April 23, 2007

Assistant Chief
Division of Endangered and Threatened Species
U.S. Fish and Wildlife Service
Northeast Regional Office
300 Westgate Center Drive
Hadley, MA 01035

Re: Comments on the Proposed Rule to Remove the Virginia Northern Flying Squirrel (Glaucomys sabrinus fuscus) from the Federal List of Endangered and Threatened Wildlife

Dear Assistant Chief,

Thank you for the opportunity to comment on the Proposed Rule to Remove the Virginia Northern Flying Squirrel (Glaucomys sabrinus fuscus) from the Federal List of Endangered and Threatened Wildlife. The undersigned individuals and organizations are always interested in the listing and recovery of endangered and threatened species and in the (West) Virginia Northern Flying Squirrel (Glaucomys sabrinus fuscus, also referred to as the WVNFS) in particular. We submit these comments on behalf of the undersigned individuals and organizations found at the end of this letter.

We appreciate the effort the agency has engaged in to complete the five-year review process for the flying squirrel. However, we have a number of significant concerns with the analysis conducted to date. There are serious flaws in the analysis and conclusions reached that must be corrected. We believe the questions and concerns in this letter must be addressed before the decisionmaker has the information required to make an informed decision as to a change in federal status. At this point in time there is insufficient evidence for the proposed delisting of the flying squirrel. That lack of evidence coupled with the lack of analysis of significant threats to the flying squirrel lead us to conclude that a change in federal status is not warranted at this time.

Major Concerns

Overall, we have a number of concerns with the proposed delisting of the (West) Virginia Northern Flying Squirrel (Glaucomys sabrinus fuscus) from the Federal list of endangered and threatened species. Specific explanations for each item follow, but in broad terms we are most concerned with:

- The **process** the US Fish and Wildlife Service (FWS) is using to consider delisting the flying squirrel, including:
    - Violation of the Endangered Species Act by ignoring the WVNFS recovery plan
    - Failing to provide a post-delisting monitoring plan for public review and comment at this time
- The fact that there is no credible information on the flying squirrel **population**, which in turn does not allow assessment of population trends
- The lack of adequate information on flying squirrel **habitat**
- Flaws in the **modeling** for flying squirrel presence, population totals and habitat needs
- The lack of adequate analysis of **ongoing and cumulative impacts** on flying squirrels, including failure to examine the devastating effects of:
    - Global Warming
    - Energy Development
    - Private Land Development and Highway Construction
- A reliance on the good intentions and interest of others in FWS post-delisting **proposals to protect** the squirrel.

Process Concerns

Ignoring the Recovery Plan is Violation of the Endangered Species Act

The WVNFS delisting proposal is the clearest crystallization to date of a heretofore background effort by the Bush administration to dispense with recovery plans by arguing that objective, measurable, concrete delisting criteria should be overridden by the five non-criteria-based listing factors. We refer to this as the No Recovery Plan Theory (NRPT). In keeping with the White House approach to conservation, NRPT maximizes bureaucratic discretion and minimizes objective scientific standards. It also violates a well established legal canon that when Congress establishes two distinct legal provisions, the administration can not collapse one into the other. Federal courts and the Interior Solicitor have recently taken the administration to task for doing exactly this in collapsing the Endangered Species Act's "significant portion of range" provision into the "all of range" provision.

The WVNFS squirrel presents an excellent factual circumstance to challenge the No Recovery Plan Theory because 1) the recovery plan was amended as recently as 2001, 2) the Service has not and can not demonstrate that the recovery criteria are scientifically inadequate, 3) the recovery plan's requirement of population stability is bedrock of conservation biology and

can not credibly be replaced by an unscientific concept of "persistence," and 4) the recovery plan's requirement of perpetual habitat protection is a bedrock of conservation biology and can not be credibly replaced by an ill-defined approach which ignores the well-established threat of global warming and the demonstrated intent of private and government land owners to continue destroying WVNFS habitat. In short, the Service's intent to use the WVNFS to launch the NRPT is ill-conceived and will result in a legal challenge resulting not only in the squirrel's continued listing, but the dismantling of the theory.

We strongly recommend that the final delisting decision drop the NRPT and instead base the decision on whether the recovery plan criteria have been met. Additionally, it should convene the recovery team to review the current delisting criteria. If the team determines the criteria should be altered, the Service should revise the recovery plan. That is the proper and rational way to proceed.

The 5-year review and the delisting proposal differ in their justification for dispensing with the recovery plan. The former asserts ("argues" would be too strong a word) that the recovery plan is somehow inadequate and out-of-date. Perhaps because it realized that there is no basis for this assertion, the latter presents an alternative argument that the Service is free to delist based on a five factor listing analysis regardless of whether the recovery criteria have been determined to be invalid. This is the No Recovery Plan Theory. We show the inadequacy of both approaches below.

The WVNFS recovery plan was approved in 1990 and amended in 2001. It includes the following recovery criteria:

Downlisting:

1. populations are stable or expanding at greater than or equal to 80% of Geographic Recovery Areas (GRAs) for 10 years
2. Sufficient life history information is available to permit effective management
3. GRAs are managed for squirrels in perpetuity

Delisting:

4. the existence of the high elevation forests on which the squirrels depend is not threatened by disease, pollution, or other systematic threats such as global warming[1]

The WVNFS GRAs identified at the time the recovery plan was written were Stuart Knob area (Randolph County, WV), Cheat Bridge area (Pocahontas and Randolph Counties, WV), Cranberry area (Greenbrier, Pocahontas, Randolph, and Webster Counties, WV), Blackwater

[1] Global warming is not expressly mentioned in this recovery criteria, but elsewhere the plan states "Even without human intervention, small, relict populations might suffer disproportionately from…climatic and vegetational processes associated with post-Wisconsin changes in mountain environments. However, habitat destruction, fragmentation, or alteration associated with clearing of forests, introduced insect pests, mineral extraction, recreational other development, pollution (heavy metals, pesticides, acid rain), the potential for global warming outweigh any known natural threats to the species or its habitat." (p. 12)

Falls area (Tucker County, WV), and the Spruce Knob/Laurel Fork area (Pendleton and Randolph Counties, and Highland County, VA).[2]

The 5-year review states that the recovery plan is out of date because 1) it was developed over 15 years ago, 2) the criteria are not based on the threats to the species, 3) the criteria are directed largely toward maintaining populations and protecting habitat within designated GRAs, 4) "new light" has been shed on the "appropriateness of the GRA nomenclature" for the WVNFS, and 5) New information has also become available with reference to the plan's threat-based recovery criteria. (5-year review at 4-5).

Point #1—that the plan is old—is irrelevant and contradicted by other Service documents. The age of a plan does not in itself determine its quality. The Service must explain what the problem is in biological terms, not presume it from age. Also note that the plan was updated in 2001 and that both the 1990 plan and the 2001 update were previously "deemed objective, measurable, and adequate" by the Service (5-year review at 4). The Service can not simply change is mind in order to ignore the delisting criteria which have not been met. It must provide a legally and scientifically adequate rationale.

Point #2—that the recovery criteria are not threat based—is both irrelevant and incorrect. The Endangered Species Act does not require that recovery criteria be threat based, it says simply that recovery plans must include "(i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; (ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal." (4(f)(1(B)). It is patently illegal for the Service to establish new standards for recovery plans which contradict the Endangered Species Act.

Furthermore, the recovery plan identifies and seeks to control every threat mentioned by the delisting proposal, except global warming which it mentions only in passing. But since the listing proposal expressly rejects global warming as a threat to the WVNFS, it is hard to see how that distinguishes its approach from the recovery plan. The patent falsity of the 5-year review's critique is manifest by its own admission that:

- "habitat-related threats are addressed in the delisting criterion and threats abatement can be inferred to some extent from meeting the population- and habitat-based downlisting criteria" (5-year review at 5)
- "(t)he 2001 recovery plan amendment and the 2004 amendment to the MNF Land and Resource Management Plan significantly removed the threat of habitat loss (via logging) across much of the squirrel's range." (5-year review at 12)

[2] Note that the 5-year review and listing proposal erroneously state that the recovery plan designated the GRAs. The plan, however, states on page 19 that the five GRAs already exist.

- "With regard to active conservation of the squirrel, numerous conservation actions have been implemented since 1985 by land stewards, biologists, and conservation groups. These include research and recovery actions specified in the 1990 recovery plan and 2001 recovery plan update for G.s. fuscus…" (5-year review at 19)
- "the 2001 amendment included an update to Appendix A, Guidelines for Habitat Identification and Management for the WVNFS. Implementation of the amended Appendix A Guidelines by the Monongahela National Forest (MNF) effectively abated the main threat to the squirrel (i.e., habitat loss from timber management) throughout the majority of its range, by eliminating adverse impacts on all suitable habitat on the MNF without having to prove WVNFS presence" (proposal at 75925).

How is it possible that the primary threats to the species across much of its range were addressed by implementing the recovery plan if the recovery plan supposedly doesn't address the threats? The entire argument of the delisting proposal and five year review on this point is patently false and self-contradictory.

Point #3—that recovery objectives attempt to stabilize population within the GRAs—is incomplete at best. Is it the Service's position that the populations should not be stabilized with at least 80% of GRAs? We can only guess because the Service provides no explanation as to why this strategy is inadequate. This will be especially hard to explain since the delisting proposal goes to great length to justify delisting based on the alleged "persistence" of the species within the seven relict areas were it is known. How does that differ from this allegedly inadequate recovery criterion?

The 5-year review does state that "Additionally, the current known range of the species is much more widespread than the GRAs designated in the recovery plan." (5-year review at 6). In fact, the recovery plan identifies five GRAs whereas today the species is known from seven areas. But this increase was expressly anticipated by the plan: "Additional GRAs may be defined as further survey data are accumulated." (5-year review at 17). The stability criterion is expressed in terms of a percentage (80%) instead of a number precisely so it does not become outdate with the expected discovery of new population centers. It is incumbent upon the Service to explain its disagreement with the criteria. If there is no disagreement at least 80% of the population centers should have stable or increasing populations, there is no problem with the recovery plan.

Point #4—new light shed on GRA nomenclature—is also undeveloped. What is this "new light"? How does a change in GRA nomenclature invalidate the recovery plan? There is no explanation of this decidedly obscure assertion. The only allusion to what might be called "nomenclature" we can find in the 5-year review is the following:

> "Although the 1990 recovery plan treated the southwestern Virginia *Glaucomys sabrinus* population as *G.s. coloratus* for management purposes, both the plan and the information that has become available since then leaves the taxonomy of this population as an open question. This uncertainty is only germane to the ESA status of *G.s. fuscus* if the MRNRA populations play a critical role in assuring the persistence of this subspecies" (5-year review at 8).

But this paragraph states that the recovery plan and recent information agree on the taxonomic uncertainty and that both the plan and current conservation strategy defer incorporation of the zone of uncertainty into planning for the WVNFS until more information is available. The Service's assertion is contradicted by its own explanation.

Point #5—"new information has become available" about the "plan's threat-based recovery criteria"—is obscure. What is this new information? It is not presented anywhere as such. And how can there be new information about the plan's threat-based criteria when the Service in the same paragraph asserts that there are no threat-based criteria? This argument must be explained in the final listing rule. As presented here, it is inscrutable.

It is quite evident that there is nothing inadequate with the recovery criteria in the plan. The delisting proposal and 5-year review certainly do not demonstrate any inadequacies. To the contrary, its justification for designating the species as recovered follows the same general logic as the plan: the population is healthy, the species life history is sufficiently known to be managed, the habitat is currently protected, the habitat will be protected into the foreseeable future. Furthermore, the delisting proposal and 5-year review repeatedly state that these have been accomplished by implementing the plan.

It is no accident that while the Service tries to imply difference where none exists, it purposefully refuses to identify the three clearest and most important differences between the recovery plan and the delisting proposal. The recovery plan requires that 80% of the GRAs have a stable or increasing population for at least ten years. This would prevent delisting because there are no data indicating whether the WVNFS is stable, increasing or decreasing. While not alerting the reader that it is violating this provision of the recovery plan, the Service substitutes the demographically meaningless and undefined concept of "persistence". Secondly, the recovery plan requires that all GRAs be managed for the species in perpetuity. The delisting proposal admits that they are being managed under a multiple-use mandate that will result in continued logging of important squirrel habitat. And thirdly, the recovery plan requires that high elevation forests be protected in perpetuity, while the delisting proposal notes that they may be completely destroyed by global warming.

Process Out of Order: Need for Comment Period on the Post-Delisting Monitoring Plan

It is clear from the December 19, 2006 Federal Register Notice and the meeting on February 9, 2007 between Friends of Blackwater and the FWS that the agency does not have a post-delisting monitoring plan in place. This is a problem for a number of reasons.

Fragmentation of the Commenting Process

The ESA requires that a post-delisting monitoring plan needs to be published simultaneous with the delisting rule. Unless and until such a plan is distributed to the public, this delisting rule is arbitrary, capricious, and not in accordance with the law.

Any purported plan has not undergone full public scrutiny. The public has a right to comment on the full range of what is proposed in delisting the flying squirrel. In failing to provide the post-delisting monitoring plan at this time, the FWS is fragmenting the commenting process and denying the public the opportunity to provide fully informed comments. A second comment period will be required when the post-delisting monitoring plan is completed. We believe the agency would be better served by delaying the current comment period until the post-delisting monitoring plan is completed. The 5-Year Review and the post-delisting monitoring plan are inextricably linked. In order to understand if the assertions of species viability after delisting contained in the 5-Year Review are true, it is necessary to know the monitoring steps proposed to ascertain the state of squirrel viability. This critical information is missing since the post-delisting monitoring plan has yet to be written.

Lack of FWS Understanding of State and Forest Service Mandates and Activities

In addition, in light of the Weigl Paper (Weigl, 2007) delisting without a post-delisting monitoring plan already in place violates the ESA. Dr. Weigl essentially eviscerates the agency's contentions that a post-delisting monitoring plan can wait.

From agency representations and statements at the meeting, the Fish and Wildlife Service has a poor understanding of the Monongahela's Forest Plan and the West Virginia Department of Natural Resources' legal requirements, mandates and management activities. We, the undersigned, understand the limitations of the Forest Service if for no other reason than many of us have extensive involvement with agency plans and projects and have administratively appealed and sued the agency more than most.

As to the agency's assertion the delisting statute allows the FWS to shift responsibility of the species to the Forest Service, Dr. Weigl addresses this in his paper at line 449 et. seq.: "One has only to fly over parts of the Rockies, Sierras and Cascades or along the Appalachians to appreciate the scope of forest destruction and roadway construction in national and privately owned forests." Weigl, 2007. Nothing in the Forest Plan forbids the building of roads, logging, or any other kind of commercial extraction in the historical areas of squirrel habitat. The purpose of the Forest Service is to manage the forests for "multi-use" – that is, for forest products, as well as wildlife, water quality, recreation, soil integrity, etc.

Further on in the Weigl paper, he addresses arguments, such as the one in the delisting rule concerning the "growth of forests since 1985":

> Finally some second growth stands may well appear to support healthy densities of squirrels, but, in reality, are population sinks for migrants from neighboring old growth habitats and thus may not permanently maintain viable populations (Smith and Person, in press)."
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> Weigl, 2007, line 458.

