide the planning and implementation process. The regional plans relevant to Seney NWR are:

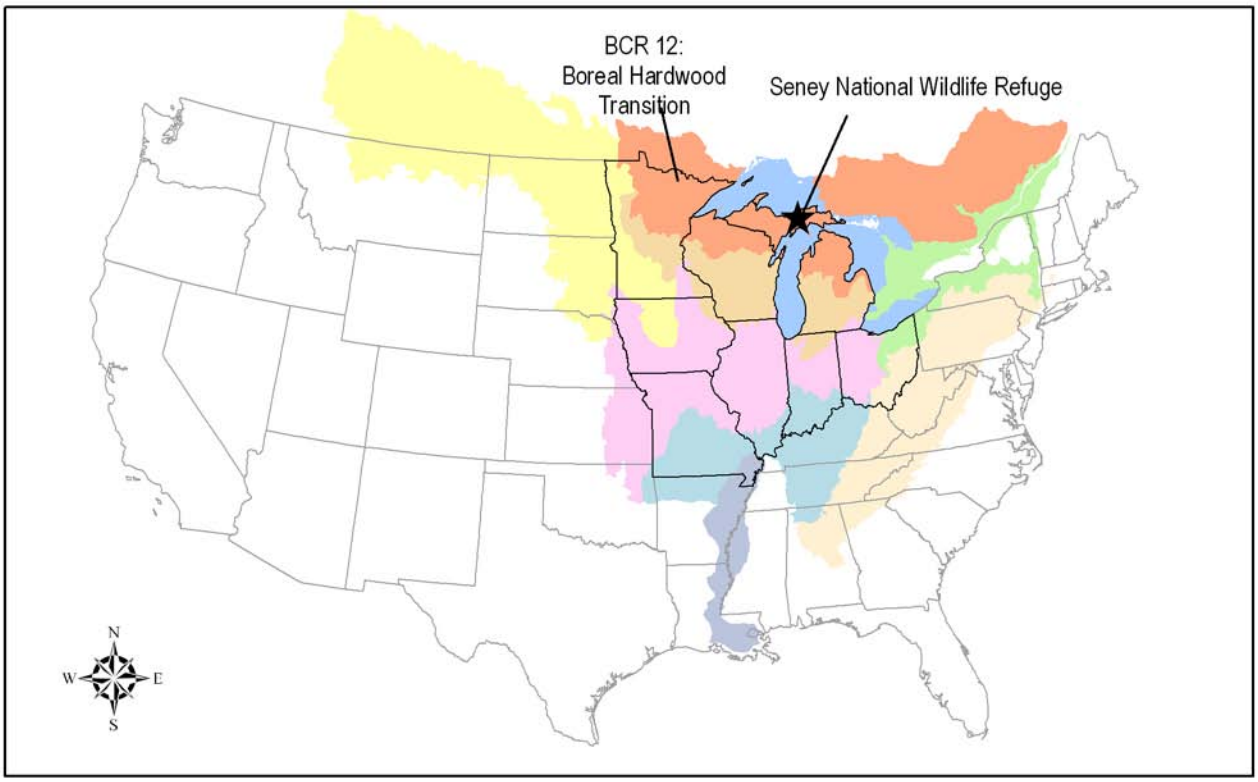
- The Upper Mississippi River/Great Lakes Joint Venture Implementation Plan of the North American Waterfowl Management Plan;
- The Partners in Flight Boreal Hardwood Transition [land] Bird Conservation Plan;
- The Upper Mississippi Valley/Great Lakes Regional Shorebird Conservation Plan; and
- The Upper Mississippi Valley/Great Lakes Regional Waterbird Conservation Plan.

All four conservation plans will be integrated under the umbrella of the North American Bird Conservation Initiative. Each of the bird conservation initiatives has a process for designating priority species, modeled to a large extent on the Partners in Flight method of computing scores based on independent assessments of global relative abundance, breeding and wintering distribution, vulnerability to threats, area importance, and population trend. These scores are often used by agencies in developing lists of priority bird species. The Service based its 2001 list of Non-game Birds of Conservation Concern primarily on the Partners in Flight, shorebird, and waterbird status assessment scores.

Wildlife Species of Management Concern

Table 9 on page 42 summarizes information on the status and current habitat use of important wildlife species found on lands within by Seney NWR. Individual species, or species groups, were chosen because they are listed as Regional Resource Con-

Figure 14: Bird Conservation Region 12, Boreal Hardwood Transition



servation Priorities or state-listed threatened or endangered species. Other species are listed due to their importance for economic or recreational reasons, because the Refuge or its partners monitor or survey them, or for their status as a nuisance or invasive species.

Current Refuge Programs: Where We Are Today

Consistent with its authorizing legislation, Seney NWR conducts a broad array of wildlife management activities and provides a variety of visitor services. Refuge management has made significant progress in implementing these planned activities over the years since establishment. Refuge planning and management, however, are a continual work in process and evolve over time, depending on feedback and monitoring as well as changing values, needs, and priorities in wildlife management at the Refuge, regional, and national scale.

This section summarizes current management programs, operations, and facilities at Seney NWR. It also describes the participation and cooperation of Refuge staff and management activities with our partnering agencies and stakeholders in the wider community on efforts to balance competing demands for natural resources, wildlife, and protection from environmental hazards.

Habitat Restoration

Many of the current management efforts on the Refuge focus on restoring ecosystems and wildlife habitats and populations that have declined since the intensive habitat modification and destruction wrought by Euro-American settlement, agricultural development and drainage projects.

Prescribed Fire

Fires are a natural part of the Boreal Forest in the Great Lakes Ecosystem. Prior to European settlement, large fires (10,000 to 25,000 acres) swept across the landscape approximately every 25 to 35 years (Drobyshev et al. In Press). This ecological disturbance shaped the composition and structure

Table 9: Wildlife Species of Conservation Concern at Seney NWR and Nearby Lands

Common Name	Scientific Name	Special Designations			Occurence on the Refuge a= Abundant c= Common u=Uncommon r= Rare-occasional, vagrant,				Preferred Habitat(s)
		Region 3 Conservation Priority	Regional Forester Sensitive	Michigan Special Animal	a	c	u	r	
Birds									
Common Loon	*Gavia immer*	✓	✓	✓		✓			OWA
Double-creasted Cormorant	*Phalacrocorax auritus*	✓						✓	OWA
American Bittern	*Botaurus lentiginosus*	✓		✓		✓			OWE
Least Bittern	*Ixobrychus exilis*	✓	✓	✓				✓	OWE
Black-crowned Night Heron	*Nycticorax nycticorax*	✓	✓	✓				✓	OWE
Trumpeter Swan	*Cygnus buccinator*	✓	✓	✓	✓				OWA
Snow Goose	*Chen caerulescens*	✓						✓	OWA
Canada Goose	*Branta canadensis*	✓			✓				OWA
American Black Duck	*Anas rubripes*	✓				✓			OWA
Canvasback	*Aythya valisineria*	✓						✓	OWA
Lesser Scaup	*Aythya affinis*	✓						✓	OWA
Wood Duck	*Aix sponsa*	✓				✓			OWA, OWE
Mallard	*Anas platyrhynchos*	✓				✓			OWA, OWE
Blue-winged Teal	*Anas discors*	✓				✓			OWA, OWE
Northern Pintail	*Anas acuta*	✓						✓	OWA, OWE
Osprey	*Pandion haliaetus*			✓		✓			OWA
Bald Eagle	*Haliaeetus leucocephalus*	✓		✓		✓			OWA
Peregrine Falcon	*Falco peregrinus*	✓	✓	✓				✓	OWE, GRA, HAY
Merlin	*Falco columbarius*			✓			✓		DCF, DMF, MCF, MMF, WCF, WMF
Red-shouldered Hawk	*Buteo lineatus*	✓	✓	✓				✓	WMF, WCF
Cooper's Hawk	*Accipiter cooperii*			✓			✓		DCF, DMF, MCF, MMF, WCF, WMF

