Draft
Post-Delisting Monitoring Plan
for the
West Virginia Northern Flying Squirrel
(Glaucomys sabrinus fuscus)

West Virginia Northern Flying Squirrel at a nestbox.
Photo courtesy of Craig Stihler, West Virginia Division of Natural Resources.

Prepared by
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This post-delisting monitoring plan for the West Virginia northern flying squirrel was prepared by the U.S. Fish and Wildlife Service (Service) West Virginia Field Office (WV Field Office), in cooperation with the Service's Virginia Field Office and Canaan Valley National Wildlife Refuge (NWR); U.S. Forest Service Northern Research Station, Monongahela National Forest (Monongahela NF), and George Washington National Forest (George Washington NF); West Virginia Division of Natural Resources (WV Division of Natural Resources); and Virginia Department of Game and Inland Fisheries (VA Division of Game and Inland Fisheries). Effective implementation of this monitoring plan will be achieved only through the cooperation of these same partners. Laura Hill of the WV Field Office was the primary author of this plan. She sought technical assistance and review during the development of this plan from: Craig Stihler (WV Division of Natural Resources), Mark Ford (Northern Research Station), Shane Jones (Monongahela NF), Dan Arling (Monongahela NF), Cathy Johnson (Monongahela NF), David Ede (Monongahela NF), Carol Hardy-Croy (George Washington NF), Rick Reynolds (VA Division of Game and Inland Fisheries) Ken Sturm (Canaan Valley NWR), Leah Ceperly (Canaan Valley NWR), Anne Hecht (Service, Northeast Regional Office), Diane Lynch (Service Northeast Regional Office), and Glenn Smith (Service, Northeast Regional Office). All of their contributions at various stages of plan development are greatly appreciated.

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SUMMARY

This draft Post-delisting Monitoring (PDM) Plan lays out a 10-year framework to monitor the status of the Virginia northern flying squirrel (*Glaucomys sabrinus fuscus*), more commonly known as the West Virginia northern flying squirrel (WVNFS). The Plan focuses primarily on monitoring of (1) habitat status and trends and (2) implementation of habitat management plans and agreements. Habitat changes will be tracked rangewide by interpretation of remote-sensed imagery obtained at or near the time of delisting (baseline), compared to the end of the PDM period. These data will be verified by a subsample of stand data and on-the ground field checks. In addition, land managers will self-report annually accomplishment of key components of land management plans or agreements for WVNFS, including the acres of habitat modified (positively and negatively), as well as land management problems and solutions.

The Plan also includes actions for monitoring of WVNFS distribution and persistence. The nest box and live trapping survey component will be largely a continuation of ongoing annual presence/absence surveys by the West Virginia Division of Natural Resources, Monongahela National Forest, and other participants, but with an increased emphasis on covering as much of the extant distribution within core habitat areas as possible. This will help determine if WVNFS continue to be present in these areas over multiple generations.

The Plan identifies measurable management thresholds and responses for detecting and reacting to significant changes in WVNFS habitat, distribution, and persistence. If declines are detected equaling or exceeding these thresholds, the U.S. Fish and Wildlife Service (Service), in combination with participants, will investigate causes of these declines, including consideration of habitat changes, low natality, deaths or emigration, weather, trap shyness, competition for nest sites, or any other significant evidence. The result of the investigation will be to determine if the WVNFS warrants expanded monitoring, additional research, additional habitat protection, and/or resumption of Federal protection under the Endangered Species Act. At the end of the 10-year monitoring program, the Service will conduct a final review. It is the intent of the Service to work with all of our partners toward maintaining continued species recovery.

INTRODUCTION

On December 19, 2006, the Service published a proposed rule to remove the WVNFS, from the List of Threatened and Endangered Wildlife and Plants (50 CFR 17.11 and 17.12) due to recovery (71 Federal Register 75924). The proposed rule included a brief description of species monitoring that would occur if the species is delisted. This draft PDM Plan provides additional detail to guide the collection and evaluation of pertinent information during the post-delisting monitoring period, and identifies funding needs for PDM.

Justification and Purpose

The purpose of this PDM plan is to verify that the WVNFS remains secure from risk of extinction after it has been removed from the protections of the Endangered Species Act. Implementation of post-delisting monitoring fulfills the final post-recovery requirement of the Act.

Section 4(g)(1) of the Endangered Species Act requires the Service to implement a system, in cooperation with the States, to monitor effectively for no fewer than 5 years the status of all species that have recovered and been removed from the List of Threatened and Endangered Wildlife and Plants. To fulfill this requirement, development of this PDM Plan has been facilitated by the monitoring specified in the West Virginia Conservation Action Plan (WV Division of Natural Resources 2006a, pp. 861-867, 959-969, and 1046-1049) and in the Monongahela National Forest Land and Resource Management Plan (USDA 2006a). Both of these management plans include monitoring of the WVNFS and its habitat.

The Service and its partners intend to monitor the status of the WVNFS for 10 years after delisting. A longer duration than the 5-year minimum requirement is needed to document that the subspecies remains secure, given consideration of practicable monitoring methods and the needed to establish a trend in effective implementation of long-term management plans and agreements (see section on Plan Duration for more details).

This PDM Plan contains several components designed to detect changes in the status of the WVNFS. The primary focus is on WVNFS habitat and implementation of management plans. Distribution and persistence of the subspecies throughout its range will also be monitored. The Service will initiate procedures to re-list the WVNFS, including, if appropriate, emergency listing, if data from this monitoring effort or from some other source indicate that the WVNFS or its habitat is experiencing a significant decline and that a proposal to relist the subspecies as threatened or endangered is warranted.

Roles and Responsibilities

Section 4(g) of the Endangered Species Act explicitly requires cooperation with the States in development and implementation of PDM programs, but the Service remains responsible for compliance with section 4(g) and therefore must remain actively engaged in all phases of PDM. The Service also seeks active participation of other entities that are expected to assume responsibilities for the conservation of WVNFS after delisting or that have natural resources management mandates.

In keeping with that requirement, the Service's West Virginia Field Office (WV Field Office) developed this PDM Plan with input from governmental agencies that would help to implement the plan: the West Virginia Division of Natural Resources; the U.S. Forest Service's Monongahela National Forest, George Washington National Forest, and Northern Research Station; the Service's Canaan National Wildlife Refuge and Virginia Field Office; and the Virginia Department of Game and Inland Fisheries.

The WV Field Office is the lead agency responsible for this monitoring effort and will coordinate all phases of implementation of the plan. Roles and responsibilities of all participants are outlined in Appendix 1.

The Service sought expert review of this plan by State and Federal biologists and resource specialists familiar with the ecology of the WVNFS and the red spruce (*Picea rubens*)-northern hardwood ecosystem it depends upon. Their comments were incorporated into the draft PDM Plan made available for public comment.

The Service also will open a 30-day public comment period by publishing a Notice of Availability of this draft PDM Plan in the Federal Register. Public comments will be addressed in the final PDM Plan. The draft and final plans will be posted to our northeast region Endangered Species Program's web page at http://www.fws.gov/northeast/endangered.