The proposed post-de-listing monitor plan – which, apparently, turns over protection of the species to the Forest Service and the states of West Virginia and Virginia – does not address the fact that the West Virginia and Virginia Divisions of Forestry as well as the US Forest Service all engage in extensive timber harvesting. In fact, the Forest Service has a multiple-use mandate with timber harvest a focal point of agency activities. Cutting down trees requires the building of roads and skid trails. "The ongoing harvest of old growth forest, its replacement with plantations or regenerating stands and the increasing fragmentation of much of the remaining habitat has alarmed some biologists concerned about this and other rare animal species (see Smith, this issue)." Weigl, 2007, line 181. The result of delisting will be that the Forest Service, Divisions of Forestry and private landowners can return to timber harvest and development without having to consult with the FWS. Relying on management by the Forest Service, state agencies and any Memorandum of Understanding will be an overly simplistic solution to the conservation and recovery of this species.

It is difficult to believe that state and Forest Service monitoring and protection measures will be sufficient for continued recovery of the squirrel given the differences in management, laws, regulations and mandates between the states, the Forest Service and the FWS. Add in staffing and funding shortages and the problems are compounded. Even if the states and the Forest Service are dedicated to squirrel survival it is difficult to believe that all MOU activities will be carried out. Given these factors it is essential that the public be able to see and comment on the post-delisting monitoring plan at this time, in order to understand and assess the ability of the states and the Forest Service to hold up their end of the bargain.

Finally, the much-alluded to "Memorandum of Understanding" will be unenforceable for anybody but the parties to the MOU. That is, it is a quasi-contractual document. Only parties to the contract can enforce a MOU. Third-party individuals or groups, like the undersigned, will have a much more difficult time enforcing a contract. Not impossible, but difficult; certainly more difficult than going into court under the ESA.

FOIA Request and the Comment Period Deadline

Friends of Blackwater submitted a FOIA request (#2006-00988) on the West Virginia northern flying squirrel proposed delisting rule Sept 10th, 2006. We received materials from that FOIA request on December 19th. Friends of Blackwater appealed the partial denial of 2,325 pages of documents. This appeal was submitted on Feb 2, 2007 (Appeal Number 2007-060). We received phone confirmation that more documents would be released in February. We have yet to receive any of the released documents.

We would like an official explanation for the long delay in the release of these materials. When can we expect to receive these documents? Withholding documents undermines the rule making process, and lessens public trust in federal agencies. It further undercuts the ability of the public to make informed comments when denied access to legally releasable materials that serve to illuminate the proposed delisting. The signatories of this letter request that the comment period remain open until all documents have been received and reviewed.

Use of Best Available Science

The Data Quality Act and the agencies' interpreting guidance require that influential information or decision-making input be based on "best available science and supporting studies conducted in accordance with sound and objective scientific practices."[3] Under the Data Quality Act, federal agencies are required to use information that is of high quality and that is objective, useful, and verifiable by others.[4] The agency must also use "sound statistical and research" methods.[5]

An essential component of the scientific process is for other scientists to peer review reports. The peer review process is important for establishing whether the Fish and Wildlife Service is in fact using the best available science. Work by both Menzel and Rollins do not appear to have been adequately peer reviewed and yet have set the course for much of WVNFS management and recovery. More complete peer review of these studies should be conducted.

Population Concerns

The foundation of wildlife biology is understanding the population ecology of a species and its habitat. The conservation of species hinges on understanding the dynamics of its population and the biological and ecological factors that affect it. This essential knowledge guides management decisions and assist wildlife agencies in determining the efficacy of conservation action. In the case of rare species, population data and empirical evidence is often elusive and many times fails to illustrate the population ecology of a species much less its status. The lack of empirical data has led conservation biologists to design and construct models based on the knowledge of a species' biology, habitat, and ecology. While models are useful they can never completely be relied on. As pointed out in later sections, assumptions and caveats abound with any model and they are only as good as the data used to build them. In the absence of population data the utmost caution must be observed in considering any action they may directly impact a species or its habitat. This is indeed a central tenant of the Endangered Species Act and it must guide the US Fish and Wildlife Service's (FWS) operations and decisions.

We completely sympathize with the practical issues surrounding species conservation and the

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[3] Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub.L.No. 106-554, § 515. *See also*, Office of Management and Budget "Information Quality Guidelines," available at http://www.whitehouse.gov/omb/inforeg/iqg_oct2002.pdf and individual "Agency Information Quality Guidelines," available at http://www.whitehouse.gov/omb/inforeg/agency_info_quality_links.html.

[4] Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub.L.No. 106-554, § 515. *See also*, Office of Management and Budget "Information Quality Guidelines," available at http://www.whitehouse.gov/omb/inforeg/iqg_oct2002.pdf and individual "Agency Information Quality Guidelines," available at http:/www.whitehouse.gov/omb/inforeg/agency_info_quality_links.html.

[5] *Ibid*.

limitations the FWS is operating with. This does not however absolve the agency of its duties to protect and restore native biodiversity. We commend the FWS' dedication to the conservation of hundreds of this nation's most imperiled wildlife. The West Virginia Northern Flying Squirrel (WVNFS) is no exception and we appreciate all that has been done to date to recover the species and ensure that its population thrives. However, it is troubling that after decades of conservation efforts the agency is now proposing to delist the WVNFS without the knowledge or the data to support such a decision.

The FWS must follow through on its responsibility to design and implement conservation strategies for the WVNFS. The Recovery Plan was written and later amended to guide the conservation of the species. By the agencies own admission in the Five Year Review the Recovery Plan has not been followed nor implemented to the extent needed or intended. Without having done this, the FWS cannot claim to be implementing sound principles of wildlife management, and has no hope of maintaining viable populations of an endangered species.

We have several major concerns about the proposed delisting as it relates to the population of the WVNFS. Specifically, we are concerned with:

1) The absence of population information
2) The absence of population trend data for this species
3) The use and interpretation of capture data
4) The lack of genetic research
5) The knowledge of the species life cycle
6) The consideration of science regarding the species ecology

Population Dynamics

One of the most obvious facts about the WVNFS is the lack of information regarding the population of the species. It seems incomprehensible to consider delisting a species without understanding its population. The 5-Year Review fails to address the issues of population viability in regards to the WVNFS. To adequately analyze population viability, you must explicitly consider population dynamics. Population dynamics refers to persistence of a population over time, which is key to making predictions about population viability. The USFWS has failed to consider the following factors in examining population dynamics:

1) Population growth rate: Impacts that influence long-term population growth rate are perhaps the most important factors affecting persistence. Persistence is pointed to as the key factor for considering the decision to delist the WVNFS. This approach is flawed because it is not tied to knowledge of the population but merely presence. Presence and absence surveys conducted for the species have been broadly interpreted. As discussed in later sections we have serious concerns about the exclusive reliance on the WVNFS capture data.

2) Population size: Larger populations will take longer to decline to dangerously small numbers. The FWS has failed to disclose the population numbers for this species. In Grumbine (1992, p. 34) a population size of 50 is said to be the minimum number to assure short-term viability, but "a manager could not count on maintaining many species at this reduced level for very long." However this refers to an "effective population" which means 50 reproducing individuals. This is "at the bottom of the genetic basement" (ibid., p. 35) and when factors other than just genetics are taken into consideration, "the models constructed so far have ratcheted viable-population estimates up from the original genetics-derived 50-500 toward the low thousands or higher" (ibid., p. 37). Identification of a viable population must be completed before any decision on delisting is made.

3) Linkages to other populations: Truly effective corridors, or linkages, should be shown to exist that connect the habitat for populations of WVNFS. It is clear that the WVNFS habitat is fragmented and the impacts of roads, logging and residential and resort development are far from abated especially when one considers the large geographic range of this species. It was shocking to read in the Five Year Review that the USFWS "recognizes that long standing isolation can produce important local adaptations that could be compromised through artificially induced connectivity". First, this statement assumes that currently isolated populations are discreet and viable. Assuming that isolated portions of the population are indeed adapting locally requires that a population is genetically healthy. This statement is another example of a flawed assumption based on limited knowledge of the population. Second, what is artificially induced connectivity? We have never heard the term used when discussing the obvious need to recover and restore forest ecosystems for a species that has a large geographic range. Is the USFWS saying that habitat fragmentation is necessary to protect the WVNFS? This is absurd and contradictory to the ecology of the species and the basic tenants of conservation biology.

There Is No Evidence of Population Growth

The proposed rule states that delisting is justified because of "an increase in the number of individual squirrels" (proposal at 75924). At the time of listing, ten squirrels where known at four sites; between 1985 and 2005 there were 1,141 captures at 107 sites (proposal at 75926). An unknown portion of the captures were recaptures, thus the 1,141 captures do not represent 1,141 squirrels. The population size was not known or estimated at any point between 1985 and 2005. These data do not in any manner support the Service's assertion that the population has increased since 1985, nor has the Service provided any additional data to support the strange assertion. The only valid conclusions one can draw about WVNFS populations trends are 1) the population size is not known now or at any time between 1985 and 2005, 2) the 1985 to 2005 population trend is not known, 3) the current population trend is not known, 4) some capture sites have been used relatively continuously since 1985, some have been used sporadically, some have been abandoned, and many are lacking in sufficient data to determine whether use has been consistent, sporadic or abandoned between 1985 and 2005, and 5) the Service has completely dropped the ball on WVNFS monitoring, having consistently failed over a 20-year period to fund or establish

demographically useful surveying methodology. The Service's failure is especially evident when compared to its successful efforts elsewhere to work with partners to obtain good demographic data on the listed Mt. Graham red squirrel, Delmarva Peninsula fox squirrel, and northern Idaho ground squirrel. It also compares unfavorably with researchers who have collected useful demographic data on unlisted flying squirrels.

The lack of data is better acknowledged in the five-year review, which does not assert an increase in squirrel numbers. This rhetorically motivated assertion is without scientific basis and should not be included in the text or rationale of the final delisting decision. The population could just as easily have declined or remained stable as have increased since 1985. There are no data demonstrating that any of these three conclusions is more or less valid than the others.

Both the proposal and five-year review repeatedly invoke the term "persist" to indirectly suggest the demographic trend is stable. The administrative record indicates that the term was expressly chosen to obscure the embarrassing fact that the Service is proposing to delist a species without having any knowledge of its population size or trend. In an April 10, 2006 email, Mark Ford of the U.S. Forest Service warned Shane Jones, then of the U.S. Fish and Wildlife Service (now a Monongahela National Forest employee): "I still maintain that the density or population estimate …no matter how many caveats… is really dangerous – rather just focus on persistence…" In a February 27, 2006 email Shane Jones of the U.S. Fish and Wildlife Service explains to other U.S. Fish and Wildlife Service personnel that analyzing the nest box data for indications of demographic trend is fruitless: "The bottom line is persistence. If you are OK with that, then you understand the rationale for saying it is no longer an endangered species. If you are not OK with that, trust me, you are not going to glean anything else from this data."

We are not OK with the notion that persistence is an indication of population health or stability. It means no such thing. The Service is apparently well aware of this because the proposal studiously avoids any rigorous definition of "persistence," analysis of the capture data, or explanation of how "persistence" relates to demographic health, recovery plan criteria of "stability," or the five listing factors. The invocation of "persistence" is little more than a rhetorical hand-waving gesture.

Persistence is presence/absence data; it does not index population size or demographic trend unless the site actually winks out. Short of this extreme, it does not indicate whether a population is declining, improving or remaining stable. Just as a pass/fail grading scheme does not distinguish between a student doing "A" work and one doing "D" work, persistence does not distinguish between healthy and declining populations. Take for example the Red Run site (five-year review, Appendix B, p. 10). Squirrels "persisted" at the site from 1989 to 2004, but the number of captured squirrels declined from an average of 8.7 in 1989-1991 to 2.7 in 2002-2004. It is unclear if surveys were conducted in 2005. If so, the 2003-2005 average would be just 2.0. Thus the fact that squirrels persisted at Red Run is absolutely no indication of the trend or health of squirrels at that site.

A recent analysis of all listed species in eight northeast states determined that all had persisted and 93% had increased in size or remained stable since listing (Suckling 2006). Under

the proposal's "persistence" criteria, all of them should be removed from the endangered species list. Some such as the piping plover, roseate tern, and green sea turtle have done considerably better than persist, they have dramatically increased in size, yet none have been proposed for delisting because, unlike the case of the WVNFS, the Service is requiring that the species meet scientific recovery criteria established in recovery plans. The Service's procedure in this case is to ignore the recovery plan and proceed to delist in the absence of any explicit recovery criteria based on the nearly meaningless and poorly defined concept of "persistence." This clearly violates the Endangered Species Act requirement that the Service scientifically demonstrate the species is recovered.

As the WVNFS is currently listed as an endangered species, the burden is on the Service to demonstrate that its population is sufficiently large and stable (or improving) to be considered non-imperiled. As neither the size nor the population trend is known, the Service cannot and has not demonstrated population health. Thus the WVNFS has not been demonstrated to be recovered. It must remain on the endangered list unless and until the Service conducts scientifically credible studies indicating what the population size and trajectory are.

Perversely, the Service appears to be using its failure to conduct meaningful demographic studies over the past 20 years to justify delisting the species. Its argument that lack of trend/size data would make the species fail the five listing criteria test treats the species as if it is unlisted and the burden of proof is on the listing advocate to demonstrate endangerment. The Service's lack of meaningful research would indeed weaken the listing advocate's position, but the burden of proof is not on those seeking to retain listing; it is on those seeking to delist.

The nest box data in Appendix B of the five-year review is fatally incomplete because they only indicate the year in which animals were found; they do not indicate years in which the size was monitored and no animals were located. Thus it is impossible to tell how often squirrels were not found, significantly undermining confidence in the Service's assurance of site persistence. The final decision should include a complete dataset showing results for all monitoring years, not just successful years.

The proposal states that the 107 capture sites are "dispersed across seven general areas of relict habitat in the Allegheny Highlands region" (proposal at 75926). It cites pages 9 and 26 of the five-year review. Page 26 is the bibliography. Page 9 states that the species "is distributed extensively across the Allegheny Highlands," but provides no definition of "extensive." Thus the reference to the five-year review provides no additional information that is not in the delisting proposal. Without citation or supporting data, the proposal states that the WVNFS occurs in "numerous additional sites dispersed throughout its historical range, suggesting that its current range roughly approximates the extent of its historical range." Occurring in "numerous sites" does not suggest the species current range is similar to the historic range, and the Service has provided no citation or explanation for why it believes this to be true. Since diminishment of range is one of the five listing factors, can not simply assert the range is "extensive" while failing to describe what portion of the historical range is occupied. The final decision should provide maps showing the presumed historic range and sites that have been recently occupied (e.g. in the past ten years). It should also calculate what proportion of the historic range is known to be

currently occupied by the species. The maps in the five-year status review may help to construct clear historic vs. current range maps, but do not in themselves constitute such a map.

Flying Squirrel Life Cycle

As stated earlier the FWS has not been able to obtain any useful demographic data to support their assertions about the status of the WVNFS population. This problem is compounded by a lack of consideration and knowledge of the life cycle of the WVNFS. Leading WVNFS expert Dr. Peter Weigl refers to a study by Stephens, et al in his recent article submitted to the Journal of Mammalogy. In this article Weigl points out that Smith, et al have analyzed the demography of the *G. sabrinus* and "raised questions about the distribution and stability of populations" (Weigl 2007). Weigl goes on to describe the species as more long lived than previously thought, with a very low reproductive rate for a mammal of its size. This new information is quite relevant to the proposed delisting and must be considered. If WVNFS has a longer life span and a lower reproductive rate then the assertions of persistence and reproductive success based on capture data must be reevaluated.

Lack of Genetic Studies

Genetic research has expanded our knowledge of population ecology and recently has begun to transform taxonomy. The examination of genetics and genetic variation within a population are critical to understanding if the population represents a distinct species and if a population is experiencing a genetic bottleneck caused by isolation, genetic drift, or inbreeding. The genetic research on the WVNFS is grossly deficient. Considering the amount of attention the WVNFS has received in the past few decades it is hard to understand why more genetic studies were not carried out or genetic material gathered.