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		Region 3 Conservation Priority	Regional Forester Sensitive	Michigan Special Animal	a	c	u	r	
Northern Goshawk	*Accipiter gentiles*	✓	✓	✓			✓		DCF, DMF, MCF, MMF, WCF, WMF
Northern Harrier	*Circus cyaneus*	✓	✓	✓		✓			OWE, GRA, HAY, OLD
Spruce Grouse	*Falcipennis canadensis*		✓	✓			✓		DCF, WCF
Sharp-tailed Grouse	*Tympanuchus phasianellus*		✓	✓			✓		GRA, HAY, OLD
Yellow Rail	*Coturnicops noveboracensis*	✓	✓	✓			✓		OWE
Upland Sandpiper	*Bartramia longicauda*	✓	✓				✓		GRA, HAY, OLD
American Woodcock	*Scolopax minor*	✓				✓			SUP
Greater Yellowlegs	*Tringa melanoleuca*	✓				✓			SHO
Caspian Tern	*Sterna caspia*		✓	✓		✓			OWA
Common Tern	*Sterna hirundo*	✓	✓	✓			✓		OWA
Black Tern	*Chlidonias niger*	✓	✓	✓			✓		OWA, OWE
Black-billed Cuckoo	*Coccyzus erythropthalmus*	✓					✓		SWE, SUP
Long-eared Owl	*Asio otus*	✓		✓			✓		DCF, DMF, WCF, WMF
Great Gray Owl	*Strix nebulosa*		✓					✓	OWE, GRA, HAY, OLD
Short-eared Owl	*Asio flammeus*		✓	✓				✓	OWE, GRA, HAY, OLD
Boreal Owl	*Aegolius funereus*		✓					✓	WDF
Whip-poor-will	*Troglodytes aedon*	✓					✓		DCF, GRA, HAY, OLD
Black-backed Woodpecker	*Picoides arcticus*		✓	✓			✓		DCF, DMF, MCF, MMF, WCF, WMF

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		Region 3 Conservation Priority	Regional Forester Sensitive	Michigan Special Animal	a	c	u	r	
Northern Flicker	*Colaptes auratus*	✓			✓				DCF, DMF, MCF, MMF, WCF, WMF
Red-headed Woodpecker	*Melanerpes erythrocephalus*	✓						✓	GRA, HAY, OLD
Olive-sided Flycatcher	*Contopus cooperi*	✓	✓				✓		DCF, DMF, MCF, MMF, WCF, WMF
Yellow-bellied Flycatcher2	*Empidonax flaviventris*		✓			✓			DCF, DMF, MCF, MMF, WCF, WMF
Marsh Wren	*Cistothorus palustris*			✓			✓		OWE, SWE
Sedge Wren	*Cistothorus platensis*	✓				✓			SWE
Wood Thrush	*Hylocichla mustelina*	✓					✓		MMF, DCF
Swainson's Thrush2	*Catharus ustulatus*		✓				✓		WCF, WMF
Black-throated Blue Warbler	*Dendroica caerulescens*	✓	✓				✓		MDF
Canada Warbler	*Wilsonia canadensis*	✓					✓		MDF, WMF, MMF
Kirtland's Warbler	*Dendroica kirtlandii*	✓		✓				✓	DCF
Connecticut Warbler	*Oporornis agilis*	✓	✓			✓			SUP
Cape May Warbler	*Dendroica tigrina*	✓					✓		WCF, WMF
Bay-breasted Warbler	*Dendroica castanea*		✓				✓		WCF, WMF
Cerulean Warbler	*Dendroica cerulean*	✓	✓	✓				✓	WMF, WCF
Golden-winged Warbler	*Vermivora chrysoptera*	✓						✓	SUP
Field Sparrow	*Spizella pusilla*						✓		GRA, HAY, OLD, SUP
Le Conte's Sparrow	*Ammodramus leconteii*	✓	✓			✓			OWE
Bobolink	*Dolichonyx oryzivorus*	✓	✓			✓			GRA, HAY, OLD, PAS

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Common Name	Scientific Name	Special Designations			Occurence on the Refuge a= Abundant c= Common u=Uncommon r= Rare-occasional, vagrant,				Preferred Habitat(s)
		Region 3 Conservation Priority	Regional Forester Sensitive	Michigan Special Animal	a	c	u	r	
Eastern Meadowlark	*Sturnella magna*	✓					✓		GRA, HAY, OLD, PAS
Western Meadowlark	*Sturnella neglecta*	✓		✓				✓	GRA, HAY, OLD, PAS
Mammals:									
Water Shrew	*Sorex palustris*		✓				✓		MDF, MMF, MCF, SHO
Northern Bat	*Myotis septentrionalis*		✓					✓	DDF
Gray Wolf	*Canis lupus*	✓		✓			✓		DDF, MDF, DMF, MMF, DCF, MCF, SUP, OLD, GRA, PAS, HAY, SHO
Black Bear	*Ursus americanus*		✓			✓			DDF, MDF, DMF, MMF, DCF, MCF
River Otter	*Lutra canadensis*		✓			✓			OWA
Badger	*Taxidae taxus*		✓					✓	GRA, PAS, HAY
Marten	*Martes americana*		✓				✓		DCF, MCF
Canada Lynx	*Lynx canadensis*			✓				✓	DCF, MCF, WCF
Bobcat	*Lynx rufus*		✓			✓			DMF, MMF, DCF, MCF
Moose	*Alces alces*			✓			✓		WCF, SWE
Fish:									
Brook Trout	*Salvelinus fontinalis*	✓						✓	OWA
Pugnose Shiner	*Notropis anogenus*			✓				✓	OWA

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		Region 3 Conservation Priority	Regional Forester Sensitive	Michigan Special Animal	a	c	u	r	
Sea Lamprey	*Petromyzon marinus*	✓						✓	OWA
Lake Sturgeon	*Acipenser fulvescens*	✓		✓				✓	OWA
Herpofauna									
Wood Turtle	*Clemmys insculpta*		✓	✓			✓		WCF, SHO, SWE
Blanding's Turtle	*Emydoidea blandingii*		✓	✓				✓	WCF, SWE, SHO, GRA, OLD, OWE
Chorus Frog	*Pseudacris triseriata*			✓			✓		WDF, MDF, GRA, OWE
Four-toed Salamander	*Hemidactylium scutatum*		✓					✓	WCF, OWE