STATUS OF WEST VIRGINIA NORTHERN FLYING SQUIRREL

Habitat

Amelioration of threats to habitat is the primary factor supporting the proposal to delist the WVNFS. The WVNFS is associated with high-elevation forest types, particularly those dominated by red spruce, in the Allegheny Mountains. The WVNFS also has been captured in stands dominated by overstory northern hardwoods, though generally with a conifer understory and/or some overstory red spruce or eastern hemlock (*Tsuga canadensis*) (Stihler et al, 1995). Though tolerant of a variety of stand conditions, optimal habitat for the WVNFS is believed to be comprised of mesic, mature forest conditions in the red spruce or in the red spruce-northern hardwood ecotone, on north-facing slopes, with widely–spaced, mature trees, abundant snags and downed woody debris, and abundant lichens and hypogeal fungi (Ford et al. 2004). Radio-telemetry research indicates that the WVNFS preferentially selects stands with a spruce component over northern hardwood or mixed mesophytic stands (Menzel et al. 2006a).

Exploitive harvest was the main reason for decline in WVNFS habitat quality and quantity. Prior to European settlement, there were in excess of 500,000 acres of old-growth red spruce or mixed red spruce-northern hardwood forests in the Allegheny Mountains (Hopkins 1899). Red spruce was most common above 3,000 feet and was seldom found below 2,400 feet (Pielke 1981). Wholesale removal of red spruce forests occurred during the railroad logging era of 1880 to 1930. Intense fires from burning slash, often associated with train sparks, consumed the soil humus layer and greatly reduced the remaining red spruce seed source (Clarkson 1993). These former red spruce stands often then regenerated to northern hardwood forests or in some instances to shrub, forb, or grass-dominated barrens and balds (Rentch and Fortney 1997).

Subsequently, limited timber harvest, due mostly to market conditions (Steer 1948) but now controlled by past and current Monongahela National Forest Land and Resource Management Plans, has been a primary driver behind regeneration of red spruce forests in the last 70 to 80 years in the central Appalachians. Secondarily, fire suppression during this time also has allowed regenerated red spruce forests to slowly mature or begin regeneration in the understory of northern hardwood forests that were formerly red spruce. Combined, these factors have led to an increase in the extent and quality of habitat for WVNFS. Red spruce is shade tolerant, often living longer than 300 years, can persist in the understory for long periods, and can respond to release after as much as 100 years of suppression (Blum 1990, Seymour 1995, Rentch et al. 2007). Continuous hardwood canopy cover probably has improved soil nutrient status and microhabitat suitable for germination and survival of red spruce seedlings (Pielke 1981). Accordingly, red spruce is now recolonizing areas of hardwood forest near existing red spruce stands, areas that historically were red spruce until the logging and fires at the turn of the 20th century (Adams et al. 1995, Mayfield 1997). There also is evidence that the red spruce-northern hardwood ecotone is either stabilizing or decreasing in elevation to more approximate its former extent (Adams et al. 1999, Schuler et al. 2002). Rollins (2005) found that the amount and quality of red spruce at study sites in the central Appalachians appeared to be gradually improving through natural regeneration. In addition, the planting of red spruce seedlings or release of suppressed red spruce through hardwood control on federal, state, and private lands is accelerating the restoration of the red spruce ecosystem. With the exception of localized habitat impacts, forest succession has resulted in older forest stands with improved forest structure, reflecting a continuing positive rangewide trend.

Several methods for estimating WVNFS habitat have been developed over the years. Odem et al. (2001) derived a model for a restricted portion of the WVNFS distribution in West Virginia. This model was a good first step but was inconclusive in its ability to accurately predict WVNFS presence in habitats not surveyed directly by nest boxes or trapping. Subsequent methods developed by Menzel et al. (2006b) and by the Monongahela National Forest (unpubl. data) complement each other and are reasonable predictors of WVNFS habitat. The Menzel et al. (2006b) model covers public and private land within the range of the WVNFS and is a good coarse filter tool to assess suitable habitat rangewide. It is based on micro and macro-habitat relationship data aggregated at the stand-level, predicts the probability of WVNFS occurrence across the landscape, and can be used to broadly predict habitat quality. The Monongahela National Forest (unpubl. data) also developed a model of suitable WVNFS habitat using micro and macro-habitat relationships, but aggregated data at the plot level. The Forest is using aerial photo interpretation, stand data, and field verification to classify vegetation and to map suitable WVNFS habitat on the Forest. This method is used to classify habitat as suitable or not, but does not identify habitat quality. Mapping has been completed for roughly two-thirds of the forest. This technique currently is being updated to reflect more accurate stand boundaries using aerial photo interpretation. Because of its finer scale of resolution, this ongoing effort will be completed and expanded during the PDM Plan to track changes in WVNFS habitat rangewide over time. Baseline habitat acreages will be established at or near the time of delisting, and re-evaluated at the conclusion of the PDM period.

Although not being used to establish baseline conditions for PDM monitoring, results from the Menzel et al. (2006b) model and the Monongahela NF suitable habitat model (unpubl. data) provide a coarse estimate of the current extent and quality of WVNFS habitat (Figure 1). Combining data layers from these two modeling efforts shows a high degree of congruency. The red shading in Figure 1 shows highly probable WVNFS habitat (as determined by combining overlays of the Monongahela NF suitable habitat layer, and the Menzel et al. (2006b) habitat layer for >75 percent predicted WVNFS occupancy). Other probable habitat is shown in blue(as determined by the Menzel et al. 2006b layer for 50 to 75 percent predicted WVNFS occupancy).

The Menzel et al. (2006b) model identified roughly 47,000 acres of area with greater than 75 percent predicted probability of occurrence and 554,000 acres with 50-75 percent predicted probability of occurrence of WVNFS in West Virginia. This model tends to underestimate higher quality habitat and to overestimate lesser quality habitat, especially near the 50 percent predicted probability of occurrence threshold (M. Ford, Northern Research Station, pers. comm.). Therefore, the Service and U.S. Forest Service's Northern Research Station used these data to derive more conservative metrics, as did the Monongahela NF, which derived a separate model of WVNFS suitable habitat.

Based upon the results of these additional analyses, the Service conservatively estimates that there are roughly 242,000 acres of WVNFS habitat rangewide in the central Appalachians (USDA 2006b unpublished data). This estimate includes highly probable habitat of optimal quality (having greater than a 75 percent chance of occupancy by WVNFS), as well as other likely habitat of lesser quality located within close proximity (500 feet) of red spruce-northern hardwood forests (having a 50 to 75 percent chance of occupancy). Of the 242,000 acres of modeled habitat, roughly 20% (47,350 acres) is optimal habitat and roughly 80 percent (194,650 acres) is likely habitat.

Of the estimated 242,000 acres of WVNFS habitat, approximately 164,560 acres (68 percent) occurs on the Monongahela NF. This acreage figure (164,560 acres) is within 6 percent of the amount of suitable WVNFS habitat (154,375 acres) on the Forest predicted by the modeling efforts of the Monongahela NF staff (unpubl. data).

A substantial portion of WVNFS habitat is protected for the long term. Of the 242,000 acres of modeled habitat (USDA 2006b), most is publicly owned and managed (68 percent on the Monongahela NF and 10 percent on other public lands), or privately owned but protected by legal instruments such as conservation easements (2-3 percent). Legal commitments and long-term management plans make the threat of exploitive logging or habitat conversion on these protected lands unlikely in the foreseeable future. The Monongahela National Forest contains the greatest amount of modeled WVNFS habitat and therefore bears primary responsibility for the protection, restoration, and management of the red spruce and red spruce-northern hardwood ecosystem in the central Appalachians. The Forest's 2006 Land and Resource Management Plan provides substantial long-term direction and guidance toward implementing this responsibility (USDA 2006a).

