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Southern Region

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Environmental Assessment for 2010 Suppression of Hemlock Woolly Adelgid Infestations

Pisgah National Forest: Haywood, Madison, Avery, Burke, Caldwell, McDowell, Buncombe, Henderson, Mitchell, Transylvania, and Yancey Counties, North Carolina

Nantahala National Forest: Graham, Swain, Jackson, Macon, Cherokee, and Clay Counties, North Carolina

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Content

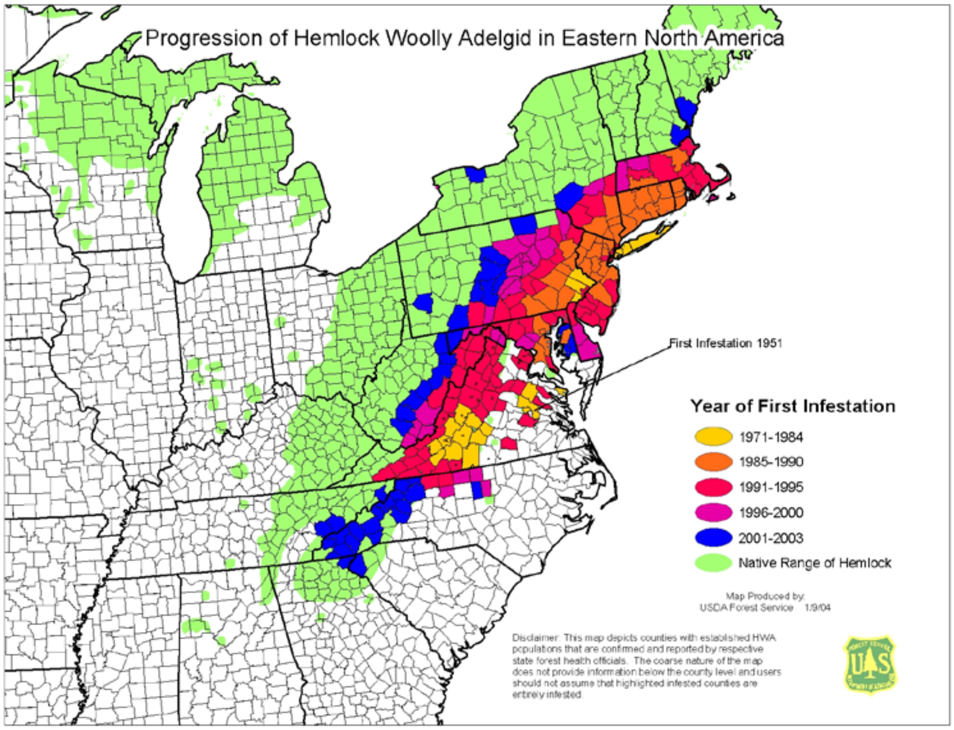
Summary

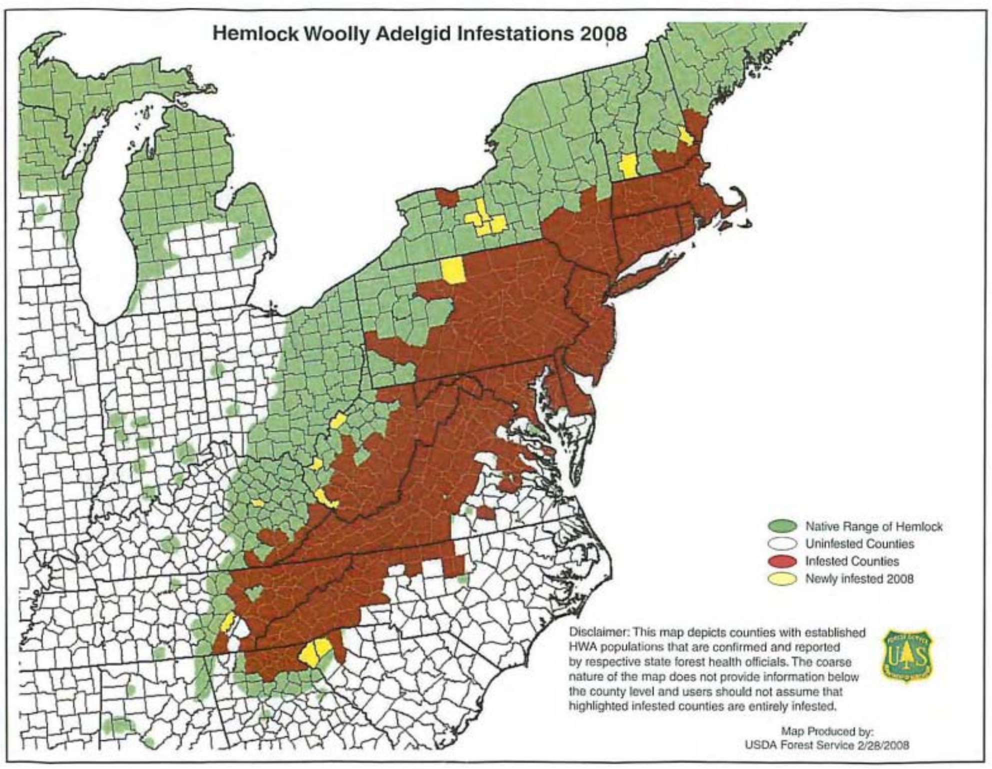
In 2005, the US Forest Service Regional Forester issued a decision for The Suppression of Hemlock Woolly Adelgid (HWA) Infestations on the Nantahala and Pisgah National Forests. That decision allowed for treatment of woolly adelgid infestations affecting eastern and Carolina hemlock on 159 sites across the Nantahala and Pisgah National Forests (NPNFs) using a combination of biological (beetle release) and chemical (imidacloprid) treatments.

In the five years since that decision, HWA populations have continued to spread and decimate hemlocks across the forest. The decline of hemlock is much more rapid than originally anticipated and more aggressive management is needed to protect the remaining stands of hemlock while long term solutions are developed. We currently have the opportunity to protect a number of eastern and Carolina hemlock stands that are still relatively intact, by utilizing additional treatment methods and by broadening the scope of treatment areas.

Project objectives are to: (1) Reduce hemlock mortality from HWA by establishing reproducing populations of predator beetles that feed on HWA; (2) Maintain reproducing populations of eastern hemlock and Carolina hemlock throughout the historical geographic and elevational range across the Forests, and; (3) Ensure survival of ecologically and culturally important groups of hemlocks.

Progression of HWA in the Eastern U.S.





Chapter 1 – Purpose and Need

Background

Existing Management Strategy

The USDA Forest Service has statutory responsibility to take steps to preserve the diversity of tree species in the forest. The Hemlock Woolly Adelgid (HWA, *Adelges tsugae*) is a catastrophic introduced pest of hemlock trees in the eastern United States. Without long-term control of HWA there may be devastating impacts to southern Appalachian ecosystems as eastern and Carolina hemlocks are lost throughout their range. HWA began attacking hemlock along the east coast in the 1950's and it currently infests about one-half of the area where hemlocks grow in the eastern U.S. It was found in North Carolina in the mid-1990's, but was not known to occur on the Nantahala or Pisgah National Forests until 1999. Early in 2004 it became obvious that infestation was widespread and many trees were heavily infested with visible signs of decline. Current monitoring indicates that over half the range of hemlock in the eastern U.S. is now infested and that the entire range of eastern hemlock is at risk.

The 2005 Decision by the Regional Forester for The Suppression of Hemlock Woolly Adelgid Infestations (2005 Decision) allows for the release of HWA predatory beetles on 159 hemlock conservation areas across the Nantahala and Pisgah NFs, including Wilderness areas. The 159 potential conservation areas were selected to meet the requirements of a hemlock conservation network designed to represent community diversity within the distribution of known Carolina and eastern hemlock stands. Conservation areas are identified as plant communities in which Carolina or eastern hemlock are the predominant tree species and which contain an adequate number of trees to ensure genetic diversity within the population.

The HWA predatory beetle species currently approved for release have had their biology and environmental safety thoroughly evaluated, and meet USDA risk assessment criteria for release (Hennessey, R. 1995, Salom, S. 1998, Zilahi-Balogh, G.M.G. 2001, Montgomery et al. 1997, Lu and Montgomery 2001, Butin et al. 2002).

In addition to beetle releases, ongoing treatments include the application of the chemical imidacloprid in specified conservation areas, including Wilderness areas. Imidacloprid is a widely used systemic insecticide with applications ranging from agricultural food production to flea control on pets. Unlike common aerosol insecticides that may injure or kill non-target species, systemics are absorbed by the host plant and kill only those insects that feed upon the host. Imidacloprid is classified as a neonicotinoid (nicotine-like) pesticide with remarkably high insecticidal activity against plant-sap-sucking insects, such as HWA. It has proven to be a valuable treatment for ensuring hemlocks remain alive until effective biocontrols become established.

Long Term Objectives

Careful consideration went into the selection of conservation areas during the 2005 analysis to ensure that adequate eastern and Carolina hemlock genetic diversity was conserved. A conservation strategy was designed to maintain genetic, species, community and landscape diversity with consideration for capturing representative communities across different environmental strata and ecological zones.

Over the last five years some of the originally identified conservation areas are no longer viable and we are therefore expanding the scope of treatments outside of the original conservation design. In addition, a number of the previously identified Carolina hemlock sites were later determined to be eastern hemlock sites. Due to the fact that Carolina hemlock is a sensitive species with a limited range, there is additional emphasis on locating and treating Carolina hemlock sites.

In addition to ongoing chemical and biological treatments to protect important hemlock areas, the Forest Service is also working with Camcore under a cooperative agreement to collect hemlock cones in an effort to establish ex situ (off-site) seedling establishment. The overall goal of the project is to preserve hemlock gene pools in perpetuity until a time when effective HWA management strategies are in place and conserved seed resources can be utilized to restore hemlock throughout its native range (Jetton et al. 2008).

Purpose and Need for Action

Monitoring over the last five years indicates that infested hemlock areas that have not received treatment have continued to decline and hemlocks in many of the areas have been killed by the HWA infestations. The rate of HWA spread across the forest is more rapid than originally thought, and the loss of hemlocks continues to have devastating effects on the ecosystem. While predator beetle treatments have been effective on a small scale there is a pressing need to supplement with other treatments to ensure adequate numbers of trees remain viable within each conservation area. Additionally we need to ensure that as new hemlock sites are identified they are analyzed for possible treatment.

The purpose of this proposal is to ensure that we continue to use the most effective suite of treatment options to protect as many viable stands of remaining hemlocks as possible.

There is a need to:

(1) Utilize additional bio-control agents for long-term control of HWA across the landscape;

(2) Preserve reproducing hemlock populations as seed sources for future re-establishment;

(3) Allow greater flexibility with chemical treatments to support the protection of genetically diverse hemlock populations; and

(4) Increase the flexibility of selecting treatment sites in an effort to conserve viable hemlock populations.

Proposed Action

The forest proposes the following:

- Authorize the use of fungus treatments, *Lecanicillium muscarium,* as a biocontrol agent for HWA.
- Include the chemical dinotefuran, Safari™, as a potential pesticide treatment in hemlock areas identified as having heavy infestation and needing immediate attention for the survival of the trees.
- Expand the scope of potential treatment areas beyond those identified in the original conservation design.
- Include the use of additional predator beetle species as they become available and are evaluated for effectiveness.
- Expand the use of imidacloprid as an option on all hemlock treatment areas, consistent with label direction.

This proposal to add treatment options does not apply to designated Wilderness areas. HWA predator beetle and chemical treatments in Wilderness will continue under the 2005 Decision but no additional treatments are being proposed in Wilderness at this time.

Monitoring

In addition to the specific proposed actions, this proposal incorporates monitoring to ensure that the appropriate and most effective treatments are being used. When responding to a forest threat such as an invasive insect it is essential that treatments adapt to changing conditions in the forest. As new areas of infestation are identified they will be evaluated for treatment within the broader context of the landscape.

Monitoring for this project will address the following areas:

1. Establishment, dispersal, and effectiveness of biocontrols;
2. Water quality in areas receiving chemical treatments;
3. Effectiveness of chemical treatments and application methods; and
4. Locations of conservation areas as new critical populations of eastern and Carolina hemlock are identified.

While existing and proposed treatments include the use of chemicals it is important to recognize that chemical treatments are an essential short-term treatment and as adequate biocontrols become established there will be less reliance on chemical treatments.

Fungus Treatment

While predator beetles have shown to be effective at reducing HWA populations in localized areas, it is likely that a complex of natural enemies (introduced predatory insects and diseases), rather than a single “magic bullet,” will be needed to maintain hemlock woolly adelgid below damaging levels (Ward et al. 2004). The insect-killing fungus *Lecanicillium muscarium* is being proposed for aerial application to hemlock conservation areas, excluding Wilderness areas, in the spring of the year. The intent of the fungus treatment is to treat a select number of demonstration sites, with the long-term objective of treating all hemlock conservation areas if treatments in the demonstration area are shown to be effective.

Lecanicillium muscarium occurs naturally in western North Carolina and has been shown to cause significant reductions in adelgid populations in small scale field trials. Initial studies show that an application of the fungus in a whey-based solution (cheese by-product) enables the fungi to better persist in the environment and have lasting effects on the HWA population (Costa 2008). The fungus has been labeled for use in the UK as the product Mycotal. An evaluation for European registration that included human health, environmental and ecotoxicological analysis concluded that Mycotal is not considered harmful to the environment. Research conducted in the laboratory and field with *L. muscarium* found no negative impacts on a predatory beetle being released for hemlock woolly adelgid management (Reardon and Onken 2004). Based on initial field studies with Mycotal, there is little concern associated with the effects of the fungus on non-target insects.

Dinotefuran, Safari™ Treatment

Safari™ is a trade name for a pesticide that has the chemical dinotefuran as the active ingredient. It is a relatively new pesticide that the U.S. Forest Service is considering for use to control HWA as well as the emerald ash borer. It has been used effectively in the Great Smoky Mountain National Park as well as on private land in the southern Appalachians. Dinotefuran is being proposed as an additional chemical treatment option for the Nantahala and Pisgah National Forests because compared to imidacloprid it is highly water soluble and therefore much faster acting than imidacloprid. It has been shown to effectively reduce adelgids on branch tip within two weeks (Cowles and Lagalante 2009).

Dinotefuran treatments would be used in areas prioritized for attention due to their advanced level of infestation and need for immediate treatment. When used in combination with imidacloprid, infested trees will receive both the short term benefits of dinotefuran along with the longer lasting protection attributed to imidacloprid.

Similar to imidacloprid, dinotefuran is a systemic pesticide that is absorbed by the tree and kills only those insects that feed upon the tree. Because of its greater mobility in the soil, there is a greater risk to contamination of aquatic systems from the application of dinotefuran. However, risks to aquatic systems would be minimized through the strict adherence to label direction which sets guidelines regarding application near water.

Expanded Scope of Conservation Areas

The 2005 Decision identified 159 eastern and Carolina hemlock areas for potential treatment. Areas were selected to meet the requirements of a hemlock conservation network designed to represent community diversity within the distribution of known hemlock stands in western North Carolina. Monitoring in recent years has indicated that some of the original sites have already been decimated by the HWA, beyond the point of preserving viable trees. Additional sites continue to be identified across the forest and are proposed for treatment based on their geographic distribution within the larger hemlock conservation network.

Expanded Use of Imidacloprid

The 2005 Decision identified specific hemlock treatment areas that would receive application of imidacloprid in order to ensure that genetically diverse hemlocks remain alive until biological controls take effect. This proposal would allow greater flexibility of using imidacloprid on any of the identified hemlock treatment areas as necessary. The beetles that have been released for HWA control have shown some success and persistence in the forest but their populations are not yet high enough in many areas to maintain viable trees without the supplemental use of chemical treatments. It is necessary to maintain the option of using chemical treatments until the biocontrol agents become sufficiently established in the ecosystem. Once biocontrols become adequately abundant in the ecosystem and effective at controlling HWA populations, there will be less reliance on chemical treatments.

The 2005 Decision specified that soil injection of imidacloprid would not be used in close proximity to water or in highly permeable (sandy or gravelly) soils. Stem injection was previously the preferred method of imidacloprid application in these areas. However, aquatic monitoring studies at Coweeta Research Station show no detectable levels of imidacloprid in streams following soil application. This revision to the EA would allow less restrictive application of imidacloprid in areas near flowing aquatic systems, consistent with label direction, and with continued periodic aquatic monitoring to ensure there are no detectable traces of chemicals in the streams.

Decision Framework

The decision to be made by the Forest Supervisor at this time is whether or not to expand the treatment options and number of treatment areas for suppression of HWA infestations beyond what was identified in the 2005 Decision.

Public Involvement

A detailed proposal with preliminary issues and alternatives was provided to the public and other agencies for comment during April and May 2010.

Thirteen comment letters were received from the public, organizations, and other government agencies. Eleven of the thirteen respondants support the proposed action while two individual commenters support the no-action alternative of continuing treatments covered under the previous analysis. No new issues were identified to warrant the development of additional alternatives.

Issues

The April 14, 2010 scoping and 30-day comment letter that was mailed to the public outlined two potential issues and three alternatives. These issues were based on public comments received during the original 2005 analysis and recent internal scoping.

Comments received during the 30-day comment period were evaluated to determine whether there were any additional issues regarding the proposed action. The Forest Service defined significant issues as those directly or indirectly caused by implementing the proposed action. Non-significant issues were identified as those: 1) outside the scope of the proposed action; 2) already decided by law, regulation, Forest Plan, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. The Council for Environmental Quality (CEQ) NEPA regulations require this delineation in Sec. 1501.7, "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…"

Based on the comments received, there were no additional issues identified with the proposed action. The two significant issues to be analyzed in this environmental assessment are:

Issue 1 *The aerial application of fungus may have negative effects on non-target insects in the forest.*

Issue 2 *Due to its relatively high mobility in soil, there is concern regarding the use of dinotefuran as a chemical treatment and the possible environmental effects near aquatic ecosystems.*

Chapter 2 - Alternatives

This chapter describes and compares the alternatives considered for the 2010 HWA Suppression project. It includes a description of each alternative considered. These alternatives were developed by the interdisciplinary team in response to the purpose and need and the issues identified for this project. Mitigation measures for activities in each alternative, if any, are also described in this chapter. Table 2-1 summarizes the management activities for each alternative.