Habitat Definitions (Brewer et al. 1991): **DDF**= Dry Deciduous Forest or Savanna; **MDF**= Mesic Deciduous Forest; **WDF**= Wet Deciduous Forest; **DMF**= Dry Mixed Forest or Savanna; **MMF**= Mesic Mixed Forest; **WMF**=Wet Mixed Forest; **DCF**=Dry Coniferous Forest; **MCF**=Mesic Coniferous Forest; **WCF**= Wet Coniferous Forest; **SUP**= Shrub Uplands; **SWE**= Shrub Wetland; **OLD**= Old Field; **GRA**= Grassland ; **PAS**= Pasture; **HAY**= Hayfield; **OWE**=Open Wetland; **SHO**= Shoreland; **OWA**= Open Water

of vegetative communities and over the millennia many native plants and animals have not only adapted to but have become dependent on fire. For example, Yellow Rails depend on open expanses of sedge marsh for breeding and Red Crossbills feed almost exclusively on seeds produced in mature red and white pine forests; both of these habitat types are maintained by fire.

With human settlement came extensive logging followed by catastrophic fire and then years of fire suppression. These anthropomorphic activities have had a profound impact on the fire frequency and resulting vegetation at Seney NWR. The frequency of small fires (fewer than 250 acres) has increased, but large fires are no longer allowed to sweep across the landscape (Drobyshev et al. In Press). As a result, shrubs encroach upon the sedge wetlands and jack pine dominates sites that were once inhabited by red and white pines.

At Seney NWR, prescribed fire is primarily used to set back succession in the wetlands, to conserve early successional forests (e.g., jack pine, aspen), or to conserve upland old fields and other openlands. In some upland areas, after mechanical tree removal to restore the dominance of red and white pine, periodic fire will help maintain this dominance. In wetlands, periodic burning is used to kill the shrubs and regenerate the sedges.

Prescribed fires at Seney NWR are being carried out under the guidance of the Refuge's Fire Management Plan, which calls for burning an average of 6,000 acres annually. Post-burn monitoring is used to ensure prescribed burning is meeting objectives. The Fire Management Plan also contains a "Fire Use" provision which allows for the management of a wildland fire as a prescribed fire on nearly 62,000 acres or 65 percent of Seney NWR.

Invasive Plants and Other Pests

Many non-native plants and pathogens have been identified at the Refuge. Exotic plant species presently found at the Refuge include glossy buckthorn, multiflora rose, reed canary grass, purple loosestrife, spotted knapweed, tartarian honeysuckle, leafy spurge, silvery cinquefoil, timothy, live-forever, Japanese barberry, St. John's wort, Canada thistle, musk mallow, yellow sweet clover, smooth brome, butter-and-eggs, orchard grass, Kentucky bluegrass, catnip, shepherd's purse, ryegrass, Queen Anne's lace, ox-eye daisy, tall buttercup, bladder campion, bird's foot trefoil, orange hawkweed, heal-all, plantain, yellow goat's-beard, and field sow-thistle. However, many more species occur in the Eastern Upper Peninsula and are likely to colonize the Refuge in the near future. The Refuge staff watches for new invaders and attempts to manage them appropriately.

Dutch Elm Disease

Historically, one of the largest and most dominant members of Refuge hardwood forest communities, American elm has been virtually eliminated from the Eastern Upper Peninsula of Michigan by Dutch elm disease. Spread principally by the European elm beetle, the fungal pathogen arrived in Michigan in 1950 (Dickman and Leefers 2003). By the 1970s, Dutch Elm disease had so heavily infested the hardwood areas around the Chicago Farm, that all of the elm was logged. Today, American elm trees can still be found on the Refuge, but they are short-lived and never attain the size or stature they once had.

Glossy Buckthorn

Glossy buckthorn is an exotic invasive shrub within many Midwestern wetlands, including much of Unit 1 of Seney NWR. It grows as a tall shrub, and can be identified by its glossy, dark green leaves and gray bark. The U.S. Forest Service considers glossy buckthorn a "Category One" invasive species because it is highly invasive, invades natural habitats, and replaces native species. Where glossy buckthorn becomes established, it out-competes natural vegetation (e.g., *Alnus*, *Betula*, *Prunus*, *Viburnum*, and *Salix* species), can become a monoculture, and can alter ecosystem patterns and processes. Previous studies have indicated that invasions of glossy buckthorn along wetland areas have resulted in decreased plant species diversity and altered hydrology (Devine 1999), with negative implications for wildlife habitat.

Mixed pine forest, Seney NWR. USFWS photo.

Active management of glossy buckthorn is critical to minimize the spread of this species to other wetland areas, and to rehabilitate those areas presently impacted. At Seney NWR, glossy buckthorn is the main invasive plant species which the Refuge manages. Nagel et al. (2008) studied the efficacy of different management actions on reducing the amount and distribution of glossy buckthorn at the Refuge. Treatments were implemented in concert with control efforts currently practiced. Stump application of 20 percent glyphosate alone proved ineffective 1 year after treatment, with no difference in sprout density between this concentration of herbicide applied by sponge application, scorching with the flame of a propane torch, or untreated controls. Additional low-volume broadcast application of 5 percent glyphosate to resprouts the following year significantly reduced sprout density as compared to scorching and controls, with no difference between scorch treatments and the controls. Low-volume spraying of the herbicide to extirpate seedlings reduced the number of stems by 96 and 91 percent 1 and 2 years following treatment. There was no difference in seedling density between scorching treatments and the controls. It appears the most effective management option for reducing glossy buckthorn is repetitive herbicide application, possibly for more than 2 years (Corace et al. 2008). In

addition to implementation of treatments, monitoring is critical for ensuring an effective glossy buckthorn management program.

Beech Bark Disease

Beech bark disease (BBD) is a serious threat to the American beech tree and northern hardwood forests. This disease is caused by an interaction of the exotic sap-feeding beech scale insect (*Cryptococcus fagi*) and at least three species of Nectria fungi. Beech scale was first introduced to North America from Europe sometime around 1890. By the 1930s, the scale was found in Maine and the Maritime Provinces of eastern Canada. Other areas of New England and New York were found to have the scale in their forests by the 1960s. By 1975, the scale was in northeastern Pennsylvania. Presently, it is also found in West Virginia, Virginia, North Carolina, Tennessee, Ohio, Ontario, and Michigan. Although the disease has likely been in Michigan for quite some time, it was not until 2000-2001 that beech bark disease was reported in nine counties in Michigan's northern Lower Peninsula and the Upper Peninsula counties of Luce, Chippewa, Alger, and Delta.