Because the WVNFS is a species that has suffered large scale habitat loss and occurs across a wide range it should be prioritized for genetic study. This will allow wildlife mangers to know if there are discreet population segments of WVNFS that require protection, such as the Virginia population, or if the population is threatened. With the challenges of determining population numbers and the limited number of squirrels available for study the collection and analysis of DNA should be completed before changing the status of the species is considered.

Data Analysis of Captures from Field Reporting Forms for WVNFS

Initial analysis consisted of a review of data from a digital database provided by the US Fish and Wildlife Service and included data collected by the West Virginia Department of Natural Resources from 1988 through 2006. This data analysis concluded there were a total of 1,199 captures during this time period with only 79 recaptures. However, there were some 327 captures that did not include any information about tag numbers with no clear reasoning for this

lack of information. These 327 records represent a distinct anomaly in the capture data that seemed to indicate that there may have been as few as 793 unique captures.

Due to this and several other inconsistencies within the data source we obtained copies of the actual field reporting sheets from the West Virginia Department of Natural Resources office in Elkins, WV in order to try to further understand these and other inconsistencies in the capture data.

Data from available field capture forms was then entered into an Excel Spreadsheet. A total of 1,233 documents representing research from years 1985 to 2006 were entered for assessment. As a means of trying to keep the information as accurate as possible, forms that were illegible (in part or whole), forms that were duplicates of others, as well as type written forms that appeared to be summary in nature but lacked definitive information were excluded for the purpose of data analysis. After excluding data that fell into those categories, capture data was assessed for some 1,147 separate events.

Upon review of the capture data, 104 events had been recorded as recaptures and 114 events were recorded as unknown. For the purpose of analysis it was assumed that unknown meant it was not possible for any number of reasons to determine whether the animal had been captured in previous field studies. This led to the determination (based solely on the exclusion captures recorded as recaptured or unknown) that only 929 events remained as possible unique captures.

Further analysis of the data included assessment of the assignment of tag numbers during capture events. During 275 captures the animal was not tagged. Reasons for the lack of tagging ranged from escape of the animal to "not applicable". These 275 events also included several nestlings that were not tagged at the time the data was recorded. Without tagging of these animals on initial capture it cannot be known if they were ever recaptured. Analysis of the data from these 1,147 captures presents several inconsistencies in the actual collection of the field data.

To summarize, analysis results show 114 events where initial capture or recapture was unknown; 275 instances where a tag number was not assigned to an animal; and 104 events that were definitively recaptures. When these numbers are considered, unique squirrel captures over the last 21 years may only number 654 individuals.

Review of Capture Data

In the absence of any real discussion regarding the population status of the WVNFS the FWS instead devotes much of the discussion in the Five Year Review to capture data gathered over the last couple of decades. While this data is useful for determining where the squirrel may be it does little to assure the public or the agency that the population is viable. Nor does it assist in the determination of population size. Without demographic data or population modeling the agency cannot assess the status of the species. The capture data that has been gathered cannot be treated as a complete dataset since it combines numerous different capture methods with

inconsistency in the information recorded and no information on survey methodology over the years. By combining trapping data only conducted at one site and at one time with long term nest box monitoring the data is quite confounded.

The capture data was also non-random which builds in bias. Only unbiased data that has been systematically collected using the same method should be considered for estimating population. Yet, the agency does not even attempt to estimate population and instead relies on persistence as a measure of population viability. Knowing that unique individuals of a species are present through time is useful for measuring persistence. The recapturing of squirrels is also useful information because it increases understanding of habitat use. The USFWS has obtained unique capture through time and recaptures at certain sites. The data is quite limited and upon further examination of the capture data it appears that only 654 captures may have been unique. And only 60 percent of the data shows presence through time. Therefore only 60% of the data can be used to estimate health of the population.

It is known that because WVNFS are plastic in their selections of nest sites that nest box surveys have a very low rate of occupancy and a very small chance of a successful capture. This fact is related not only to the plasticity of nest selection but also to the availability of nest sites and the relative abundance of WVNFS. Therefore it is important to relate the nest box surveys to measures of habitat quality. In the context of habitat it is just as essential to understand why an individual is present as it is to understand why it is not present. A major caveat of relying on the nest box data as a measure of persistence is that it does not tell us anything about the habitat. Therefore it is impossible to infer just what is optimal habitat for the squirrel and if it is available and can support the WVNFS population.

Ecological Issues to be Addressed

In examining the Five-Year Review one anticipates an extensive review of current literature related to the WVNFS alongside results of independent research performed by the agency, supported by expert opinions. Instead one encounters a synthesis of some current and relevant information alongside numerous unfounded assertions. Also troubling is the use and indeed heavy reliance on unpublished, non-peer reviewed science such as Menzel 2003. Instead of a comprehensive and objective review of the status of WVNFS the Five-Year Review fails to address relevant ecological information and basic principles of conservation biology. In an effort to correct these deficiencies we present some of the ecological issues that should be considered by the agency.

- The WVNFS has been documented and is known to inhabit deciduous forests at lower elevations and should not be considered an obligate to spruce fir forests.

- The WFNS is typically considered to inhabit forests with old growth characteristics such as an all-aged forest structure, vertical diversity, down woody debris, and a high level of diversity of plants, animals, fungi, mosses, and lichens. Although the WVNFS is associated with this habitat it can exists across a broad range of forest habitats but needs

forests with old growth conditions in enough places across its range to persist. All old growth forests across the species range must be protected in order to conserve the species.

- Protecting only old growth spruce forests will not ensure the protection of northern hardwoods. Northern Hardwoods communities must also be protected in reserves of sufficient size. Without knowing the spatial needs of the WVNFS it is presumptuous to assume that just protecting small portions of forest will be sufficient to recover the species.

- It is essential to not only maintain reserves of spruce and northern hardwoods but also to retain their connectivity across the landscape. Any loss of connectivity via road building, large scale logging, etc. should be considered as a substantial threat that has not been abated at the scale appropriate to recover the species.

- The impacts of landscape barriers such as roads, and second home development were not considered. Studies indicate that roads can have major impacts to the ability of flying squirrels to move across the landscape (Weigl et al. 2002).

- Over simplistic models of habitat requirements can not be used solely to justify the delisting of the WVNFS. The interpretation of this information has led the FWS to draw conclusions on the ecology of WVNFS and its population that are unsubstantiated.

- It is important to recognize that the WVNFS may in fact play a critical role in the dispersal and persistence of numerous fungi which have extensive mycorrhizal relationships with trees that depend on the symbiotic relationship with these fungi. This complex relationship between squirrel, fungi and forest highlights the interdependence these species have within the forest communities they occupy. This relationship raises the stakes for not safeguarding the WVNFS. By jeopardizing the squirrel an entire forest ecosystem could suffer.

- Although steps have been taken recently to gain more understanding about the ecology of the WVNFS we still know relatively little if anything about the parameters that affect its populations and we know nothing about the spatial and temporal trends of the species.

- It has been shown that WVNFS can travel considerable distances for food and mates which may impact the estimations of the home ranges of the species. "If populations in a locality can fluctuate widely in numbers, have a distinctly patchy distribution in fairly uniform forest and consist of individuals which can cover spectacular distances, is it possible that northern flying squirrels may use and require much larger expanses of suitable habitat" (Weigl 2007). If so, the connectivity of the landscape and the amount of available habitat become critical issues.

- No consideration of source sink dynamics and the concept of metapopulations was discussed in the Five-Year Review. If the WVNFS population is governed by source-

sink situations across its range then much of the variability in the capture data and the sites where squirrels are found may be explained. The distribution of the WVNFS metapopulation must be explored and used to guide the conservation of habitats and connections between habitats.

- The discussion of predators that may impact WVNFS was limited to housecats hunting where human settlement interfaces with squirrel habitat. No mention was made of the possibility of the reintroduction of the Fisher. Knowledge of the WVNFS population is essential to understanding how the reintroduction of a native predator may impact the species.

- The competition between the Southern Flying Squirrel (SFS) and the WVNFS is thought to be a non-issue. The fact that the Southern Flying Squirrel is a vector for a parasite known to impact the WVNFS is an issue that must be given considerable thought. While the relationship between the parasite and death of WVNFS is not entirely known it is believed to be mitigated by the parasites inability to survive the cold temperatures. It is also important to consider that the SFS is currently unable to inhabit the higher elevation forest because it is less adapted to cold temperatures and requires a diet of nuts and seeds that are lacking at higher elevations. This natural barrier that reduces competition and mitigates the spread of a potentially deadly parasite may not last long in the wake of climate change, the reduction of high elevation coniferous forest due to acid deposition, and the expansion of seed and nut bearing northern hardwoods.

- Other forest health issues that compound the threats to the WFNVS include: the loss of Eastern Hemlock to the Hemlock Wooly Adelgid, the loss of Fir to Balsam Wooly Adelgid, the loss of Beech due to Beech bark Disease, and the impacts of Oak Decline in northern hardwood communities. Even if it were true that all threats at the time of listing the WVNFS have been abated (which they most certainly have not) there are new threats which are growing that may have untold consequences for the WVNFS. Delisting this species now would strip away the protections offering it the best chance for survival.

Habitat Concerns

Much of the conservation effort for the species has focused on understanding its habitat and the use of this habitat. To ensure recovery, habitat must be provided for the number and distribution of reproductive individuals to ensure the continued existence of a species throughout its geographic range. In the case of the WVNFS the protection of habitat is serving as a proxy for the status of its population. The FWS proposes that by protecting the habitat for a species a species is protected. The protection of habitat is critical to the protection of a species but the outright protection of habitat does not ensure recovery. This is certainly the case when it is unclear what constitutes the WVNFS habitat.

Another important consideration is that much of the habitat believed to be important to the WVNFS is not fully protected. In fact, should this species be delisted there would be a complete

lack of protections ascribed to the WVNFS or its habitat. It is egregious to assume that the US Forest Service would work to protect a species without the force of law.

Habitat Definitions

There is a lack of a clear habitat definition for G. sabrinus fuscus. The literature reflects striking gaps in knowledge of the biology and ecology of the species. The Five-Year Review contributes to the confusion about habitat by grossly oversimplifying the results of a scientific review for habitat quality ranking contained in Appendix A. Rather than disclosing that Appendix reveals that optimal habitat is associated with a complex array of conditions including old growth spruce and hardwood, coarse woody debris, snags, and moist conditions, the Five-Year Review instead focuses on spruce as a source of one of the fungal food species, ignoring other fungal species and other food sources not associated with spruce. Appendix A of the Five-Year Review is consistent with scientific studies and capture data that habitat is difficult to describe definitively. Optimal habitat is associated with a number of factors, including large old growth spruce, but these factors are complex, likely inter-related, and poorly understood at the present.

Red Spruce

Role of Spruce in Boreal Habitat

High elevation spruce in the Southern Appalachians is a relict of widespread spruce occurrence during the Pleistocene. However, spruce is just one component of this habitat. The proposed delisting and the modeling on which the delisting proposal relies focus on spruce to the exclusion of other components of boreal habitat. It is simplistic to imagine that spruce and elevation by themselves determine preferred habitat for G. sabrinus fuscus. Indeed, a look at the literature reveals evidence for other boreal components playing key roles in the northern flying squirrel ecology. Weigl points out the key role fungi play as food for G. sabrinus fuscus and the role of the squirrel in perpetuating components of the boreal habitat. Old growth and forest with complex forest structure with a variety of tree species seem to be a component of ideal northern flying squirrel habitat. Spruce is but one component of the high elevation boreal ecology on which G. sabrinus fuscus depends. The association of G. sabrinus fuscus with spruce occurrence may be the association of both species with other boreal factors rather than a direct dependence of the squirrel on spruce. In fact Weigl (2007) points out that G. sabrinus fuscus is seldom found in pure conifer or pure spruce stands. It is more characteristic of the ecotone between hardwoods and conifers. This complexity in the habitat for G. sabrinus fuscus has been ignored by the proposal to delist the species as well as by the habitat modeling for the species (Menzel et al 2006).

Despite the direct association in the delisting proposal of spruce occurrence with preferred habitat for G. sabrinus fuscus it is not clear that this direct association exists. Weigl (2007) directly calls this assumption into question. It is significant as Weigl points out that there is a notable lack of G. sabrinus within pure spruce forest. Other factors such as food sources, climatic

factors, and elevation may explain the seeming association of G. sabrinus fuscus with spruce. The capture data also reveals significant occurrence outside spruce forest. These factors cast tremendous doubt that the species is directly linked to spruce habitat rather than other factors that may have covariance with spruce occurrence. Serious errors and false confidence can result from attributing preferred habitat to phantom factors while discounting and failing to account for factors that may play a more critical role.

Red Spruce Management

Boreal forest is a complex forest containing elements of spruce, fir, and northern hardwood species. The extent of spruce forest has declined significantly during the historical period. The decline of spruce is cause for concern and spruce restoration should be a goal for lands, especially those in public ownership. Spruce, along with other boreal species is clearly a Pleistocene relict whose range has been reduced due to past climate change. Boreal habitat and boreal species face a very serious challenge from current climate change.

It is not clear that spruce restoration efforts will be successful in face of these challenges. If northern hardwood forest is cut, it is not clear that spruce will replace the cut species. There is only one master's level study on the Monongahela NF suggesting that such recovery may be feasible. There are many factors, including the observed ongoing decline of spruce forest that suggests that such recovery is not feasible. Climate change, lack of seed source, and species competition could easily frustrate spruce restoration.

Meanwhile, it is not clear from the research that northern hardwood forest is not providing good habitat. Weigl (2007) points out a number of habitat characteristics that seem to be associated with and important to G. sabrinus fuscus habitat. Fungal and lichen food sources for the squirrel are important factors. Other habitat factors that seem to be associated with habit are moist down woody debris and a cool and moist microclimate. These factors are characteristic of northern hardwood forests. In fact despite the focus in the delisting proposal and the modeling on which the delisting depends, the species has consistently been found in northern hardwood forest. It is clear from several of the lines of research that the species is associated with older or old growth forest. Thus the focus on restoration of spruce at the expense of mature northern hardwood could easily harm G. sabrinus fuscus recovery.

The delisting proposal contains two serious and troubling errors. First of all, it assumes that spruce forest can be restored at the expense of northern hardwood forest despite extremely little evidence that this is feasible. It also ignores the likely difficulty or impossibility climate change will introduce into this effort. Secondly, the proposal ignores the lack of clear evidence that G. sabrinus fuscus are actually dependent on spruce rather than a complex set of other factors that likely associate with spruce occurrence. By focusing on the phantom of spruce occurrence the effort ignores other more significant factors and would likely harm viability of the species by encouraging the conversion of old growth or mature northern hardwood into young forest stands that may or may not have a significant spruce component.

The Squirrel and Other Habitat Types

Squirrel Adaptation

Because habitat is a complex and poorly understood complex of conditions, the modeling that has been conducted and the proposal for delisting have failed to account for the squirrel's adaptation. Climate change is likely to continue to limit the range and occurrence of red spruce in the Central Appalachians. By inappropriately linking G. sabrinus fuscus habitat to red spruce, and proposing delisting based on the unproven and unlikely expansion of red spruce, the Fish and Wildlife Service is in effect proposing a scenario for the species' demise. The logical and responsible course should be to refine the species' actual habitat requirements to document habitat factors that could assure adaptation and survival in the face of climate change.