Within the range of the WVNFS in the central Appalachians, there are numerous patches of high-quality second-growth red spruce with legacy residual trees[1] within an almost continuous matrix of more highly variable second-growth red spruce and northern hardwood forest conditions. Figure 1 shows the current degree of physical habitat connectivity. The habitat is

[1] Legacy residual trees are significantly larger and older than other trees in the landscape. These individual trees were spared during harvest or survived stand-replacing disturbances in the past, and now are near maximum size and age.

still relatively well connected from the standpoint of WVNFS movement. At a coarse scale, approximately 84 percent of the land area currently is forested in the seven counties in West Virginia where the WVNFS occurs (Table 2). At a finer scale, within the range of the WVNFS above 3,200 feet (655,558 acres), approximately 96 percent (627,237 acres) of the land is forested (USDA 2007, unpubl. data). Patch sizes on the Forest also are fairly large and contiguous. Based upon the Monongahela NF suitable habitat model, roughly 88 percent of WVNFS suitable habitat on the Forest occurs in individual patches of suitable habitat > 247 acres (100 hectares) in size (Figure 2). Over half of the suitable habitat, > 86,450 acres (35,000 hectares) occurs within six large habitat patches; four of those, broken only by the Shaver's Fork River and U.S. Highway 250, constitute an expansive 50,635 acres (20,500 hectares) of WVNFS habitat associated with Cheat Mountain in the central portion of the Forest. Three more large patches, totaling > 41,950 acres (17,000 hectares) occur at the southern end of the Forest.

Although habitat connectivity can be improved, this habitat matrix appears to provide a high degree of functional connectivity for WVNFS as evidenced by persistence at monitoring sites across a range of forest conditions. On the Monongahela NF in particular, current conditions do not overly limit WVNFS dispersal and movements. Most red spruce and red spruce-northern hardwood stands are currently in mid-late successional stages on the Forest. The continuing maturation of this habitat into multiaged, complex stands will improve conditions further. These stands are beginning to develop, and through natural processes will continue to develop, multiple size and age class cohorts of trees with abundant snags and coarse woody debris loadings. Adjacent, lower quality hardwood stands also are likely to exhibit these structural characteristics due to natural processes. Most importantly, these hardwood stands are likely to undergo compositional changes that will favor WVNFS, thus contributing to habitat connectivity (D. Arling, Monongahela NF, pers. comm.). Captures of males in marginal habitats also suggest that WVNFS will easily cross areas of relatively poor habitat to find mates (C. Stihler, WV Division of Natural Resources, pers. comm.).

The WVNFS has proven to be a resilient species largely due to its vagile nature and plasticity in nest tree selection. Studies have confirmed the ability of WVNFS to recolonize new habitat areas over time by adjusting its activity patterns to meet ecological requirements in and around spruce and mixed spruce-northern hardwood patches of forest (Menzel et al. 2004, 2006a).

The historic record indicates that the health of red spruce forest stands in the Appalachians has included cycles of periodic decline and recovery (Hopkins 1899). During the 1980s and 1990s, reductions in health and vigor of high elevation red spruce were reported in the central (Adams et al. 1985, Eager and Adams 1992) and southern Appalachians (Cook 1988, Bruck et al. 1989). However, Leblanc et al. (1992) and Reams et al. (1993) concluded that the extent of decline in the southern Appalachians was within the historical range of natural variability for southern red spruce populations. Recent evidence suggests improving trends in health of spruce forests within the range of the WVNFS in the central Appalachians. Audley et al. (1998) evaluated crown condition and nutrient status of red spruce in West Virginia, and found that the majority of trees sampled were healthy. Several studies have shown that growth rates of red spruce in West Virginia have leveled off or slightly increased since the 1960s (Hornbeck and Kochenderfer

1998, Schuler et al. 2002, Monongahela NF unpubl. data). Stable growth rates have been attributed to high stocking volume and a full growing space.

In the WVNFS 5-year status review and proposed delisting rule, the Service analyzed several potential threats to the red spruce-northern hardwood ecosystem (development on private lands, insect pests, climate change, and atmospheric acid deposition). Although these concerns are not significant enough to merit direct monitoring during the PDM period, they will be monitored indirectly by tracking habitat trends at a landscape level.

On private land, forest management, mining, highway construction and second-home development is occurring primarily on the edge of the WVNFS' local range, with the greatest losses expected from anticipated expansion of Corridor H, and housing development at the Snowshoe Mountain and Canaan Valley areas. Predictions of housing density increases on private lands bordering the Monongahela NF indicate the potential for low to moderate losses of forest cover (0 to 5 percent within the core of the WVNFS range and 5 to 20 percent on the edges of the range) (Stein 2005). Prospecting for wind farm development on public and private land within the range of WVNFS has also begun, although roughly 75 percent of projects in West Virginia are in the early feasibility stages and few to date have been constructed or have even advanced to the siting certificate approval stage by the West Virginia Public Service Commission (Boone 2006).

The proposed rule noted that infestations of forest insects and disease (such as balsam and hemlock wooly adelgids and beech bark disease), could affect the structure, extent, and integrity of WVNFS habitat patches on both public and private lands within the range of the subspecies. Although American beech (*Fagus grandifolia*) mortality can reduce large overstory boles, this mortality can add to the potential pool of snags suitable for cavity denning in the upcoming years and reduce hard mast crops important to the southern flying squirrel (*Glaucomys volans*), a deleterious competitor of WVNFS. The Balsam wooly adelgid (*Adelges piceae*) is believed to pose a minor or discountable threat because balsam fir (*Abies balsamea*) is a minor component of WVNFS habitat (Service 2006a). Hemlock wooly adelgids (*A. tsugae*), though, may comprise a greater threat as eastern hemlock is a more dominant component of the overstory than balsam fir throughout the WVNFS range; i.e. eastern hemlock comprises 1-9 percent of forested land in counties within the range of WVNFS in West Virginia (Kish 2007). A predominantly eastern hemlock overstory also is known to occur at some WVNFS nest site locations (such as Blackwater Falls Sate Park) (WV Division of Natural Resources 2006b), and its loss potentially could affect future regeneration of eastern hemlock (Kish 2007), particularly where white-tail deer (*Odocoileus virginianus*) herbivory is a problem (M. Ford, Northern Research Station, pers. comm.). Whether or not eastern hemlock is replaced by red spruce, thereby ameliorating losses, also is unknown (T.Schuler, Northern Research Station, pers. comm.).

While there is almost unanimous consent that global scale increases in temperature have occurred, the regional models and predictions are more equivocal (Inkley et al. 2004, Prasad et al. 2007. For the mid-Atlantic highland region and the higher elevations within the central Appalachians, predictions range from significant increases in temperature and precipitation, to significant decreases in precipitation and changes in extremes (more droughts and more hurricane/wind-related events). There is little consensus as to specific effects on WVNFS or its habitat. For example, hotter, drier summers but wetter, snowier winters might have minimal or positive impact on WVNFS if vegetation conditions are unchanged but winter climate is less favorable to the competing southern flying squirrel. Conversely, wholly warmer and drier conditions year-round over several decades could reduce the extent of red spruce-northern hardwood forests at their lowest and mid-elevational ranges, particularly on marginal habitat and at the northern and southern limits of its range (as predicted by regional models for the northeastern and southeastern United States (Delcourt and Delcourt 1998, Hansen et al. 2001, Iverson et al. 2005); however, much of this is based on uncertain models, and estimates about extent and rate of red spruce geographic range displacement and migration during climate shifts, thus making the results unpredictable. Results become even more unpredictable when scaled down to a local level. For example, applications of eight climate change models to red spruce forest in West Virginia (Prasad et al. 2007), ranging from the mildest to harshest scenarios, show potential decreases in importance values of red spruce within the state (roughly a measure of potential habitat); however, these models do not predict red spruce range displacement or migration rates, and due to small sample sizes for red spruce in West Virginia, the authors caution that the accuracy of these predictions in the state is questionable (L. Iverson, Northern Research Station, pers. comm.). (See http://www.nrs.fs.fed.us/atlas/tree/summ6pp_97.html and http://www.nrs.fs.fed.us/atlas/tree/wv_mod_change.html.) Thus it is not possible to predict any measurable impacts of climate change on WVNFS through the foreseeable future. The currently identifiable natural habitat conditions and trends, however, are generally positive and improving even without active management.