Alternative 1 – No Action

The No Action alternative consists of continuing suppression of the HWA under the existing 2005 Decision. Treatments include application of imidacloprid and beetle releases on identified hemlock conservation areas. This alternative responds to issues 1 and 2 regarding the concern over the additional treatment options. Under this alternative there will be no change in our current management strategy. We would continue to treat conservation areas but we would be missing opportunities to utilize the best treatment strategies to combat the spread of HWA.

Alternative 2 – The Proposed Action

This is the proposal that is described in detail in chapter 1. Fungus would be used as an additional biological control and dinotefuran would be available as a chemical treatment option in areas where immediate treatment is necessary for the survival of the trees. The scope of treatment areas would be expanded to allow flexibility of treating newly identified areas outside of the originally defined conservation design.

This proposal uses the best available science to treat hemlock populations across the forest using and adaptive management strategy to determine the most effective treatment for a specific area.

Alternative 3 – No Additional Chemicals

Alternative 3 is being presented in response to issue 2, the concern over adding dinotefuran as a chemical treatment for HWA. This alternative differs from the proposed action only in that dinotefuran would not be available as a treatment option.

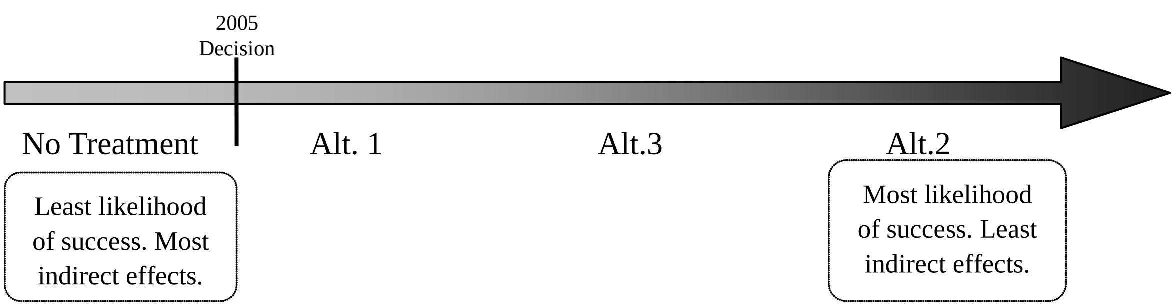
Table 2-1. Comparison of Alternatives

Activities	Alternative 1 Current Management	Alternative 2. Proposed Action	Alternative 3 No Additional Chemicals
Fungus Treatment	None	Potential to be used on all treatment sites*	Potential to be used on all treatment sites *
Use of dinotefuran	None	Potential to be used on all treatment sites*	None
Scope of Treatment Areas	Approximately 159 conservation areas	Use an adaptive management approach to identifying new areas	Use an adaptive management approach to identifying new areas
Use of imidacloprid	Only on sites specifically identified for chemical treatment in the 2005 Decision	Potential to be used on all treatment sites *	Potential to be used on all treatment sites *

*Excluding sites located in Wilderness

One approach to considering the alternatives in this analysis is to look at their relative potential for successfully conserving hemlocks. The 2005 EA considered the implications of doing no treatment and the potential indirect effects of hemlock loss on the ecological and human environment. The analysis in chapter 3 of this EA includes a comparison of alternatives with varying levels of treatment options. The assumption that this analysis makes is that the more treatment options we have available, the greater the potential is for saving hemlock populations across the landscape. The more hemlocks that remain in the forests, the less indirect adverse effects there will be to the ecosystem.

Our current management strategy described in Alternative 1, is the result of the 2005 analysis decision, and was based on our best available treatment options in 2005. Current treatment options include the use of a fungus and additional chemical options. The figure below demonstrates the relative potential for successfully maintaining hemlock populations across the forest based on the suite of treatments proposed for use.



Alternatives Considered But Not Evaluated In Detail

Include additional proposed treatments in Wilderness areas

Wilderness is a unique and valuable resource. In addition to offering primitive recreation opportunities, it is valuable for its scientific and educational uses, as a benchmark for ecological studies, and for the preservation of historical and natural features (FSM 2320.1).

The forest recognizes the importance of conserving hemlocks as an important component in Wilderness and Wilderness study areas, and as such, treatment with imidacloprid and beetle release will continue in wilderness and wilderness study areas as described in the 2005 HWA Decision. Additional treatment options are not being proposed for Wilderness areas at this time but may be considered in future analysis.

Mitigation Measures Common to All Alternatives

All chemicals used for the suppression of hemlock woolly adelgid will be applied according to registered label requirements and specifications.

All predator beetles proposed for release will have their biology and environmental safety thoroughly evaluated, and meet USDA risk assessment criteria for release (Hennessey, R. 1995, Salom, S. 1998, Zilahi-Balogh, G.M.G. 2001, Montgomery et al. 1997, Lu and Montgomery 2001, Butin et al. 2002).

Chapter 3 – Affected Environment and Environmental Consequences

The 2010 Environmental Assessment for Suppression of Hemlock Woolly Adelgid Infestations is a follow-up to the 2005 Suppression of Hemlock Woolly Adelgid Infestations on the Nantahala and Pisgah National Forests. The 2010 EA analyzes the effects of chemical and fungus treatments beyond what was analyzed in the 2005 analysis. This analysis thereby incorporates by reference the 2005 EA for the Suppression of Hemlock Woolly Adelgid Infestations.

Chapter 3 describes the environmental components of the area that would be affected by the alternatives under consideration. It provides the analytic basis for comparison of the alternatives, and describes direct, indirect, and cumulative impacts of the alternatives. Chapter 3 is organized around each potentially affected resource. It should be emphasized here that the No Action alternative, as described in chapter 2, is the continuation of current HWA management as decided in the 2005 Hemlock Woolly Adelgid EA.

3.1 Botanical Resources

Affected Environment

The release of predator beetles and use of systemic insecticide to control the hemlock woolly adelgid is proposed in two very different and distinct forested environments on the Nantahala and Pisgah National Forests. These are: (1) forest stands dominated by or having a major component of eastern hemlock (*Tsuga canadensis)* on stream terraces, in cool and moist coves, or on sheltered mountain slopes, and (2) forest and woodland stands where Carolina hemlock (*Tsuga caroliniana)* is a major canopy component on hot and dry mountain ridges and exposed upper slopes. A comprehensive description of the eastern hemlock and Carolina hemlock plant communities is available in the project file.

Eastern hemlock is a widespread species occurring in five Canadian provinces and in the United States from New England to the Lake States, Mid-Atlantic States, and Southern Appalachians. On the Nantahala and Pisgah National Forests it occurs primarily at mid-elevation forests in plant communities classified as Acidic Cove Forest or Eastern Hemlock Forest (Schafale and Weakley 1990).

Carolina hemlock is not a widespread species and is limited in its range to southwestern and south central Virginia, western North Carolina, northwestern South Carolina and Georgia, and eastern Tennessee (Natureserve 2009, Weakley 2010). Carolina hemlock, although not a common species, is more widespread in North Carolina than elsewhere within its rangewide distribution and populations were stable before HWA infestation. The species can occur on a variety of landscapes, but persists as a canopy dominant only along xeric to dry ridges and upper slopes, or in rare situations, on rocky well-drained river banks, e.g. the Carolina Hemlocks campground. It is the characteristic species in plant communities classified as Carolina Hemlock Bluffs (Schafale and Weakley 1990). Tables 3-1 and 3-2 summarize the extent of hemlock dominated stands across the Forests and across the southern Appalachian region, and the age class distribution of hemlock dominated stands across the Forests.

Species Composition of Hemlock stands

In general most eastern hemlock dominated forests are species poor. While many plant species documented on the Nantahala and Pisgah National Forests occur within eastern hemlock stands proposed for HWA treatment, typically any one community has few herbaceous species, given the frequently dense *Rhododendron maximum* understory (Danley and Kauffman 2000, Schafale and Weakley 1990). Overall, there is less species diversity in Carolina hemlock stands than eastern hemlock stands. This is also true of a typically dense heath layer and also the much drier site conditions.

Table 3-1. Area of forests in the Southern Appalachian and North Carolina mountains dominated by eastern and Carolina hemlock (CISC is the Continuous Inventory of Stand Conditions database).

	CISC Hemlock [1/]	Acidic Coves [2/]	CISC xeric pine [3/]	Pine-Oak Heath [/2]	Hemlock	Hemlock - White Pine	Total
Pisgah	5,270	151,500	12,700	128,630			
Nantahala	8,500	50,500	11,300	66,270			
National Forest total	13,770	202,000	22,800	194,900			
Western NC		1,331,000		759,000			
NC Mountains [4/]				Private	11,200	21,100	32,300
				USFS	2,400	9,500	12,900
				Total	13,600	30,700	44,300
Southern Apps. [5/]					40,100	185,300	225,400

[1/] CISC Hemlock = Forest types 5 (Hemlock), 4 (White Pine-Hemlock), and 8 (Hemlock-Hardwood)
[2/] from Simon, and McNab 2004
[3/] CISC xeric pine = Forest types 38 (Pitch Pine), 15 (Pitch Pine-Oak), 39 (Table Mountain Pine) and 20 (Table Mountain Pine-Hardwoods)
[4/] FIA 2002 Includes 21 Mountain counties in N.C.
[5/] FIA 1999 Includes Southern Appalachian States (Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, and Virginia)

Table 3-2. Age class distribution in Eastern and Carolina hemlock Stands on the Nantahala and Pisgah National Forests.

	Eastern hemlock				**Carolina hemlock**			
	All CISC [1/]		**HWA control stands**		**All CISC [2/]**		**HWA control stands[/]**	
Age Class (years)	acres	percent	acres	percent	acres	percent	acres	percent
0-10	0	0.0%	0	0.0%	326	1.5%	0	0.0%
11-20	16	0.1%	0	0.0%	34	0.2%	45	0.7%
21-30	0	0.0%	0	0.0%	0	0.0%	80	1.3%
31-40	0	0.0%	0	0.0%	608	2.8%	53	0.9%
41-50	450	3.4%	169	2.0%	68	0.3%	0	0.0%
51-60	340	2.5%	23	0.3%	268	1.2%	0	0.0%
61-70	1160	8.7%	592	6.9%	1603	7.4%	386	6.3%
71-80	2243	16.7%	991	11.6%	5475	25.2%	3423	55.6%
81-90	2525	18.9%	1733	20.2%	6521	30.0%	1169	19.0%
91-100	1043	7.8%	781	9.1%	2664	12.3%	460	7.5%
100+	5616	41.9%	4289	50.0%	4175	19.2%	544	8.8%

[1/] CISC Hemlock = Forest types 5 (Hemlock), 4 (White Pine-Hemlock), and 8 (Hemlock-Hardwood)

[2/] CISC xeric pine = Forest types 38 (Pitch Pine), 15 (Pitch Pine-Oak), 39 (Table Mountain Pine) and 20 (Table Mountain Pine-Hardwoods)

Direct Effects

Alternative 1 – No Action

There are no direct effects to the botanical community from the application of imidacloprid by soil injection because it is an insecticide and is not toxic to plants.

The release of predatory beetles would have no direct effect on plants because the beetles proposed for release feed almost exclusively on adelgids and not on plants.

Alternative 2 – Proposed Action

There are no direct effects to the botanical community from the application of dinotefuran because it is an insecticide and is not toxic to plants.

The fungus being proposed for the treatment of HWA is an insect pathogen that occurs naturally in western North Carolina forest ecosystems. There is no evidence to suggest that the fungus will negatively impact any plant populations (Costa 2008).

Alternative 3

As described in Alternatives 1 and 2 there would be no direct effects to the botanical community from the application of imidacloprid, beetle release, or fungus treatments.

Indirect Effects

Indirect effects can be attributed to the relative loss of hemlock from the ecosystem. The three alternatives vary in their potential loss of hemlocks based on the assumption that more treatment options would result in less hemlock mortality. The loss of hemlock will have an indirect effect on plant species associated with the hemlock community. Some species will benefit from the reduced competition for light, moisture, and nutrients, while other species that thrive in deep shade may be negatively affected. There are no plant species that depend entirely upon hemlock for substrate, e.g. non-vascular plants, and there are no plant species that depend entirely on hemlock for shade. Associated tree species such as white pine and shrubs such as rhododendron are likely to increase in cover in the gaps left by the dead and dying hemlocks. Some reduced vigor and mortality of shade-dependent forbs and non-vascular plants, especially rare species, is likely where hemlock mortality is high.

Shifts in species composition are likely but deforestation is highly unlikely, especially in acidic coves where many tree, shrub and forb species currently exist. Propagules of these species also exist in the soil and can provide rapid stand replacement when the canopy is opened up after hemlock mortality. For example, yellow birch seeds, evergreen woodfern (*Dryopteris intermedia*) spores, red-berried elder *(Sambucus pubens)* seeds and hay-scented fern *(Dennstaedtia punctilobula*) spores germinated in abundance from the propagule banks in eastern hemlock stands in New York in controlled greenhouse situations(Yorks et. al. 1999). The rate of regeneration is likely inversely proportional to the density of *Rhododendron maximum*.

As hemlocks in the overstory die and create openings in the understory there is the potential for increased spread of nonnative invasive plants. Many invasive plants thrive in open, disturbed conditions such as those created by gaps in the forest canopy. In areas that are dominated by a thick rhododendron understory, invasive plants would be less of a concern.

Both eastern and Carolina hemlock stands have died in the last 5-7 years since initial treatments began on the forest. Even with the increase in the proposed treatments there would still be additional hemlock areas across the forest that do not receive treatment and would eventually succumb to HWA. Therefore, indirect effects are expected to differ markedly between areas treated and those outside of treatment areas where shifts in species composition are expected to be the greatest as a result of hemlock mortality.

Cumulative Effects

Past and present timber harvest and prescribed burning activities on the Nantahala and Pisgah National Forests have affected individual eastern and Carolina hemlocks and have affected sites that could support eastern hemlock such as acidic coves. Many of these activities will continue in the future but the resulting effects are individually minor when compared with the major impacts expected from the HWA. They are therefore unlikely to add or combine measurably with the impact from HWA infestation over time. Alternatives 2 and 3 would result in less cumulative losses to hemlocks from HWA infestation compared to Alternative 1.

Control of HWA on the Nantahala and Pisgah National Forests will continue to be affected by the condition of hemlock forests and HWA infestations on adjacent private and public lands. Limited beetle releases and chemical treatments have occurred in the previous decade on both public and private lands adjacent to the Forests and additional treatments are likely to occur in the future. The Great Smoky Mountains National Park, Blue Ridge Parkway, and Highlands, NC area in particular have implemented treatments, though outside the context of an overall conservation design scheme. These actions would potentially add to the effectiveness of this proposed action in maintaining hemlock community and genetic diversity across the landscape.

It has taken about 10 to 12 years from the initial heavy HWA infestations to see mortality of more than 90% in some of the hemlock stands in New Jersey (Mayer et al. 2002). During this period of time, other factors may contribute to the death of the hemlock trees, such as the secondary pest *Fiorinia externa* and the hemlock borer, *Melanophila fulvoguttata* both of which cause additional stress. The longer that a stand has been heavily infested or the more times that a stand has been heavily infested, the greater the tree mortality. Tree mortality occurs 5 to 6 years after a stand has been heavily infested and surviving trees may begin to recover if HWA populations decline but are not likely to survive a second heavy infestation (Mayer et al. 2002).

Secondary infestations originating from adjacent lands are likely if control measures are not implemented in those areas in the near future. There is some indication that hemlock stands with HWA infestations located at lower elevations tend to result in more crown health decline and subsequent mortality than those found at higher elevations (Bair 2002) and therefore there is hope that colder temperatures at higher elevation may limit HWA spread. However, this hope may dissipate because it is expected that the HWA will develop sufficient cold-hardiness over time to expand its distribution (McClure 1996) both northward and into higher elevations.

Compared to eastern hemlock Carolina hemlock is much more restricted in its range and global climate change may exacerbate the decline of Carolina hemlock as the amount of suitable habitat is forecast to decline by as much as 40% (Iverson et al. 1999).

3.2 Terrestrial Wildlife Resources

Affected Environment

Eastern hemlock forests create distinctive microclimates and provide important habitat for a wide variety of wildlife. Many species of birds, small mammals, amphibians, and insects inhabit hemlock forests. In the the Northeast, 96 bird and 47 mammal species are associated with hemlock forests (Yamasaki et al. 2000). Use of hemlock by various wildlife include habitat considerations such as the distribution of hemlock trees and the variety of structural habitat features, dense patches of regeneration, hard-mast inclusions, cavity trees, coarse wood debris, wetland seeps and inclusions, and suitable cover opportunities (Yamasaki et al. 2000).

During the non-breeding season and throughout the winter, eastern hemlocks provide an important seed source for pine siskin, goldfinch, red crossbill and evening grosbeak (DeGraaf and Rudis 1986, Howe and Mossman 1995). Birds such as blackburnian warblers and black-throated green warblers occur almost exclusively in hemlock forests in the Delaware Water Gap National Recreation Area (Evans et al. 1996). Ruffed grouse, yellow-bellied sapsucker, great horned owl, and a number of overwintering forest birds use hemlock for a variety of reasons. Ruffed grouse habitat management guidelines often address the importance of hemlock stands, inclusions, and single trees as high quality fall and winter roosting locations (Edminster 1947, Jordan and Sharp 1967). Affinity for hemlock tree boles by foraging and cavity dwelling primary excavators like the yellow-bellied sapsucker and pileated woodpecker have been recognized by Rushmore (1969). Hemlock tends to be long-lived, develops a number of potential cavity sites and perhaps a higher level of cavity-dwelling and foraging use by an array of woodpeckers and smaller mammals.

Many small mammals, such as deer mouse, southern red-baked vole, masked shrew, short-tailed shrew, white-footed mounse, and woodland jumping mouse use hemlock forests. Annual small mammal abundance and species richness can fluctuate dramatically due to variables such as food availability (e.g., prior year's mast crop) and winter severity (e.g., frozen ground with no snow cover). Important structural habitat features for smaller mammal communities include a range of overstory canopy closures. The resulting effects on the midcanopy and shrub layers, and perhaps the patterns of coarse woody debris, contribute to the subsequent accessibility of prey by both avian and mammalian predators such as northern gowhawk, barred and great horned owls, and typical forest carnivores like raccoon, red fox, and bobcat (DeGraaf et al. 1992, Powell et al. 1997a,b). Species like gray squirrel, eastern chipmunk, and northern flying squirrel also use hemlock stands and inclusions, especially when hard mast-producing trees such as beech (*Fagus grandifolia*) and oak (*Quercus* spp.) are present in the overstory even though hemlock is not their preferred habitat (DeGraaf et al. 1992). Throughout the winter, eastern hemlock provide an important seed source for red squirrels. Cavity trees, both live and dead, provide summer roosting opportunities for forest bats, including the endangered Indiana bat. The hoary bat is known to roost in coniferous foliage (DeGraaf and Rudis 1986).