Beech bark disease has several effects on trees, stands, and ecosystems. These include reduced leaf size, discolored foliage, dieback, reduced tree growth, reduced mast, and tree mortality. In 2003, three long-term beech bark disease monitoring plots were established on the Refuge. The objectives are to: 1) identify the extent of Michigan's beech resource that is affected by BBD, 2) collect baseline data on current conditions of the beech resource and northern hardwood stands containing beech before this resource is affected by BBD, and 3) monitor changes in the beech resource and northern hardwood forests due to BBD and other disturbances. The non-native scale insect associated with BBD was first documented on the Refuge in 2003.

In 2006 a northern hardwood stand assessment and evaluation was conducted at the Refuge (Whitman and Corace unpub. manuscript). Specific research questions posed were: 1) what is the present composition and structure of the Refuge's northern hardwood-dominated stands?; 2) how might the loss of American Beech affect forest composition and structure?; 3) what will regenerate in the canopy gaps created by American Beech mortality?; 4) and what might be the wildlife implications? In general, all stands had a considerable American beech component and the American beech trees found are highly susceptible to beech bark disease based on their size and suspected age. Eventually, tree mortality caused by BBD will create canopy gaps in these stands followed by natural stand development and the concomitant mortality of shade intolerant trees. In the absence of active management, results suggest that in most of the resulting canopy gaps sugar maple will be dominant in the new cohort of seedlings and saplings. If conserving, enhancing, or restoring stand composition and structure is desired, management actions should focus on enhancing stand-level compositional diversity by promoting less common tree species, such as eastern hemlock and yellow birch. This can most effectively be done by increasing the canopy gaps created by beech mortality near existing yellow birch and eastern hemlock trees. No harvesting of American beech trees is warranted, unless for safety reasons.

Bog, Seney NWR. USFWS photo.

Emerald Ash Borer

According to the Michigan Department of Natural Resources, the natural range of *Agrilus planipennis*, the emerald ash borer (EAB), is eastern Russia, northern China, Japan, and Korea. It is unknown exactly when this exotic arrived on this continent, although it is suspected that the carrier was ash wood used for stabilizing cargo in ships or for packing or crating heavy consumer products. In Michigan all species of North American ash appear to be susceptible. In the absence any natural enemies and with an ample supply of ash trees that lack any form of resistance to them, ash borers have exploded in population size during the last 2 years. Trees in woodlots as well as landscaped areas tend to be most vulnerable to infection. For the most part, affected trees or branches appear to be 2 inches in diameter or larger. The canopy of infested

trees begins to thin above infested portions of the trunk and major branches because the borer destroys the water and nutrient conducting tissues under the bark. Heavily infested trees exhibit canopy die-back usually starting at the top of the tree. One-third to one-half of the branches may die in 1 year. Most of the canopy will be dead within 2 years of when symptoms are first observed, though occasionally ash trees will push out sprouts from the trunk after the upper portions of the tree dies. At the Refuge, black or white ash are not a dominant member of any forest community, so the adverse impact of EAB may be minimal. However, the Refuge is part of an EAB monitoring program run by Schoolcraft County.

Nuisance Species Control

Seney NWR has little need to control nuisance species. Presently only beaver needs to be managed. Beaver are managed because they plug water-control structures, which obstructs water flow to the pool system and can negatively impact the dikes and dams. Trapping is the primary means of controlling nuisance beaver. The Refuge maintains a list of trappers who are asked to trap specific areas where beaver are causing problems. The number of beaver taken annually varies annually depending upon the number of problems areas and the number of beaver contributing to the problem. In 2006, 31 beaver were trapped and the year before four were trapped.

Brown-headed Cowbirds are of concern to those wishing to conserve migratory songbirds due to their parasitism of other bird species nests. Management of cowbirds by lethal means has aided in the recovery of endangered species, such as Kirtland's Warbler, and other passerines of conservation concern (Chace et al. 2005). At Seney NWR, cowbirds are frequently observed foraging on the headquarters lawn, but relatively infrequently observed elsewhere. Using a combination of commercial bird seed and "decoy" birds, a total of 41 cowbirds (19 males, 22 females) were caught and killed during April and May 2006 in accordance with a state permit. Future low-cost management efforts such as this should continue.

Wildlife Monitoring and Research

Seney NWR staff use literature reviews, monitoring and research to guide its management, and all play a vital role in wildlife habitat management at the Refuge. Wildlife monitoring consists of surveys and censuses of selected species or species groups and are typically made on an annual basis. Wildlife monitoring is generally done by Seney NWR staff and volunteers, and consists of organized surveys and or censuses or a compilation of observations and recorded sightings made over the course of the year. Research studies are usually undertaken in cooperation with universities or other government agencies or NGOs, often with the direct participation and cooperation of Refuge staff and assisted by volunteers.

Surveys and Censuses

Most surveys and censuses at Seney NWR are guided by the 1990 Wildlife Inventory Plan. This plan is currently under revision and should be completed within the next few years.

Endangered and Threatened Species – On March 12, 2007 the gray wolf was officially delisted as an endangered species. However, a federal court decision on September 29, 2008 overturned the delisting action and gray wolves in the Great Lakes area are once again listed as endangered under the Endangered Species Act. The Refuge has two or three collared wolves and four to six non-collared wolves using the Refuge during any time of the year. The Michigan DNR conducts aerial surveys for the wolves all year long and reports the information to the Refuge. The Bald Eagle was delisted on August 9, 2007. There are nine Bald Eagle nests on the Refuge, four to five of which are in good to fair condition. The Refuge produces two to four eaglets annually. Eaglets are banded every other year by researchers from Clemson University, and the data are added to the national database.

Bald Eagle banding, Seney NWR. USFWS photo.

Waterfowl – Waterfowl surveys are conducted each spring and fall to document use of the Refuge pools during migration. Weekly roadside surveys are conducted by driving the pool dike system and counting all waterfowl seen. Spring surveys are conducted from ice out until the first week of May. Fall surveys are conducted from early September to the middle of November or first ice up. The Refuge has waterfowl count data going back to 1937. Current species distribution has Trumpeter Swan, Canada Goose, Ring-necked Duck, Hooded Merganser, and Mallard as the most common species that are observed and nest on the Refuge. Other common migrants include American Wigeon, Bufflehead, and Wood Duck. There are greater numbers of duck species using the Refuge during the fall migration than the spring migration. The Common Loon first appeared at Seney NWR in 1939 and has been a fixture on the waterscape ever since. To date, Seney NWR has one of the most intensively monitored Common Loon populations in North America. The population is annually monitored, nests are checked for reproductive output, and young are banded. In recent years, Seney NWR has averaged 15 territories with pairs and produced about 12 chicks each year.

Trumpeter Swans – Trumpeter Swans were first reintroduced to the Refuge in 1991 and the first recorded nesting of these swans was in 1992, when a pair bred as 3-year olds (Corace et al. 2006). A total of 44 birds were introduced from 1991 to 1993. Currently the Refuge supports 240 adult birds, 30 swan nests, and hatches out over 100 cygnets. Trumpeter Swan surveys are conducted in the same way the waterfowl surveys are done, except the focus is on the swans. Data that are collected include the total number of adult swans, total number of swan nests, and the number of cygnets hatched per nest. Once cygnets have hatched, the numbers of cygnets per nest are tracked over time until fledging occurs in October. Data are currently being collected on the nesting ecology of the birds, on the number of eggs per nest, eggs hatched per nest and egg viability.