Though largely speculative, there is the long-term potential for acid deposition to diminish the extent and quality of WVNFS habitat. While such future effects are necessarily subject to some uncertainty, to date there have been no documented declines in red spruce forests as a result of atmospheric acid deposition in the central Appalachians where the WVNFS occurs despite being in a zone of high atmospheric deposition (Adams 1999). These forests do not reach the very low winter temperatures observed farther north and have not exhibited the winter kill due to decreased cold tolerance that has been observed in the northern Appalachians and Adirondacks (NAPAP 2005). Sulfate deposition in the central Appalachians has dropped by at least 25 percent in the last 10 years and pH of deposition has increased (Adams 1999, Adams et al. 2006). Deposition of nitrogen has either leveled off or may be slightly increasing, but the overall acid load is decreasing in high elevation spruce forests of the central Appalachians (Adams et al. 2006). Red spruce also is more resistant to ozone than many deciduous trees, often found in combination with high levels of acid deposition (Adams et al. 2006).

Despite speculation about residual and future threats, the red-spruce northern hardwood forest in the central Appalachians appears to be expanding at present. Considering these recent trends, the extent and quality of this habitat for WVNFS is likely to continue to increase in the foreseeable future.

Distribution
With exception of the extreme northern portions of Grant County (roughly 5 percent of the historic range), and the area from Briery Knob south to Cold Knob in Greenbrier County (collectively less than 10 percent of the historic range), the current distribution of the WVNFS closely matches its historic range (Menzel et al. 2006b). At present, the WVNFS occurs along the spine of the high Allegheny Plateau in a northeast to southwest alignment. Helmick Run (Grant County, West Virginia) marks the northeast periphery and Briery Knob (Greenbrier County, West Virginia) the southwest periphery, covering seven counties in West Virginia and a small portion of Highland County, Virginia (Service 2006a) (Figure 1). At the end of the 2006 monitoring season, there had been 1,198 captures (including 85 recaptures) of WVNFS at 107 sites dispersed across 7 core areas of red spruce, red-spruce northern hardwood, or northern hardwood forest habitat in the Allegheny Highlands region. Approximately half of these captures were detected prior to 1997 and half were detected between 1997 and 2006.

The subspecies is still restricted to seven forested counties, a geographical area defined largely by the current or former distribution of the red spruce forest type, but at present the WVNFS is distributed across a much larger and well connected area than was suspected at the time of listing, and new population centers have been discovered in the interim years, such as the Kumbrabow State Forest/Mead Westvaco Ecosystem Research Forest, and those in or north of the Canaan Valley area.

Detectability
This subspecies of northern flying squirrel has proven to be very difficult to detect even when present. Based on original methodologies used, only 1.5 to 2 percent of nest box checks result in WVNFS capture, whereas the success of live traps is slightly better (Terry 2004, Service 2006b). These data confirm the difficulty of capturing squirrels via nest boxes as well as live traps. Furthermore, caution should be used when relying on these survey results to determine occupied habitat. Although a captured individual affirms presence, an empty nest box does not necessarily signify absence. In addition, the presence of natural cavities in forest stands with nest box or trap lines could influence WVNFS detectability, as stands with high cavity abundance might have a lower rate of nest box or trap use, whereas the opposite might be true in stands with low cavity availability (Menzel et al. 2006b). For sites where there have been multiple captures, the average interval between detections is 2.5 years (SD = 2.1, n = 245), but has ranged from 1 to 16 years.

Persistence
Given the low detectability of WVNFS, the Service considers persistence over time to be the best indicator of successfully reproducing populations. For this PDM Plan, persistence is defined as continuing captures of WVNFS over multiple generations at previously documented sites throughout the historic range. Data from 21 years of nest box monitoring and live-trapping (WV Division of Natural Resources 2006b) provide strong evidence of WVNFS continued presence throughout the WVNFS range over multiple generations. Thirty-eight sites have been monitored over a period spanning 10 or more years. Of these 38 sites, 33 sites (87 percent) have had WVNFS detections within the last 10 years, and 29 sites (76 percent) have demonstrated evidence of reproduction (nestlings or juveniles) during this monitoring period. In addition,

surveys within the last 10 years show that WVNFS still persist in or near all of the historic areas where it was originally known at the time of listing—in West Virginia, in the Cheat Bridge area and along the North Fork of the Cranberry River; and in several locations in Highland County, Virginia.

When considering persistence, it is important to consider the life history of the subspecies. The WVNFS is relatively short-lived, produces single litters of 3-4 young/year, and demonstrates variable inter-annual detectability (Stihler et al. 1995). Wels-Gosling and Heaney (1984) noted that average longevity of *Glaucomys sabrinus* was less than 4 years. During a 13-year study of *Glaucomys sabrinus* in the Pacific northwest, Villa et al. (1999) recorded 3 squirrels, initially captured as adults, which were known to be at least 7 years old at recapture; however, the majority of squirrels captured were not known to survive beyond 2-3 years. Villa et al. (1999) noted that a summer study of northern flying squirrels in Sakatchewan in 1963 revealed a high annual mortality rate and almost complete population turnover within a 3-year span. Recapture data of WVNFS in the central Appalachians also suggest high annual population turnover. Out of 85 recaptures of WVNFS in West Virginia, the majority have been one-time recaptures of adults during the same year they were marked (WV Division of Natural Resources, unpubl. data). Three individuals, initially captured as adults in the spring (assumed to be at least 1 year old), were recaptured 1.8 to 2.4 years later (making them at least 2.8 to 3.4 years old). The oldest WVNFS, initially captured as an adult, was known to be at least 4.5 years old at last recapture (compared to 7 years for *G. sabrinus* in the Pacific Northwest). Thus based upon a review of the literature and regional data, and assuming that high annual mortality is typical for *Glaucomys sabrinus*, the average lifespan span for WVNFS probably is about 2 to 3 years.

The generation span (or average age of first reproduction) of WVNFS is not precisely known but can be inferred from other northern flying squirrel subspecies. Villa et al. (1999) determined that northern flying squirrels in the Pacific Northwest attained adult size and weight and showed signs of past or current reproduction between 12 and 22 months of age; although some subadults exhibited external signs of sexual development they did not reproduce the first year. Likewise, Weigl (2007) and Weigl et al. (1999) noted that although *G.s. coloratus* in the southern Applachians may initially reproduce at one year of age, some do not and he speculated that adverse environmental conditions may inhibit reproduction in certain years. The Service therefore concludes that the generation span for WVNFS is likely between 1 and 2 years; and for purposes of this PDM Plan we define the average generation span for WVNFS as roughly 1.5 years.