Hemlock is a well-documented habitat element in winter deer range management throughout the northeastern United States and eastern Canada (Mattfeld 1984, Huot et al. 1984, Blouch 1984, Reay et al. 1990). Black bear are known to forage in wetland seeps, swales, and riparian drainages in the spring for ephemeral herbaceous forage (e.g., skunk cabbage, various sedges, grasses, and tubers) present in these habitat conditions (Elowe 1984). Female black bear use coniferous riparian areas in Maine when hard mast crops are marginal (Schooley 1990). Vander Haegen and DeGraaf (1996) found black bear travel along coniferous tributary buffer zones between forested watersheds. Coarse woody debris is a source of grubs and ants especially in the spring, and large hollow trees and logs, and slash piles can be wintering den sites (DeGraaf and Rudis 1986).

Direct and Indirect Effects

Potential direct and indirect effects are discussed together in the terrestrial wildlife analysis because it is difficult to separate effects to habitat and effects to species that depend on those habitats. For this analysis, direct effects are defined as the results of the action on the quality and quantitiy of terrestrial habitat, and indirect effects are the result of the action's effects on terrestrial species due to habitat changes.

Alternative 1 – No Action

Golden-crowned kinglet

Treating infested hemlock trees will preserve some hemlocks across the Nantahala and Pisgah National Forests. Use of predator beetles will have no negative effect on the kinglet since the released beetles only eat adelgids. The use of imidacloprid will have no negative effect on the kinglet since the bird would have no contact with the chemical. By preserving hemlocks, kinglets will continue to have access to nesting habitat.

Blue Ridge two-lined salamander

When a hemlock tree dies, the amount of sunlight reaching the ground increases, drying out leaf litter near the tree. This drying makes the areas less hospitable for salamander species that move on the forest floor, including the Blue Ridge two-lined salamander. By treating the hemlock with predator beetles or imidacloprid, shade will be maintained in the forest, thus making it more suitable for salamander species requiring moist conditions. Since imidacloprid is either injected directly into the bole of the tree, or it is injected approximately 2-8 inches deep into the soil (below the leaf litter), use of this chemical will have no negative effect on the Blue Ridge two-lined salamander. This is because the chemical, once injected, does not move upward in the soil toward the leaf litter zone (Bayer 2004).

Raccoon

Although raccoons are dependent on alluvial forests, they are not dependent on hemlock habitat. The raccoon's best suitable habitat is 80+ year old stands with an oak component, usually within half a mile of water. Use of predator beetles or imidacloprid to treat infested hemlock trees will not negatively affect raccoon since there would be no direct contact with the beetle or imidacloprid. Since raccoons require tree dens near water, the death of hemlock trees, especially those near streams, may actually increase habitat for the raccoon by creating snags that could serve as potential tree dens. It is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags will still be created as untreated hemlock die, thus creating potential den trees for raccoon.

Mink

Although mink is a riparian-associated species, it is not dependent on hemlock. Because mink populations tend to be limited by the availability of denning sites (e.g., dens of other species such as the bank dens of beavers or muskrats) or food sources, the death of hemlock is not likely to affect mink. Use of predator beetles or imidacloprid will not negatively affect mink since there would be no contact with the beetles or imidacloprid.

Black Bear

The loss of hemlock may affect black bear both negatively and positively. Bears use forested riparian corridors, where hemlock is often present and provides important cover, as travel ways. Loss of hemlock would initially open up riparian areas, and cover would be lacking until other trees species grow up to replace the hemlock in the canopy. However, with the opening up of stream-side areas, a flush of growth (both herbaceous and soft mast) would occur, thus providing food for black bears. Hemlock snags, especially larger ones (>36” dbh) could provide denning opportunities for black bears. An increase in coarse woody debris could increase the amount of protein food source (e.g., grubs and ants), especially in the spring.

Use of predator beetles or imidacloprid to treat hemlocks infested with hemlock woolly adelgid will not negatively affect black bear as there would be no contact with either the beetles or the insecticide. Maintenance of hemlock along streams will help provide cover along riparian travel corridors. It is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags and coarse woody debris will still be created as untreated hemlock die, creating potential den trees and foraging habitat for black bears.

Bats

Use of predator beetles or imidacloprid to treat hemlocks infested with hemlock woolly adelgid will not negatively affect bats since there would be no contact with either the beetles or the insecticide. Although hemlock is generally considered to represent less than optimal summer habitat for many species of bats, the death of hemlock could increase potential summer roosting habitat. Many bats will use conifer snags for summer roosting habitat, and hemlock snags could provide good roosting habitat, especially since hemlock snags persist on the landscape for an extended period of time. However, it is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags will still be created that are potential roost trees for a variety of bats.

Gray squirrel

Use of predator beetles or imidacloprid to treat hemlocks infested with hemlock woolly adelgid will not negatively affect gray squirrels as there would be no contact with either the beetles or the insecticide. Although gray squirrels are not dependent on hemlock, the death of scattered hemlock that occur in mature hardwood stands may increase habitat for the squirrel by creating snags that could provide potential cavity nests. It is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags will still be created that provide potential cavity nests for squirrel.

White-breasted nuthatch

Use of predator beetles or imidacloprid to treat hemlocks infested with hemlock woolly adelgid will not negatively affect white-breasted nuthatch since there would be no contact with either the beetles or the insecticide. Although nuthatches are not dependent on hemlock, the death of scattered hemlock that occur in mature hardwood stands may increase habitat for the nuthatch by creating snags that could provide potential cavity nests. It is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags will still be created that provide potential cavity nests for the nuthatch.

Ruffed grouse

Use of predator beetles or imidacloprid to treat hemlocks infested with hemlock woolly adelgid will not negatively affect ruffed grouse since there would be no contact with either the beetles or the insecticide. Maintenance of hemlock will help provide roosting cover. It is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some coarse woody debris will still be created as untreated hemlock die, creating potential drumming logs for male grouse. Also, with the flush of growth that will occur with the death of hemlock, an increase in food (both herbaceous and soft mast) may increase for ruffed grouse.

Yellow-bellied sapsucker

Use of predator beetles or imidacloprid to treat hemlocks infested with hemlock woolly adelgid will not negatively affect yellow-bellied sapsuckers since there would be no contact with either the beetles or the insecticide. Although sapsuckers are not dependent on hemlock, the death of hemlock could increase the amount of sapsucker habitat by creating snags that would be used for foraging and cavity nesting. It is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags will still be created that are potential nest and foraging trees for sapsuckers.

Pileated woodpecker

Use of predator beetles or imidacloprid to treat hemlocks infested with hemlock woolly adelgid will not negatively affect the pileated woodpecker since there would be no contact with either the beetle agent or the insecticide. Although pileated woodpeckers are not dependent on hemlock, the death of hemlock could increase the amount of potential woodpecker habitat by creating snags that would be used for foraging and cavity nesting. It is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags will still be created that are potential nest and foraging trees for woodpeckers.

Jordan’s salamander

When hemlock trees die, the amount of sunlight reaching the ground increases, which dries out leaf litter beneath the dead tree. This drying will make the areas less hospitable for any salamander species that moves on the forest floor, including the Jordan’s salamander. By treating the hemlock with predator beetles or imidacloprid, shade will be maintained, making localized areas more suitable for salamander species requiring moist conditions. Since imidacloprid is either injected directly into the trunk of the tree, or approximately 2-8 inches into the soil (below the leaf litter), use of this chemical will have no negative effect on the Jordan’s salamander. This is because once injected, imidacloprid does not move upward in the soil profile (Bayer 2004). Additionally, it is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some downed woody debris will still be created that provide potential cover for Jordan’s salamander. Use of predator beetles or imidacloprid on infested hemlock will not negatively affect Jordan salamander since there would be no contact with either the beetles or the insecticide

Alternative 2 – Proposed Action

Effects of using predator beetles on terrestrial wildlife would be similar to those described for Alternative 1. Additionally, Alternative 2 includes expanded use of imidacloprid on all hemlock treatment areas. Effects from the use of imidacloprid on terrestrial wildlife would be similar to those described for Alternative 1 but more areas would be treated with imidacloprid.

Alternative 2 proposes the use of dinotefuran on trees that are heavily infested and need immediate attention to ensure survival. The chemical compound is highly soluble in water, is relatively stable to hydrolysis at pH 4 to 9 (the range of most soils and water across the Forests), and has an average aerobic half-life of 81 days. The chemical is highly mobile in most soil types. High water solubility combined with high soil mobility indicates low potential for bioaccumulation. The major dissipation route for dinotefuran is aqueous photolysis (half-life 1.8 days) (EPA 2004).

Dinotefuran is nontoxic to birds on an acute basis and slightly toxic on a subacute dietary basis. Dinotefuran is nontoxic to mammals on an acute basis. Slight effects on mammalian reproductive characteristics were noted, but these changes did not affect reproductive success. Dinotefuran is highly toxic to honeybees on both oral and contact bases (EPA 2004). Therefore, the primary risk of using dinotefuran on terrestrial wildlife is to pollinating insects.

Hemlock is a wind-pollinated species. Therefore, the only contact between pollinating insects and plant material exposed to dinotefuran would be incidental. Dinotefuran is a systemic herbicide and will be applied through soil injection. There will be no aerial or broadcast application of the chemical; therefore, there will be little risk of acute or contact exposure to pollinating insects.

Alternative 2 also proposes the use of naturally occurring fungus *Lecanicillium muscarium*. This fungus attacks the hemlock woolly adelgid by penetrating directly through the body wall, inducing death, and then releasing spores to continue the fungal infection throughout the adelgid population. Although most fungi are generalists within their natural range, a variety of biological, ecological, and behavioral factors limit effects on non-target species. Additionally, certain species and strains of a given species tend to be virulent to insects within a given order (Gouli et al. 2008; Reid 2003). Extensive laboratory studies have been done to verify fungi and isolates that are effective in infecting the hemlock woolly adelgid (Reid 2003). Based on laboratory assays and initial field studies, there is little concern about non-target effects of *L. muscarium* on non-target insect species, including HWA predator beetles, *Sasajiscymnus spp*. and *Laricobius spp*., also used as adelgid biocontrols (Cheah et al. 2002).

Alternative 3

Alternative 3 is the same as Alternative 2 except that dinotefuran will not be used. Refer to the effects analysis above (Alternative 2) for the expanded use of imidacloprid and treatment with *Lecanicillium muscarium*. Effects of using predator beetles on terrestrial wildlife would be similar to those described for Alternative 1.

Cumulative Effects

Past and present timber harvest and prescribed burning activities on the Nantahala and Pisgah National Forests have affected eastern and Carolina hemlocks and have affected sites that could support hemlock, such as acidic coves. Many of these activities will continue in the future, but the individual minor effects are insignificant when compared with the magnitude of change to the landscape expected from infestation of the HWA. Therefore, past and present forest management activities are unlikely to add measurably to potential impacts of an expanding HWA population. This project would result in lessening cumulative impacts to hemlock from HWA infestation and all other actions.

When hemlock dies, numerous changes will occur across the landscape. Where trees die along streams, cover is eliminated initially from riparian travel corridors (especially for black bears). Once the canopy is opened, sunlight reaches the forest floor, drying out the leaf litter and making those moist areas unsuitable for salamanders (until cover and shade return). A flush of herbaceous and soft mast species growth will occur, creating forage for black bears and ruffed grouse. The increase in the creation of snags will increase potential habitat for several species, especially those that use snags for denning, roosting or foraging. Increased snags will benefit raccoons, black bears, bats, and pileated woodpeckers, and increased downed woody debris will benefit Jordan's salamanders and ruffed grouse. However, death of hemlock forests could be detrimental for the golden-crowned kinglet, which occasionally uses hemlock. As a result of the death of high elevation spruce-fir forests (golden-crowned kinglet's primary habitat) from the Balsam woolly adelgid, kinglet nesting and foraging habitat across the Forests has declined, making moderate quality habitats (e.g., hemlock) more desirable.

Treating infested hemlock trees will reduce species mortality and effects on local terrestrial wildlife habitats. The use of chemicals will have no negative effect on any of the Management Indicator Species. Golden-crowned kinglets will retain nesting habitat (although of moderate quality), and Blue Ridge two-lined salamanders and Jordan's salamanders will continue to have moist habitats. However, it is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some snags will still be created that will potential roost trees for a variety of bats, den trees for raccoons and black bears, and nesting and foraging habitat for pileated woodpeckers, and downed woody debris for Jordan's salamanders and ruffed grouse.

3.3 Aquatic Resources

Environmental consequences to aquatic resources are evaluated based on impacts to the following management indicator species (MIS) habitats: brook, brown, and rainbow trout, blacknose dace, sculpin, and smallmouth bass (sculpin were removed from the aquatic MIS list during the last update because of overlapping habitat with blacknose dace and restricted range across the Forests). See section 3.4 for more information regarding the selection of these species for analysis, and population trend information.

Affected Environment

Approximately 5,060 miles of streams and rivers flowing through the Nantahala and Pisgah National Forests have been defined as coldwater habitats (National Forests in North Carolina 2001). These streams represent all major stream types (Rosgen 1996) and exhibit a broad range of environmental conditions (i.e. from “pristine” to rated as impacted by the NCDWQ). Coldwater streams are approximately 89% of the total stream and river mileage across the Forests (Table 3.1-1). Aquatic ecoclassification efforts on the National Forests in North Carolina have indicated that approximately 58% of all stream mileage is not inhabited by any fish species, largely due to low stream order and high gradient (Bryan and Hill 2000, unpublished). If these assumptions are applied across the Forests, approximately 2,100 miles of occupied coldwater habitat are occupied by coldwater MIS across the National Forests in North Carolina (Table 3.3-1). Over six hundred miles of fish-occupied coldwater streams are associated with hemlock communities.

Approximately 400 miles of streams and rivers flowing through the Nantahala and Pisgah National Forests have been defined as coolwater habitats (National Forests in North Carolina 2002). These streams represent all major stream types (Rosgen 1996) and exhibit a broad range of environmental conditions (i.e. from “pristine” to rated as impacted by the NCDWQ). Coolwater streams are approximately 7% of the total stream and river mileage across the Forests. Approximately 168 miles of coolwater streams are occupied by the MIS smallmouth bass. An estimated seven miles of fish-occupied coolwater streams are associated with hemlock communities.

None of the estimated 210 miles of warmwater streams on the Forests are associated with hemlock communities.

Table 3-3. Aquatic resources across the Nantahala and Pisgah National Forests.

Biological Community	Forest wide Estimate (miles)	Occupied Habitat (miles, estimated)	Occupied habitat associated with hemlock communities (miles, estimated)
coldwater streams	5,060	2,125	600
coolwater streams	400	168	7
warmwater streams	210	88	0

Woody debris constitutes the major organic input to low order streams, where it is apparent that wood has a significant role in energy flow, nutrient dynamics, and stream morphology, and in shaping the biotic community (Swanson et al. 1976, Keller and Swanson 1979, Anderson and Sedell 1979). Across the Forests, aquatic habitats and populations associated with low order, coldwater streams are at risk from the decline or loss of hemlock species. While this influence is less observable in larger streams, the influence of large woody debris (LWD) along the margins of larger coolwater systems is still important.

Direct and Indirect Effects

Potential direct and indirect effects are discussed together in the aquatics analysis because it is difficult to separate effects to habitat and effects to species that depend on those habitats. For this analysis, direct effects are defined as the results of the action on the quality and quantity of aquatic habitat, and indirect effects are the result of the action’s effects on aquatic species due to habitat changes.

Alternative 1 – No Action

The use of predator beetles will have no measurable direct or indirect effects on any of the MIS considered or their habitat. Until the beetles become established in riparian hemlock stands, it is assumed that the amount of large woody debris (LWD) in streams will increase as hemlocks die.

Positive effects of increased LWD include improved aquatic habitat diversity where hemlock is a significant component of riparian forests, and for a short distance downstream. These effects will last until LWD breaks down or is flushed downstream, and until dead and dying hemlock trees are no longer serving as a source of LWD to adjacent streams. Trout (brook, brown, and rainbow) spawning may increase as a result of increased habitat diversity in coldwater streams, resulting in a positive trend for local trout populations. LWD effects are less pronounced in coolwater streams and therefore are not expected to measurably affect smallmouth bass habitat or population stability.

Negative effects of dead and dying hemlocks within riparian areas include decreased bank stability and increased summer maximum water temperatures as trees at the water's edge die and fall into or across streams. Decreased bank stability can lead to local changes in hydrology and increased erosion. In coldwater streams, negative effects of increased sedimentation on trout spawning and population stability are well documented. Smallmouth bass spawning and population stability are not expected to be measurably affected by these relatively small bank disturbances due largely to stream order and position within the watershed.

Generally speaking, trout habitat and population stability are not expected to be affected by increases in maximum summer water temperatures due to relatively small contribution of hemlock to riparian vegetation and low stream order and position within the watershed (i.e. higher elevations where the elevation mitigates milder fluctuations in water temperature). However, it is possible that brown trout populations occupying lower elevation coldwater and coolwater streams where hemlock is a significant riparian component could be affected by even slight increases in summer maximum temperatures. Such effects would include reduced or eliminated spawning shifting of the lower end of occupied habitat upstream. In streams where brown trout and brook trout populations co-exist, this increased competition for habitat and food could result in negative effects on brook trout populations.

Conversely, with the same subtle changes in stream temperatures, smallmouth bass populations could expand upstream. Interspecific competition between brook trout and smallmouth bass is not well-documented (the species do not overlap much naturally across the Forests due to specific habitat requirements), but is expected to be less than that between trout species.