Northern Hardwood Habitat Use

In particular northern hardwood forest appears to play an important factor in G. sabrinus fuscus habitat. Northern hardwood is likely to continue to expand at the expense of spruce habitat as climate change continues. In fact, even the presence of northern hardwoods in this region in the future due to climate change is an open question. Weigl (2007) documents that Northern Flying Squirrel in some regions uses northern hardwood forest without spruce and fir. With the likely limitation of spruce forest under a climate change scenario, the FWS has the obligation to attempt to identify factors that can assure survival and control management to optimize these conditions. From the scientific literature it seems likely that northern hardwood forest and conditions within northern hardwood forest can play important roles in G. sabrinus fuscus recovery. Basing delisting on spruce restoration, which has questionable and uncertain prognosis and whose role in habitat is uncertain, is not a course of action that will contribute to the viability or recovery of the species.

Habitat Age-Class and the Squirrel

One of the most consistent factors associated with G. sabrinus fuscus is old growth trees and old growth conditions. This should be a primary focus of recovery efforts. However, this is in direct opposition to efforts to "restore" spruce forest as this is likely to involve harvesting mature tree to be replaced with new regeneration. Even if spruce regeneration is successful, which is highly unlikely under a climate change scenario, these immature trees are unlikely to provide good habitat in any foreseeable future.

Food Sources

The use of food sources by Glaucomys sabrinus fuscus is critical to an understanding of their habitat use. One study of the G sabrinus fuscus fecal pellet contents, done by Donna Mitchell of the WV DNR in 1998 gives us some insight into what the squirrel eats. Entitled "Spring and Fall Diet of the West Virginia Northern Flying Squirrel" it was published by the American Midland

Naturalist in 2001. The pellets studied were collected from 115 captured squirrels from 1989 to 1991 in the spring and fall. No information was collected for winter and summer food sources. The spring samples show equal consumption of buds from red spruce and beech trees and fungus associated equally with both conifer and broadleaf trees. In the fall, fungi were more widely eaten as were beech nuts. Lichen and mosses were also found in the samples. This small study supports the contention that the squirrel forages in both northern hardwood and conifer habitat and is not limited to red spruce forest types.

The second study cited in the Five-Year Review was by Loeb et al 2000, "Habitat Associations of Hypogeneous Fungi in the Southern Appalachians: Implications for the Endangered Northern Flying Squirrel (Glaucomys sabrinus coloratus)". This study uses data from 1995 to 1996. The study is less useful than the Mitchell study because it just looks at fungi found near flying squirrel capture sites. There is no proof that this is a food source used by the Appalachian squirrel. The study does not cover the West Virginia northern flying squirrel (Glaucomys sabrinus fuscus).

In the Loeb study the most common fungus, found 78.8% of the time, is Elaphomyces. It is "is one of the most common and widely distributed species of hypogeous fungi in the northern hemisphere and is found in a variety of habitats including pine, chestnut, beech and oak forests (Smith et al., 1981, Zhang and Minter, 1989) from Loeb, page 293. This fungus, despite the authors' claims, does not lead to the scientific conclusion that flying squirrel are found in red spruce habitat. The study was done in spruce and spruce/hardwood forests skewing the results toward red spruce. No comparative study was done in pure hardwood stands even though the Glaucomys sabrinus coloratus has been found in such stands. The study of structural and vegetation characteristics in the area of the fungus was conducted on just three one meter by one meter plots. This limited data cannot be used to define the canopy cover, soils, logs, snags, and vegetation characteristics (distance to closest tree species) of Glaucomys sabrinus coloratus habitat let alone that of fuscus. This study is too limited to be useful in this Five-Year Review.

Additional research is needed to further define habitat preferences, for example by looking at factors such as the presence of food sources by predominant surrounding age class. Until such research is completed, pinning species viability on limited understanding of food source preferences and extrapolation to the larger issue of overall habitat preference is unwarranted.

Capture Sites vs. Habitat Needs

The use of capture sites to define habitat needs for G. sabrinus fuscus is useful but is not definitive. There is no evidence that the capture sites have been placed or sampled with a strategy to accurately establish particular optimum or preferred habitat conditions.

Elevation

Certainly elevation plays a role establishing suitable habitat for the species. There is general consensus that habitat for the species is found in boreal areas, and boreal habitat is found in the

higher elevations of the Central Appalachians. It is not surprising that capture studies have found an association between elevation and captures. However, this tells us nothing about the finer relationships or what components of higher elevation boreal habitat the species is dependent on.

Timber Types

The fact that there is an association in capture studies with spruce occurrence is not necessarily surprising nor particularly revealing. Spruce is an important component of boreal habitat. Are there aspects of spruce biology that G. sabrinus fuscus is dependent on? Or as Weigl (2007) suggests are there underlying conditions that both spruce and the squirrel are responding to. There is a true danger in depending on spruce as a surrogate for these underlying conditions. The association of spruce to other conditions could mask the more fundamental dependence of the squirrel on these conditions. If these conditions are masked, management could ignore these conditions or actually degrade them. It seems likely from the literature and Appendix A of the five year review that old growth or mature northern hardwood is superior habitat to newly regenerated or early succession spruce forest. Yet this is ignored by the delisting proposal and the models being used for G. sabrinus fuscus habitat.

Food Sources

The literature and Appendix A of the five year review indicates a strong association with certain fungi and other food sources. Yet there is no indication that captures have taken food into account, that the delisting proposal has considered this association in any detail, or that the delsiting proposal has addressed how its reliance on Forest Srvice management plans would impact these food sources.

Canopy Closure

The literature and Appendix A of the five year review document that forest structure may be one of the most important conditions impacting G. sabrinus fuscus habitat. Yet capture studies have scarcely addressed this factor. The association of the species' habitat with large old trees and complex structure including snags and coarse woody debris would logically call for addressing this habitat component. Yet the delisting proposal fails to address this habitat concern, and the strategy it is relying on to assure recovery would likely degrade this condition on significant areas on national forest land.

Habitat Manipulation

As detailed in previous sections, the habitat manipulations the US Fish and Wildlife Service is relying on to assure viability of G. sabrinus fuscus on national forest lands are untested and unproven, are contrary to much of the biology that is known about the species, and are likely to harm its viability rather than enhance it. A logical approach to relying on habitat manipulation to enhance habitat would include before and after examination of populations (or at least capture rates) that could be tied to the manipulations. There are no studies in this case. In fact careful

examination of the capture data history reveals that nest boxes have been in areas that have been harvested, but no subsequent sampling has been conducted to assess how these management activities have affected capture rates.

Other Effects on Habitat Use and Quality

Most studies, e.g. (Weigl, 2007) and Appendix A of the five year review, suggest the association of optimum or preferred habitat with moist conditions, high rainfall, and northern aspects. This association could result from the presence of food sources proliferating under moist conditions or other microclimatic effects. Moist conditions can be associated with micro-climate regimes in northern aspects, areas receiving higher precipitation and fog in certain positions in relation to prevailing weather patterns, and certain drainage patterns. In converse to this, aspect, drainage pattern, and areas within rain shadows can have reduced moisture. The model relied on to predict habitat (Menzel et. Al., 2006) lumps all of these areas together based on elevation and spruce occurrence. It is unlikely that these factors have no effect. Rather, it is more likely that the data and modeling are too insensitive to reveal these habitat patterns. In practice this inability to distinguish these habitat factors potentially overestimates the optimum habitat. It is premature to assess that there is adequate habitat for viability for G. Sabrina fuscus on national forest lands with the current state of knowledge about habitat needs, the likely changes to habitat with climate change, and the continued loss of high elevation habitat.

Modeling Concerns

The Menzel Model

The delisting proposal for Glaucomys sabrinus fuscus is heavily based on habitat modeling (Menzel, 2006). While this modeling is useful as an interesting addition to characterizing G. sabrinus fuscus, the study should not be promoted as definitively characterizing the habitat of G sabrinus fuscus. The model contains untested assumptions, is based on limited data, is a simplified model that does not account for important variables in the species' biology, and remains an unverified and untested model. The model is also being applied outside of its intended scope and for purposes that are not supported by the study that the model is based on.

The Model Contains Untested Assumptions

Any modeling involves assumptions but the number and scope of assumptions made in the Menzel model is staggering.

- The assumption stated explicitly in the paper that use of nest boxes provides insight into preferred habitat is a huge assumption. However the model actually goes beyond this and implicitly assumes that there is a direct relationship between nest box use and preferred habitat.

- The underlying assumption of the model that quality of habitat is predicted by elevation and vegetative community alone is almost surely false since studies by Weigl and others indicate that quality of habitat is dependent on forest and tree maturity as well as other factors that vary across the landscape.

- The assumption that data from spring and summer tracking reveals information on habitat the remainder of the year is not discussed although it potentially ignores habitat needs the remainder of the year.

- The assumption that a model from limited tracking data can be both tested with and applied to nest box occupation is highly questionable. This self validating methodology raises the same concerns as were originally raised by Menzel et al for the exclusionary modeling approach: "It is important to note, however, a generally untested assumption of the exclusionary modeling approach is that capture locations are indicative of quality habitat. If individuals are artificially attracted to an area … if a capture method such as nest boxes provides artificial den sites, the results of the habitat model could be misleading." Menzel, et.al, 2006. The fact that a limited amount of tracking data is incorporated on the front end, does not cancel this concern in applying and testing the model for nest box occupancy as a surrogate for habitat quality.

The Model Is Based On Limited Data

The Menzel model (Menzel, et.al. 2006) was built on data from only 4 sites. This represented data on only 13 animals and documented only 59 nest trees over the course of the study which was conducted during the spring and summer of 2000 and 2001. Modeling based on this limited data is useful, but hardly definitive in characterizing G. sabrinus fuscus habitat. The data is very limited both spatially and temporally and can be generalized spatially and temporarily only with great caution. The 5-year review and the proposed delisting documentation have not treated this model with the caution and caveats that are appropriate.

The Model Is a Simplification of Existing Knowledge and Does Not Account for Important Variables in the Species' Biology

The model uses only elevation, aspect, and vegetative community as modeling variables (aspect was used in the regression but discarded). Such a model can have some value for predicting nest boxes that have been used at some point by the squirrel. However, it will fail to give accurate information – and may even provide misleading information on finer points of distribution and habitat.

The model clearly ignores significant factors in the species' biology that should be used in population and habitat assessment. There are many unknowns about the biology and ecology of G sabrinus fuscus. However, a survey of the literature or reference to Appendix A in the Five-Year Review quickly reveals factors that are clearly or likely relevant for the species' biology and ecology but are not accounted for in the model. Such factors as old growth trees (of both

spruce and hardwood), old growth forest structure including presence of snags and coarse woody debris, fungal and other food sources, suitable nest sites, and moist conditions appear to play important roles in the species' biology and ecology. The fact that the model shows acceptable fit with a selection of nest box occurrences can not be construed to demonstrate model validation.

The Model Remains an Unverified and Untested Model

As pointed out above, the fact that the model shows acceptable fit with a selection of nest box occurrences is an interesting result, but it should not be used to test or validate the model. Nest box occurrence is used as both data to broaden the model and as its test. The model's prediction of habitat from tracking data should have been verified in following years (different temporal frame) and on different areas of the range (different spatial frame). Testing the simple model of G sabrinus fuscus habitat at different sites within the range would have provided opportunity to test and refine the model. Jumping from application of the model to prediction of nest box occurrences as a surrogate for predicted habitat is premature, and the application of the model as a rationale for delisting is a misapplication of the model.

The Model Is Being Applied Outside Of Its Intended Scope and For Purposes That Are Not Supported By the Study That the Model Is Based Upon

The Menzel et al (2006) paper states in its Discussion, "Our Virginia northern flying squirrel habitat model is not a definitive attempt to predict presence or absence, but rather an attempt to identify areas where conservation and/or forest-habitat enhancement could be prioritized." As such it is a useful study. However, the model's use as justification for delisting the species is using the model for precisely the above purpose. Making the case that habitat can be accurately predicted and that this habitat protects the animal's viability, clearly assumes that the model <u>does</u> definitively predict presence and absence. The paper goes on to state, "Our deductive modeling approach allows the use of statistically significant quantitative data to build a habitat model that describes areas similar to those used by radio-collared animals." This is an important distinction. A case can be made that the model predicts areas similar to the areas used by the original radio-tracked animals. However, it has not been demonstrated that this habitat is necessarily preferred habitat for G sabrinus fuscus across its range, across time, and across seasons.

The model is also misapplied as a justification for delisting because it is a very simple model that fails to distinguish between other characteristics of the habitat such as forest age, structure, and tree composition (other than spruce) that very likely play key roles in the species ecology. The model likely grossly overestimates habitat by treating young forest the same as old forest. Much of the research suggests that the fungi, trees, and complex vertical structure of old forest are important in the squirrel's ecology. Further, treating spruce regeneration as a potential strategy to increase preferred habitat in the short term is also an error in the proposed delisting because it a) ignores this distinction in habitat needs and b) ignores the practical difficulty of boreal restoration in light of climate change.

Too little of the important details of G sabrinus fuscus' habitat needs are known. The misapplication of the Menzel model obscures this fact. The various inadequacies and

misapplication of the model detailed above make it clear that the proposed delisting is premature.

Ongoing and Cumulative Effects on Squirrels

In order to evaluate the WVNFS' appropriate status under the ESA, the FWS conducted a threats assessment conforming to the five listing factors in December 2003 (Five-Year Review at 10.) That assessment concluded that various threats were either insignificant in their effects on the squirrel or beyond the Service's control. We take issue with these conclusions. The effects of global warming, private land development, highway construction and energy development are examined in greater detail below.

The Effects of Global Warming Have Not Been Considered

There is a strong scientific consensus that spruce-fir forests will disappear from the Southern and Central Appalachians (and probably the United States) under even the most conservative global warming models. While some components of the northern hardwood forest will likely remain in the region, it will likely cease to function as a discrete ecological community. This will likely result in the extinction of the WVNFS. In the medium term (i.e. next 100 years), global warming is probably the greatest threat to the squirrel's existence, yet the delisting proposal provides only a cursory glance at the issue. This violates the Endangered Species Act requirement to employ the best available scientific information in making delisting decisions. The proposal's passing reference, moreover, is miscited, misinterpreted, and relies on criteria disallowed by the Endangered Species Act. The final decision must provide a thorough review of the large body of published scientific studies examining the likely impact of global warming on the WVNFS and its habitat.

Without citation, the listing proposal states: "…the long-term potential exists for anthropogenic acid deposition and climate change to diminish the extent and quality of the boreal-like spruce forests that have survived on the high ridges and plateaus, by pushing them farther up the slopes, and, if warming continues, reducing and eventually eliminating habitat at higher elevations." (p. 75929). The five-year review cites Delcourt and Delcourt (1984) as authority for a nearly identical passage. Delcourt and Delcourt (1984), however, do not predict future vegetation patterns, so we presume the intended reference is Delcourt and Delcourt (1998) who present several models of spruce migration in relationship to global warming. All models predict the extirpation of *Picea rubens-Abies fraseri* and *Picea rubens–Abies balsamea* forests south of approximately 44.0º (i.e. the White Mountains, NH).

The proposal then presents a rationale for ignoring the threat of global warming: "However, [1] there has been no evidence of acid deposition or climate change reducing the extent of red spruce-northern hardwood forests in the Allegheny Highlands since the WVNFS' listing in 1985 (Rollins 2005, pp. 39–51; Service 2006b, p. 10), and [2] it is not possible to predict measurable impacts on WVNFS habitat through the foreseeable future. Thus, the effects of acid deposition and climate change on G. s. fuscus and its habitat are not predictable and [3] it is beyond our capacity to eliminate such threats through interventions at the species level." [bracketed numbers

added].