Figure 3 shows the known detection span (defined as the interval between the first WVNFS observation and the last) of 54 sites that were monitored for WVNFS across at least a 5-year period after nest boxes or traps were installed. The WVNFS was observed at 45 of the sites (83 percent) across periods spanning ≥3 years (two or more generations), including one site where WVNFS were observed across a 53-year span (35 generations) and another across a 63-year span (42 generations). Of 6 sites (11 percent) where WVNFS were observed only 1 year, 3 sites were checked infrequently (across only a 5 year period), and 3 sites were considered habitat [based on Menzel et al. (2006b)[2]] where the predicted probability of occurrence is less than 50 percent.

Table 1 shows the persistence of WVNFS occupied sites by habitat quality and geographical area (for sites checked multiple times over at least 5 years). Habitat quality was classified using the Menzel et al. (2006b) habitat model categories and sites were ranked using criteria for persistence (Appendix 2). Eighty-three percent of sites surveyed ≥ 5 years (n = 60) show evidence of persistence. When habitat types are classified by quality, 85 percent of high quality sites, 86 percent of moderate quality sites, and 70 percent of low quality sites show persistence. Thus, even in lower quality habitats where the chance of encountering a WVNFS over the landscape would occur at a rate less than expected by simple chance, persistence is still fairly high when observed in that habitat condition. Persistence also is consistently high across three geographical zones, varying from 80 to 85 percent across the northern, central, and southern portions of the range of WVNFS. The distribution of persistent vs. non-persistent sites across the geographic zones (Fisher's Exact test, $P = 1.00$), as well as across habitat qualities ($P = 0.4762$) is equitably distributed and not significantly different from expected values.

Additionally, observed sex ratios of WVNFS from surveys are within the range needed for normal reproductive performance. Smith (2007) determined that reported sex ratios of *G. sabrinus* typically do not deviate from unity over the long term. Combining nest box and trapping data, WVNFS show roughly a 1:1 sex ratio (492 males, 539 females) during monitoring in West Virginia and Virginia from 1985 to 2006, with a slight bias toward capture of females.

Collectively, the ratio of persistent (83 percent) to non-persistent sites (17 percent) distributed among habitat quality types and within geographic zones, the routine documentation of nestlings or juveniles (76 percent of sites) indicating reproductive success, and balanced to slightly female-skewed sex ratios are not indicative of sink characteristics. Rather, this shows a high degree of population stability and constant habitat occupancy.

When considering that the monitoring program to date (designed to determine presence/absence) has had such a low success rate of WVNFS captures, these long-term monitoring data may underestimate the range of the population (Terry 2004). Locally reproducing populations are the most likely factors for continuing to find WVNFS in numerous locations within their historic range, given their low detectability, relatively short-life span and reproductive capacity, and naturally patchy nature of suitable forest habitat distribution.

MONITORING METHODS

Historic habitat loss, conversion, and degradation were the primary threats to WVNFS identified at the time of listing. Habitat protection and primarily passive management of the habitat has

[2] Monitoring sites were categorized by habitat classification by using the Menzel model (Menzel et al. 2006a) which predicts the probability of occurrence of WVNFS across the landscape. Each survey line (typically consisting of 15 or more boxes or traps) was categorized as high, medium, or low probability of WVNFS occurrence, based upon the habitat type classification for the majority of the boxes or traps within a line. High quality habitat has greater than a 75 chance of WVNFS occupancy; moderate quality habitat, a 50-75 percent chance of occupancy; and low quality habitat, less than a 50 percent chance of occupancy.

allowed WVNFS to recover. The primary focus of this PDM Plan therefore is on monitoring habitat protection and long-term management. Continuing to monitor the quality and quantity of habitat at both a landscape level, and at the stand or site level, will help determine whether or not the WVNFS will be threatened by habitat loss or degradation. Monitoring of habitat and management commitments will focus on public land where the majority of WVNFS habitat occurs.

This Plan also includes actions for monitoring of WVNFS distribution and persistence. The nest box and live trapping survey component will be largely a continuation of ongoing annual presence/absence surveys by the West Virginia Division of Natural Resources, Monongahela National Forest, and other participants, but with an increased emphasis on covering as much of the extant distribution within core habitat areas as possible. This will help determine if WVNFS continue to be present in these areas over multiple generations.

Although it is not practicable to detect precise population changes rangewide in response to habitat trends, coarse thresholds and other indicators provide sufficient information to fulfill PDM responsibilities. At a smaller scale, the Monongahela NF is developing a long-term monitoring plan that is intended to provide WVNFS population trend information for some areas on the Forest.[3] Population trend information of this nature is not essential to the effectiveness of this PDM Plan because the threats are well monitored; however, demographic or other information from this or other ancillary efforts will be accepted and synthesized in the final report.

Habitat Management Plans or Agreements

The WV Field Office will monitor implementation of key components of management plans or agreements covering roughly 80 percent of WVNFS habitat (Table 3). Federal, State, and private land managers will provide brief annual reports on progress toward achieving management objectives for WVNFS and its habitat, including acres of habitat affected (positively and negatively), any land management problems encountered, and solutions implemented or planned.

At years 5 and 10 of the PDM period, the Service will compile land manager reports and evaluate whether management objectives pertinent to WVNFS are being implemented as agreed. The Service will rely on self-reporting by land managers of specific accomplishments, subject to

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[3] Beginning in June 2005, the Monongahela NF initiated an ongoing pilot study to provide survey data which, in addition to providing demographic data for WVNFS in the specific study areas, will be used to refine the Monongahela NF's forest-wide, long-term WVNFS monitoring design and protocol. The ongoing pilot study is designed to look at the efficiency of different monitoring methods, including: the use of nest boxes vs. traps vs. both; the number of boxes or traps to be used; and the frequency of box and/or trap checking. Within each of 10 sampling blocks located across the Forest, 75 boxes have been placed and are being checked over specific temporal schedules (25 checked once in spring and fall, 25 checked daily for four sequential days in spring and fall, and 25 checked once monthly). In addition, in each sampling block, two trappings grids are being run for 4-day periods in spring and fall (checked daily to prevent mortality of trapped squirrels). Results from the pilot study will be used to develop a long-term WVNFS monitoring plan for the Monongahela NF that is expected to continue beyond the duration of this PDM plan. During 2008-2017, the Monongahela NF will contribute to this PDM plan by monitoring WVNFS in areas that are not adequately covered by other participants.

verification if any questions arise. The Service will evaluate implications of any substantial deviations for WVNFS.

Monongahela National Forest

U.S. Forest Service direction under the 2006 Monongahela NF Land and Resource Management Plan constitutes the core of this PDM Plan (USDA 2006a). Effective implementation of the objectives, goals, and standards under this plan is expected to result in protection, improvement, and monitoring of red spruce-northern hardwood forest composition, structure, and health on approximately 68 percent of WVNFS habitat. These activities directly respond to the primary threats to WVNFS habitat cited at the time of listing and to potential residual threats identified at the time of proposed delisting. The following two key components of the Land and Resource Management Plan will be monitored.

Forest Composition and Structure. Vegetative composition and structure (important components of WVNFS habitat quality) will be monitored, evaluated, and reported by the Monongahela NF at 5-year intervals to determine to what extent the Forest is meeting age-class desired conditions for management prescriptions (monitoring items 34 and 38 in the Land and Resource Management Plan). Habitat for WVNFS is managed primarily under Management Prescription 4.1 and benefits indirectly from passive management of designated wilderness, recommended wilderness, and backcountry recreation areas and special areas (portions of management prescriptions 5.0, 5.1, 6.2, and 8.0). Management Prescription 4.1 focuses on developing a late successional stage (>120 years) forest over time (50+ years) with the multi-age stand structure that likely existed prior to exploitive logging (USDA 2006a, pp. III-12). At the stand level, desired vegetation conditions include a mix of trees of different ages, complex vertical habitat structure, scattered small openings (<2 acres) dominated by shrubs and saplings, scattered over-mature trees, and an abundance of snags, den trees, and downed woody debris. While these conditions will take longer to develop than the duration of the PDM Plan, during the PDM monitoring period, progress will be measured qualitatively in terms of advancement toward long-term desired conditions, focusing on red spruce and red spruce-hardwood species composition in the overstory, and on establishing vertical habitat structure in early-mid (2-39 year), mid (40-79 year), and mid-late (80-120 year) successional stands.