Imidacloprid is moderately toxic to fish and highly toxic to aquatic invertebrates. It has a long half-life in soil (>31 days) at pH 5, 7, and 9, which represents most of the soil conditions across the Forests. Additionally, the chemical is moderately mobile in some soils. Imidacloprid has been found to be photolytic in water, and has a half life of less than 3 hours (Fossen 2006). Pesticide label restrictions prohibit the use of the chemical where surface water is present. It further states that use of the chemical where the water table is shallow may contaminate groundwater. Local water quality monitoring done by the Coweeta Hydrologic Lab documented an extremely low detection of imidacloprid in coldwater streams on the Nantahala National Forest (Churchel et al. 2008).

The Forests have developed a clearance process to aid in the determination of whether it is safe to use imidacloprid to treat individual trees. This process was developed to minimize or eliminate the potential for contact between imidacloprid and aquatic resources. By following the clearance process and label restrictions there will be no effect on aquatic resources from the use of imidacloprid.

Mixing and transporting procedures for the chemical are designed to avoid any possibility of imidacloprid accidentally entering a stream. In the unlikely event an accident does occur during application that results in imidacloprid entering a stream, local populations of brook trout or smallmouth bass (as well as other fish species occurring in the affected stream) could be affected. However, extensive effects are not expected due to the extremely short photolytic half-life of imidacloprid in water. The local aquatic invertebrate community would be affected similarly. Additionally, should an accident occur, the chemical would be rapidly diluted beyond measurable levels, further minimizing the affects to aquatic populations. It is important to note that the loss of one population of brook trout or smallmouth bass or one local aquatic invertebrate community will not affect overall species' trends across the Forests. Any accidental chemical spills would be rapidly diluted and the area would be quickly recolonized by fish populations upstream or downstream from the spill area.

Alternative 2 - Proposed Action

Effects of using beetles on aquatic resources would be similar to those described for Alternative 1.

Alternative 2 includes expanded use of imidacloprid on all hemlock treatment areas. Effects from the use of imidacloprid on aquatic ecosystems would be similar to those described for Alternative 1 but more areas would be treated with imidacloprid. More chemical treatments would result in less large woody debris reaching streams, and therefore less increase in aquatic habitat diversity. Negative effects including loss of bank stability and increased stream temperatures would be less than in Alternative 1 since more aquatic habitats that are shaded by hemlocks would be protected.

Alternative 2 proposes the use of dinotefuran on trees that are heavily infested and need immediate attention to ensure survival. The chemical compound is highly soluble in water and is relatively stable to hydrolysis at pH 4 to 9 (the range of most soils and water across the Forests). The chemical is highly mobile in most soil types. High water solubility combined with high soil mobility indicates that this compound has the potential to leach into area streams. The major dissipation route for dinotefuran is aqueous photolysis (half-life 1.8 days), although even in its parent state, the chemical is practically nontoxic to fish and freshwater aquatic invertebrates (EPA 2004). Additionally, none of dinotefuran's degradates were found to be toxic to aquatic organisms (EPA 2004).

The Forests will utilize a clearance process similar to that for imidacloprid to aid in the determination of whether it is safe to use dinotefuran to treat individual trees. This process will minimize the potential for direct contact between dinotefuran and aquatic resources. This, combined with low toxicity of dinotefuran to aquatic organisms, will insure that effects are minimized. By following the clearance process and label restrictions there will be no effect on aquatic resources from the use of dinotefuran.

Mixing and transporting procedures for the chemical are designed to avoid any possibility of dinotefuran accidentally entering a stream. In the unlikely event an accident does occur during application, local populations of brook trout or smallmouth bass (as well as other fish species occurring in the affected stream) could be affected, but extensive effects are not expected due to the short photolytic half-life of dinotefuran in water and the chemical's low toxicity to freshwater aquatic organisms. The local aquatic invertebrate community would be affected similarly. Additionally, should an accident occur, the chemical would be rapidly diluted beyond measurable levels, further reducing the probability that aquatic populations would be affected. It is important to note that the loss of one population of brook trout or smallmouth bass or one local aquatic invertebrate community will not affect overall species' trends across the Forests. This is because the local stream reach that could be affected by an accidental spill would be quickly recolonized by fish populations upstream or downstream following rapid dilution.

Alternative 2 proposes the use of the naturally occurring fungus *Lecanicillium muscarium*. Based on initial field studies of the fungus, there is little concern associated with effects of the fungus on non-target insects, including aquatic insects. Use of this fungus will have no effect on aquatic species or their habitats.

Alternative 3

Alternative 3 is the same as Alternative 2 except that dinotefuran will not be used. Refer to the effects analysis above for the expanded use of imidacloprid and *Lecanicillium muscarium*.

Cumulative Effects

New and revised treatment methods will not change the cumulative effects analysis for aquatic resources presented in the 2005 EA.

Vegetation management activities seldom occur near streams, though recreational activities often occur near water. Past, present, and reasonably foreseeable future activities include the occasional construction of stream crossings for roads or trails, water based recreational activities and streamside camping. If sediment enters the stream from these sources it can result in localized and temporary reductions in the quality of the habitat for aquatic invertebrates and fish.

In riparian areas with many streamside hemlocks, the addition of LWD from dead hemlocks (from HWA infestation) could initially help offset sedimentation effects by providing additional in stream habitat in the short term. However, once that LWD decomposes, a more long term loss of additional LWD inputs would occur while riparian forests move through early stages of succession. Treatment of the HWA along riparian areas would effectively moderate LWD inputs over time.

The adherence to safety precautions would minimize or eliminate the potential contact between imidacloprid or dinotefuran and aquatic resources, therefore the use of insecticides would not add cumulatively to effects on aquatic habitats or populations from all other sources.

Releasing biocontrols (predator beetles or the fungus *Lecanicillium muscarium*) would have no measurable direct or indirect effects on aquatic resources, therefore the actions would not add cumulatively to effects on aquatic habitats or populations from all other sources.

3.4 Management Indicator Species (MIS) Population Trend Information

MIS considered for this project

The forest-wide list of MIS was considered as it relates to this project analysis area. The project analysis area includes forests dominated by eastern or Carolina hemlock, forests where these species are important components, and aquatic habitats associated with these forests. Only those MIS that occur or have habitat within the project analysis area and may be affected by any of the alternatives were carried through the in-depth analysis. All MIS were considered and Table 3-1 shows which MIS were chosen to represent the effects of management actions along with the rationale for these selections.

Consistent with the Forest Plan and the associated FEIS, the effects analysis focuses on changes to MIS habitat. These project-level effects are then put into context with the forest-wide trends for populations and habitats.

The following MIS were considered because they occur in biological communities associated with eastern and or Carolina hemlock communities.

Table 3-4. MIS associated with hemlock communities.

MIS	Estimated Population Trend	Associated biological community or special habitat
Carolina Hemlock	Decreasing	Carolina Hemlock Bluffs
Lung lichen	Increasing	Old Forest Communities
Golden Crowned Kinglet	Decreasing	Fraser Fir Forests
Blue Ridge two-lined salamander	Static	Alluvial Forests
Raccoon	Increasing	Alluvial Forests
Mink	Static	Alluvial Forests
Black Bear	Increasing	Old Forest Communities
Bats	Varies by species	Caves
Gray Squirrel	Static	Hard mast-producing species
White-breasted Nuthatch	Increasing	Small snags and dens
Ruffed Grouse	Static	Early successional (0-10)
Yellow-bellied Sapsucker	Decreasing	Small snags and dens
Pileated Woodpecker	Increase	Old Forest Communities
Jordan's salamander	Static	Down woody debris – all sizes
Brook trout	Static	Coldwater streams
Brown trout	Static	Coldwater streams
Rainbow trout	Static	Coldwater streams
Blacknose dace	Static	Coldwater streams
Sculpin	Static	Coldwater streams
Smallmouth Bass	Static	Coolwater streams

Approximately 2,100 miles of coldwater habitat across the Forests are occupied by wild brook, brown, or rainbow trout (coldwater MIS). Of these miles, approximately 600 are associated with hemlock communities. Therefore, wild trout (brook, brown, or rainbow) are identified as an MIS for this analysis.

Approximately 400 miles of streams and rivers flowing through the Forests have been classified as coolwater habitats. Of these miles, approximately 168 miles are occupied by the MIS smallmouth bass. An estimated seven miles of fish-occupied coolwater streams are associated with hemlock communities. Therefore, smallmouth bass are identified as an MIS for this analysis.

None of the estimated 210 miles of warmwater streams on the Forests are associated with hemlock communities.

Table 3-5. Management Indicator Species for biological communities potentially affected by HWA treatments.

Biological Community	Management Indicator Species
coldwater streams	wild trout (brook, brown, rainbow), blacknose dace
coolwater streams	smallmouth bass
warmwater streams	N/A
Carolina hemlock bluff forests	golden-crowned kinglet
Alluvial forests	two-lined salamander (mid-late successional stages), raccoon (all forest types), mink
Old Forest Communities (100+ years old)	black bear (dens, low levels of disturbance), bats (roosting and foraging habitats in mature forests), pileated woodpecker (cavities, foraging habitat)
Snags and dens (>22" dbh)	pileated woodpecker, raccoon (moderate sized dens)
Small snags and dens	Gray squirrel, yellow-bellied sapsucker (breeding populations)
Downed woody debris – all sizes (foraging and cover habitats)	Black bear (all communities), pileated woodpecker, ruffed grouse (down logs for drumming), Jordan's salamanders

Potential effects of proposed treatments for HWA on aquatic MIS are summarized in Sections 3.2 and 3.3. Table 3-6 summarizes these effects and anticipated population trends.

Table 3-6. Management Indicator Species population effects and trends by alternative.

MIS	Current Trend	Alternative 1	Alternative 2	Alternative 3
Wild trout (brook, brown, rainbow), blacknose dace	Stable, with annual variability	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
Smallmouth bass	Stable, with annual variability	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
Golden-crowned kinglet	Decreasing	Loss of local populations, but no change in species' viability	Loss of local populations, but no change in species' viability	Loss of local populations, but no change in species' viability

MIS	Current Trend	Alternative 1	Alternative 2	Alternative 3
Two-lined salamander	Static	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
Raccoon	Increasing	Increase denning habitat: maintain current trend	Increase denning habitat: maintain current trend	Increase denning habitat: maintain current trend
Mink	Static	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
Bear	Increasing	Increase denning habitat: maintain current trend	Increase denning habitat: maintain current trend	Increase denning habitat: maintain current trend
Bats	Varies by species	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
Gray squirrel	Static	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
White-breasted nuthatch	Increasing	Increased nesting habitat; maintain current trend	Increased nesting habitat; maintain current trend	Increased nesting habitat; maintain current trend
Ruffed grouse	Static	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
Yellow-bellied sapsucker	Decreasing	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend
Pileated woodpecker	Increasing	Increased snags; maintain current trend	Increased snags; maintain current trend	Increased snags; maintain current trend
Jordan's salamander	Static	No effect; maintain current trend	No effect; maintain current trend	No effect; maintain current trend

3.5 Threatened, Endangered, Sensitive, and Forest Concern Species

3.5.1 Rare Botanical Species Evaluation

The project analysis area includes forests dominated by eastern or Carolina hemlock in Pisgah and Nantahala National Forests with Wilderness areas excluded.

Species considered and Species Evaluated
Four hundred forty-four rare plant species occur or are known to occur on the Pisgah and Nantahala National Forests. Two hundred eighty-seven are rare vascular plants and 157 are rare non-vascular plants consisting of hornworts, liverworts, mosses, and lichens. Out of the 444 rare plant species, 14 are federally listed: seven endangered and seven threatened. One hundred forty-five are regionally-listed sensitive species. Sixty-nine of the sensitive plant species are non-vascular consisting of hornworts, liverworts, mosses, and lichens. The remaining 285 are forest concern plant species, 87 of these are non-vascular. Regional sensitive species are believed to have viability concerns throughout the southern region and generally exhibit a global rank of G3 or T3 or lower, or a national rank of N3 or lower. The regional sensitive list was last updated in 2001. Forest concern plant species are less globally restricted species but typically grow at the periphery of their range or disjunct from their main range.

Eastern Hemlock
The list of 444 rare plants was queried for those species documented within habitats with significant eastern hemlock components. Of the 444 tracked species, 372 species were excluded from further analysis because proper habitat does not occur within the proposed treatment area. Excluded habitat included Grassy Balds and other high elevation grassy openings, Heath Balds, Southern Appalachian bogs, rock outcrop communities, Rich Cove Forest, Northern Hardwood Forest, oak dominated forest communities, and xeric pine dominated forest communities. Queried habitats for eastern hemlock associated rare plant species included Canadian Hemlock Forest, Acidic Cove Forest, and Spray Cliff communities. Several vascular plant species, such as *Carex woodii* and *Lysimachia fraseri*, were excluded from this eastern hemlock habitat list of plant species since they are only occasionally located within Acidic Cove Forest and are not known to occur within this habitat where hemlock is an important component (G. Kauffman, personal observation). Species such as *Taxiphyllum alternans*, which are associated with high base rock surrounding Spray Cliff communities, were also excluded since eastern hemlock is not associated with soils influenced by high base rock. Other species, such as *Spartina pectinata*, also associated with Spray Cliff, were excluded since they prefer more open habitat and would not be associated with waterfalls surrounded by *Tsuga canadensis*. The final list of rare plant species that may occur with eastern hemlock-dominated habitats includes one federally-listed, 45 sensitive and 26 forest concern plants. Of the 72 species, 58 are nonvascular.

None of the 72 eastern hemlock forest associated rare species are known to be obligate associates of hemlock forest communities although *Brachymenium andersonii* is only known within North Carolina from the Kelsey tract, a tract dominated by both eastern and Carolina hemlock near Highlands. However it has not been relocated since 1951. Various searches during the past 15 years have not successfully located the species. Only one species, *Schlotheimia lancifolia*, is known to occur on eastern hemlock bark although it does not exclusively occur on the bark (Anderson 1996). This species has also been located on *Acer rubrum* and *Quercus rubra* as well as on rock (P. Davison, University of North Alabama bryology professor, personal communication). *Buckleya distichophylla*, a rare southern Appalachian endemic shrub, parasitizes eastern and Carolina hemlock; however neither hemlock species is an obligate host (Natureserve 2004, Weakley 2010).

All 72 of the rare plant species associated with eastern hemlock-dominated forests prefer humid conditions. There are no known direct effects to any of these 72 species from current control treatments of HWA, imidacloprid applications and beetle releases (Alternative 1). Nor are there any direct effects to any of the 72 species anticipated with the proposed use of Safari or the fungus. Thus there will be no direct effects to any of these 72 plant species with implementation of either alternative 2 or alternative 3.

Indirect effects to these rare species may be more variable. They can be more readily separated for these rare species by the substrate or microhabitat they occupy, varying from either the forest floor to hardwood or conifer bark. The following analysis will determine indirect effects to these groups of species based on their preference for four separate substrates.

Forest Floor Substrate

Fourteen rare species associated with eastern hemlocks are typically rooted in humus or soil in Acidic Cove Forest (Table 3.5-3). This diverse group includes 3 mosses, 2 liverworts, 2 deciduous herbs, 4 evergreen herbs, 2 shrubs, and 1 small tree. Except for *Buckleya distichophylla* or *Tsuga caroliniana*, the species are very limited in the mountain forests. Three are not presently known within the Nantahala and Pisgah National Forest. As previously mentioned, *Brachymenium andersonii* is only known from the Kelsey tract on the Highlands Plateau.

It is not as clear what indirects affects will result from the three alternatives. The 13 species listed in Table 3-7, while all associated with acidic cove forest, occur in quite diverse microhabitats. The two *Hexastylis* species, two *Shortia* species, and *Dalibardia repens* are closely associated with either *Rhododendron maximum* and or *Rhododendron minus*. As such the indirect effects, such as decrease in humidty or increase in light from a dieback of *Tsuga canadensis* in the overstory will be buffered. Previous surveys within *Hexastylis rhombiformis* and the *Shortia galacifolia* var. *brevistylia* occurrences indicate *Tsuga canadensis* is scattered within the canopy (Kauffman, personal observation, NC Biotics 2010). In addition, the evergreen tree, *Pinus strobus*, is commonly associated with these four rare species and will buffer any indirect changes associated with the loss of hemlock in the overstory.

Table 3-7. Eastern hemlock associated species primarily occurring on the forest floor.

Species	Populations	Form	Forest Designation	Substrate
Nardia lescurii	0	Liverwort	Sensitive	Thin Soil on Rock
Cephalozia pleniceps var. carolinana	0	Liverwort	Forest Concern	Soil
Brachymenium andersonii	1	Moss	Forest Concern	Soil
Brachymenium systylium	1	Moss	Forest Concern	Soil
Buckleya distichophylla	11	Vascular plant	Sensitive	Forest Floor
Diervilla rivularis	1	Vascular plant	Sensitive	Forest Floor
Geum lobatum	0	Vascular plant	Sensitive	Forest Floor
Hexastylis contracta	3	Vascular plant	Sensitive	Forest Floor
Hexastylis rhombiformis	3	Vascular plant	Sensitive	Forest Floor
Shortia galacifolia var. brevistyla	4	Vascular plant	Sensitive	Forest Floor

Shortia galacifolia var. galacifolia	1	Vascular plant	Sensitive	Forest Floor
Dalibarda repens	1	Vascular plant	Forest Concern	Forest Floor
Stewartia ovata	2	Vascular plant	Forest Concern	Forest Floor

Stewartia ovata, Diervilla rivularis and *Buckleya distichophylla* are the only three rare woody species associated with eastern hemlock forests. However, both are also associated with either drier habitats such as bluffs and appear to bloom more profusely with more light (Weakley 2009, NC Biotics 2010, G. Kauffman, personal observation). The same is true for *Geum lobatum*, barren strawberry, which occurs within hemlock associated forests but further south can occur in oak –hickory-pine forests (Chafin 2007). Thus the decrease in evergreen canopy cover may improve suitable habitat for these species.

The remaining four nonvascular species may experience decreases in their surrounding relative humidity when eastern hemlock trees die and leave an open gap. All of these species are believed to prefer low light levels and could be adversely affected by a change in light levels. However, the effects to individual species are unknown. Recent research in eastern hemlock forests with significant decline suggest the impact to bryophytes may not be as significant as previously anticipated (Cleavitt et. al. 2008). Gains in bryophyte species richness were observed on bare soil although not to the extent as observed on downed woody debris and plots closer to streams (Cleavitt et. al. 2008).