The third point—that the Service can not control global warming at the species level—is wrong but also, more importantly in the context of a delisting process, legally irrelevant. The Endangered Species Act does not exempt the listing of imperiled species in cases where the Service believes it is powerless to save them. If a species is endangered, it must remain listed. Speculation about what actions may or may not be possible to save it have no bearing on whether the species is endangered. Invoking such an argument in the delisting context is arbitrary and capricious. The final decision must confine its rationales to the statutory framework of the Endangered Species Act.

The first point—that global warming impacts were not evident between 1985 and 2007—is miscited, misinterpreted, incorrect, and substantially irrelevant. The miscitation is to the five-year review (i.e. Service 2006b). The five-year review presents no independent information on the topic. It merely cites Rollins (2005), which is already cited in the proposal. Citing one's own opinion elsewhere as authority for the same opinion violates scientific standards.

The citation to Rollins (2005) is erroneous in that Rollins's study period—contrary to the description in the listing proposal—did not cover the listing period of the WVNFS. More importantly, it did not establish either the past or the current extent of red spruce-northern hardwood forests. Nor did Rollins offer any opinions as to whether the range had recently shifted, is expected to shift, is being affected by global warming or is expected to be affected by global warming. Rollins simply measured regeneration on three small (300 m2) sites, one each in Tucker, Randolph and Pocahontas County. His finding that regeneration was occurring and that *Picea rubens* had increased in proportional density on each site says absolutely nothing about the past, current or future distribution of red spruce-northern hardwood forests.

The Service's misrepresentation of Rollins (a non-peer-reviewed master's thesis) is compounded by its failure to refer to peer-reviewed literature that *does* address the potential contribution of global warming to the recent condition of red spruce (McLaughlin et al. 1987, Johnson et al. 1988, Cogbill 1988). The final rule should fully examine all studies of red spruce condition in relationship to all factors contributing to that condition, not just those that it believes can be twisted to affirm a pre-determined conclusion.

Point two—"it is not possible to predict measurable impacts on WVNFS habitat through the foreseeable future"—is illogical. By definition, the foreseeable future is that span of time in which measurable impacts can be reasonably predicted. There is no such thing as a foreseeable future in which impacts can't be foreseen. We presume the Service meant to say that the impact of global warming on the WVNFS's habitat is so uncertain that it is not able to foresee any significant negative consequences.

This position is arbitrary and incorrect. First we note that the Service has provided no rationale for the conclusion of unpredictability. Delcourt and Delcourt (1998) foresaw that the southern range of *Picea rubens-Abies fraseri* and *Picea rubens–Abies balsamea* forests would move to northern New England in the next 100 years. If the Service believes this peer-review

study is wrong, it must present evidence and argumentation to explain its position. It is arbitrary and capricious to simply assert without explanation that it is unable to foresee what Delcourt and Delcourt clearly foresaw.

In its explanation, the Service should note that numerous researchers have considered the same question, approached it with different assumptions and methodologies, and have all reached the same conclusion: under all global warming scenarios, red spruce will be eliminated from the Central and Southern Appalachians and the northern hardwood forest will no longer exist in its current composition. There is strong scientific consensus that this is foreseeable. The Service can not ignore these studies and must acknowledge that they are the best available scientific information. Note that as the models become more refined and the data better calibrated between 1998 and 2007, they show faster and more dramatic effects.

Davis, M.B. and D.B. Botkin. 1985. Sensitivity of cool temperate forests and their fossil pollen to rapid climatic change. Quaternary Research 23:327-340. Modeling efforts based on past distributions reconstructed from the paleological record and current ecology show that small increases in temperature may change the distribution of red spruce dramatically.

Delcourt, P.A. and H.R. Delcourt, 1998. Paleoecological insights on conservation of biodiversity: a focus on species, ecosystems, and landscapes. Ecological Applications 8(4):921-934. Several models of spruce migration in relationship to global warming are presented. All models predict the extirpation of *Picea rubens-Abies* fraseri and *Picea rubens–Abies balsamea* forests south of approximately 44.0º (i.e. the White Mountains, NH).

Hansen, A.J., R.P. Neilson, V.H. Dale, C.H. Flather, L.R. Iverson, D.J. Currie, S. Shafer, R. Cook and P.J. Bartlein. 2001. Global change in forests: Responses of species, communities, and biomes. BioScience 51(9):765-779. Ranges of tree species and forest communities were predicted over 100 years using several models and six CO2 emission scenarios. Eastern spruce-fir forest were predicted to decline by 97% and disappear from southern and central Appalachians. Maple-beech-birch forests (including red maple (*Acer rubrus*), sugar maple (*Acer saccharum*), black cherry (*Prunus serotina*), American beech (*Fagus grandifolia*) and yellow birch (*Betula alleghaniensis*)) would also be eliminated from the region. Individual species suffering at least a 90% loss of current range include sugar maple (*Acer saccharum*), bigtooth aspen (*Populus grandidentata*), quaking aspen (*P. tremuloides*), northern white cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), red pine (*Pinus resinosa*), and paper birch (*Betula papyrifera*).

Iverson, L.R. and A.M. Prasad. 2001. Potential changes in tree species richness and forest community types following climate change. Ecosystems. 4:186-199. The range of 80 common tree species was predicted over 100 years under five CO2 emission scenarios. All five predicted the extirpation of spruce-fir from the eastern United States. All predicted significant declines in maple–beech–birch forests (*Acer rubrum, A. saccharum, Fagus grandifolia, Betula alleghaniensis, Prunus serotina, Juglans nigra*) including their extirpation from West Virginia. Only the two lowest emission scenarios predicted retention of aspen-birch forests in the United

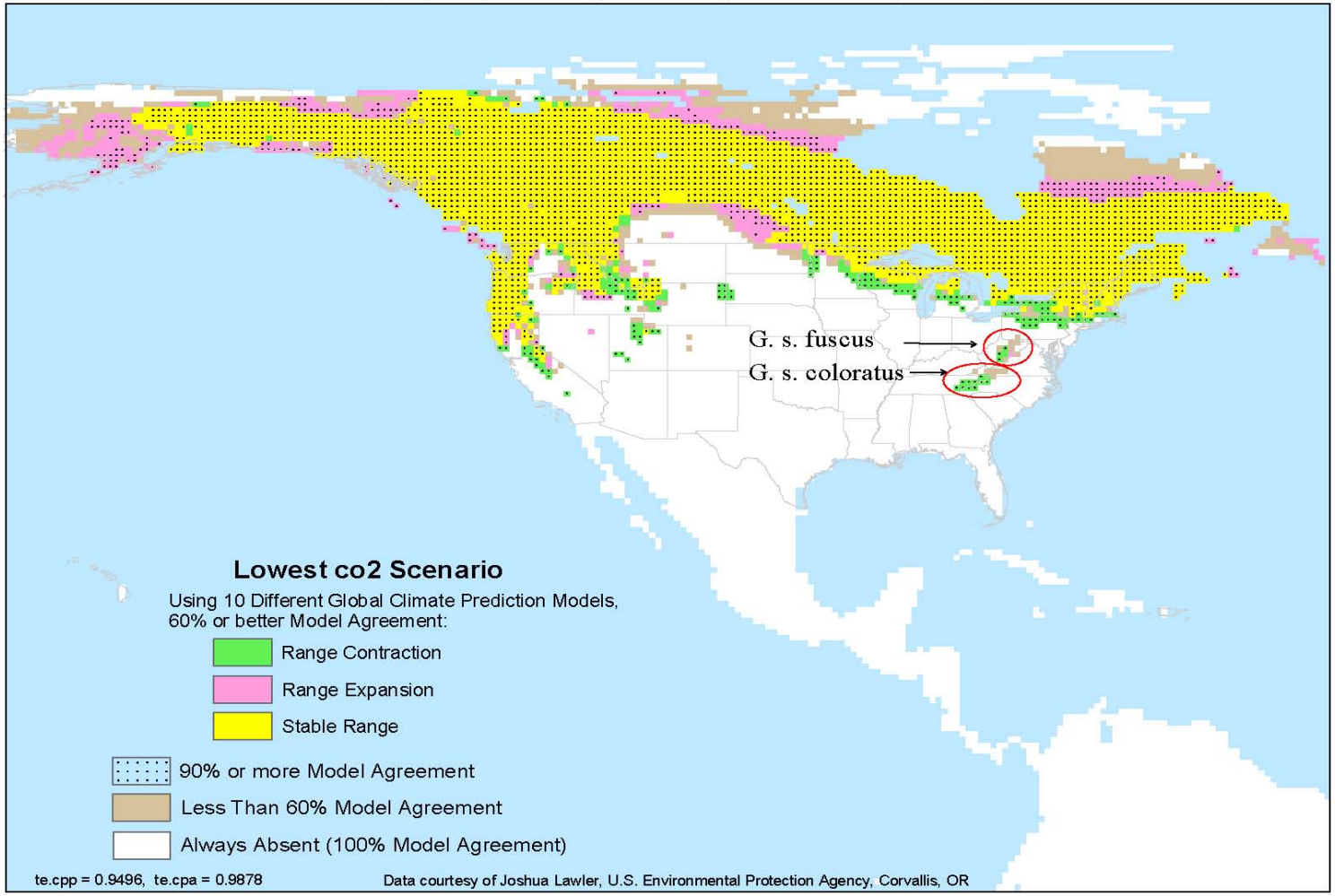
States, albeit at drastically reduced levels. This includes yellow birch (*Betula alleghaniensis*), the preferred WVNFS den tree (Menzel *et al.* 2006).

Iverson, L.R., A.M. Prasad and M.W. Schwartz. 2005. Predicting potential changes in suitable habitat and distribution by 2100 for tree species of the eastern United States. Journal of Agricultural Meteorology. 6:29-37. In an update and expansion of Iverson and Prasad (2001), Everson et al. (2005) examine the likely effect of global warming under various CO2 scenarios and trend models over 100 years on the range of 135 tree species. Most of the trees within the Southern and Central Appalachian spruce-fir and northern hardwood forests would experience significant northward range shifts.

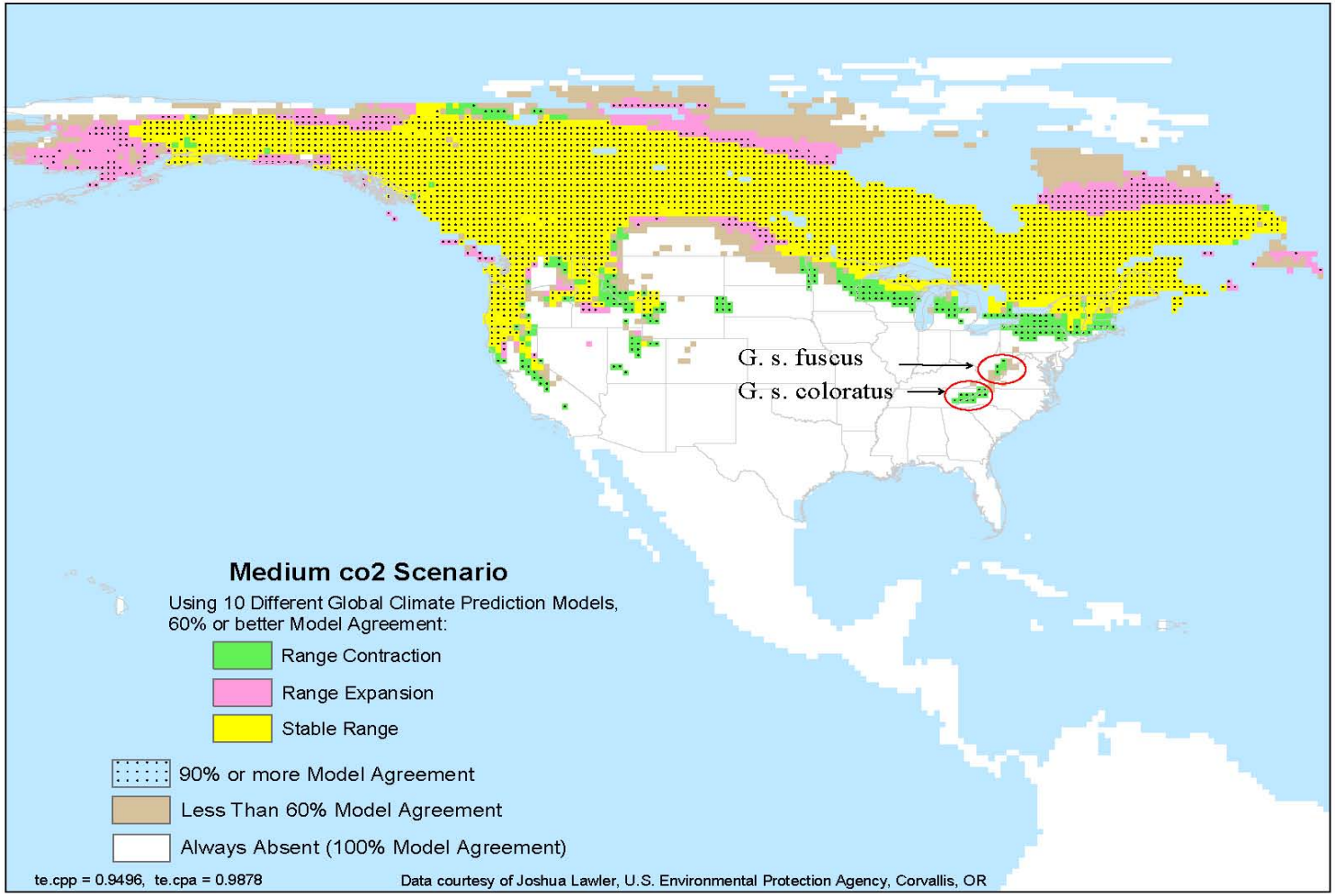
Lawler, J.J. 2007. Unpublished maps provided by Dr. Joshua Lawler, University of Washington, to Curtis Bradley, Center for Biological Diversity, March 29, 2007. Using the bioclimatic model of Lawler *et al.* (2006), which predicts future animal species distribution based on the current climate envelope, Lawler (2007) determined that under low, medium and high CO2 scenarios, all habitat of the WVNFS and the Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*) will be eliminated from the United States within the period 2061-2090.

The three following maps indicate that under low, medium and high CO2 scenarios, all habitat of the West Virginia northern flying squirrel (Glaucomys sabrinus fuscus) and Carolina northern flying squirrel (Glaucomys sabrinus coloratus) is predicted to be eliminated from the United States within the period 2061-2090. The maps were created using a bioclimatic model that predicts future distribution based on the species' current ‘climate envelope’ following the methods of Lawler et al. (2006).