Habitat Patch Size and Connectivity. The Land and Resource Management Plan sets an objective of engaging in restoration activities to improve red spruce composition or habitat condition on 1,000 to 5,000 acres in 10 years.[4] Treatment areas will be prioritized in an effort to

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[4] The Monongahela NF will use a variety of tools, including research or administrative studies (USDA 2006a, pp. III-9) to achieve this objective, and will involve a broad array of partners and expertise in this matter, including the Northern Research Station, academia, Service, WV Division of Natural Resources, other State agencies, private researchers, as well as in-house expertise.

For example, the Northern Research Station and West Virginia University will continue an ongoing study designed to test the effectiveness of silvicultural manipulation of hardwoods to encourage red spruce release and eventual overstory/stand dominance to expand or link occupied patches of WVNFS habitat. The study will examine the response of individual trees, rather than the stand-level response at 7 study sites: two in the Gauley Ranger District near Briery Knob; two at Kumbrabow State Forest; one at the Mead Westvaco Experimental Research Forest near the Kumbrabow State Forest line; and two on Canaan Valley National Wildlife Refuge. Effects will be monitored for 5-10 years following additional treatments at Kumbrabow State Forest, the Monongahela National Forest, and the Canaan Valley National Wildlife Refuge during summer 2007.

increase habitat patch size, and to improve habitat connectivity and travel corridors for WVNFS. The Monongahela NF will report acres of treatment annually during the PDM period.

Other Land Managers

In addition to monitoring land management activities on the Monongahela NF, this PDM Plan includes monitoring implementation of management plans and agreements for the WVNFS by the George Washington NF, Canaan Valley NWR, state forests and wildlife management areas, Snowshoe Mountain, Inc., and The Nature Conservancy (Appendix 3). These include a variety of activities to protect, maintain, restore, or enhance habitat for WVNFS.

Habitat Status, Trends, and Threats

Annual Habitat Status

The WV Field Office will annually track the status (acres) of protected lands[5] through self-reporting by land managers on implementation of management plans and agreements (as described above). The WV Field Office will also accept and evaluate reports of proposed or actual habitat loss submitted through receipt of National Environmental Policy Act documents for projects, or from other sources. The WV Field Office will keep a running total of habitat loss in order to evaluate whether the habitat loss trigger has been reached at any point during the PDM period (see Monitoring Thresholds and Responses section).

10-Year Habitat Trend

The WV Field Office, Monongahela NF, WV Division of Natural Resources, and others will collaborate on a 10-year WVNFS habitat trend analysis. Expanding upon an ongoing effort, baseline acreages of habitat will be determined at or near the time of delisting, as well as at or near the end of the PDM period. The agencies will pool resources to obtain remote sensed imagery, stand data, and other data that most accurately identifies red spruce and red spruce-northern hardwood habitat. Vegetation classification by remote-sensed imagery will be ground-truthed, as needed, at a subset of sites to confirm habitat suitability (e.g., using site-specific project information on the Monongahela NF). At the end of the PDM period, the WV Field Office will prepare a final report that includes an analysis of changes in habitat quantity since delisting, reporting habitat acreages on protected vs. unprotected lands separately. In addition, the WV Field office will include in the final report an analysis of the 10-year trend in habitat patch sizes and connectivity compared to baseline conditions near the time of delisting.

Residual and/or Emerging Habitat Threats

As noted earlier in the status section, residual or emerging habitat threats (such as housing development, highways, wind power projects, atmospheric acid deposition, climate change,

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[5] The following lands are considered protected by public ownership, conservation easements, and/or land management plans or agreements: WVNFS habitat on the Monongahela NF, primarily within Management Prescription 4.1; George Washington NF within the Laurel Fork Special Management Area; Kumbrabow State Forest; Handley Wildlife Management Area; Blackwater Falls State Park; Canaan Valley State Park; Canaan Valley NWR; The Nature Conservancy preserves (Upper Shaver's Fork, Bear Rocks); The Nature Conservancy conservation easement on Spruce Mountain; and the conservation easement area associated with two approved habitat conservation plans.

and/or forest insects and disease), will be monitored indirectly through monitoring and analyzing trends in habitat acreages, patch sizes, and connectivity. At the end of the PDM period, the WV Field Office will compile, accept, and review reports indicating any significant residual or new emerging threats to WVNFS and its habitat. Should WVNFS habitat quantity or quality decline over broad geographic areas, possible causes will be investigated and appropriate actions will be taken.

Distribution and Persistence

To determine if WVNFS continue to persist throughout their extant distribution once the Endangered Species Act protections are removed, nest box monitoring and live-trapping will continue to be used to document WVNFS presence/absence. Participating monitors may choose nest boxes, or live traps, or some combination of both methods for capturing WVNFS. At the conclusion of years 5 and 10 of the monitoring period, the WV Division of Natural Resources will analyze distribution and persistence data collected during the period by all participants and will prepare an interim report (for the first PDM 5-year monitoring increment), and a final report (for the entire 10-year increment), comparing these data to pre-delisting baseline data (e.g. parameters such as WVNFS distribution, and percent of sites demonstrating persistence, as determined from persistence criteria in appendix 2).

Sampling and Analysis Considerations

A total of 105 independent[6] monitoring sites for WVNFS have been established in West Virginia and 2 in Virginia. During post-delisting monitoring, participants will monitor a subset of the sites previously known to be occupied to determine if WVNFS continue to occupy their historic range. Participants will meet annually to coordinate on site selections. Sites will be selected for monitoring to ensure that WVNFS surveys occur in or near all 7 general core areas[7] (Figure 4 and Table 4). For sites that have not been visited in awhile, access to the site and the ability to relocate it may eliminate some of these sites from consideration.

The WV Division of Natural Resources will monitor an extensive subset of previously known occupied sites, but with less frequent checks of sites than that of the Monongahela NF. During the first 5 years of PDM monitoring, the WV Division of Natural Resources will focus on visiting a random sample of sites (not monitored by the Monongahela NF) that have not had WVNFS observations since 1996. During the second 5 years of PDM monitoring, the WV Division of Natural Resources focus will shift to checking a random sample of sites (not monitored by the Monongahela NF) that had WVNFS observations between 1997 and 2007. The WV Division of Natural Resources will check a site annually until WVNFS occupancy is detected and the site meets persistence criteria (see Appendix 2 for more details), or 5 years elapses without an observation. For sites that were determined to be persistent during baseline,

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[6] The WV Division of Natural Resources defines a site as a capture location greater than 0.5 mile from another capture location. This distance equals or exceeds twice the radius of the average home range size of male WVNFS (134 acres, radius of 0.25 mile) or female WVNFS (38 acres, radius of 0.14 mile), based on the adaptive kernel method (Menzel et al. 2006a). In addition, marking of individual squirrels with ear tags and/or pit tags helps to ensure identification of independent sites.