Stream Bedrock or Boulder

Seven rare species associated with eastern hemlock occur on bedrock or boulders within streams, creeks or rivers (Table 3.5-4). All of these species are nonvascular, 4 lichens, 2 hornworts and 1 moss. The majority of these species occur directly adjacent to the stream edge. Two are typically immersed, *Megaceros aenigmaticus* and *Ephebe solida. Gymnoderma lineare*, a federally endangered species, has two distinct habitats throughout its range and across the forest, both in high elevation shaded rock outcrops and on boulders in streams and rivers. The discussion for this analysis only includes those occurrences where it occurs on boulders within streams or cascading spray cliffs surrounded by eastern hemlock dominated forest communities. As such this would include between 20-25% of the occurrences known for this species in North Carolina.

Table 3-8. Eastern hemlock associated species occurring on boulders within streams.

Species	Populations	Form	Forest Designation	Substrate
Aspiromitus appalachianus	0	Hornwort	Sensitive	Stream bedrock
Megaceros aenigmaticus	45	Hornwort	Sensitive	Stream bedrock
Gymnoderma lineare	32	Lichen	Endangered	Stream boulder
Peltigera venosa	60	Lichen	Sensitive	Stream boulder
Ephebe lanata	0	Lichen	Forest Concern	Stream boulder
Ephebe solida	4	Lichen	Forest Concern	Stream bedrock
Hygrohypnum closteri	1	Moss	Sensitive	Stream boulder

Of all of the 72 rare species analyzed in eastern hemlock treatment zones, these seven species probably have been the least affected by hemlock mortality, and the resulting reduction in relatively humidity, because of their proximity to water. It is less certain how these species have been affected by changes in light levels due to hemlock canopy loss. Existing light levels surrounding known populations can be highly variable ranging from densely shaded with 2-3 meter tall overhanging *Rhododendron maximum* to completely open surrounding larger rivers or creeks such as occurs on the Pigeon River, the Whitewater River, the Chattooga River, and upper Greenland Creek (NC BCD 2004, G. Kauffman, personal observation). Of the seven rare plants, the least well known both in terms of range and habitat characteristics, is *Ephebe lanata*. Most information indicates that this species occurs on moist rock near waterfalls or within flowing streams. Light conditions in these situations vary from shaded to open (Hale 1979, Flenniken 1999, Brodo et al. 2001). Because of the variable site conditions and since the species have been known to persist within more open conditions, it is believed that this group of organisms have not been negatively impacted by the loss of surrounding *Tsuga canadensis* trees or with additional losses depending on the application and effectiveness of control methods. Recent research in eastern hemlock forests with significant decline indicates greater gains in bryophyte species richness occurring on plots closer to streams (Cleavitt et. al. 2008).

Tree Bark & Downed Wood Substrate

Table 3-9. Eastern hemlock associated species primarily occurring on bark.

Species	Populations	Form	Forest Designation	Substrate
Anzia americana	1	Lichen	Sensitive	Tree Bark
Cheilolejeunea evansii	2	Liverwort	Sensitive	Downed Wood
Drepanolejeunea appalachiana	15	Liverwort	Sensitive	Tree Bark
Metzgeria uncigera	0	Liverwort	Sensitive	Rhododendron Bark
Riccardia jugata	1	Liverwort	Sensitive	Downed Wood
Schlotheimia lancifolia	5	Moss	Sensitive	Tree Bark, Rock
Brachythecium rotaeanum	2	Moss	Forest Concern	Tree Bark, Rock

Seven of the 72 rare species occur on and prefer wood, including tree bark and downed debris. *Schlotheimia lancifolia* is known to occur on eastern hemlock bark although the moss is not dependent on hemlock as a substrate (Anderson 1996). The type locality of *Schlotheimia lancifolia* is hemlock hardwood forest (Crum and Anderson 1981). None of the other six wood preferring species are known to adhere to eastern hemlock bark. Except for *Drepanolejeunea appalachiana*, all of the bark-preferring rare species are quite limited within the Nantahala and Pisgah National Forest as well as within North Carolina. All seven are primarily restricted to the Blue Ridge escarpment, apparently preferring narrow vertical gorges where high rainfall and high humidity is maximized (NC Biotics 2010).

Individuals of these seven species have experienced an increase in light and a decrease in their surrounding relative humidity in areas where eastern hemlock trees have recently died and opened a gap. In addition, one species, *Schlotheimia lancifolia* individuals may have died if it occurred on a dead eastern hemlock tree. Effects on individual species from changes in light levels are less certain. *Drepanolejeunea appalachiana* has been located within more open woodland at the Standing Indian Campground as well as in open woodland at a serpentine site (Dr. Paul Davison, University of North Alabama, personal observation). It has been difficult to locate populations of *Schlotheimia lancifolia* since it has been located as high as 34 feet above the butt of the tree trunk (Crum and Anderson 1981, Anderson 1996, Dr. Paul Davison, personal communication). This would suggest the species may persist at higher light levels present in the upper reaches of the canopy. These two species may not be dramatically affected by higher light levels if adjacent hemlock trees die provided the humidity levels remain high. *Metzgeria uncigera*, occurring exclusively on *Rhododendron* bark in the mountains, probably will be buffered by the dense Rhododendron thickets where it occurs.

Two species, *Cheilolejeunea evansii* and *Riccardia jugata* occur on downed logs. Recent research indicates a greater increase in bryophyte species occurring on coarse woody debris as a result of hemlock dieback (Cleavitt et. al. 2008). *Brachythecium rotaeanum* is known from Whitewater River Falls but also occurs on soil and rock including dry ledges within the gorge. In some of the sites it is not necessarily associated with a spray cliff community, occurring in the coastal plain in a swamp cypress gum forest (NC Biotics 2010). Perhaps the least well known of this group of species is *Anzia americana*, which is thought to prefer low light levels and could be adversely affected by a change in light levels. There are few occurrences of this species in the mountains and all occur in protected gorges.

Rock Substrate

Forty-five of the 72 rare plant species occur primarily on rock substrates (Table 3.5-6). Five of these species are nonvascular and five are ferns. Most of the rare species preferring rock substrates occur within spray cliff communities. If not present in a spray cliff, the species (when occurring in hemlock dominated forests) are specifically associated with fast-flowing streams and cascades (The Nature Conservancy of Tennessee 1999, Hicks 1992, Hicks 1996, Anderson 1996).

Table 3-10. Eastern hemlock associated species primarily occurring on rock substrate.

Species	Populations	Form	Forest Designation	Substrate
Acrobolbus ciliatus	5	Liverwort	Sensitive	Rock
Cephalozia macrostachya ssp. australis	2	Liverwort	Sensitive	Rock
Lejeunea blomquistii	2	Liverwort	Sensitive	Rock
Lophocolea appalachiana	3	Liverwort	Sensitive	Rock
Marsupella emarginata var. latiloba	0	Liverwort	Sensitive	Rock
Metzgeria furcata var. setigera	0	Liverwort	Sensitive	Rock
Nardia lescurii	0	Liverwort	Sensitive	Rock, Soil
Pellia appalachiana	1	Liverwort	Sensitive	Rock
Plagiochila austinii	5	Liverwort	Sensitive	Rock
Plagiochila caduciloba	12	Liverwort	Sensitive	Rock
Plagiochila echinata	3	Liverwort	Sensitive	Rock
Plagiochila sharpii	7	Liverwort	Sensitive	Rock

Plagiochila sullivantii var. spinigera	2	Liverwort	Sensitive	Rock
Plagiochila sullivantii var. sullivantii	7	Liverwort	Sensitive	Rock
Plagiochila virginica var. caroliniana	3	Liverwort	Sensitive	Rock
Porella japonica ssp. appalachiana	0	Liverwort	Sensitive	Rock
Porella wataugensis	3	Liverwort	Sensitive	Rock
Radula sullivantii	4	Liverwort	Sensitive	Rock
Radula voluta	0	Liverwort	Sensitive	Rock
Lophocolea muricata	3	Liverwort	Forest Concern	Rock
Mylia tayorii	1	Liverwort	Forest Concern	Rock
Plagiochila ludoviciana	1	Liverwort	Forest Concern	Rock
Bryocrumia vivicolor	1	Moss	Sensitive	Rock
Philonotis cernua	4	Moss	Sensitive	Rock
Plagiomnium carolinianum	2	Moss	Sensitive	Rock
Platyhypnidium pringlei	1	Moss	Sensitive	Rock
Sphagnum flavicomans	1	Moss	Sensitive	Rock
Taxiphyllum alternans	1	Moss	Sensitive	Rock
Brachythecium populeum	0	Moss	Forest Concern	Rock
Bryoxiphium norvegicum	5	Moss	Forest Concern	Rock
Bryum riparium	1	Moss	Forest Concern	Rock
Dichodontium pellucidum	6	Moss	Forest Concern	Rock
Entodon sullivantii	7	Moss	Forest Concern	Rock
Homalia trichomanoides	3	Moss	Forest Concern	Rock
Racomitrium aciculare	3	Moss	Forest Concern	Rock
Rhabdoweisia creulata	2	Moss	Forest Concern	Rock
Rhytidadelphus subpinnatus	1	Moss	Forest Concern	Rock
Sphagnum pylaesii	2	Moss	Forest Concern	Rock
Sphagnum squarrosum	2	Moss	Forest Concern	Rock
Warnstorfia fluitans	1	Moss	Forest Concern	Rock
Hymenophyllum tayloriae	5	Vascular plant	Sensitive	Rock
Asplenium monanthes	1	Vascular plant	Forest Concern	Rock
Huperzia porophila	9	Vascular plant	Forest Concern	Rock

Trichomanes boschianum	4	Vascular plant	Forest Concern	Rock
Trichomanes petersii	5	Vascular plant	Forest Concern	Rock

Individuals of these 72 species could experience a dramatic decrease in their surrounding relative humidity if any eastern hemlock trees died and opened a gap. However, this negative effect would be less dramatic or not result in any perceptible change for those species associated with the spray zone from a waterfall. Additionaly, many of these rock adhering species are closely associated with either a nearby stream or river. As previously mentioned, recent research on changes in bryophyte densities in hemlock stands impacted by HWA suggests no decline, rather an increase in species richness for plots located near water (Cleavitt et. al. 2008). Recent anecdotal observations on rock adhering rare bryophyte populations suggests persistence and even increases in eastern hemlock dieback areas (Dr. Paul Davison, personal communication). Recent bryophyte survey work within the Chattooga River gorge located most of the historical populations (Kauffman, personal observation). The Chattooga River gorge has been heavily affected by eastern hemlock dieback. One exception was the fern species, *Trichomanes petersii*, which is typically found in humid gorges, however it occurs on relatively dry rock faces not directly affected by seepage or dry rock (Weakley 2009, TNC of Tennessee 1999). As a result this *Trichomanes* has a greater potential for negative impacts from hemlock dieback. In fact it was not relocated during the 2007 Chattooga River survey.

Carolina Hemlock

The list of 444 rare plants was queried for those species documented within habitats with significant Carolina hemlock components. Of the 444 tracked species, all but four were excluded from further analysis because proper habitat does not occur within the proposed activity area. The queried habitat for Carolina Hemlock associated rare species included Carolina Hemlock Forest (Bluff or Typic type), Carolina Hemlock-Pine Forest, Carolina Hemlock Forest (mesic type), and Pine-Oak/Heath Forest (Natureserve 2009, Schafale and Weakley 1990). All of these communities are more limited in abundance and range across western North Carolina in comparison to Eastern Hemlock Forest or Acidic Cove Forest.

Several vascular plant species, such as *Hudsonia montana* and *Liatris helleri*, were excluded from this Carolina hemlock habitat list of plant species since they have a well-known narrow range and are associated with rock outcrops on the edge of Pine-Oak/Heath Forests with only scattered Carolina hemlocks. In 2007 a portion of these sites had stand replacement fires which improved suitable habitat for the two rare species, but not for Carolina hemlock. In addition, communities with scattered Carolina hemlocks are not currently targeted for control efforts. Other xeric pine loving species, such as *Sabatia capitata*, were excluded from further analysis since their suspected range in North Carolina is within the far western counties where Carolina hemlock is not known to occur. The final list of rare plant species that may occur with Carolina hemlock-dominated habitats includes five sensitive and two forest concern plants. Except for a single lichen all are vascular plants.

Table 3-11. Rare plant species known or suspected to occur in the Proposed Carolina Hemlock treatment sites.

Species	Populations	Form	Designation
Canoparmelia amabilis	01	Lichen	Forest Concern
Fothergilla major	07	Vascular plant	Sensitive
Monotropsis odorata	07	Vascular plant	Sensitive
Thermopsis fraxinifolia	06	Vascular plant	Sensitive
Thermopsis mollis	03	Vascular plant	Forest Concern
Tsuga caroliniana	60+	Vascular plant	Sensitive
Cleistes bifaria	01	Vascular plant	Sensitive

There are no known direct effects to any of these seven rare plant species from any of the proposed new treatments for Alternative 2 and Alternative 3. Except for the lichen and Carolina hemlock, all seven species are known to be fire-loving with more flowering and fruiting in more open or partially open site conditions. As such it is uncertain on how closely associated these five rare species could ever be in these Carolina hemlock dominated communities. Their greater abundance would be on the periphery of these communities where treatments could occur. *Canoparmelia amabilis* has been located on *Kalmia latifolia* bark on xeric ridges in the southern Appalachians.

Individuals of these seven species have experienced an increase in light and a decrease in their surrounding relative humidity if they occurred in areas where Carolina hemlock trees have recently died and opened a gap. Except for the lichen all the species are known to occur in more open habitats. Given the site conditions they persist at, the change in light conditions from dying hemlock is not expected to affect the species.

Alternative 1 - NoAction

Previous analysis for the current HWA efforts across the Nantahala and Pisgah National Forests determined there would be no direct effects from use of imidacloprid or release of beetles to any rare plant species.

There would however be indirect effects from the loss of hemlocks. These effects included negative impacts from dead falling trees as well as negative impacts from increased light and lower humidity on the forest floor. Thirty-three species (1 lichen, 15 mosses, 9 liverworts, 3 ferns, 4 herbs, and 1 shrub) were identified with possible negative impacts based on the inability to apply treatments across all eastern hemlock dominated communities.

The previous analysis determined that there would be greater impacts to rare species adhering to bark, rock and on the forest floor and principally occurring in hemlock associated stands. These assumptions may have been overly cautious and based on recent observations in areas with dead hemlocks, may not be negative. As such the previous determinations have been updated in this analysis. Probably one forest concern plant species, *Trichomanes petersii,* may be most susceptible to any decrease in humidity and could be affected if numerous hemlocks continue to die surrounding existing populations.

Finally it cannot be discounted that there may be short-term negative impacts from dead hemlock trees crushing individual rare plants when they die and fall. The greatest likelihood of this impact would be to those species rooted in the forest floor and specifically those species not associated with spray cliff soils. Species with the greatest risk include seven sensitive plant species, *Buckleya distichophylla*, *Diervilla rivularis, Hexastylis rhombiformis, H. contracta, Shortia galacifolia var. galacifolia, S. galacifolia var. brevistyla,* and *Geum lobata*. Two forest concern rare plant species, *Dalibarda repens* and *Stewartia ovata* could be impacted. These potential impacts are not expected to eliminate any single population of these nine species.

For Carolina hemlock associated habitats the previous analysis only identified Carolina hemlock with potential negative impacts from not treating all known sites. This assumption is still true. As previously discussed for eastern hemlock, it cannot be discounted that there may be a short-term negative impact from dead Carolina hemlock trees crushing individual rare plants when they die and fall. All seven of the possible Carolina hemlock associated species could be impacted. The five sensitive species are *Tsuga caroliniana*, *Fothergilla major, Monotropsis odorata, Thermopsis fraxinifolia,* and *Cleistes bifaria*. *Canoparmelia amabilis* and *Thermopsis mollis* are the two forest concern plant species that could be impacted. These potential impacts are not expected to eliminate any single population of these nine species. There will be a long-term beneficial impact to *Tsuga caroliniana* where the previously identified treatments are continued.

Alternative 2 – Proposed Action

As previously stated the application of dinotefuran, imidacloprid, and/or the release of a fungus in new treatment areas is not expected to result in any direct impacts to any rare plant species.

Indirect effects should not vary from Alternative 1 and potentially could impact the same species; however the potential negative impacts may be slightly less than Alternative 1 or Alternative 3 if the greater availability of treatment options results in more hemlock communities with these rare species being successfully treated.

Adelgids are not known to pollinate any flowering vascular plants and since the fungus is potentially target specific to hemlock woolly adelgid, there should be no indirect affects to rare plant species pollinators. The potentially greater number of treatments across Carolina hemlock dominated communities will beneficially impact *Tsuga caroliniana*. Potentially this benefit will be greater than either Alternative 3 or Alternative 1.

Alternative 3

This alternative differs from Alternative 2 only in that it does not include the use of dinotefuran as a treatment option. This alternative is not expected to result in any direct impacts to any rare plant species.

Indirect effects should not differ from Alternative 1 and potentially would impact the same species; however the potential negative impacts may be slightly more if the absence of the dinotefuran treatment option results in greater hemlock mortality.

Cumulative Effects – All alternatives

Many of the ten rare eastern hemlock and seven Carolina hemlock associated plant species may be negatively impacted on private lands over the next 10 to 20 years as HWA populations increase and hemlocks die. On the Nantahala and Pisgah National Forests, most of these species occur within humid gorges where few vegetation management projects occur. For these rare plant species, the HWA represents the greatest potential impact to the surrounding environment in the foreseeable future.

The widespread rare species, *Buckleya distichophylla,* has been more recently impacted from other forest management activities. A wildfire within Madison County in 2004 near the Tennessee border affected a small *Buckleya distichophylla* population. The population was relocated and found to be as persistent as prior to the fire (D. Danley, Pisgah National Forest botanist, personal observation). *Dalibardia repens* has a large populations within the Pink Beds in Transylvania County. Recent beaver activity has resulted in localized flooding and possible death to some individuals of this species. A proposed project in the upper Chattooga River gorge is not anticipated to affect suitable habitat for *Trichomanes petersii*.

Recent fires in and surrounding the Linville Gorge Wilderness have burned populations of *Monotropsis odorata, Fothergilla major,* and *Thermopsis mollis.* Individuals have been relocated since the fire and anecdotally the populations appear to be vigorous although no specific population data pre and post fire has been gathered across these areas. In addition a trail improvement project (Foothills Trail) on the Nantahala Ranger District may have impacted some *Monotropsis odorata* individuals. New subpopulations of this species have been located in this area following the trail reconstruction.