Marshbirds and other Migratory Birds – Seney NWR conducts surveys for secretive marshbirds each spring and early summer. Species that are surveyed for include (but are not limited to) American Bittern, Pied-billed Grebe, Sora and Virginia Rail. Passive calls and call playback techniques are used. The most common marshbirds encountered during the surveys in order of most common to least common are the American Bittern, Sora Rail and Virginia Rail. Seney NWR is currently expanding its Marshbird Survey Program by adding more routes to the survey to get a more complete coverage of the Refuge and develop a population index to these secretive birds. Also, the Refuge participates in the American Woodcock Peenting Survey that is run by the USFWS Migratory Bird Management Office out of Fort Snelling, Minnesota. The Refuge has one survey route for woodcock on the northern boundary. The Refuge participates in a spring and fall Sandhill Crane count. The spring count is conducted by the International Crane Foundation out of Baraboo, Wisconsin, and Seney NWR serves as the Schoolcraft County coordinator for the survey. The fall count is conducted by the USFWS Migratory Bird Management Office out of Fort Snelling, Minnesota. The Refuge has one USGS Breeding Bird Survey Route within the boundary of the Refuge and conducts migratory songbird point counts each June. The more common species that are using the Refuge at this time include Hermit Thrush, Oven Bird, Nashville Warbler, and Blue Jay.

Upland Game Birds – As part of an MDNR, Wildlife Division-led effort to survey Ruffed Grouse, Seney NWR conducts a roadside route to count the number of males heard drumming. The route has 10 listening stops that are consistent from year to year. The number of Ruffed Grouse heard during a fixed time interval (4 minutes) is recorded at each stop. Data are summarized by the Michigan Department of Natural Resources, Wildlife Division as the number of grouse heard per survey route. This survey provides the Wildlife Division an additional method to monitor the population.

Sharp-tailed Grouse in Michigan's Upper Peninsula – including those at Seney NWR – represent the most easterly distribution of the species in the United States. A state-listed species of special concern, the Sharp-tailed Grouse is an area-sensitive flagship species of large openland ecosystem complexes in the eastern Upper Peninsula of Michigan. The annual lek survey is an attempt to estimate the population size of sharptails in Michigan.

Amphibians – Seney NWR is home to nine native species of anurans (frogs and toads). In recent years, many observers have been concerned with the apparent rarity, decline, and/or population die-offs of several of these species in Michigan and elsewhere. These concerns were not only for the species themselves, but also for the ecosystems on which they depend. As a result, the Michigan Frog and Toad Survey was initiated in 1988. Seney NWR has one survey route that consists of 10 wetland sites

Snapping turtle, Seney NWR. USFWS photo.

that are visited by an observer three times annually: in early spring, late spring, and summer. At each site, the observer identifies the species present on the basis of their breeding season calls or songs, and makes a simple estimate of abundance for each species, using a Call Index Value of 1, 2, or 3.

Other Raptors – Refuge volunteers, interns, visiting researchers and staff compile observations of raptors at the Refuge, especially owls and woodland hawks. The Refuge also has nesting Osprey on the Refuge. There are five nests on the Refuge with two or three active at any one time. The Refuge produces on average about three to four chicks per year. Chicks are banded each year by researchers.

Furbearers – The Refuge works in conjunction with the MDNR in identifying trends in furbearer populations. Species seen during this survey include gray wolf, the reintroduced fisher and American marten, the Federally regulated bobcat and river otter, and a number of other furbearers of varying status. Seney NWR has two survey routes used to conduct a structured winter track count to assist the MDNR in determining the distribution and relative abundance of several furbearers and selected prey species, simultaneously.

Studies and Investigations

The Refuge has a long tradition of hosting a variety of research projects that have assisted in the management of the Refuge. The Refuge's first peer-reviewed publication was in The Journal of Wildlife Management in 1947. Written by the first Refuge Manager, C. S. Johnson, the article was entitled "Canada Goose Management, Seney National Wildlife Refuge." Research that has occurred on the lands of Seney NWR has covered every decade since 1940 and has yielded more than 81 research projects, 31 peer-reviewed publications, 14 Master's Theses, and three Doctoral Dissertations.

Seney NWR recognizes the important and much needed role research has in the management of federal lands. The Refuge's vision statement includes a section about research:

> "Students and researchers will be encouraged to use the Refuge as an outdoor laboratory for biological and ecological research that focuses on understanding natural patterns and processes and developing habitat management techniques."

Seney NWR encourages researchers to actively pursue projects with the staff. Seney NWR has the infrastructure (12-person bunkhouse, equipment, volunteers, and other facilities) to support a wide array of research projects. Recent and ongoing studies include (but are not limited to) the following:

Joint Fire Science Project: Restoration-based fuel reduction recommendations for mixed-pine forests of Upper Michigan – This project was initiated in 2005 by Seney NWR Refuge Forester and co-principal investigators from The Ohio State University and the U.S. Forest Service. The project 1) developed a better understanding of the fire history regimes, fuel loadings, and forest composition and structural characteristics of pre-European settlement and post-settlement mixed-pine forest; 2) analyzed current fire hazard and forest stewardship of mixed-pine forest ecosystems; and 3) developed restoration-based fuel reduction recommendations for mixed-pine forest ecosystems of eastern Upper Michigan.

The Effects of Summer Grazing from Trumpeter Swans on the Aquatic Macrophyte Communities in Seney NWR – This project was initiated in 2006 as a result of the successful reintroduction of the swans over 15 years ago. The project is headed by the University of Wisconsin-Oshkosh in conjunction with the Refuge Biologist. About 240 Trumpeter Swans use Seney NWR, and concern has been raised as to whether the swans are impacting the pools. This ongoing project has set up feeding exclosures in the pools to keep swans out of areas where they are known to feed. The project will assess the impacts the swans are having on the types and distribution of the macrophytes in the pools.

Fire ecology in Northern Sedge Meadows: Factors Influencing Yellow Rails and Other Birds at Seney NWR – This project was initiated in 2006 by the Refuge Biologist and USGS-Northern Prairie Wildlife Research Center, Jamestown, North Dakota, and was originally entitled "Evaluating Techniques for Determining Habitat Use of Yellow Rails." Seney NWR often hosts a substantial number of breeding Yellow Rails in large expanses of sedge meadows. Previous studies at Seney NWR and elsewhere have described shallow flooding and vegetative conditions preferred by rails and have documented a positive response by rails to habitat changes due to prescribed fire (Burkman 1993). However, in-depth examinations of how rails use sedge meadows and the interacting factors influencing rail use of burned areas are lacking. This project has completed one field season and upon examination of the first year data and lack of Yellow Rails found for the telemetry portion, a new study has evolved to look at all birds that use the wet sedge meadows and their response and the vegetation response to prescribed fire.