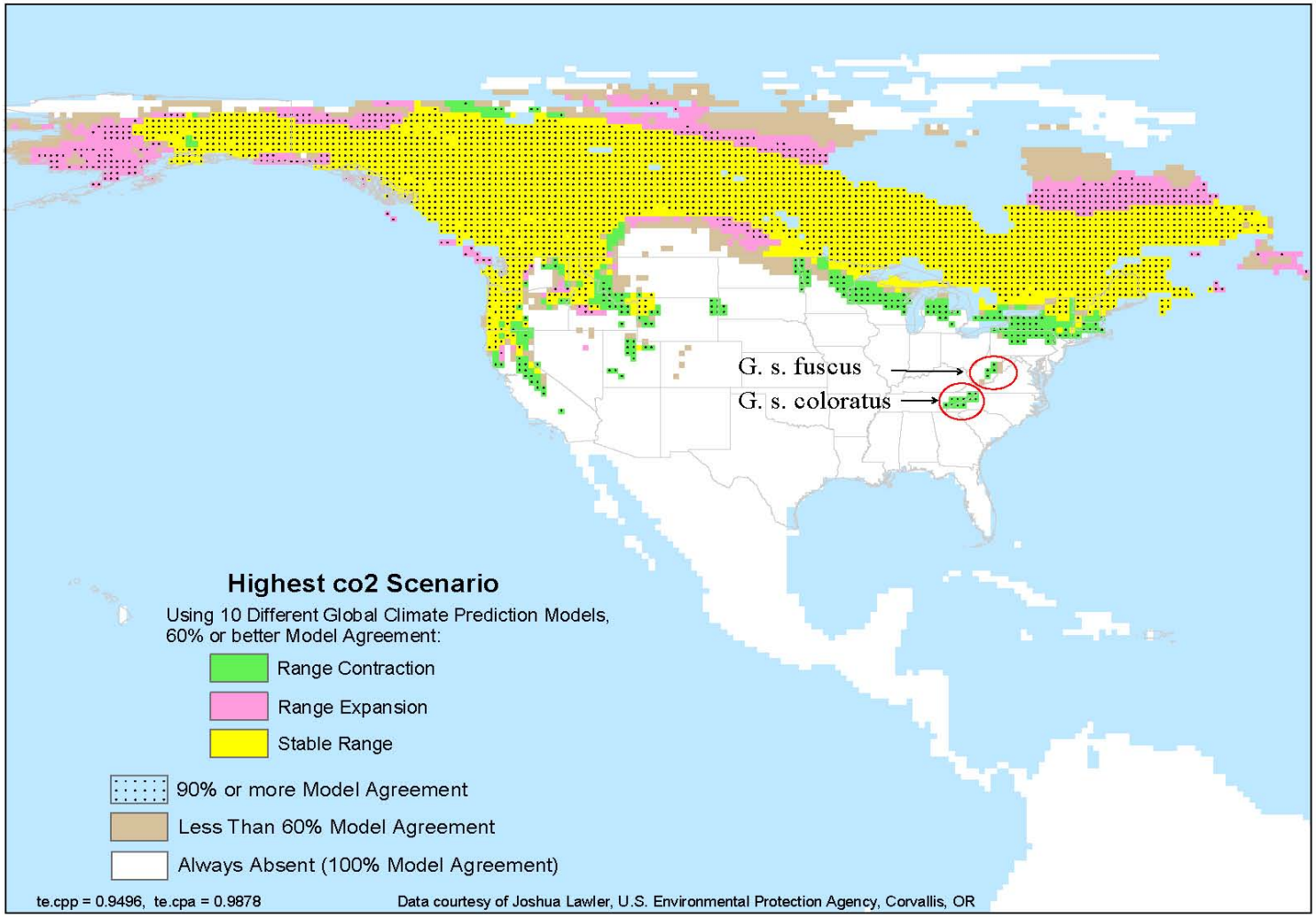
Effect of Climate Change
on Northern Flying Squirrel (glaucomys sabrinus) Range: 2061-2090



Effect of Climate Change
on Northern Flying Squirrel (glaucomys sabrinus) Range: 2061-2090



Effect of Climate Change
on Northern Flying Squirrel (glaucomys sabrinus) Range: 2061-2090



McNulty, S.G. and J.D. Aber. 2001. US National Climate Change Assessment on Forest Ecosystems: An introduction. BioScience 51(9):721-722. Though not a primary research article, McNulty and Aber reviewed studies developed for the U.S. National Climate Assessment concluding: "Under all of the climate scenarios, many of the northern US forest groups that are adapted to cooler temperatures will migrate northward, while isolated communities of other species, such as red spruce, may become extinct within their current region."

Morse, L.E., L.S. Kutner and J.T. Kartesz. 1995. Potential impacts of climate change on North American Flora. in U.S.G.S. Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. Washington, D.C. This review of the national impact of global warming on 1,500 vascular plants concluded that "The relatively high proportion of species vulnerability in the Southeast may be due in part to the presence in state floras of Appalachian Mountain species at their southern range limits. Many of these species are already rare in states along their southern range limits and are likely to be lost from the local floras if the climate warms."

Natureserve. 2006. Southeast seamless network of protected areas, Appendix 5: Ecological system reports for southeast seamless network. Natureserve, Arlington, VA www.nature.nps.gov/biology/seamlessnetworks/seamless_appendix_5_072806.doc. Though not an original research paper, NatureServe (2006) reviews conservation status of the "Central and Southern Appalachian Spruce-Fir Forest" and concludes that "Global warming can be expected to raise the lower elevational limit and greatly reduce the land area available to this system."

Overpeck J.T., P.J. Bartlein and T. Webb III. 1991. Potential magnitude of future vegetation change in Eastern North America: comparisons with the past. Science 254: 692–695. Three climate model simulation of doubled CO2 concentrations show that changes in the equilibrium distribution of natural vegetation over eastern North America over the next 200 to 500 years could be larger than the overall change during the past 7,000 to 10,000 years and equivalent to the change that took place over the 1,000- to 3,000-year period of most rapid deglaciation. Red spruce will be eliminated south of about latitude 45° N.

Vann, D.R, A.H. Johnson and B.B. Casper. 1994. Effect of elevated temperatures on carbon dioxide exchange in *Picea rubens*. Tree Physiology. 14:1339–1349. Though it does not present original research in regard to red spruce distribution, Vann et al. examine the impact of increased temperature on carbon dioxide and conclude that the mechanisms they identified are consistent with Overpeck et al. (1991): "Over the period described by Overpeck et al. (1991), red spruce may move 20--50 km. Even assuming that this estimate is conservative, only the northernmost populations of red spruce would survive. Thus, susceptibility to high temperatures combined with a low migration rate may make red spruce an early victim of global warming."

The data, methods, and time horizon of foreseeability used by the studies above are consistent with the scientific community's approach to modeling the impact of climate change on forests. Thus the issue of what can be foreseen is well-established by the scientific community:

Aber, J.D., R.P. Neilson, S. McNulty, J.M. Lenihan, D. Bachelet and R.J. Drapek. 2001. Forest processes and global environmental change: predicting the effects of individual and multiple stressors. Bioscience. 51(9):735–751. Existing ecological communities probably will not survive climate change intact.

Bachelet, D., R.P. Neilson, J.M. Lenihan and R.J. Drapek. 2001. Climate change effects on vegetation distribution and carbon budget in the United States. Ecosystems 4(3):164–185. Conifer forest in northern Wisconsin were replaced by northeast mixed forest in two climate change scenarios.

Bachelet D., J.M. Lenihan, C. Daly, R.P. Neilson, D.S. Ojima and W.J. Parton. 2001. MC1: a dynamic vegetation model for estimating the distribution of vegetation and associated carbon, nutrients, and water. Gen. Tech. Rep. 508. US Department of Agriculture, Forest Service. Pacific Northwest Research Station. Portland, OR.

Davis, M. B., and C. Zabinski. 1992. Changes in geographic range resulting from greenhouse warming: effects on biodiversity in forests. Pages 297–308 in R. L. Peters and T. E. Lovejoy, editors. Global warming and biodiversity. Yale University Press, New Haven, Connecticut, USA. Rapid climate change puts species at risk of extinction by shifting the climate envelope within which they can persist outside their current geographic range.

Golubyatnikov, L.L., I.I. Mokhov, E.A. Denisenko and V.A. Tikhonov. 2005. Model estimates of climate change impact on the vegetation cover and atmospheric carbon sink. Izvestiya, Atmospheric and Oceanic Physics 41(1):19–28. Changes in the terrestrial net primary production under possible climate changes in the 21st century are estimated. The computations are based on the dependence of net primary production on the surface radiation balance and evaporation. This dependence is derived using the relationship between the thermal conditions (annual total of effective daily mean surface temperature) and the radiation balance. Possible changes in the net primary production over Russia under a 1°C increase in the annual mean global surface temperature are estimated by using the atmosphere–ocean general circulation models ECHAM4/OPYC3 and HadCM3 and the intermediate-complexity IAP RAS climate model for anthropogenic scenarios of greenhouse gas changes. The results obtained are used to estimate the atmospheric carbon sink associated with changes in the vegetation cover.

Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K. Nicholas Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunchd, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. 101(34):12422–12427. Statewide tree distribution in California was modeled under four CO2 scenarios over 100 years. Extreme reduction in alpine/subalpine forest was predicted.

Iverson, L.R., M.W. Schwartz and A.M. Prasad. 2004. Potential colonization of newly available tree-species habitat under climate change: an analysis for five eastern U.S. species. Landscape Ecology. 19:787–799. Migration of five eastern tree species that currently do not occur in Canada was modeled over a 100-year period under two CO2 emission scenarios.

Significant range shifts were predicted for all species.

Kirschbaum M.U.F.. 2000. Forest growth and species distribution in a changing climate. Tree Physiology 20:309–322.

Lenihan, J.M., R. Drapek, D. Bachelete, and R.P. Nelson. 2003. Climate change effects on vegetation distribution, carbon, and fire in California. Ecological Applications 13(6):1667–1681. The objective of this study was to dynamically simulate the response of vegetation distribution, carbon, and fire to the historical climate and to two contrasting scenarios of climate change in California. The results of the simulations for the historical climate compared favorably to independent estimates and observations, but validation of the results was complicated by the lack of land use effects in the model. The response to increasing temperatures under both scenarios was characterized by a shift in dominance from needle-leaved to broad-leaved life-forms and by increases in vegetation productivity, especially in the relatively cool and mesic regions of the state. The simulated response to changes in precipitation were complex, involving not only the effect of changes in soil moisture on vegetation productivity, but also changes in tree–grass competition mediated by fire. Summer months were warmer and persistently dry under both scenarios, so the trends in simulated fire area under both scenarios were primarily a response to changes in vegetation biomass. Total ecosystem carbon increased under both climate scenarios, but the proportions allocated to the wood and grass carbon pools differed. The results of the simulations underscore the potentially large impact of climate change on California ecosystems, and the need for further use and development of dynamic vegetation models using various ensembles of climate change scenarios.

Neilson, R.P.. 1995. A model for predicting continental-scale vegetation distribution and water balance. Ecological Applications 5(2): 362–385.

Neilson R.P., I.C. Prentice and B. Smith. 1998. Simulated changes in vegetation distribution under global warming. In Watson R.T., Zinyowera M.C. and Moss R.H. (eds). The regional impacts of climate change: an assessment of vulnerability, pp. 439–456. Cambridge University Press, New York.

Pastor J, and W.M. Post. 1988. Response of northern forests to CO2-induced climate change. Nature 334:55–58. Climate change is predicted to reduce aboveground biomass by 44 to 96% in northern Wisconsin, dependent upon soil water-holding capacity.

Scheller, Robert M. and David J. Mlandenoff. 2005. A spatially interactive simulation of climate change, harvesting, wind, and tree species migration and projected changes to forest composition and biomass in northern Wisconsin, USA. Global Change Biology. 11:307–321. Aboveground live biomass and tree species composition were modeled over 200 years in a 1.5 million-ha study area of mesic northern hardwood forests, pine barrens, and boreal forest in northern Wisconsin based on two global warming scenarios. Six species (balsam fir (*Abies balsamea*), paper birch (*Betula papyrifera*), white spruce (*Picea glauca*), jack pine (P. banksiana), red pine (*P. resinosa*) and pin cherry (*Prunus pensylvanica*)) were projected to be eliminated from the study area.

VEMAP Members. 1995. Vegetation/ecosystem modeling and analysis project: comparing biogeography and biogeochemistry models in a continental-scale study of terrestrial ecosystem responses to climate change and CO2 doubling. Global Biogeochemical Cycles 9:407–437.

Walker, KV, M.B. Davis and S. Sugita. 2002. Climate change and shifts in potential tree species range limits in the Great Lakes region. Journal of Great Lakes Research 28:555–567. Northern pines (*Pinus* spp.) and spruces (*Picea* spp.), may be extirpated from the Great Lakes region due to global warming.

The Effects of Private Land Development and Highway Construction Have Not Been Considered

The FWS addresses the threats to the WVNFS from private land development and highway construction in the most cursory manner. Highway development and recreational development, as well as mining/gas exploration and wind farm development are assessed as follows:

> "Activities such as these are expected to continue on private lands. While some low level of local impacts are likely to continue into the future, there is no indication that the activities would occur over a landscape level, or at such a magnitude as to pose a threat to the continued existence of G.s. *fuscus*."
>
> Five-Year Review at 11.

No documentation or evidence accompanies these assertions for any of the above activities. There is no description of the criteria or thresholds for assessing magnitude. What level of activity or development would constitute "such magnitude as to pose a threat"? The FWS must define this condition, so that both FWS staff and the public can assess if or when this threat level is reached.

This minimal treatment of threats to the WVNFS flies in the face of the current level of private land development. Primary residence and especially second home construction in the affected areas of West Virginia and Virginia has been booming. As reported by the Washington Post, "From 1990 to 2000, West Virginia had the second-biggest jump in the nation in the share of its housing considered "seasonal," according to a West Virginia University analysis of recent census data. The state trailed only Hawaii. The Mountain State also was the sixth-fastest-growing state for second homes in the last decade, behind Hawaii, Arkansas, Tennessee; Kentucky and Georgia, said Randy Childs, a West Virginia University economist." (Sandra Fleishman, Washington Post, April 19th, 2003)

Increased second home development in the habitat of the West Virginia Northern flying squirrel is removing the forest cover so vital to the squirrel's life cycle. It is fragmenting populations, reducing food supplies, and exposing the squirrel to increased predation. In addition, condo and resort developments have contributed to changing the face of VA and WV in

the last few years. The pace of this growth is astounding. Most of West Virginia lacks any land use zoning laws further exacerbating the effects of this explosive growth.

The Five-Year Review touched on the topic of highway development, but failed to address the subject in any substantive manner. Appalachian Corridor H is a large 4-lane highway planned for the northern end of the current range of the West Virginia Northern flying squirrel. Once fully completed, Corridor H will open up this region to even more resort, condo and second home development as travel times from the Baltimore-Washington corridor will be shortened considerably.

Corridor H will have another adverse impact to the WVNFS as well. The preferred alternative described in the Supplemental Final Environmental Impact Statement for the Parsons to Davis Section released in February of 2007 cuts off two small populations of flying squirrels from the rest of the Blackwater Canyon population. These squirrels will be isolated from the larger breeding population to the south and from suitable habitat. They are already cut off from suitable habitat to the north by state route 219. The fact that these squirrels will not cross a two-lane highway let alone a four-lane one is well documented by Weigl et al. in 2002 in their study of the Cherohala Skyway. Their chances of survival on this small island of habitat is doubtful. This is but one example of the ongoing threats to these fragile populations.