It is not feasible to protect individually all of the hemlock trees across the Nantahala and Pisgah National Forests and therefore some damage and loss of individuals and stands will occur regardless of the proposed HWA control measures. As such, some Carolina hemlock trees, a sensitive plant, are expected to die regardless of any alternative. If no HWA control treatments occur on private land or other public lands, rare plant species associated with hemlock could be potentially affected by crushing plants, however these would be potentially restricted to species occurring on the forest floor and should not result in the loss of any species.

There will be no cumulative affect or loss of viability across the Forest for *Buckleya distichophylla*, *Dalibardia repens, Trichomanes petersii*, *Monotropsis odorata*, *Fothergilla major*, and *Thermopsis mollis* or any other rare plants with implementation of additional HWA control measures. There are no other projects across the Nantahala and Pisgah National Forests that have affected any of the other 10 rare plant species.

3.5.2 Rare Aquatic Species Evaluation

One hundred twenty-one rare aquatic species have been listed by the NCWRC, USFWS, or NCNHP as occurring or potentially occurring on the Nantahala and Pisgah National Forests (reference Rare Aquatic Species List in the project file). Of the 121 aquatic species included on the original list for analysis, 45 were dropped as a result of a likelihood of occurrence evaluation based on preferred habitat elements and known species occurrences. The Rare Aquatic Species Lists (available from project file) summarize this process. Those species dropped from analysis were largely fish and freshwater mussels, where knowledge of the species, their habitats, and occurrence across the Forests are well documented. Species considered in this analysis include many aquatic insects, crayfish, and other invertebrates for which accurate, comprehensive habitat and distribution data do not yet exist (although many of these species and groups of species are currently under study). For this analysis, if suitable habitat is present, species in Table 3-12 are considered present. Table 3-12 lists Federally-listed and Sensitive aquatic species considered in this analysis.

Aquatic Forest Concern species considered in this analysis can be found in the Rare Aquatic Species List (within the project file). These species are not included here because: the list is fluid (as species State and Global ranks are updated), and the list contains 63 species, which makes the table difficult to read within the body of this document.

Since data on individual species, particularly aquatic insects, is often difficult to collect and analyze and because many of the aquatic Forest Concern species contribute to the stability and diversity of the aquatic invertebrate community as a whole, this analysis addresses the aquatic insect community, making appropriate species-specific notes as needed. Also, when data on aquatic invertebrates is collected, it is most often presented in the community perspective, with individual species considered as components of the community. For example, the EPT index used by most resource agencies in North Carolina to assess aquatic community health relies on this community approach, while also maintaining lists of individual species that contribute to the index.

Table 3-12. Rare aquatic species considered in the analysis.

Group	Status	Scientific Name	Common Name
Mussel	Endangered	*Alasmidonta raveneliana*	Appalachian elktoe
Mussel	Endangered	*Pegius fabula*	Littlewing pearlymussel
Fish	Threatened	*Erimonax monachus*	Spotfin chub
Crayfish	Sensitive	*Cambarus chaugaensis*	Oconee stream crayfish
Crayfish	Sensitive	*Cambarus georgiae*	Little Tennessee R crayfish
Crayfish	Sensitive	*Cambarus parrishi*	Hiwassee headwaters crayfish
Crayfish	Sensitive	*Cambarus reburrus*	French Broad crayfish
Crustacean	Sensitive	*Caecidotea carolinensis*	Bennett's Mill cave water slater
Crustacean	Sensitive	*Stygobromus carolinensis*	Yancey sideswimmer
Dragonfly	Sensitive	*Gomphus diminutus*	diminuitive clubtail
Dragonfly	Sensitive	*Ophiogomphus edmundo*	Edmund's snaketail
Dragonfly	Sensitive	*Ophiogomphus howei*	pygmy snaketail
Mussel	Sensitive	*Alasmidonta varicose*	brook floater

Affected Environment

Section 3.3 gives a detailed description of the aquatic habitats present in this analysis. This section incorporates information from the Aquatic Resource Analysis - Treatment of the Hemlock Wooly Adelgid on the Nantahala and Pisgah National Forests (available from the project file).

All perennial stream miles on the forests have the potential to be occupied by aquatic insects and crayfish listed above and on the Rare Aquatic Species, Forest Concern list (located within the project file).

Appalachian elktoe (endangered), littlewing pearlymussel (endangered), spotfin chub (threatened), brook floater (sensitive), hellbender (forest concern), and common mudpuppy (forest concern) are known to occur or may occur in lower elevation, lower gradient coldwater systems. In general, these species occupy the upper end of the transition zone between cold- and coolwater systems across the Forests.

There are no rare aquatic species with direct habitat ties to hemlock forests.

Direct and Indirect Effects

Hemlock trees that die as a result of HWA infestation will contribute large woody debris (LWD) to riparian areas as well as the forest floor. Woody debris constitutes the major organic input to low order streams, where it is apparent that wood has a significant role in energy flow, nutrient dynamics, and stream morphology, and in shaping the biotic community (Swanson et al. 1976, Keller and Swanson 1979, Anderson and Sedell 1979). Across the Forests, aquatic habitats and populations associated with low order, coldwater streams are at risk from the decline or loss of hemlock species. While this influence is less observable in larger streams, the influence of large woody debris along the margins of larger coolwater systems is still important.

Potential direct and indirect effects are discussed together in the aquatics analysis because it is difficult to separate effects to habitat and effects to species that depend on those habitats. For this analysis, direct effects are defined as the results of the action on the quality and quantity of aquatic habitat, and indirect effects are the result of the action's effects on aquatic species due to habitat changes.

Positive effects of increased LWD include improved aquatic habitat diversity where hemlock is a significant component of riparian forests, and for a short distance downstream. These effects will last until LWD within the stream breaks down or is flushed downstream and until dead and dying hemlock trees are no longer present in the riparian area and serving as a source of LWD. Aquatic community diversity and stability may increase as a result of increased habitat diversity in coldwater streams, resulting in a positive trend for local trout populations. These effects will be less pronounced in coolwater streams and are not expected to measurably affect Appalachian elktoe (E), littlewing pearlymussel (E), spotfin chub (T), brook floater (S), hellbender (FC), and common mudpuppy (FC) habitat or population stablity due largely to stream order and position within the watershed.

Negative effects of dead and dying hemlocks within riparian areas include decreased bank stability and increased summer maximum water temperatures as trees with roots at the water's edge die and fall into or across streams. Decreased bank stability can lead to local changes in hydrology and increased erosion and sedimentation. Aquatic community diversity and stability may be impacted locally, but are not expected to be measurably impacted across the Forest by these relatively localized bank disturbances.

Generally speaking, aquatic communities within or adjacent to hemlock forests are not expected to be impacted by increases in maximum summer water temperatures due to relatively small contribution of hemlock to riparian vegetation and low stream order and position within the watershed (i.e. higher elevations where the elevation mitigates milder fluctuations in water temperature). However, it is possible that species occupying coolwater habitats, such as the Appalachian elktoe (E), littlewing pearlymussel (E), spotfin chub (T), brook floater (S), hellbender (FC), and common mudpuppy (FC), where hemlock is a significant riparian component could be affected by even slight increases in summer maximum temperatures. Such effects would include reduced or eliminated reproduction or shifting of the lower end of occupied habitat upstream.

Alternative 1 – No Action

The use of predator beetles will have no measurable direct or indirect effects on any of the rare aquatic species considered or their habitat. Until the beetles become established in riparian hemlock stands, it is assumed that the amount of large woody debris (LWD) in streams will increase as hemlocks die.

Imidacloprid is moderately toxic to fish and highly toxic to aquatic invertebrates. It has a long half-life in soil (>31 days) at pH 5, 7, and 9, which represents most of the soil conditions across the Forests. Additionally, the chemical is moderately mobile in some soils. Imidacloprid has been found to be photolytic in water, and has a half life of less than 3 hours (Fossen 2006). Pesticide label restrictions prohibit the use of the chemical where surface water is present. It further states that use of the chemical where the water table is shallow may contaminate groundwater. Local water quality monitoring done by the Coweeta Hydrologic Lab documented an extremely low detection of imidacloprid in coldwater streams on the Nantahala National Forest (Churchel et al. 2008).

The Forests have developed a clearance process to aid in the determination of whether it is safe to use imidacloprid to treat individual trees. This process was developed to minimize or eliminate the potential for contact between imidacloprid and aquatic resources.

Mixing and transporting procedures for imidacloprid are designed to avoid any possibility of the chemical accidentally entering a stream. In the unlikely event an accident does occur that results in imidacloprid entering a stream, local aquatic populations could be affected, but extensive effects are not expected due to the extremely short photolytic half-life of imidacloprid in water. Additionally, should an accident occur, the chemical would be rapidly diluted beyond measurable levels, further reducing the probability that aquatic populations would be affected. It is important to note that the loss of one local aquatic invertebrate community will not affect overall species' trends across the Forests. This is because the local stream reach that could be affected by an accidental spill would be quickly recolonized by populations up- or downstream following rapid dilution.

Through strict adherence to label restrictions, and because the chemical has an extremely short half-life in water, the use of imidacloprid will have no effect on Appalachian elktoe, littlewing pearly mussel, spotfin chub, or their habitats. These species occupy coolwater habitats across the forests, where hemlock forests are less common, further reducing the chance that the species would ever come in contact with the chemical, even accidentally.

Similarly, the use of imidacloprid will have no effect on the following sensitive species: Oconee stream crayfish, Little Tennessee River crayfish, Hiwassee headwaters crayfish, French Broad crayfish, Bennett's Mil cave water slater, Yancey sideswimmer, diminuitive clubtail, Edmund's snaketail, pygmy snaketail, and brook floater. Additionally, the use of imidacloprid will not impact aquatic Forest Concern species.

Alternative 2- Proposed Action

Effects of using beetles on aquatic resources would be similar to those described for Alternative 1.

Alternative 2 includes expanded use of imidacloprid on all hemlock treatment areas. Effects from the use of imidacloprid on aquatic ecosystems would be similar to those described for Alternative 1 but more conservation areas could be treated with imidacloprid. More chemical treatments would result in less LWD reaching streams and therefore less increase in aquatic habitat diversity. Negative effects including loss of bank stability and increased stream temperatures would be less than in Alternative 1 since more aquatic habitats that are shaded by hemlocks would be protected.

Alternative 2 proposes the use of dinotefuran on trees that are heavily infested and need immediate attention to ensure survival. Dinotefuran is highly soluble in water, highly mobile in most soil types, and is relatively stable to hydrolysis at pH 4 to 9 (the range of most soils and water across the Forests). High water solubility combined with high soil mobility indicates that this compound has the potential to leach into area streams. The major dissipation route for dinotefuran is aqueous photolysis (half-life 1.8 days), although even in its parent state, the chemical is practically nontoxic to fish and freshwater aquatic invertebrates (EPA 2004). Additionally, none of dinotefuran's degradates were found to be toxic to aquatic organisms (EPA 2004).

Dinotefuran would be applied with strict adherence to label direction, specifically in regards to the required distance from riparian areas and standing water. This process will minimize the potential for direct contact between dinotefuran and aquatic resources. This, combined with low toxicity of dinotefuran to aquatic organisms, will insure that effects to aquatic organisms are minimized.

Mixing and transporting procedures for dinotefuran are designed to avoid any possibility of dinotefuran accidentally entering a stream. In the unlikely event an accident does occur during application, local aquatic populations could be affected, but extensive effects are not expected due to the short photolytic half-life of dinotefuran in water and the chemical's low toxicity to freshwater aquatic organisms. Should an accidental spill occur, the chemical would be rapidly diluted beyond measurable levels, further reducing the probability that aquatic populations would be affected.

Through strict adherence to label restrictions, and because the chemical is not toxic to aquatic organisms, the use of dinotefuran will have no effect on Appalachian elktoe, littlewing pearly mussel, spotfin chub, or their habitats. These species occupy coolwater habitats across the forests, where hemlock forests are less common, further reducing the chance that the species would ever come in contact with the chemical, even accidentally.

Similarly, the use of dinotefuran will have no impact on the following sensitive species: Oconee stream crayfish, Little Tennessee River crayfish, Hiwassee headwaters crayfish, French Broad crayfish, Bennett's Mil cave water slater, Yancey sideswimmer, diminuitive clubtail, Edmund's snaketail, pygmy snaketail, and brook floater.

Alternative 2 also proposes the use of native-occurring fungus *Lecanicillium muscarium*. Based on initial field studies of the fungus, there is little concern associated with effects of the fungus on non-target insects, including aquatic insects. Use of this fungus will have no effect on Appalachian elktoe, littlewing pearly mussel, or spotfin chub. Additionally, use of the fungus will have no impact on the following sensitive species: Oconee stream crayfish, Little Tennessee River crayfish, Hiwassee headwaters crayfish, French Broad crayfish, Bennett's Mill cave water slater, Yancey sideswimmer, diminuitive clubtail, Edmund's snaketail, pygmy snaketail, and brook floater, or on any aquatic Forest Concern species.

Alternative 3

Alternative 3 is the same as Alternative 2 except that dinotefuran will not be used. Refer to the analysis above for the effects from the expanded use of imidacloprid and *Lecanicillium muscarium*.

Cumulative Effects

New and revised treatment methods will not change the cumulative effects analysis for aquatic resources that were presented in the 2005 EA.

Vegetation management activities seldom occur near streams, though recreational activities often occur near water. Past, present, and reasonably foreseeable future activities include the occasional construction of stream crossings for roads or trails, water based recreational activities and streamside camping. If sediment enters the stream from these sources it can result in localized and temporary reductions in the quality of the habitat for aquatic invertebrates and fish. In areas with many streamside hemlocks, the addition of LWD from dead hemlocks (from HWA infestation) could initially help offset sedimentation effects by providing additional instream habitat in the short term. However, once that influx of LWD decomposes, a more lengthy loss of new LWD inputs would occur while riparian forests move through early stages of succession. Treatment of the HWA to slow down or prevent the loss of riparian hemlocks would moderate LWD inputs, since fewer hemlocks would die over the next few years, allowing for a more stable influx of LWD into streams over time.

Since use of a clearance process and other safety precautions would minimize or eliminate the potential for contact between imidacloprid or dinotefuran and aquatic resources, the use of insecticides would not add cumulatively to effects on aquatic habitats or populations from all other forest activities.

Since releasing biocontrols (predator beetles or the fungus *Lecanicillium muscarium*) will have no measurable direct or indirect effects on aquatic resources, the actions would not add cumulatively to effects on aquatic habitats or populations from all other forest activities.

Table 3-13. Summary of effects on rare aquatic species, by alternative,.

Status	Scientific Name	Common Name	Alt. 1 (I=imidacloprid, B=beetle)	Alt. 2 Dinotefuran (D) & fungus (F)	Alt. 3 Effects same as Alt. 2 without Dinotefuran
E	*Alasmidonta raveneliana*	Appalachian elktoe	B: no effect I: no effect	D: no effect F no effect	B: no effect I: no effect
E	*Pegius fibula*	Littlewing pearlymussel	B: no effect I: no effect	D: no effect F no effect	B: no effect I: no effect
T	*Erimonax monachus*	Spotfin chub	B: no effect I: no effect	D: no effect F no effect	B: no effect I: no effect
S	*Cambarus chaugaensis*	Oconee stream crayfish	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Cambarus georgiae*	Little Tennessee R crayfish	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Cambarus parrishi*	Hiwassee headwaters crayfish	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Cambarus reburrus*	French Broad crayfish	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Caecidotea carolinensis*	Bennett's Mill cave water slater	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Stygobromus carolinensis*	Yancey sideswimmer	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Gomphus diminutus*	diminuitive clubtail	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Ophiogomphus edmundo*	Edmund's snaketail	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Ophiogomphus howei*	pygmy snaketail	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
S	*Alasmidonta varicosa*	brook floater	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact
FC	*63 species:Rare Aquatic Species, Forest Concern*	*(reference project file)*	B: no impact I: no impact	D: no effect F no effect	B: no impact I: no impact

E – Endangered
S – Sensitive
FC – Forest Concern

3.5.3 Rare Terrestrial Wildlife

Affected Environment

One hundred forty-five rare terrestrial wildlife species have been listed by the NCWRC, USFWS, or NCNHP as occurring or potentially occurring on the Nantahala and Pisgah National Forests (reference Rare Terrestrial Wildlife Species List in the project file). Of the 145 terrestrial wildlife species included on the original list for analysis, 41 were dropped from this analysis as a result of a likelihood of occurrence evaluation based on preferred habitat elements and known species occurrences. The Rare Terrestrial Wildlife Species Lists (available from project file) summarize this process. Species dropped from analysis were largely associated with grassy or other non-forested habitats, or where knowledge of the species, their habitats, and occurrence across the Forests are well documented. Species considered in this analysis include many terrestrial insects and gastropods for which accurate, comprehensive habitat and distribution data do not yet exist (although many of these species and groups of species are currently under study). For this analysis, if suitable habitat is present, species in Table 3-14 are considered present.

Table 3-14 lists Federally-listed and Sensitive terrestrial wildlife species considered in this analysis. These species have been grouped to facilitate discussion of effects. For example, potential effects on amphibians will be discussed as a species group, except when species-specific effects differ from the taxonomic group.

Terrestrial wildlife Forest Concern species considered in this analysis can be found in the Rare Terrestrial Wildlife Species List (within the project file). These species are not included here because the list is fluid (as species State and Global ranks are updated), and the list contains 73 species, which makes the table difficult to read within the body of this document.

Table 3-14. Rare terrestrial wildlife species considered in this analysis.