Clutch Size and Nest Site Characteristics of Trumpeter Swans – This project was initiated in 2006 by the Refuge Biologist. The project is evaluating the success of the Trumpeter Swan reintroduction program by looking at demographic characteristics of the birds. Clutch size, egg viability, and fecundity are all important variables to measure when determining how well an animal adapts to a new area. After 1 year of data collection, the swans at Seney NWR on average have larger clutches than Trumpeter Swans in other flyways. Data collection continued into 2007 and 2008 as time and funding permited.

Rapid Change in Species Composition of Mammal Communities in the Northern Great Lakes – This project was initiated by the Museum of Zoology and Department of Ecology and Evolutionary Biology, University of Michigan. The Upper Peninsula fauna is of particular interest to biologists because it represents a transition zone where many boreal species reach the southern limits of their distributions while several austral species are at or near their northern limits. Research has documented the range extensions of two small mammals, the white-footed mouse and southern flying squirrel, both of which are moving eastward and northward. Preliminary data also suggest that the eastern chipmunk is increasing in abundance relative to the more boreal least chipmunk. It is argued, based on analyses of population fluctuations of the white-footed mouse, that these changes are likely due to climatic warming. The project is ongoing.

Impacts of a Constructed Pool on a Fen in Seney NWR: Restoration Implications – This project was initiated with USGS-BRD-Great Lakes Science Center and Seney NWR staff. The study examined the nature and extent of degradation to the Marsh Creek wetland caused by alteration of natural hydrology and provided base line data for the restoration project. Wetlands bordering Marsh Creek were quantitatively sampled to characterize the wetland plant communities, groundwater hydrology and water quality. Ecological and hydrologic differences were observed in the wetlands upstream and downstream from the C-3 Pool. Redirecting some of the water in the C-3 Pool down the historic Marsh Creek channel could restore surface flow in the creek, increase the amount of disturbance associated with fluctuating water levels, and affect wetland plant communities.

An Experimental Approach to Determinging the Efficacy of Glossy Buckthorn Management at Seney NWR – This project was initiated by the Refuge Forester and the School of Forest Resources and Environmental Science, Michigan Technological University. Glossy buckthorn is an exotic species that has become a major invasive plant within wetlands of Seney NWR and elsewhere in the Midwest. Invasion of glossy buckthorn along wetland areas has resulted in decreased plant species diversity and altered hydrology, with implications for wildlife habitat management and restoration. The objectives of this research were to test the efficacy of different management actions on seedlings and mature glossy buckthorn shrubs. Treatments were implemented in concert with control efforts currently practiced on the Refuge. Stump application of 20 percent glyphosate alone proved ineffective 1 year after treatment with no difference in sprout density between herbicide, scorching, or controls. Additional broadcast application of 5 percent glyphosate to resprouts the following year significantly reduced sprout density as compared to scorching and controls. It appears the most effective management option for reducing glossy buckthorn is repetitive herbicide application possibly for greater than 2 years (Nagel et al. 2008, Corace et al. 2008).

Relationship of Small Mammals and Habitat Variables in the Context of Forest Restoration at Seney NWR – This project was initiated by the Refuge Forester and the University of Michigan. Infor-

Seney NWR. USFWS photo.

mation regarding what habitat variables affects small mammal diversity and abundance may help guide management decisions and restoration efforts at Seney NWR. Fieldwork included small mammal trapping and the collection of habitat variables among three macro-habitat categories of conifer-dominated and hardwood forest stands. At the macro-habitat scale, no significant differences were found between small mammal captures and site categories on either deciduous or coniferous plots. However, the results did show that microhabitat features are important in predicting the distribution of small mammals. Binomial regression analysis identified three important habitat elements on which managers should concentrate restoration efforts: coarse woody debris, snags, and tree species diversity (Harrington 2006).

Mercury Exposure in Common Loons of the Upper Peninsula – This long-term project was initiated by Common Coast Research and Conservation and former Refuge staff. In concert with banding activities that have enabled long-term research into the population dynamics and life history of the Common Loon, blood and feather samples have been collected from Upper Peninsula adults and juveniles since 1991 for the purpose of assessing their exposure to the persistent neurotoxin mercury (Hg). Extensive sampling on the federally protected lands of Isle Royale National Park, Ottawa National Forest, and Seney NWR have focused upon juvenile loons and their utility as a bio-indicator of mercury loading and uptake within specific lake environments. Results from this ongoing research have suggested that 1) juvenile loons, as top-level piscivorous integrators, represent an accurate, efficient and underutilized barometer of single-source Hg bioavailability, 2) some Upper Peninsula lakes are among the most merucyr-contaminated ecosystems in the northern Great Lakes region, and 3) Seney NWR could, for reasons of geography, hydrology, and infrastructure, serve as an exceptional site for a broad-base mercury monitoring program

Predator and Exotic Wildlife Management

Sea Lamprey

The sea lamprey (*Petromyzon marinus*) is an invader from the Atlantic Ocean that entered the Great Lakes following the dredging of the Welland Canal. This parasitic fish spends part of its life cycle feeding on the blood and body fluids of native fishes by attaching, via a suction mouth, and rasping a hole in the side of their host using a toothed-tongue. Each sea lamprey destroys up to 40 pounds of fish during its adult lifetime. Great Lakes sea lamprey populations exploded during the 1940s and 1950s and contributed significantly to the collapse of fish species, such as lake trout, that were the economic mainstay of commercial fisheries.

Since 1954, the Great Lakes Fishery Commission has administered the Great Lakes Sea Lamprey Management Program. The Service, as the U.S. agent for sea lamprey control, has managed sea lamprey populations in U.S. waters of the Great Lakes. The primary method for controlling sea lamprey uses the lampricide TFM (3-trifluoromethyl-4-nitrophenol) to kill larval sea lampreys burrowed in stream sediment. Barriers that block upstream migration of spawning sea lampreys provide a second important method of control.

During 1971, sea lampreys were detected in the Manistique River near Germfask. Prior to that, the Manistique Paper Co. Inc (MPI) dam, located near the mouth of the Manistique River, effectively served as a barrier to upstream infestation. During 1974, the river was treated with TFM and the MPI dam was patched to prevent further infestation of the watershed. Over the years, patchwork of the dam had been successful. However, during the late 1990s, the dam deteriorated further and sea lampreys again colonized the watershed. The river was treated with lampricides during 2003, 2004, and 2007. Since the Manistique River has become one of the largest contributors of parasitic sea lamprey in the Great Lakes, it is anticipated that additional

lampricide treatments will be required to control the infestation to protect the highly valued fisheries of northern Lake Michigan.