[7] The boundaries of core areas have not been precisely defined but they include generalized centers of WVNFS extant distribution. The boundaries are intended to be somewhat vague to allow flexibility to include future WVNFS capture locations near the edges of these generalized areas.

a single capture of WVNFS at that site during the PDM period will be adequate to demonstrate continued persistence at that site. For known sites without previously documented persistence (i.e. sites where WVNFS were documented pre-delisting, but were not monitored across at least 5 years or there was insufficient evidence of persistence), a capture of one or more WVNFS will be required during PDM to confirm persistence. For any site, if there is no detection of WVNFS in 5 years, or persistence criteria have not been met in 5 years, then that site will be categorized

as not meeting persistence criteria, and another randomly selected site will be monitored. It is estimated that the WVDNR effort will monitor at least 50 sites cumulatively during the PDM period.

The Monongahela NF will focus on annual monitoring WVNFS on the Forest within or near the Cheat Mountain core area in the central portion of the Forest, but will sample these sites intensively in an ancillary effort (not essential to this PDM Plan) to determine population trend. The same persistence criteria for previously known occupied sites (appendix 2) will apply to the Forest's efforts, except the Forest will continue to visit a site after persistence has been confirmed.

Monitoring efforts by other parties at other sites will round out this effort as funding allows (e.g. at Canaan Valley NWR, George Washington National Forest, and various private lands). The same persistence criteria (appendix 2) will be applied to these previously known occupied sites, but participants may continue to monitor these sites after persistence criteria have been met.

Only previously known occupied sites that have been monitored across at least a 5-year period (including the time preceding delisting) will be used for calculating persistence rates. While sites monitored across shorter time spans do demonstrate short-term occupancy, they do not demonstrate persistence across multiple generations.

Although the focus of PDM monitoring will be directed at sites where WVNFS have been documented in the past, captures may be documented at some new trapping or nestbox sites. These new sites will not be included in calculations of persistence at previously documented known sites. However, should the persistence threshold be reached or exceeded, then new locations that meet the persistence criteria will be considered when evaluating the significance of the event and developing an appropriate response. For example, it would be important to consider whether the number and distribution of newly found persistent sites compensates for a reduction in persistence among previously known sites during the PDM period.

Protocol

Procedures for the use of nest boxes, trapping, and handling of captured WVNFS will follow the recommendations in the recovery plan (Appendix 3), unless new information demonstrates more effective protocol. Most nest boxes are configured in linear strings or "sets" of 15 boxes per site. At some sites, nest boxes and/or live traps have been placed in a grid or block design. The recovery plan specifies using a minimum of 15 nest boxes per 50 acres of habitat, plus 1 box for each additional 5 acres; or 20 to 40 traps at a minimum spacing of 50 meters in 1 or 2 transects through areas to be trapped. Boxes or traps are attached 6 to 15 feet above the ground on live trees.

Consistent with past effort, nest boxes checks and/or live-trapping will be conducted during two seasons corresponding to late spring/early summer (April-June) and during fall (October-November) to coincide with the reproductive season and probability of greatest use. Spring/summer box checks have higher WVNFS occupancy rates than fall checks (Terry 2004). The spring check coincides with the most likely time of year for detecting reproductive activity and the presence of immobile young. The fall check coincides with the greatest probability of detecting juveniles to subadults that have survived the nestling stage. Boxes and traps will be checked during daylight hours when den occupancy is expected (one hour before sunrise until two hours before sunset) as the subspecies is nocturnal in its foraging activity patterns. Box sets will be checked at least twice per year and traps will be checked daily at least 7 to 10 days per area trapped.

The presence of WVNFS and number captured will be recorded for each check of a nest box or live trap (see appendix 4 for WVNFS individual capture form). WVNFS will be individually marked with ear or pit tags or both in order to track recaptures. Although not essential for this PDM Plan, other information that has been collected historically will continue to be recorded: 1) WVNFS will be measured, weighed, and examined to determine sex, age class, reproductive condition, and overall health, then marked and released at the point of capture; 2) Qualitative measures of vegetative composition and structure also will be described.

MONITORING THRESHOLDS AND RESPONSES

The primary goal of this PDM Plan is to confirm that the subspecies does not require re-listing following removal from the Endangered Species Act's protection. This will be accomplished by several triggers that allow detection of a substantial decline in the quantity of WVNFS habitat; a substantial decline in WVNFS distribution and/or persistence; or substantial re-emergence of residual threats (or emergence of a new threat) affecting the likelihood of survival of the WVNFS. If any of the thresholds for WVNFS habitat, distribution, or persistence is equaled or exceeded, the Service, with assistance from the participants, will investigate causes of these declines and any confounding factors. The result of these investigations will determine an appropriate response which could include, but is not limited to, increasing the duration or intensity of monitoring, additional research, conserving or enhancing additional habitat, or resumption of Federal protection under the Endangered Species Act.

Habitat Trigger:

- A 10 percent or greater net reduction in WVNFS habitat acreage rangewide at any time during the PDM period (based on baseline acreages determined cooperatively by the WV Field Office, Monongahela NF, WV Division of Natural Resources and others, at or about the time of delisting, using remote-sensed imagery interpretation, and a subset of stand data and ground-truthing, as needed). Tracking of net habitat acreage will account for habitat expansion (e.g. due to tree planting or natural regeneration) minus any habitat reduction (e.g. due to land use changes).

If monitoring indicates at any point in the PDM period that this habitat trigger has been met or exceeded (compared to baseline), the Service, with assistance from participants, will look more closely to determine possible causes. Declines in habitat may be due to imprecision in vegetation classifications or actual declines in habitat quantity and/or quality. Given this imprecision in classification, a 10 percent trigger has been set as a conservative threshold. This trigger allows detection of a sudden substantive decline in habitat acreage, as well as more subtle declines (e.g. a 1 percent decline of habitat for 10 years that could indicate an unsustainable trend if continued long-term). Causes of habitat decline could include lack of progress on achieving management objectives, land conversion, or factors affecting forest health (e.g. atmospheric acid deposition, forest insects and disease, climate change). It will be important to discern where habitat declines are occurring on the landscape (e.g., within the core of the extant distribution, or in travel corridors, or in disjunct parcels at the edge of the distribution), and whether compensatory habitat mechanisms are occurring (for example, loss of low quality habitat being offset by gains in high quality habitat). Responses to this trigger may include extended monitoring, additional research (such as refining habitat models), additional habitat protection (through conservation easements, fee acquisition, or changes in land management), additional habitat restoration, or intensified efforts to reduce threats to forest health.

<u>Distribution Trigger:</u>

- A significant reduction in the distribution of WVNFS as indicated by lack of detection for 5 years in one or more of the general core areas monitored during that time period, evaluated at years 5 and 10 post-delisting.

Failure to continue to detect a local population could signal extirpation of WVNFS from a core area. Lack of detection in any of the core areas would be cause for serious consideration from the standpoint of metapopulation dynamics, but especially within any of the three geographic zones (northern, central, or southern as grouped in table 1, or within the Cheat Mountain core area, the center of WVNFS distribution. Responses to this trigger are similar to those for persistence and are discussed below.

<u>Persistence Trigger:</u>

- Thirty-five percent or more of the previously known occupied sites monitored during the PDM period demonstrate a lack of continued persistence (as determined using the criteria for persistence in appendix 2), evaluated at year 5 following delisting, and again cumulatively at year 10.

Based on baseline data collected prior to delisting, the Service expects that roughly 75 to 85 percent of previously known occupied sites would continue to demonstrate persistence after WVNFS delisting. A rate of 65 percent or less persistence would indicate a substantial downward trend requiring investigation.