Group	Status	Scientific Name	Common Name
AMPHIBIANS			
Amphibian	Sensitive	Desmognathus santeetlah	Santeetlah dusky salamander
Amphibian	Sensitive	Eurycea junaluska	Junaluska salamander
Amphibian	Sensitive	Plethodon aureolss	Tellico Salamander
Amphibian	Sensitive	Plethodon teyahalee	Southern Appalachian salamander
Amphibian	Sensitive	Plethodon welleri	Weller's salamander
ARACHNIDS			
Arachnid	Endangered	Microhexura montivaga	Spruce-fir moss spider
Arachnid	Sensitive	Hypochilus coylei	A cave spider
Arachnid	Sensitive	Hypochilus sheari	A lampshade spider
Arachnid	Sensitive	Nesticus cooperi	A cave spider
Arachnid	Sensitive	Nesticus crosbyi	A cave spider
Arachnid	Sensitive	Nesticus mimus	A cave spider
Arachnid	Sensitive	Nesticus sheari	A cave spider
Arachnid	Sensitive	Nesticus silvanus	A cave spider
BIRDS			
Bird	Sensitive	Falco peregrinus	Peregrine falcon
Bird	Sensitive	Haliaeetus leucocephalus	Bald eagle
INSECTS			
Insect: grasshopper/katydid	Sensitive	Melanoplus divergens	Divergent melanoplus
Insect: grasshopper/katydid	Sensitive	Melanoplus serrulatus	Serrulate melanoplus
Insect: grasshopper/katydid	Sensitive	Scudderia septentrionalis	Northern bush katydid

Group	Status	Scientific Name	Common Name
Insect: grasshopper/katydid	Sensitive	Trimerotropis saxatilis	Rock-loving grasshopper
Insect: moth	Sensitive	Euchlaena milnei	Milne's euchlaena
Insect: moth	Sensitive	Semiothisa fraseri	Fraser fir geometrid moth
MAMMALS			
Mammal	Endangered	Glaucomys sabrinus coloratus	Carolina Northern flying squirrel
Mammal	Endangered	Myotis sodalis	Indiana bat
Mammal	Sensitive	Microtus chrotorrhinus caroliensis	Southern rock vole
Mammal	Sensitive	Myotis leibii	Eastern small-footed bat
Mammal	Sensitive	Sorex palustris punctulatus	Southern water shrew
MOLLUSKS			
Mollusk: terrestrial gastropod	Threatened	Patera clarki Nantahala	Noonday Globe
Mollusk: terrestrial gastropod	Sensitive	Pallifera hemphilli	Black mantleslug
Mollusk: terrestrial gastropod	Sensitive	Paravitrea placentula	Glossy supercoil
Mollusk: terrestrial gastropod	Sensitive	Ventridens coelaxis	Bidendate dome
REPTILES			
Reptile	Threatened (S/A)	Clemmys muhlenbergii	Bog Turtle

Direct and Indirect Effects on Rare Terrestrial Wildlife Species

The following discussion includes potential effects on Proposed, Threatened, and Endangered terrestrial wildlife species (P, T, and E), and terrestrial Regional Forester Sensitive species (S) (Table 3-14). Effects on terrestrial Forest Concern species are expected to be similar to proposed, threatened and endangered species, and therefore are specifically discussed only when they are different (reference Terrestrial Wildlife Rare Species Lists).

Alternative 1 – No Action

Amphibians

There are no terrestrial salamanders dependent directly on hemlock forests; however several Sensitive species (including Santeetlah dusky salamander, Junaluska salamander, Tellico salamander, Southern Appalachian salamander, and Weller's salamander) occur on the lower mountain slopes and adjacent lowlands in forested habitats with abundant leaf litter and rotting logs on the forest floor. Most terrestrial salamanders require shaded woodlands, usually hardwoods but occasionally coniferous areas in the vicinity of bottomlands, with fallen logs, leaf litter, and an organic soil layer. They forage mainly at night on the surface or within their burrows, capturing arthropods and worms. Some canopy closure is necessary to prevent excessive drying of the forest floor.

The Junaluska salamander is found at low elevations under logs and rocks along the Cheoah River and its tributaries in Graham County, North Carolina. It ventures some distance across land during rainy nights. It requires clean, clear streams with abundant rocks and logs, and its diet consists of small arthropods. Siltation or pollution of streams as well as destruction of adjacent forests and their leaf litter would be detrimental to this species.

When hemlocks die, sunlight reaching the forest floor increases and dries out leaf litter. This drying makes the areas less hospitable for terrestrial salamanders that move on the forest floor (through the leaf litter). When these areas are adjacent to streams, drying is expected to be less because of the influence of the adjacent stream on soils and leaf litter moisture.

By treating the hemlock with biocontrol or chemicals, shade will be maintained in the forest, thus making it more suitable for this salamander species that requires moist conditions.

The use of predator beetles will have no effect on Santeetlah dusky salamander, Junaluska salamander, Tellico salamander, Southern Appalachian salamander, or Weller's salamander.

Because imidacloprid is either injected directly into the trunk of the tree, or approximately 8 -10 inches deep into the soil (below the leaf litter), use of this chemical will have no effect on Santeetlah dusky salamander, Junaluska salamander, Tellico salamander, Southern Appalachian salamander, or Weller's salamander.

Arachnids

There are no rare arachnids directly dependent on hemlock or hemlock habitat. The predator beetles proposed for release feed almost exclusively on adelgids so the beetles would have no effect on *Hypochilus coylei, H. sheari, Nesticus cooperi, N. crosbyi, N. mimus, N. sheari*, or *N. silvanus.* Imidacloprid is a systemic pesticide that is absorbed into the tree through fine roots and affects sap sucking insects. Arachnids are not sap sucking insects and therefore there would be no effects of imidacloprid on the above species.

Spruce fir moss spider (E) is dependent on spruce/fir forests, and has not been shown to occupy hemlock stands outside the range of these two tree species. Scattered dying hemlock may cause canopy gaps that may make local habitats less suitable for the spruce fir moss spider. The use of predator beetles and imidacloprid may affect, but is not likely to adversely affect the spruce fir moss spider. In fact, local habitats may be protected where hemlock occurs within spruce/fir forests.

Birds

There are no Federally-listed or Sensitive birds that depend directly on hemlock forests; although several rare terrestrial bird species do show some dependence on coniferous forests, including hemlock.

The loss of hemlock would improve bird habitat (locally) by creating snags used for foraging and nesting for species such as the bald eagle (sensitive) and yellow-bellied sapsucker (federal concern). It is reasonable to believe that all infested hemlocks across the Nantahala and Pisgah National Forests will not be treated, thus new hemlock snags will be created regardless of the extent of treatments. The use of predator beetles will have no impact on bald eagle. Additionally, since imidacloprid is either injected directly into the trunk of the tree, or into the soil, use of this chemical will have no effect on the bald eagle.

Scattered dying hemlock may cause canopy gaps in hardwood forests that may make the habitat more suitable for nesting for species such as the cerulean warbler (forest concern) and blue-winged warbler (forest concern). Also, it is reasonable to believe that all infested hemlocks across the Nantahala and Pisgah National Forests will not be treated, thus some canopy gaps will still be created as hemlock die.

Although hemlock may grow near rock faces or cliffs, the peregrine falcon (sensitive) is not dependent on hemlock habitat. Because falcon populations tend to be limited by the availability of nest sites or food sources, the death of hemlock will not affect the peregrine falcon. The use of predator beetles will have no impact on peregrine falcon. Additionally, since imidacloprid is either injected directly into the trunk of the tree, or into the soil, use of this chemical would have no impact on peregrine falcon.

The magnolia warbler (forest concern) inhabits spruce/fir forests, and it is also found around the edges of bogs where spruce or fir occur. Hemlock forests are probably used sparingly, and it avoids pure hardwood forests. Although this bird does not depend on hemlock, it will nest in hemlock trees. Death of hemlock will reduce the amount of nesting habitat available for the magnolia warbler.

The hermit thrush (FC) inhabits open humid coniferous and mixed forest and forest edges and less frequently in deciduous forest and thickets. In North Carolina, hermit thrush is often found at higher elevations in spruce/fir forests, especially in moist spots, with a light to moderate understory. Hermit thrush typically nests on the ground, usually under conifers with low branches or hidden by low plants. Hemlock may be an important component of the thrush's habitat where spruce/fir trees are sparse. Death of hemlock will reduce the amount of suitable nesting habitat for the thrush at across the Forests. Biocontrol or chemical treatment of hemlock will maintain suitable nesting habitat for the hermit thrush.

Insects

There are no rare terrestrial insect species directly dependent on hemlock. The use of predator beetles will have no effect on Northern bush katydid, rock-loving grasshopper, or Milne's euchlaena. Because imidacloprid is either injected directly into the trunk of the tree, or into the soil, use of this chemical will have no impact on Northern bush katydid, rock-loving grasshopper, or Milne's euchlaena.

Fraser fir geometrid moth (sensitive) is dependent on Fraser fir, but has not been shown to utilize hemlock. The use of predator beetles will have no effect on Fraser fir geometrid moth. Additionally, since imidacloprid is either injected directly into the trunk of the tree, or into the soil, use of this chemical will have no impact on Fraser fir geometrid moth.

Scattered dying hemlock may cause canopy gaps in hardwood forests that may make the habitat more suitable for insect species that prefer ecotones between forested and more open areas such as divergent melanoplus (sensitive), serrulate melanoplus (sensitive), Diana fritillary (forest concern), and tawny crescent (forest concern). Also, it is reasonable to believe that all infested hemlocks across the Nantahala and Pisgah National Forests will not be treated, thus some canopy gaps will still be created as hemlock die. The use of predator beetles will have no impact on divergent melanoplus or serrulate melanoplus. Additionally, since imidacloprid is either injected directly into the trunk of the tree, or into the soil, use of this chemical will have no impact on divergent melanoplus or serrulate melanoplus.

Mammals

In North Carolina, the Carolina Northern flying squirrel occurs at elevations above 4,000 feet. The squirrel is found in spruce-fir and northern hardwood forests where beech or yellow birch occurs. Its optimal conditions include cool, moist, mature forest with abundant standing and down snags. These squirrels occupy tree cavities, leaf nests and underground burrows, but they prefer cavities in mature trees as den sites. Carolina Northern flying squirrel diet includes insects, fruit, nuts, roots, and rhizomes, including those from hemlock. While hemlock decline within the squirrel's habitat will increase the amount of snags available for cavity nesting, the loss of hemlock as a food source may be more significant to the survival of the species.

Both Indiana bats (endangered) and Eastern small-footed bats (sensitive) roost in snags and trees with crevices and exfoliating bark. Indiana bats have been documented in hemlock on the Forest during summer maternity roosting. Gradual loss of hemlock will improve tree-roosting bat habitat (locally) by creating snags. It is reasonable to believe that all infested hemlocks across the Nantahala and Pisgah National Forests will not be treated, thus new hemlock snags will be created even with treatment.

Additionally, scattered dying hemlock may cause canopy gaps in hardwood forests that may make the habitat more suitable for foraging bats, including Indiana bat and Eastern small-footed bat. Also, it is reasonable to believe that all infested hemlocks across the Nantahala and Pisgah National Forests will not be treated, thus some canopy gaps will still be created as hemlock die.

The use of predator beetles will have no effect on the Carolina Northern flying squirrel or Indiana bat or their habitat.

Imidacloprid was found to be slightly to moderately toxic to mammals when directly exposed to the chemical. It has a long half-life in soil (>31 days) at pH 5, 7, and 9, which represents most of the soil conditions across the Forests. Laboratory studies reported reductions in reproductive success from direct exposure to the chemical.

Indiana bats and Eastern small-footed bats will not be exposed directly or indirectly to imidacloprid. The use of imidacloprid will have no effect on the Indiana bat or the Eastern small-footed bat. The use of imidacloprid will not affect habitat for the Eastern small-footed bat since hemlock represents a small portion of total forest habitat. The use of imidacloprid may affect summer maternity habitat for the Indiana bat by slowing snag recruitment into the forest. It is not likely that all hemlock trees will be treated, therefore some hemlocks will continue to degrade, providing suitable roost trees for Indiana bats.

Since imidacloprid will be injected into the tree or below the leaf litter into the soil, direct exposure of Carolina Northern flying squirrels to the chemical is not likely. However, squirrels foraging on cones, roots, and rhizomes of trees treated with imidacloprid may be indirectly exposed to low concentrations of the chemical. It is not likely that exposures to such levels of imidacloprid would approach laboratory study levels and result in effects on the Carolina Northern flying squirrel; however many of these questions remain to be answered scientifically. Therefore, the use of imidacloprid may affect, but is not likely to adversely affect, the Carolina Northern flying squirrel. The use of imidacloprid will positively affect habitat for the Carolina Northern flying squirrel by retaining hemlocks within the species known range.

The Southern rock vole (sensitive) and Southern water shrew (sensitive) are small mammals that are associated with dry and moist rocky areas, respectively. Although neither species is hemlock-dependent, the loss of hemlock around rock outcrops or stream channels would make the habitat less suitable. Also, it is reasonable to believe that not all infested hemlocks across the Nantahala and Pisgah National Forests will be treated, thus some canopy gaps will still be created as hemlock die.

The use of predator beetles will not impact Southern rock voles and Southern water shrews. Similarly, the use of imidacloprid will not impact Southern rock voles and Southern water shrews.

Mollusks

There are no terrestrial mollusks dependent entirely on hemlock forests; however the noonday globe (threatened), black mantleslug (sensitive), glossy supercoil (sensitive), and bidendate dome (sensitive) occur in forested habitats with abundant leaf litter and rotting logs on the forest floor. Most terrestrial mollusks require shaded woodlands to prevent excessive drying of the forest floor. The noonday globe is a snail endemic to the Nantahala Gorge in Swain County.

When hemlock die, the amount of sunlight on the ground increases, drying out leaf litter on the forest floor. This drying makes the areas less hospitable for terrestrial snails, including the noonday globe that moves through the leaf litter. When these areas are adjacent to streams, drying is expected to be less because of the influence of the adjacent stream on soils and leaf litter moisture.

By treating the hemlock with biocontrol or chemicals, shade will be maintained in the forest, thus making it more suitable for this salamander species that requires moist conditions.

The use of predator beetles will not affect the noonday globe or its habitat. The use of predator beetles will have no impact on black mantleslug, glossy supercoil, or bidendate dome.

Because imidacloprid is either injected directly into the trunk of the tree, or approximately 8 -10 inches deep into the soil (below the leaf litter), use of this chemical will not affect the noonday globe, the black mantleslug, glossy supercoil, or bidendate dome.

Reptiles

The bog turtle (threatened by similarity of appearance) inhabits sphagnum bogs, swamps, and marshy meadows that have clear, slow-moving streams with soft muddy bottoms. It occurs from sea level to elevations above 1400 meters. The species is therefore excluded from closed-canopied streams. The turtle depends on a mosaic of microhabitats for foraging, nesting, basking, hibernation, and shelter.

Although the turtle occurs in wetlands where hemlock may occur, it does not depend on hemlock. Where hemlock shade wetlands, the death of hemlock may open up the wetlands and make them more suitable for the turtle by allowing herbaceous vegetation (e.g., grasses) to grow.

The use of predator beetles will not affect the bog turtle or its habitat. Because imidacloprid is either injected directly into the trunk of the tree, or approximately 8 -10 inches deep into the soil (below the leaf litter), and because it is highly photolytic in water, use of this chemical will not affect the bog turtle or its habitat.

Alternative 2 – Proposed Action

Effects of using beetles on terrestrial wildlife would be similar to those described for Alternative 1.

Alternative 2 includes expanded use of imidacloprid on all hemlock treatment areas. Effects from the use of imidacloprid on terrestrial wildlife would be similar to those described for Alternative 1 but more areas would be treated with imidacloprid. More chemical treatments would result in fewer hemlock snags and small canopy gaps within forests supporting hemlock. It is unlikely that all hemlocks will be treated, and these conditions would continue, although to a lesser extent, across the Forests. Refer to the discussion above for potential effects of imidacloprid use on terrestrial wildlife.

Alternative 2 proposes the use of dinotefuran on trees that are heavily infested and need immediate attention to ensure survival. Dinotefuran is highly soluble in water and is relatively stable to hydrolysis at pH 4 to 9 (the range of most soils and water across the Forests). The chemical is highly mobile in most soil types, but demonstrates low potential for bioaccumulation (EPA 2004). Dinotefuran is practically nontoxic to birds and mammals (EPA 2004). Dinotefuran is highly toxic to honeybees (EPA 2004). High water solubility combined with high soil mobility indicates that this compound has the potential to leach into area streams and moist habitats. The major dissipation route for dinotefuran is aqueous photolysis (half-life 1.8 days), although even in its parent state, the chemical is practically nontoxic to fish and freshwater aquatic invertebrates (EPA 2004). From this, it is reasonable to assume that dinotefuran and its major degradates would be practically nontoxic to terrestrial species dependent on surface water for all or part of their life cycle (e.g. salamanders). Additionally, the EPA (2004) recommends using fish toxicity data as a surrogate for amphibians.

Since dinotefuran is highly toxic to honeybees and remains relatively stable in most soil types, it is also reasonable to assume that the chemical may be toxic to terrestrial species within the leaf litter or top layers of soil (e.g. snails, spiders, etc.). Data on the toxicity of dinotefuran to other insects is sporadic, with some species being more sensitive to the compound than others. SERA (2009) describes the risk to nontarget insects based on exposure (e.g. direct exposure through broadcast spraying, indirect exposure through eating or using leaves or bark following soil or stem injection). Basically, the risk to nontarget insects is based on the amount and type of exposure (i.e. do nontarget insects eat leaves or bark of treated trees, or are they exposed to hemlock pollen). The Forest is not proposing to use broadcast application of dinotefuran; therefore there will be no direct exposure to any nontarget insects. Hemlock is a wind-pollinated species, so it is unlikely that nontarget insects will come in contact with relatively large amounts of pollen exposed to dinotefuran.

There is no data on the toxicity of dinotefuran to reptiles; however, the EPA recommends the use of bird toxicity data as a surrogate for these species groups (EPA 2004).

The forests would utilize a clearance process similar to that for imidacloprid to aid in the determination of whether it is safe to use dinotefuran to treat individual trees, especially near surface water. This process will minimize the potential for direct contact between dinotefuran and nontarget organisms.

Alternative 2 also proposes the use of naturally-occurring fungus *Lecanicillium muscarium*. Based on initial field studies of the fungus, there is little concern associated with effects of the fungus on non-target organisms, including insects.

Amphibians

Use of L. muscarium would have no effects on Santeetlah dusky salamander, Junaluska salamander, Tellico salamander, Southern Appalachian salamander, or Weller's salamander.

Because dinotefuran is either applied directly to the trunk of the tree, or approximately 8 -10 inches deep into the soil (below the leaf litter), use of this chemical will have no effect on Santeetlah dusky salamander, Junaluska salamander, Tellico salamander, Southern Appalachian salamander, or Weller's salamander. This method minimizes direct exposure of amphibians to the chemical. Additionally, dinotefuran is assumed to be nontoxic to amphibians.