Repeated TFM treatments can be problematic because TFM kills native lamprey larvae along with sea lampreys. Seney NWR provides habitat to three species of native lamprey (Appendix C). Although native lampreys tend to be more resistant to lampricide than sea lampreys, the difference in toxic response is not sufficient to selectively remove only sea lampreys during a lampricide treatment. A decrease in native lamprey populations has been documented in many treated Great Lake streams (Schuldt and Gould 1980; NRCC, 1985). The Service assesses the status of lamprey populations before and after lampricide treatments, and maintains a long-term database on these assessment activities. These surveys show that native lamprey continue to populate most streams in the Manistique River basin, although numbers may be reduced in reaches where TFM treatments occur.

The Refuge staff is currently involved in the planning of a new sea lamprey barrier at the site of the MPI dam, which could be operational by 2012. Reinstatement of an effective barrier to sea lamprey migration in the lower river is currently the only way to eliminate the need for repeated lampricide treatments.

Interagency Coordination Activities

It takes partnerships to run a national wildlife refuge, and Seney NWR has a long history of working with others to "get the job done" for wildlife. Examples range from the first manager's partnership with the Civilian Conservation Corps, which built many of Seney's impoundments, to the last manager's work with the Coast Guard and private industry to protect Common Tern nesting colonies on Lake Michigan. Currently the Refuge has strong partnerships with the Michigan DNR, universities (Michigan State, Michigan Tech, the University of Michigan and The Ohio State University), other Government Agencies (U.S. Forest Service, National Park Service, U.S. Coast Guard, U.S. Geological Survey) and non-government agencies (The Nature Conservancy, Seney Natural History Association, Michigan Audubon Society, and Great Lakes Shipwreck Society). Of particular note are the Refuge's research and fire and public use programs, which would not exist without partnerships.

Public Recreation and Environmental Education

The 1997 National Wildlife Refuge System Improvement Act emphasizes wildlife management and that all prospective public uses on any given refuge must be found compatible with the wildlife-related refuge purposes before they can be allowed. The Refuge System Improvement Act also identifies six priority uses of national wildlife refuges that in most cases will be considered compatible uses. They are:

- Hunting
- Fishing
- Wildlife Observation
- Wildlife Photography
- Environmental Education
- Environmental Interpretation

Seney NWR supports all six of these activities. In so doing it attracts 43,000 to 88,000 visitors per year. The number of people that visit per year is dependent upon many factors, some which the Refuge controls, such as the number of programs offered and outreach efforts. Over the past 4 years we have continued to scale back on public use activities due to lack of staff. Factors beyond our control, such as the weather, economy and game populations, also affect our visitation.

Tribal Consent Decree

On November 2, 2007 the United States, State of Michigan and five Tribes signed an Inland Consent Decree. This Decree affirms the rights of the Bay Mills Indian Community, Sault Ste. Marie Tribe of the Chippewa Indians, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band Ottawa Indians and Little Traverse Bay Band of Odawa Indians to exercise hunting and fishing rights on specified lands which were ceded by the Tribes under the Treaty of 1836. Seney NWR is within the treaty area. Therefore, to the extent a particular activity on Seney NWR is subject to State regulations those rights shall be governed by the Decree and applicable federal regulations. To the extent that an activity is not subject to State regulations, the exercise of Tribal rights shall be governed

by a memorandum of understanding between the Tribes and USFWS and by applicable Federal laws and regulations.

Visitor Services

Seney NWR provides the following facilities and opportunities for visitors:

- The Visitor Center is open May 15 to Oct 15, 9 a.m. to 5 p.m., 7 days per week.
- Informational and interpretive displays including: children's touch table, who's calling sound ID, wolf-coyote comparisons, loon diorama, bathroom blurbs, monarch life cycle live exhibit.
- Visitors can view a 14-minute slide show that provides orientation to the Refuge.
- The Pine Ridge Nature Trail is a 1.4-mile, self guided, sign in place, interpretive hiking trail (signs identify plants and interpret how they support wildlife).
- Marshland Wildlife Drive provides 7 miles of gravel road with an additional 3.5-mile fishing loop.
- There is an accessible fishing pier with observation scopes.
- Fishing-line collection containers.
- Three observation decks are located on the Refuge, each with a spotting scope and interpretive panel (loons, swans, eagles).
- There are designated areas for hunting deer, grouse, hare, woodcock and bear.
- The Refuge has a photo/observation blind that receives limited use.
- More than 90 miles of backcountry roads are open to hiking and biking.
- Native gardens are planted around the Visitor Center.
- Five cross-country ski trails are groomed weekly.
- Binoculars are available for loan at the Visitor Center.
- Information kiosks are found at several locations on the Refuge including the Visitor Center and Wigwams Pavilion.

Environmental education program, Seney NWR. USFWS photo.

Hunting

Hunting on the Refuge is very popular with local residents and many visitors. There are two hunting units on the Refuge. Hunting Area A encompass 49,522 acres in the center of the Refuge. Area B covers much of the Wilderness, a strip of land along the north boundary and in the southeast corner; it contains 36,200 acres. The Refuge unit containing the Headquarters and Visitor Center is closed to hunting.

When small game populations are high, hunters journey from throughout the Midwest to the Refuge. Hunting for Ruffed Grouse and American Woodcock is allowed in Area B. Snowshoe hare hunting is allowed in Area A after December 1 and throughout the season in Area B. All hunting is done in accordance with Michigan DNR regulations.

Hunting for big game (white-tailed deer and black bear) on the Refuge is permitted during the state seasons, however there are added restrictions. The use of bait, dogs, snowmobiles or ATVs are prohibited. Area A is open for hunting deer during the "regular gun," "muzzleloading," and "late archery" seasons. Area B is open for all big game hunting seasons. These restrictions all but eliminate black bear hunting on the Refuge, because the state issues a limited number of bear tags and few hunters are willing to hunt without bait or dogs.

The Refuge's restrictions may have the opposite effect on deer hunting. While some may disagree with the restrictions, an overwhelming number of deer hunters surveyed in 2003 said they hunt at Seney NWR because it is a large area where they

can hunt traditionally, without the influence of baiting or the annoyance of ATVs. Despite the low hunter success, 9 percent compared to a state-wide average of 40 percent, many hunters have come back for decades. To facilitate deer hunting, Refuge roads are opened and camping is allowed west of the Driggs River.

Fishing

Seney NWR provides a 3.5-mile Fishing Loop and a universally accessible pier to facilitate fishing. Many people enjoy fishing for yellow perch and northern pike from the banks of Refuge impoundments. Others fish the Driggs River for brook trout or the Manistique River for walleye, smallmouth bass, and brown trout. Impoundment fishing is open from May 15 to September 30 in specified locations, and river fishing is allowed in accordance with state regulations. No boats or flotation devises are allowed on the impoundments and lead-free tackle must be used. Ice fishing is permitted on all Refuge impoundments, but this activity is not very popular.

Each year, during the state's "free fishing weekend," Refuge staff, volunteers and the Seney Natural History Association (SNHA) host a children's fishing day. This event began in 1990 and has become a tradition with many local families. Volunteers are stationed along the fishing loop with poles and bait to help children fish, there are fishing related activities in the Visitor Center and certificates are awarded for the largest yellow perch and northern pike in five age categories. The SNHA provides a free fish dinner to participants and their families and local vendors donate fishing-related items as door prizes.