Apparent declines in distribution and/or persistence could be confounded by density-dependent population fluctuations (Lehmkuhl et al 2006). Low capture rates could be due to absence of WVNFS (mortality or emigration), very low density, low natality, high juvenile mortality and low recruitment, or to other factors such as individual trap-shyness, weather, competition for nest sites with other species, food supply, or other habitat limitations. On the other hand, improving habitat conditions could also result in a decrease in capture rates by providing natural dens that may be preferred over artificial boxes or tarps. It would also be important to consider whether the number, distribution, and persistence of any newly discovered sites compensates for a reduction in persistence among previously known occupied sites (see appendix 2). Responses to these two triggers may include an extended or intensified monitoring effort, additional research (such as modeling metapopulation dynamics), enhancement of food supply (such as increasing the availability of snags and downed woody debris as substrates for growth of lichens and hypogeal fungi), enhancement of other microhabitat features, or an increased effort to improve patch sizes and habitat connectivity.

During any stage of the PDM period, the Service will initiate procedures to re-list the WVNFS if data from this monitoring effort or from some other source indicates that the WVNFS or its habitat is experiencing a significant decline and that a proposal to relist the subspecies as threatened or endangered is warranted. If the best available information indicates an emergency posing a significant risk to the well being of the WVNFS, then the Service will review, and if necessary, use Endangered Species Act § 4(b)(7) authority (emergency listing) to prevent any significant risk to the well being of the WVNFS. While it is not possible to predict all conditions that could result in emergency relisting, we can provide examples of outcomes that would cause us to seriously re-evaluate the status of the subspecies, such as, but not limited to: large declines in red spruce-northern hardwood forests across a significant portion of the WVNFS range; or lack of detection of WVNFS in the core of the range (Cheat Mountain area) and failure to detect WVNFS in this area when monitoring efforts are extended or intensified.

At the end of the 10-year monitoring period the Service will conduct a final review. Any relisting decision by the Service will be made by evaluating the status of the WVNFS relative to the Endangered Species Act's five listing factors (ESA § 4(a)(1)). It is the intention of the Service to work with all of our partners toward maintaining continued subspecies recovery.

PLAN DURATION

The duration of this PDM Plan is for 10 years after the WVNFS is delisted. While the Endangered Species Act requires a minimum of 5 years of monitoring after a species is delisted, practicable monitoring methods and management needs of the WVNFS support a longer monitoring period to demonstrate continued persistence of a subspecies with low and variable detectability. Given that the WVNFS inhabits later seral stages, little would be gleaned by monitoring changes in forest structure or composition over a 5-year time period, but 10 years should provide a solid indicator of post-delisting trends. In addition, long-term management, such as implementation of Land and Resource Management Plans, is key to the continued improvement in conservation status of the WVNFS. These forest plans typically are in place for

10 to 15 or more years before revision. A 5-year monitoring period would barely discern a trend in effective implementation of these complex plans, whereas a 10-year monitoring period is long enough to provide a good indication of progress toward achieving management objectives for WVNFS. For these reasons a 10-year PDM Plan is warranted.

REPORTING

Reports summarizing the activities, data collected, and results of each component of this PDM Plan will be submitted by participants to the WVDNR or the WV Field Office, as further described below. These reports will be prepared and reviewed in a timely manner to ensure that adequate data are being collected, to allow evaluation of the efficacy of the monitoring programs and their modification, if necessary, and to allow periodic assessment of the status of the WVNFS.

By December 31 of each year, participants will submit brief annual reports to the WV Field Office describing accomplishment of key habitat management components for WVNFS, as outlined in Table 3). Reports will discuss overall progress implementing management activities (Table 3) and will quantify acres of WVNFS habitat affected (positively and negatively) during the time period. Reports also will discuss any problems encountered in meeting management objectives and solutions implemented or proposed. The WV Field Office will compile habitat reports annually in order to evaluate whether the habitat loss trigger has been reached that year or cumulatively. The WV Field Office will also accept and consider reports of habitat loss submitted by other sources. The WV Field Office will prepare an interim habitat report at year 5 which evaluates whether the habitat trigger has been reached cumulatively for that time period. At year 10, the WV Field Office will prepare a final report that includes the results of the collaborative multi-agency assessment of habitat acreage trends rangewide (based on remote-sensed imagery interpretation, and a subset of stand data and field verification), as well as an assessment of trends in functional habitat connectivity.

By September 30 of each year, participants will submit to the WV Division of Natural Resources northern flying squirrel capture forms for entry into a data base. At year 5, the WVDNR will prepare an interim report, and at year 10 a final report on WVNFS distribution and persistence. These reports will evaluate whether distribution and persistence triggers have been reached for the monitoring period. The WV Field Office will incorporate the DNR's final distribution and persistence report into the final PDM report.

At the end of the PDM period, the WV Field Office will prepare a final report on all components of the PDM Plan for the entire monitoring period. In addition, this report will briefly address the threats to the WVNFS with respect to the five factors considered when a species is proposed for addition to the Federal List of Threatened and Endangered Wildlife and Plants [i.e., A) the present or threatened destruction, modification, or curtailment of habitat or range; B) overutilization for commercial, recreational, scientific or educational purposes; C) disease or predation; D) inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors affecting its continued existence.

Progress will be discussed at an annual meeting held pursuant to the Red Spruce and Northern Hardwood Ecosystem Memorandum of Understanding[8], and open to the public. The interim 5-year report and final 10-year report also will be posted to the Fish and Wildlife Service web-page for viewing by the public. The Service intends to publish a Notice of Availability of the final report in the Federal Register.

FUNDING

Funding of post-delisting monitoring is needed by partners committed to ensuring the continued viability of the WVNFS following removal of Endangered Species Act protections. This PDM Plan largely relies upon continuation of ongoing monitoring measures using existing staff and resources. We anticipate that the total cost of implementing required measures of the plan is roughly $645,000 for 10 years (Table 5), or on average $64,500 per year.

All participants in this PDM Plan have made similar or larger expenditures on WVNFS monitoring and management during the last few years. Staff from each of the governmental agencies listed in Appendix 1 have reviewed their roles and responsibilities in this PDM Plan, including key management components in Table 4, and have agreed that these activities are within their capabilities subject to continuing appropriation of funds. Federal and state agency participants intend to continue seeking adequate funding to accomplish these tasks through the appropriations processes.

Although the Endangered Species Act authorizes expenditure of both recovery funds and section 6 grants to the states to plan and implement PDM, Congress has not allocated nor earmarked any special funds for this purpose. Funding of PDM activities, therefore, represents trade-offs with other competing endangered species conservation needs. Decisions to request or allocate funding for this PDM effort will consider opportunities for cost-sharing and use of other federal funding sources, such as Federal Aid in Fish and Wildlife Restoration Act, State Wildlife Grants, or allocations for other Service management responsibilities. In particular, the WV Division of Natural Resources is eligible for federal funding from the State Wildlife Grants program to implement the West Virginia Conservation Action Plan, which includes a goal to monitor WVNFS distribution and habitat (WV Division of Natural Resources 2006a). Nothing in this PDM Plan should be construed, however, as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, U.S.C. 1341, or any other law or regulation.

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[8] In January 2007, multiple parties signed a Memorandum of Understanding for the long-term conservation and monitoring of the red spruce-northern hardwood ecosystem. Signatory parties include the WV Field Office, Canaan Valley National Wildlife Refuge, Monongahela National Forest, Northern Research Station, West Virginia Division of Natural Resources, West Virginia Division of Forestry, and The Nature Conservancy.

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