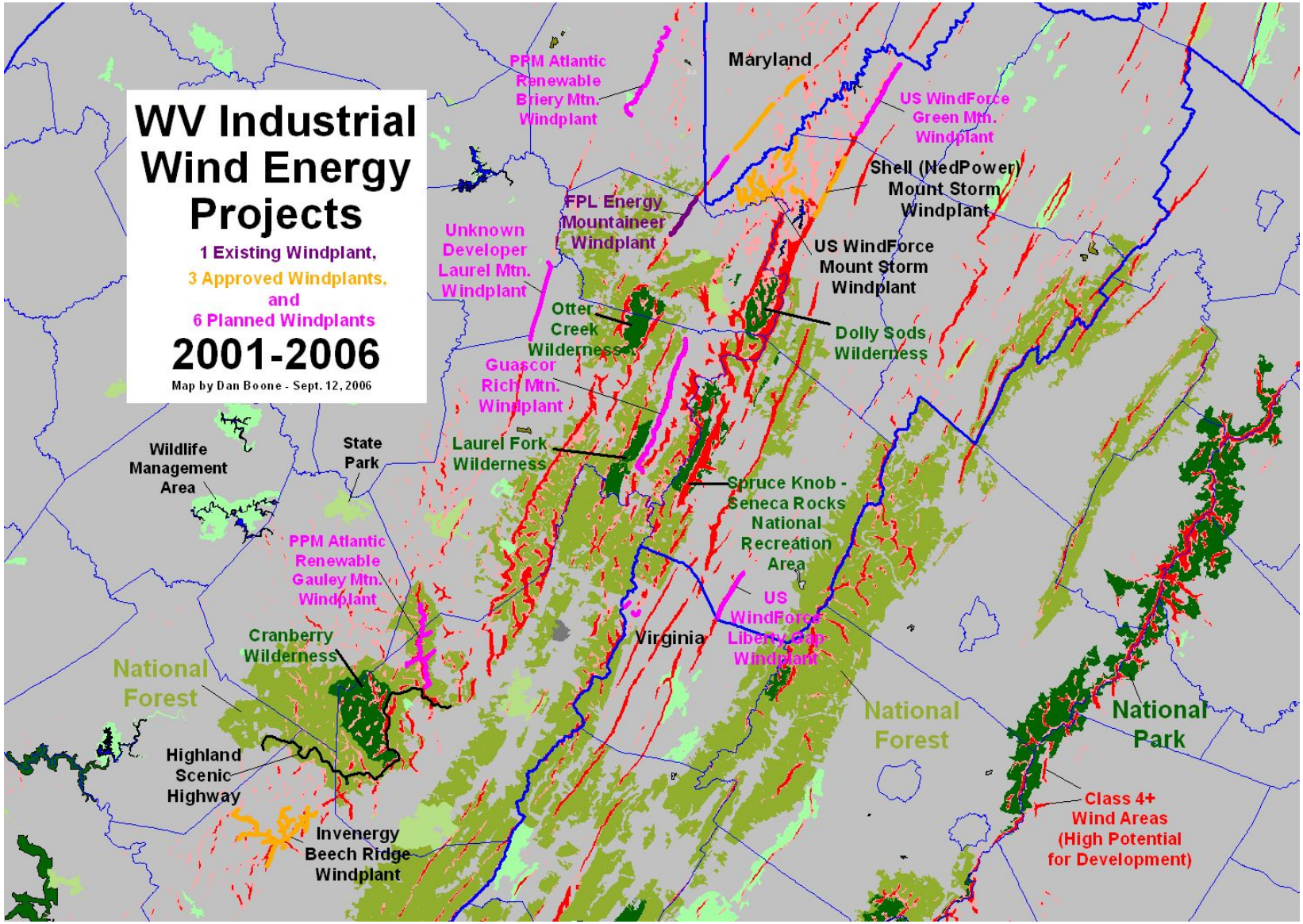
The Effects of Energy Development Have Not Been Considered

Mining and drilling for gas in the habitat range of the WVNFS is a real threat on both private and public lands. The growth of mining in the currently defined squirrel range has increased in the past couple of years. Many acres of land are cleared of forests prior to strip mining and portal development for deep mines. Road building to reach these facilities also results in significant areas being cleared of trees.

Gas exploration and the development of pipelines in the range of the WVNFS is increasing and will further fragment the habitat of the squirrel. This makes it more vulnerable to predators and separates the flying squirrel from food sources. In addition, it isolates the squirrel from suitable mates, further isolating populations which could lead to extinction.

The development of industrial wind turbine projects which requires the removal of large swaths of sensitive high elevation ridgeline forest ecosystems also can fragment and wipe out suitable habitat for the WVNFS. There is a great deal of existing, approved or planned wind energy development in Virginia and West Virginia that could adversely affect WVNFS habitat and should have been examined more thoroughly in the Five-Year Review (see the following map by Dan Boone).

These threats were barely touched on, let alone adequately considered in the Five-Year Review. The FWS must conduct a more thorough examination than simple statements that local impacts will be low level and will not be of enough magnitude to threaten the continued existence of the WVNFS.


WV Industrial Wind Energy Projects
1 Existing Windplant,
3 Approved Windplants,
and
6 Planned Windplants
2001-2006
Map by Dan Boone - Sept. 12, 2006
PPM Atlantic Renewable Briery Mtn. Windplant
Maryland
US WindForce Green Mtn. Windplant
Shell (NedPower) Mount Storm Windplant
FPL Energy Mountaineer Windplant
Unknown Developer Laurel Mtn. Windplant
US WindForce Mount Storm Windplant
Otter Creek Wilderness
Dolly Sods Wilderness
Guascor Rich Mtn. Windplant
Wildlife Management Area
State Park
Laurel Fork Wilderness
Spruce Knob - Seneca Rocks National Recreation Area
PPM Atlantic Renewable Gauley Mtn. Windplant
US WindForce Liberty/Crab Windplant
Virginia
Cranberry Wilderness
National Forest
National Forest
National Park
Highland Scenic Highway
Invenergy Beech Ridge Windplant
Class 4+ Wind Areas (High Potential for Development)

FWS Protection Proposals

The MOU with the Forest Service

The FWS has entered into a Memorandum of Understanding (MOU) with the Forest Service for continued management and protection of the WVNFS. We have a number of concerns with this approach given our knowledge of the Forest Service and its funding and management priorities. The Forest Service, like the FWS, faces significant cuts in budget and staff in the near and foreseeable future. The Monongahela NF (MNF) has not had the time or funds to engage in extensive monitoring or to publish a monitoring plan in a few years. Given upcoming budget cuts we question the ability of the agency to fulfill its obligations in the MOU.

Further, the MOU lacks sufficient detail as to force any of the parties to do much in the way of specific activities. The Forest Service is tasked as follows, "As such, the Forest Service would try to ensure that management activities would not contribute to a trend towards federal listing" (emphasis added). (MOU at pg 3) This is hardly represents adequate protection for the WVNFS. In addition, the MOU contains a termination clause with a low threshold: all parties can opt out for any reason with 30-days notice. (MOU, Exhibit 2 at pg 3). Again, this is insufficient to protect the squirrel or its habitat.

Stateside Funding

Where will the stateside funds come from to carry out the post-delisting monitoring plan? Expert staff at the West Virginia Department of Natural Resources are retiring and leaving for other reasons and funds are limited to carry out this type of work. The parties to the MOU should explain the certainty of their funding sources. This issue is not explained in the proposed Rule.

FWS Arguments for Delisting

The delisting rule of 19 December 2006 does not adequately address the following criteria, as required by 16 U.S.C. §1533(a)(1):

1. The present or threatened destruction, modification, or curtailment of its habitat or range;
2. Over utilization for commercial, recreational, scientific, or educational purposes;
3. Disease or predation;
4. The inadequacy of existing regulatory mechanisms; or
5. Other natural or manmade factors affecting its continued existence.

Instead, the FWS arbitrarily and capriciously asserts that the delisting complies with the ESA because of the following:

1. A significant increase in the number of known WVNFS capture sites;
2. An increase in the number of individual squirrels;
3. Multiple generation reproduction;
4. The proven resiliency of the squirrels; and
5. The vast improvement and continued expansion of suitable habitat.

71 Fed. Reg. 75924 (2007).

At a minimum, the delisting rule fails to utilize the "best scientific and commercial data available." The undersigned have analyzed the squirrel capture data and nest box data available to the public and acquired via the Freedom of Information Act. What is clear is that the capture data does not consistently and adequately identify capture sites. Each of the five factors the FWS relies upon for delisting are examined below.

Significant Increase in the Number of Known WVNFS Capture Sites, an Increase in the Number of Individual Squirrels, and Multiple Generation Reproduction

Erroneous Assumptions

The West Virginia Northern Flying Squirrel was not described until 1936. In 1985, 10 WVNFS individuals were known from Randolph and Pocahontas Counties, WV, and Highland County, VA (Service 2006b, p. 8). Finding just 10 more squirrels would double the population and significantly increase the number of capture sites. Twenty squirrels would not constitute a "recovered" population, but that reasoning appears to be behind the statement that there is a significant increase in the number of capture sites. Finding over 1,000 squirrels in eight counties (and likely closer to 650 squirrels) cannot, logically or scientifically, constitute recovery without adequate analysis.

Lack of Studies and Data

Knowledge of the species is still quite fragmentary as relatively few long-term studies have been conducted, (Fryxell et al. 1998; Carey et al. 147 1999; Weigl et al. 1999; Cotton and Parker 2000a, 200b; Ransome and Sullivan 2002; Lehmkuhl et al. 2006; Smith and Person, in press). The Menzel study – upon which so much of the delisting rule is based – produced its model based on the review of 87 boxes. The Forest Service states that 4,500 nest boxes were placed in likely squirrel habitat in West Virginia and yet no detailed results of this survey work are available. The Five-Year Review does state that the nest box surveys had only a 2% success rate (pg 7). The nest boxes were located in red spruce habitat skewing this monitoring program toward a finding of red spruce as preferred squirrel habitat, but actual squirrel capture data seems to refute the exclusive focus on red spruce (Menzel, 2003, p 93.).

Alternate Data That Disproves Assumption

The Five-Year Review states that 1,141 captures have been recorded. Our review of the field capture sheets shows 1,147 captures but only 654 captures that can be

considered unique captures. The additional 493 captures were either not tagged, were recaptures, or it is unknown if they were tagged. The data used by the Fish and Wildlife Service comes from a combination of studies, surveys, and one time trapping to clear the way for a project. Different methodology was used for different projects so that the capture data cannot be analyzed as a whole. The failure to set up protocols for this research makes the data set meaningless. The Fish and Wildlife Service should have reviewed these records themselves before claiming that numbers and sites are increasing. Their assertions appear to be inaccurate.

The Proven Resiliency of the Squirrels

Erroneous Assumptions

The FWS appears to premise this assertion on the fact that the West Virginia Northern Flying Squirrel is still around 22 years after listing as though this proves the squirrel is resilient. It is unclear what scientific reasoning supports this assertion. A species can take decades to become extinct. Even though it persists does not mean it is "surviving" or "recovering" to a stable, sustainable population. As acknowledged by the agency current habitat conditions are not as favorable for the WVNFS as historic conditions. While current conditions may be much improved compared to that at the time of listing, have they improved to a point that ensures the species is recovered? The FWS has not shown this to be the case.

Lack of Studies and Data

The study of trends in population has not been done and cannot be done based on the limited data set described above.

What we have done in this letter is to provide the FWS with the evidence that shows the threats to this species are increasing unabated. Global warming is simply not addressed in the delisting analysis. The threats to the species have not abated over the last 22 years, and have, in fact, increased. In addition to global warming the flying squirrel faces the following threats:

- Loss of food supply. Changes to the forest from the removal of older trees reduce the fungus that the squirrels eat. Fungal growth is dependent on older trees and the micro-habitat they create. More science is needed on this. The fact that the Monongahela National Forest proposes to log up to 40% of Management Area 4.1 (red spruce with a focus on flying squirrel habitat) will only exacerbate the loss of the squirrel's food supply.

- Fragmentation of habitat exposes squirrels to mesopredators (such as cats, raccoons, possums, foxes, etc.) as the canopy is opened up. Fragmentation isolates populations reducing access to mates and to food supplies. The effect on genetic diversity within the species has not been studied to the degree that more

habitat fragmentation, through activities such as logging and road building, should be supported or allowed.

- Science shows that roads create absolute barriers to flying squirrel movement. The increase in highway construction, second homes, and logging roads will exacerbate this problem.

The Vast Improvement and Continued Expansion of Suitable Habitat

Erroneous Assumptions

In 1985, the Service noted "[I]n these last occupied zones, the squirrels [G. s. fuscus and G. s. coloratus] and their habitat may be coming under increasing pressure from human disturbances such as logging and development" (50 FR 26999, p. 27000). 71 Fed. Reg. 75925 (2007). As explained elsewhere in these comments the human population (and second home population) is increasing in the squirrel's habitat and the Forest Service, state forestry divisions, and private landowners are increasing their commercial extraction of this area. Going from industrial clearcutting in the 1970s and 1980s to a system where logging is less reliant on clearcutting may be a "vast improvement" for some species, but there is no evidence that it is an improvement for the squirrel.

Lack of Studies and Data

Knowledge of the species is still quite fragmentary as relatively few long-term studies have been conducted, (Fryxell et al. 1998; Carey et al. 147 1999; Weigl et al. 1999; Cotton and Parker 2000a, 200b; Ransome and Sullivan 2002; Lehmkuhl et al. 2006; Smith and Person, in press). Only one small study of red spruce in West Virginia by Rollins shows an increase in this forest type and this master's thesis has very little data to support this contention.

No studies have been done in West Virginia on the impacts of logging on the flying squirrel which is planned for the "squirrel habitat" (MA 4.1) on the Monongahela National Forest.

Alternate Data That Disproves Assumption

The climate change scenarios cited in this document show a steep decline in red spruce forest type. Other forest types like the northern hardwoods used by the flying squirrel also are at risk from climate change, beech disease, the hemlock wooly adelgid and extensive logging.

The Carey study above is the only one that describes the effects of timbering on flying squirrels and it was done in the Pacific Northwest. This logging study showed a reduction in the number of flying squirrels after logging in its habitat. The Forest Service is proposing to protect the squirrel under Management Prescription 4.1 in the Forest Plan (2006) but they also plan to do logging in this habitat. This proposed logging will likely

result in a decrease of older growth northern hardwood forests, a component of flying squirrel habitat, and ultimately could threaten the recovery of the flying squirrel.

Reports to Congress

The Fish and Wildlife Service is required to report to Congress on a regular basis the status of threatened and endangered species. In the case of Glaucomys sabrinus fuscus, the formal time line of the agency's management of the species in the last 22 years indicates that the threats have been uniform. To whit, at no time has the agency communicated to Congress that the species is recovered.

The *Glaucomys sabrinus fuscus* was listed as an endangered species on July 1, 1985. It has never been listed as "threatened." At that time it was noted, "A decision to propose only threatened status would not adequately express the evident rarity and multiplicity of problems of these animals." 49 Fed. Reg. 45882 (1984). On September 24, 1990 a recovery plan for the Squirrel was published.

Between 1994 and 2004, the FWS consistently reported to Congress that the squirrel still faced threats. In 1996, the FWS stated that the species' population status was "Improving"; that 51%-75% of recovery had been achieved; and that the Recovery Priority remained at "9." (The scale is 1-18 with 1 being species with highest potential for recovery.) The 1997- 1998 Report stated that the population status was "Stable" (no change for the species' numbers and threats since last reporting period); that 26%-50% of recovery had been achieved; and that the recovery priority remained a "9."

In the 1999-2000 Report to Congress, the agency stated that population status was "Stable"; that 26%-50% of recovery had been achieved; and the Recovery Priority remained at "9." In the 2001-2002 Report to Congress, the agency stated that the population status was still "Stable"; that 26%-50% of recovery had been achieved; and that the Recovery Priority Number was now "9c." (The C indicates the species is or may be in conflict with construction or other development projects, or other forms of economic activity.)

On February 24, 2003, the FWS issued a Habitat Conservation Plan to a ski resort so that it could expand its operations and harvest some trees. On January 23, 2006, the FWS again issued a Habitat Conservation Plan to the same ski resort to further expand its facilities. In the 2003-2004 Report, population status was still "Stable"; 51%-75% of recovery had been achieved; and the Recovery Priority Number remained at " 9c." As late as September 2005 the species was given a recovery priority number of 9c indicating a moderate degree of threat, high recovery potential, and conflict with economic development for this subspecies. High recovery potential does not indicate that recovery has been achieved.