Wildlife Observation

Seney NWR is known as a great place to watch wildlife and the Whitefish Point Unit is recognized internationally for its importance as a migratory bird stopover. Each year, visitors from around the world come to the Refuge to observe wildlife. The road network and impoundments provide excellent opportunities for people of all ages and abilities to observe wildlife. Others prefer to walk the Pine Ridge Nature Trail or hike and bike the backcountry roads in search of wildlife. If they are lucky they may glimpse a black bear, moose, or gray wolf. During the winter, visitors can don cross-country skis or snowshoes to track wildlife.

Staff and volunteers working at the Visitor Center maintain a wildlife observation log and share that information with visitors. They also loan binoculars to visitors and help them locate observation decks with viewing scopes. Tours are given on Wednesday evenings that provide viewing opportunities along the back country roads and Yellow Rail tours offer a unique nighttime opportunity to see or hear a much sought-after species.

Red squirrel, Seney NWR. Photo by Igor Drobyshev.

Wildlife Photography

The network of roads and other facilities along the pools affords photographers of all skill levels excellent opportunities to photograph wildlife. Many beginners focus their lens on the charismatic Trumpeter Swan or Common Loon, as is evident by entries to the Annual Seney NWR Photo Contest. More seasoned photographers often venture beyond the auto tour route to capture images of plants, insects, and landscapes bathed in a wide spectrum of light conditions.

Interpretation

The Refuge Visitor Center, which is open 9 a.m. to 5 p.m. every day from May 15 to October 15, contains a variety of displays to interpret the natural resources of Seney NWR. It contains permanent exhibits such as a loon diorama, a gray wolf/coyote comparison, a "Who's Calling" soundboard, a "lift the flap" mural, a track box, and a touch table. Creative temporary displays are used to inform the visi-

tors of what's blooming, who is migrating, the use of fire management, the threats of invasive species and other Refuge management activities.

Refuge kiosks, which are presently being upgraded, provide minimal interpretive information on the Fish and Wildlife Service and specifically Seney NWR. The Marshland Wildlife Drive and Pine Ridge Nature Trail both have interpretive panels along their routes and the observation platforms were built with a focus on loons, eagles and swans. Brochures and posters also provide additional interpretive information.

In addition to the wildlife tours that are provided every Wednesday evening, presentations, guided events, and other special events are held, including Children's Fishing Day and Scout Day. Smaller interpretive events held throughout the season provide interpretive information on a variety of topics such as hunting and fishing, endangered species, backyard wildlife, migratory birds, fire management, invasive species management, wildflowers and wildlife films.

The Refuge's interpretive program is heavily subsidized by funds from SNHA. Most of the Refuge's events and interpretive activities are carried out by interns who receive monetary stipends from SNHA. The SNHA has also paid for the publication of brochures and signs as well as the construction of observation decks. A majority of their funds are derived from the sale of books and educational material sold in a small book store located in the Visitor Center.

Children's Fishing Day, Seney NWR. USFWS photo.

The Refuge welcomes school groups and others interested in environmental education. School field trips are accommodated through tours, hikes, pond studies using a video microscope, games and career talks. On Scout Day the Refuge provides educational sessions for boy and girl scouts, grades K-6. Sessions include topics such as: bird banding, weather, water cycles, knots, orienteering, fire safety, tree identification, first aid, wildlife observation and dressing for outdoor activities. Seney NWR also provides outreach to university students by presenting tours and lectures. There is a growing demand for environmental education both on and off Refuge.

Volunteer and Friends Contributions

Seney NWR is fortunate to have an extraordinary volunteer program and a tremendous friends group. Without them there would be little substance to the Refuge's visitor use program. Volunteers staff the Visitor Center 8 hours a day from May 15 through October 15. They also help with public events, biological monitoring, maintenance projects and administrative duties. In all, volunteers contribute 8,000 to 10,000 hours annually to sustain and enhance Refuge programs. The SNHA is the Refuge's friends group. Established in 1987, the SNHA has contributed more than $400,000 and funded approximately 80 internships to support Refuge programs. All of this has been done through membership dues and revenue generated from bookstore sales.

Archaeological and Cultural Resources

Cultural resources management in the Service is the responsibility of the Regional Director and is not delegated for the Section 106 process when historic properties could be affected by Service undertakings, for issuing archeological permits, and for Indian tribal involvement. The Regional Historic Preservation Officer (RHPO) advises the Regional Director about procedures, compliance, and implementation of cultural resources laws. The Refuge Manager assists the RHPO by informing the RHPO about Service undertakings, by protecting archeological sites and historic properties on Service man-

aged and administered lands, by monitoring archeological investigations by contractors and permittees, and by reporting violations.

Law Enforcement

Enforcement of federal wildlife laws, as well as regulations specific to the Refuge System, is an integral part of Refuge operations. Law enforcement plays a crucial role in ensuring that natural and cultural resources are protected and that visitors encounter a safe environment. The Refuge currently has one dual-function officer who is commissioned to conduct law enforcement on federal property. In addition, the Zone Officer for Michigan and Ohio, currently stationed at Shiawassee NWR, and Special Agents conduct and assist with law enforcement efforts on the Refuge and surrounding lands. Federal law enforcement is a cooperative effort by many agencies in the region. Cooperative relationships and strategies have been developed with state conservation officers and the Schoolcraft County Sheriff's Department.

Wilderness Area and Wilderness Review

The Seney Wilderness Area was designated by Congress in 1970 and covers 25,150 acres (26 percent of the Refuge). The Strangmoor Bog National Natural Landmark is also located within the Seney Wilderness (Figure 12 on page 35). The majority of the wilderness is characterized by "string bog" topography, with moist organic soils and sand ridge islands (Heinselman 1965).

The variable nature of fire historically shaped the diverse Wilderness landscape (Drobyshev et al. In Press). Fluctuations in weather patterns, hydrology, topography, soils, fuels, and stand structure affected fire severity patterns. The 1976 Walsh Ditch Fire that burned most of the Wilderness demonstrated the variable nature of fire in that within its perimeter fire effects were patchy in nature. It left unburned 63 percent of the area, light surface burned 18 percent, moderately surface burned 7 percent, hard surface burned 9 percent and organic soil burned 3 percent (Anderson 1982).

The Wilderness Area is managed under the provisions of the 1964 Wilderness Act as a unit of the National Wilderness Preservation System. That is, it is: "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" (The Wilderness Act, September 3, 1964; (16 U.S.C. 1121))

As part of the CCP process, we reviewed other lands within the legislative boundaries of Seney NWR for wilderness suitability. No additional lands were found suitable for designation as defined by the Wilderness Act of 1964. Many of the lands acquired for the Refuge have been substantially altered by humans, both before and after the Refuge's establishment, particularly from agriculture, roads, and flood control and hydrological infrastructure. Manmade facilities like dikes, ditches, water control structures, roads, and other facilities are spread throughout the Refuge, while artificial impoundments and manipulated wetlands are a large part of the landscape.