On May 19, 2006, the agency published a 5-year review where it was first communicated to the public that delisting was being considered by the agency. Nothing

in the reports to Congress or any other public documents prior to 2006 indicated that the squirrel satisfied the downlisting criteria. The delisting rule is not based on a recovered population of the squirrel; the delisting rule is not based on the criteria of the 1990 Recovery Plan; the delisting rule is not based on the criteria of 16 U.S.C. §1533. Instead, the FWS is proposing to delist the species based on the persistence of the species and unverified assurances from other government agencies.

Role of Recovery Team Scientists in the Delisting Process

Research professors Dr. Peter Weigl and Dr. John Pagels, who were on the Appalachian northern flying squirrel Recovery Team and had developed much of the methodology to carry out the recovery goals, were not invited to work on the delisting process. They were not told that delisting was being considered, only downlisting. Their years of research would have been invaluable to the Fish and Wildlife Service personnel working on the Five Year Review of the West Virginia northern flying squirrel. However, they were not consulted and much of their research was not used. Dr. Weigl made clear in his comments submitted for this comment period that he is opposed to delisting Glaucomys sabrinus fuscus. Dr. Pagels raised a number of important concerns about delisting as well.

We question why this was the case. What effort did the Fish and Wildlife Service make to include Drs. Weigl and Pagels in the Five Year Review process? What efforts were made to include other Recovery Team researchers in the Five Year Review? It appears that several of the Recovery Team scientists were not consulted. Did any of the Recovery Team researchers participate in the Five Year Review? If so, whom? If not, why not?

Recommendations and Conclusions

The consideration of the proposal to delist Glaucomys sabrinus fuscus is premature at this time. Any decision to delist would be arbitrary and capricious. As we have discussed in the preceding pages, there is a significant lack of knowledge of basic elements of WVNFS existence including its population size and trends, life cycle and habitat needs.

We are also concerned with the process approach the agency seems to have used in this case. Recovery plans, standards, adherence to assessment of (delisting) criteria and the actual recovery of the species itself seem to have been abandoned in the rush to delist. We hope this approach is not indicative of a new standard for threatened and endangered species protection at the Fish and Wildlife Service, but rather an anomaly in agency performance which can be corrected.

Further action on the status of the WVNFS must be focused on filling in these significant gaps in knowledge. Obviously, more research is needed. The post-delisting

monitoring plan must also be written and submitted for public comment. We also await the release of additional materials under FOIA.

For all the reasons discussed, we ask that the US Fish and Wildlife Service withdraw this proposal.

We appreciate the opportunity to comment on the proposed delisting of Glaucomys sabrinus fuscus. Please include these comments and attachments as part of the administrative record for this matter. We'll also email an electronic version of this comment letter to aid in comment content analysis. If you have any questions about our comments, please feel free to contact me.

Please continue to send any materials regarding the delisting process. We, the undersigned, hereby each request to receive these documents in both CD-ROM and paper formats. The addresses and phone numbers of all signatories can be found below. Mary Krueger will act as point person for any questions on these comments.

Please contact Mary Krueger at:
The Wilderness Society
950 Pearl Hill Road
Fitchburg, MA 01420
(978) 342-2159
mary_krueger@tws.org

Sincerely,

Mary C. Krueger
Forest Policy Analyst
The Wilderness Society
950 Pearl Hill Road
Fitchburg, MA 01420
(978) 342-2159
mary_krueger@tws.org

Judith Holyoke Schoyer Rodd
Director - Friends of Blackwater
501 Elizabeth St., Room 3
Charleston, WV 25311
(304) 345-7663
info@saveblackwater.org

Hugh Irwin
Conservation Planner
Southern Appalachian Forest Coalition
46 Haywood Street
Suite 323
Asheville, NC 28801
(828) 252-9223
hugh@safc.org

Ben Prater
Conservation Director
Southern Appalachian Biodiversity Project
16 Eagle Street
Ste 200
Asheville, NC 28801
(828) 258-2667
ben@sabp.net

Leigh Haynie
Heartwood Staff Attorney
Heartwood
1009 Kidder Road
Carencro, LA 70520
(337) 886-9145
envirolah@earthlink.net

Kieran Suckling
Center for Biological Diversity
PO Box 710
Tucson AZ 85702-0710
(520) 623-5252
ksuckling@biologicaldiversity.org

Janet Keating
OVEC
PO Box 6753
Huntington, WV 25773-6753
Mountainwild49@yahoo.com

Tina Marie Johnson
Kentucky Heartwood
PO Box 329
Morehead, KY 40351
(606) 780-1336
tjohnson@maced.org

Myra Bonage-Hale
LaPaix Herb Farm
3052 Crooked Run Road
Alum Bridge, WV 26321
lapaix@westvirginia.net

Jim Scheff
Coordinator
Missouri Forest Alliance
20 Crabapple Court
St. Louis, MO 63132
(314) 991-4190
shagbark12@sbcglobal.net

David Muhly
Senior Regional Representative
Sierra Club - Appalachian Region
10501 East Bluegrass Trail, Ste 2
Bland, VA 24315
(276) 688-2190
david.muhly@sierraclub.org

Sherman Bamford
Public Lands Coordinator
Virginia Forest Watch
PO Box 3102
Roanoke, Va. 24015-1102
(540)343-6359
bamford2@verizon.net

Tammy Belinsky
WildLaw
9544 Pine Forest Road
Copper Hill, VA 24079
(540) 929-4222
wildlawVA@rev.net

Caitlin Love Hills
National Forest Program, Director
American Lands Alliance
(202) 547-9105
(202) 547-9213 (fax)
caitlin@americanlands.org

James Kotcon
President
West Virginia Environmental Council
2206 Washington Street, East
Charleston, WV 25301
(304) 414-0143

Paul Burke
Stewards of the Potomac Highlands
PO Box 455
Wardensville, WV 26851
numbersinstitue@juno.com

Citations

Aber, J.D., R.P. Neilson, S. McNulty, J.M. Lenihan, D. Bachelet and R.J. Drapek. 2001. Forest processes and global environmental change: predicting the effects of individual and multiple stressors. Bioscience 51(9):735–751.

Bachelet, D., R.P. Neilson, J.M. Lenihan and R.J. Drapek. 2001. Climate change effects on vegetation distribution and carbon budget in the United States. Ecosystems. 4(3):164–185.

Bachelet D., J.M. Lenihan, C. Daly, R.P. Neilson, D.S. Ojima and W.J. Parton. 2001. MC1: a dynamic vegetation model for estimating the distribution of vegetation and associated carbon, nutrients, and water. Gen. Tech. Rep. 508. US Department of Agriculture, Forest Service. Pacific Northwest Research Station. Portland, OR.

Carey, A.B., J. Kerscher, R Biswell and Dominguez De Toledo. 1999. Ecological scale and forest development: squirrels, dietary fungi, and vascular plants in managed and unmanaged forests. Wildlife Monographs 142:1-71.

Cotton, C.L., and K.L. Parker. 2000a. Winter activity patterns of northern flying squirrels in sub-boreal forests. Canadian Journal of Zoology 78:1896-1901.

Cotton, C.L., And K.L. Parker. 2000b. Winter habitat and nest trees used by northern flying squirrels in sub-boreal forests. Journal of Mammalogy 81:1071-1086.

Davis, M.B. and D.B. Botkin. 1985. Sensitivity of cool temperate forests and their fossil pollen to rapid climatic change. Quaternary Research 23:327-340.

Davis, M. B., and C. Zabinski. 1992. Changes in geographic range resulting from greenhouse warming: effects on biodiversity in forests. Pages 297–308 in R. L. Peters and T. E. Lovejoy, editors. Global warming and biodiversity. Yale University Press, New Haven, Connecticut, USA.

Delcourt, H. R. and P.A. Delcourt. 1984. Ice age haven for hardwoods. Natural History (84):22–28.

Delcourt, P.A. and H.R. Delcourt, 1998. Paleoecological insights on conservation of biodiversity: a focus on species, ecosystems, and landscapes. Ecological Applications 8(4):921-934.

Fleishman, Sandra. April 19, 2003. Heading for the hills, West Virginia, far from the big city, draws buyers of second homes. Washington Post, page FO1.

Fryxell, J.M., J.B. Falls, E.A. Falls and R.J. Brooks. 1998. Long-term dynamics of small mammal populations in Ontario. Ecology 79:213-225.

Golubyatnikov, L.L., I.I. Mokhov, E.A. Denisenko and V.A. Tikhonov. 2005. Model estimates of climate change impact on the vegetation cover and atmospheric carbon sink. Izvestiya, Atmospheric and Oceanic Physics 41(1):19–28.

Grumbine, R. Ghost Bears: Exploring the Biodiversity Crisis; Washington, DC: Island Press, 1992

Hansen, A.J., R.P. Neilson, V.H. Dale, C.H. Flather, L.R. Iverson, D.J. Currie, S. Shafer, R. Cook and P.J. Bartlein. 2001. Global change in forests: Responses of species, communities, and biomes. BioScience. 51(9):765-779.

Hamburg, S.P., and C.V. Cogbill 1988. Historical decline of red spruce populations and climatic warming. Nature 331: 428-431.

Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K. Nicholas Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunchd, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. 101(34):12422–12427.

Iverson, L.R. and A.M. Prasad. 2001. Potential changes in tree species richness and forest community types following climate change. Ecosystems. 4:186-199.

Iverson, L.R., M.W. Schwartz and A.M. Prasad. 2004. Potential colonization of newly available tree-species habitat under climate change: an analysis for five eastern U.S. species. Landscape Ecology. 19:787–799.

Iverson, L.R., A.M. Prasad and M.W. Schwartz. 2005. Predicting potential changes in suitable habitat and distribution by 2100 for tree species of the eastern United States. Journal of Agricultural Meteorology. 6:29-37.

Johnson, A.H., E.R. Cook, and T.G. Siccama 1988. Climate and red spruce growth and decline in the northern Appalachians. Proceedings of the National Academy of Sciences of the United States of America 85(15): 5369-5373.

Kirschbaum M.U.F.. 2000. Forest growth and species distribution in a changing climate. Tree Physiology 20:309–322.

Lawler, J.J. 2007. Unpublished maps provided by Dr. Joshua Lawler, University of Washington, to Curtis Bradley, Center for Biological Diversity, March 29, 2007.

Lawler, J.J, D. White, R.P. Neilson and A.R. Blaustein. 2006. Predicting climate-induced range shifts: model differences and model reliability. Global Change Biology. 12:1568–1584.

Lehmkuhl, T.F., K.D. Kistler, J.S. Bagley And J. Boulanger. 2006. Demography of northern flying squirrels informs ecosystem management of western interior forests. Ecological Applications 16:584-600.

Lenihan, J.M., R. Drapek, D. Bachelete, and R.P. Nelson. 2003. Climate change effects on vegetation distribution, carbon, and fire in California. Ecological Applications. 13(6):1667–1681.

McLaughlin, S.B., D.J. Downing, T.J. Blassing, E.R. Cook, and H.S. Adams 1987. An analysis of climate and competition as contributors to decline of red spruce in high elevation Appalachian forests of eastern United States. Oecologia 72: 487-501.

McNulty, S.G. and J.D. Aber. 2001. US National Climate Change Assessment on Forest Ecosystems: An introduction. BioScience 51(9):721-722.

Menzel, Jennifer. 2003. Thesis, WV University. "An Examination of the Habitat Requirements of the Endangered Virginia northern Flying Squirrel (Glaucomys sabrinus fuscus) by Assessing Nesting Sites, Habitat Use and the Development of a Habitat Model".

Menzel, J.M., W.M. Ford, J.W. Edwards and T.M. Terry. 2006. Home range and habitat use of the vulnerable Virginia northern flying squirrel Glaucomys sabrinus fuscus in the central Appalachian Mountains, USA. Oryx 40(2):204-210.

Mitchell, Donna. 2001. Spring and fall diet of the West Virginia northern flying squirrel. American Midland Naturalist.

Morse, L.E., L.S. Kutner and J.T. Kartesz. 1995. Potential impacts of climate change on North American Flora. in U.S.G.S. Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. Washington, D.C.

Natureserve. 2006. Southeast seamless network of protected areas, Appendix 5: Ecological system reports for southeast seamless network. Natureserve, Arlington, VA www.nature.nps.gov/biology/seamlessnetworks/seamless_appendix_5_072806.doc.

Neilson, R.P.. 1995. A model for predicting continental-scale vegetation distribution and water balance. Ecological Applications 5(2): 362–385.

Neilson R.P., I.C. Prentice and B. Smith. 1998. Simulated changes in vegetation distribution under global warming. In Watson R.T., Zinyowera M.C. and Moss R.H. (eds). The regional impacts of climate change: an assessment of vulnerability, pp. 439–456. Cambridge University Press, New York.

Overpeck J.T., P.J. Bartlein and T. Webb III 1991. Potential magnitude of future vegetation change in Eastern North America: comparisons with the past. Science 254:

692–695.

Pastor J. and W.M. Post. 1988. Response of northern forests to CO2-induced climate change. Nature 334:55–58.

Ransome, D.B., And T.P. Sullivan. 2002. Short-term population dynamics of Glaucomys sabrinus and Tamiasciurus douglasii in commercially thinned and unthinned stands of coastal coniferous forest. Canadian Journal of Forestry Research 32:2043-2050.

Scheller, Robert M. and David J. Mlandenoff. 2005. A spatially interactive simulation of climate change, harvesting, wind, and tree species migration and projected changes to forest composition and biomass in northern Wisconsin, USA. Global Change Biology. 11:307–321.

Smith, W.P. 2007 Ecology of *Glaucomys sabrinus*: habitat, demography, and community relations. Journal of Mammalogy, accepted for publication.

Smith, W.P. and D.K. Person. Estimated persistence of northern flying squirrel populations in temperate rain forest fragments of southeast Alaska Animal Conservation. In press.

Suckling, K. 2006. Measuring the Success of the Endangered Species Act: Recovery Trends in the Northeastern United States. Center for Biological Diversity, Tucson, AZ, available at www.esasuccess.org.

VEMAP Members. 1995. Vegetation/ecosystem modeling and analysis project: comparing biogeography and biogeochemistry models in a continental-scale study of terrestrial ecosystem responses to climate change and CO2 doubling. Global Biogeochemical Cycles 9:407–437.

Vann, D.R, A.H. Johnson and B.B. Casper. 1994. Effect of elevated temperatures on carbon dioxide exchange in Picea rubens. Tree Physiology. 14:1339–1349.

Walker, KV, M.B. Davis and S. Sugita. 2002. Climate change and shifts in potential tree species range limits in the Great Lakes region. Journal of Great Lakes Research. 28:555–567.

Weigl, P.D. 2007. The northern flying squirrel *Glaucomys sabrinus*: A conservation challenge. Journal of Mammalogy, accepted for publication.

Weigl, P.D., T.W. Knowles And A.C. Boynton. 1999. The distribution and ecology of the northern flying squirrel, Glaucomys sabrinus coloratus in the southern Appalachians, North Carolina Wildlife Resources Commission, Raleigh.

Weigl, P.D., R.S. Hughes and D.C. Battle. 2002 Study of the northern flying squirrel populations along the Cherohala Skyway: questions of fragmentation and ecology in the southern most part of the range. Final report to the North Carolina Department of Transportation and the U.S. Fish and Wildlife Service. Wake Forest University. Winston Salem, NC.