Arachnids

There are no rare arachnids directly dependent on hemlock. Because dinotefuran is either applied directly to the trunk of the tree, or approximately 8 -10 inches deep into the soil (below the leaf litter), use of this chemical will not affect H*ypochilus coylei*, *H. sheari*, *Nesticus cooperi*, *N. crosbyi*, *N. mimus*, *N. sheari*, or *N. silvanus.* This method minimizes direct exposure of spiders to the chemical.

Birds

There are no Federally-listed or Sensitive birds that depend directly on hemlock forests; although several rare terrestrial bird species do show some dependence on coniferous forests, including hemlock.

The use of dinotefuran would not affect rare birds because the compound is practically nontoxic to birds and there will be no direct exposure to the chemical. The use of *L. muscarium* would not affect birds as it is a fungus that attacks insects.

Insects

There are no rare terrestrial insect species entirely dependent on hemlock. The application of dinotefuran on hemlock trunks or directly into the soil could have effects to rare inspect species but these would be minimal and would not result in federally listing of the species. The use of *L. muscarium* would not affect rare insects as it has been shown to have relatively high host-specificity towards adelgid species and low infectivity to non-host species (Costa 2008).

Mammals

Dinotefuran was found to be practically nontoxic to small mammals when they were directly exposed to the chemical. It has a long half-life in soil and is relatively mobile in most soil types. Laboratory studies reported reductions in reproductive success from direct exposure to the chemical.

Indiana bats and Eastern small-footed bats will not be exposed directly or indirectly to dinotefuran and therefore the use of dinotefuran will not affect the Indiana bat or the Eastern small-footed bat. The use of dinotefuran may affect, but is not likely to adversely affect summer maternity habitat for the Indiana bat by slowing snag recruitment into the forest. It is not likely that all hemlock trees will be treated, and therefore some hemlocks will continue to degrade, providing suitable roost trees for Indiana bats.

Because dinotefuran will be directly applied to the trunk of the tree or below the leaf litter into the soil, direct exposure of Carolina Northern flying squirrels to the chemical is not likely. However, squirrels foraging on cones, roots, and rhizomes of trees treated with dinotefuran may be indirectly exposed to low concentrations of the chemical. It is not likely that exposures to such levels of dinotefuran would approach laboratory study levels and result in effects on the Carolina Northern flying squirrel; however many of these questions remain to be answered scientifically.

The Southern rock vole (S) and Southern water shrew (S) are small mammals that are associated with dry and moist rocky areas, respectively. Dinotefuran is practically nontoxic to small mammals.

The use of *L. muscarium* would not affect mammals as it is a fungus that attacks insects.

Mollusks

Because dinotefuran will be directly applied to the trunk of the tree or below the leaf litter into the soil (below the leaf litter), use of this chemical will have no effect on the noonday globe or its habitat, and no impact on black mantleslug, glossy supercoil, or bidendate dome.

The use of *L. muscarium* would not affect mollusks as it is a fungus that attacks insects.

Reptiles
Because dinotefuran will be directly applied to the trunk of the tree or below the leaf litter into the soil (below the leaf litter), use of this chemical will not affect the bog turtle or its habitat.

The use of *L. muscarium* would not affect reptiles as it is a fungus that attacks insects.

Alternative 3: No Additional Chemicals

Alternative 3 is the same as Alternative 2 except that dinotefuran would not be used. Refer to the effects analysis above for the expanded use of imidacloprid and *Lecanicillium muscarium*.

Cumulative Effects for Rare Species

Past and present timber harvest and prescribed burning activities on the Nantahala and Pisgah National Forests have affected eastern and Carolina hemlocks and have affected sites that could support eastern hemlock such as acidic coves. Many of these activities will continue in the future but the resulting individually minor effects are insignificant when compared with the major impacts expected from infestation of the HWA. Therefore, these activities are unlikely to add or combine measurably with the impact resulting from an expanding HWA population over time. This project would result in lessening cumulative impacts to hemlock from HWA infestation and all other actions.

Table 3.15. Summarized Effects to Rare Terrestrial Wildlife Species by Alternative.

Status	Common Name	Alt. 1 -Current Management (B=beetle, I=imidacloprid)	Alt. 2 Beetle, imidacloprid (see left), dinotefuran (D) & fungus (F)	No dinotefuran (see left)
AMPHIBIANS				
Sensitive	Santeetlah dusky salamander	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Junaluska salamander	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Tellico Salamander	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Southern Appalachian salamander	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Weller’s salamander	B: no impact I: no impact	D: no impact F: no impact	See left
ARACHNIDS				
Endangered	Spruce-fir moss spider	B: not likely to adversely affect (in spruce/fir forests) I: not likely to adversely affect (in spruce/fir forests)	D: not likely to adversely affect (in spruce/fir forests) F: not likely to adversely affect (in spruce/fir forests)	See left
Sensitive	*Hypochilus coylei*	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	*Hypochilus sheari*	B: no impact I: no impact	D: no impact F: no impact	See left

Status	Common Name	Alt. 1 -Current Management (B=beetle, I=imidacloprid)	Alt. 2 Beetle, imidacloprid (see left), dinotefuran (D) & fungus (F)	No dinotefuran (see left)
Sensitive	*Nesticus cooperi*	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	*Nesticus crosbyi*	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	*Nesticus mimus*	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	*Nesticus sheari*	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	*Nesticus silvanus*	B: no impact I: no impact	D: no impact F: no impact	See left
BIRDS				
Sensitive	Peregrine falcon	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Bald eagle	B: no impact I: no impact	D: no impact F: no impact	See left
INSECTS				
Sensitive	Divergent melanoplus	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Serrulate melanoplus	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Northern bush katydid	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Rock-loving grasshopper	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Milne's euchlaena	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Fraser fir geometrid moth	B: no impact I: no impact	D: no impact F: no impact	See left
MAMMALS				
Endangered	Carolina Northern flying squirrel	B: not likely to adversely affect I: not likely to adversely affect	D: not likely to adversely affect F: not likely to adversely affect	See left
Endangered	Indiana bat	B: no effect I: not likely to adversely affect (habitat only)	D: not likely to adversely affect (habitat only) F: no effect	See left
Sensitive	Southern rock vole	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Eastern small-footed bat	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Southern water shrew	B: no impact I: no impact	D: no impact F: no impact	See left
MOLLUSKS				
Threatened	Noonday Globe	B: no effect I: no effect	D: no effect F: no effect	See left
Sensitive	Black mantleslug	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Glossy supercoil	B: no impact I: no impact	D: no impact F: no impact	See left
Sensitive	Bidendate dome	B: no impact	D: no impact	See left

Status	Common Name	Alt. 1 -Current Management (B=beetle, I=imidacloprid)	Alt. 2 Beetle, imidacloprid (see left), dinotefuran (D) & fungus (F)	No dinotefuran (see left)
		I: no impact	F: no impact	
REPTILES				
Threatened (S/A)	Bog Turtle	B: no effect I: no effect	D: no effect F: no effect	See left

3.6 Soils

Affected Environment

Soils on the Nantahala and Pisgah National Forests are categorized by landscape position. The parent material is predominantly crystalline rocks with varying degrees of mica content, and metasedimentary rocks. Precipitation levels across the region range widely from 40-80 inches annually. The interaction of these factors has led to unique and highly variable soil patterns and properties across the mountain region.

Soil erosion and sedimentation are the primary causes of soil loss and are the result of factors including soil type, rainfall, as well as vegetation cover and management practices. While there are many ways to minimize erosion, vegetative cover is the most effective over the long term. When vegetation is removed, the rate of soil erosion is greatly accelerated.

Direct and Indirect Effects

None of the alternatives propose treatment activities that would increase or decrease soil productivity through soil erosion or soil compaction.

While the loss of hemlocks as vegetative cover could potentially lead to increased erosion, it is likely that as hemlocks are lost from the overstory, understory vegetation will increase, thereby providing continuous vegetative cover and relatively minimal erosion.

All alternatives include the application of the systemic insecticide imidacloprid, injected into the soil at the base of the trees. The portion of the chemical that is not taken up by the tree could spread downward in the soil a few feet from the injection sites and bind with soil particles and would not be expected to reach ground water (Burkingstock et al. 1997). Its biodegradation rate in soil has been characterized as moderately slow, with about 50% of the applied residue dissipating in a range of 48 – 190 days (Felsot 2001). Soil-inhabiting invertebrates that come into contact with the chemical while it is still active in the soil would likely be impacted, but the properties of the soil itself would not change. Invertebrates would be expected to recolonize the soil near the base of the tree when the chemical was no longer active. The loss of invertebrates in the soil at the bases of the treated hemlocks would be localized and temporary.

All alternatives propose the use of predatory beetles. The beetles are applied directly to the branches of the trees and any contact with the soil is incidental. Beetle treatments would not adversely affect soil productivity through soil erosion or soil compaction.

Alternative 2 – Proposed Action

Alternative 2 proposes the use of dinotefuran (Safari™). Dinotefuran is more soluble in water than imidacloprid and therefore care would be taken to minimize soil moisture, to prevent off-target movement of the insecticide. Dinotefuran would be applied by soil injection at the base of the tree similar to the application currently being used for imidacloprid. Soil-inhabiting invertebrates that come into contact with the chemical while it is still active in the soil would likely be impacted, but the properties of the soil itself would not change. Invertebrates would be expected to recolonize the soil near the base of the tree when the chemical was no longer active. The loss of invertebrates in the soil at the bases of the treated hemlocks would be localized and temporary.

Alternatives 2 and3

The fungus *Lecanicillium muscarium* would be aerially applied to hemlock trees and therefore would not result in erosion or soil compaction. Additionally, very little fungus would ultimately reach the soil surface so there is minimal risk associated with effects to soil composition as a result of fungus application.

Cumulative Effects

Since none of alternatives considered would impact soil productivity through erosion or compaction, this project would not contribute to any cumulative impacts.

In regards to the soil injection of imidacloprid and dinotefuran, some additional use is ongoing on both public and private lands as infestation of HWA progresses. This additional use is expected to be very limited, due to cost and logistics of treatment. On these other lands, loss of invertebrates in the soil at the bases of the treated hemlocks would be localized and temporary. There would be no cumulative effects to the loss of soil invertebrates.

3.7 Scenery and Recreation Resources

3.7.1 Scenery

Affected Environment

The Nantahala-Pisgah Forest Plan utilizes the Visual Management System (VMS) as an integral component of Forest-wide and Management Area direction.

The VMS is used to establish Visual Quality Objectives (VQO's) for each Management Area. Visual Quality Objectives are determined by three primary components: Variety Class (A, B, or C), Distance Zones (Foreground, Middleground, or Background) and Sensitivity Level (1, 2, or 3). The VQO's of Preservation, Retention, and Partial Retention have the highest standards for the protection of visual quality and tend to be located in areas with the highest visual sensitivity and/or in Variety Class A landscapes.

Variety Classes are rated from Class A to Class C based on criteria established for Southern Appalachian landscapes, with Variety Class A being the most visually distinctive. Variety Class A landscapes consist of various combinations of distinctive topographic, water, or vegetative features such as steep slopes, rock outcrops, streams, rivers, large trees, or unusual native vegetation.

Hemlocks tend to be a significant vegetative component in many visually distinctive landscapes (Variety Class A) such as scenic stream and river corridors and major rock outcrops.   Also, because of the long life and large size of many hemlocks they can be a distinctive feature anywhere they occur in abundance.

Direct and Indirect Effects

None of the alternatives would have any direct effects except that Forest Service personnel would occasionally be seen administering treatments. The following discussion describes indirect effects from loss of hemlock over time.

Alternative 1 – No Action

There will be some level of protection of hemlocks in conservation areas, including some distinctive (Class A) and sensitive landscapes, since most of the treatments are located in areas with the highest VQO's of Preservation, Retention, and Partial Retention. However, many areas across the forest will remain untreated and will result in visually degraded landscapes as hemlocks die. This would be most evident to visitors at campgrounds, along rivers, and on trails. Because of the distinctive visual character of hemlocks and the relatively large size and age of many specimens, the loss of hemlocks would be most evident in foreground views. In more distant views, dead patches would appear in the landscape in drainages and near rock outcrops.

Alternatives 2 and 3

With the additional treatment options of fungus (Alt.2 and 3) and dinotefuran (Alt. 2) there is greater potential for maintaining healthy hemlocks on the landscape therefore less negative effect on the visual resource as a result of dying hemlocks.

Dinotefuran treatments have been shown to result in a more immediate positive response of the hemlock trees and therefore there would be less dead and dying hemlocks visible on the landscape.

Cumulative Effects

There would be no cumulative effects on the scenery resulting from the actual treatments. Cumulative effects to scenery would be the relative loss of hemlocks on the landscape over time. Alternatives 2 and 3 would potentially result in less of a negative impact over time as conservation areas would receive more aggressive treatments.

3.7.2 Recreation

Affected Environment

Hemlocks contribute to the mountain recreation setting in several ways. In addition to their visual distinctiveness, hemlocks contribute to producing a cool, desirable microclimate. Their presence in riparian areas shades streams and helps produce a healthy trout fishery. Many hemlock areas in or near developed recreation areas will be prioritized for treatment.

Direct and Indirect Effects

Alternative 1 – No Action

Treatment of hemlocks will continue with the use of beetle releases and imidacloprid. Areas that do not receive treatment will continue to decline resulting in more downed trees along trails, rivers and other areas where recreationists frequent.

Alternative 2 – Proposed Action

This alternative provides the most potential to protect settings at key places where visitors may be present. There will be potential for downed trees along trails and other recreation areas, but less than in the other alternatives.

Alternative 3

The effects of this alternative will fall between Alternative 1 and Alternative 2. The use of the fungus treatment in Alternative 3 has the potential to protect more trees over the long term, however, without the use of Safari, some of the more declining areas of hemlocks have the potential to be lost from the landscape entirely.

Cumulative Effects

The cumulative effects of all three alternatives will vary only in the degree to which hemlocks are lost from the ecosystem. Alternative 2 has the greatest potential for successfully maintaining hemlock populations as it offers up the greatest amount of treatment options.

Regardless of how effective the different treatments prove to be, much of the recreation setting on the forests will be changed with the loss of hemlocks and hemlock related plant communities. Surviving areas of hemlock may be able to enhance future recovery in the areas of the forests where hemlock populations have been lost.

3.8 Wilderness Resources

Affected Environment

Wilderness is a unique and valuable resource. In addition to offering primitive recreation opportunities, it is valuable for its scientific and educational uses, as a benchmark for ecological studies, and for the preservation of historical and natural features (FSM 2320.1).

Hemlock conservation areas within Wilderness and Wilderness study areas were identified in the 2005 analysis. The conservation areas in Wilderness are high quality hemlock populations with a wide distribution of confirmed tree ages ranging up to 500 years old and potentially 800 years old or greater. Treatments were analyzed using the ‘minimum tool’ concept and will be applied with sensitivity towards the Wilderness resource.

Direct and Indirect Effects

Alternative 1 – No Action

Existing suppression activities consist of beetle release and imidacloprid in 29 identified conservation areas within Wilderness or Wilderness study areas. The presence of Forest Service personnel administering treatments or conducting monitoring is a direct effect on "wildness", though a minor one.

The application of imidacloprid and release of beetles has proven insufficient in some of the Wilderness conservation areas and the hemlocks have continued to decline. Treatments will continue as described in the 2005 decision and as new conservation areas are identified they will be considered for treatment with appropriate documentation of effects.

Alternatives 2 and 3

Alternatives 2 and 3 do not differ from Alternative 1 in terms of direct and indirect effects to Wilderness resources. Neither alternative proposes to apply fungus or Safari within Wilderness areas at this time.

Cumulative Effects

Ongoing human influences within Wilderness that tend to reduce its "wildness" include recreational activities such as trail use impacts, trail maintenance, bridge repair, campsite impacts, and the sights and sounds of humans. Outside influences on Wilderness that tend to reduce its "wildness" and "naturalness" include visual, noise, water, and air pollution as well as exotic plants or organisms. These influences would continue regardless of which alternative is implemented.

None of the alternatives propose any additional treatments in Wilderness at this time, therefore there would be no cumulative effects to Wilderness areas.

3.9 Heritage Resources

This proposed project has no potential for effect, adverse or beneficial, to heritage resources, and therefore is an Exempt Undertaking. No further Section 106 compliance documentation is required.

Precise locations of proposed treatment areas would be shared with the Eastern Band of Cherokee Indians to ensure avoidance of undesired overlap with Traditional Cultural Properties or traditional gathering sites.

3.10 Road Management

No road construction, road reconstruction, changes to current road management, or road obliteration is proposed as part of this project. No roads analysis is needed.

3.11 Human Health and Safety

Direct and Indirect Effects

Alternative 1 – No Action

The treatment of hemlocks with beetles and imidacloprid, particularly in recreation areas, would reduce the threat from dying hemlocks injuring forest users.

Beetles would primarily be released onto hemlock branches that can be reached from the ground. Should any tree climbing be necessary, professional arborists would be contracted. They would be experienced professional tree climbers who are licensed and insured and would be required to follow the specifications of the contract, including any safety-related provisions.

Soil injection and stem injection of imidacloprid would be performed by a combination of USDA Forest Service employees and private contractors. All would be certified pesticide applicators and would be required to follow precautionary procedures proscribed by the manufacturer. The potential safety issues include: accidental spills of the product and accidental contamination of skin or clothing of the applicators. A spill response plan would be developed as part of implementation of this project.

The potential for the imidacloprid used in this project to impact human health under any circumstances is extremely minimal as its toxicity to mammals in general including humans is very low. No imidacloprid is expected to reach ground water since no soil injection will occur in close proximity to water or in highly permeable soils. Also, the method of application deposits the agent within a small area approximately 10 inches beneath the surface of the soil. Imidacloprid is known to bind with the soil so that whatever is not taken up by the roots of the tree is not expected to move away from the application site.

The U.S. Environmental Protection Agency Office of Pesticide Programs has evaluated imidacloprid and determined it to be non-cancer causing (US EPA, Science and Information Branch).

Alternative 2 – Proposed Action

The risks associated with the application of imidacloprid and beetle release would be similar to those described for Alternative 1.

Safari™ is a common trade name for the chemical dinotefuran and is approved for use in North Carolina for the control of hemlock woolly adelgid. Similar to imidacloprid, it is within the class of neonicotinoid pesticides. The human health and safety effects associated with the use of dinotefuran would be similar to those described for imidacloprid. No dinotefuran is expected to reach ground water since no soil injection will occur in close proximity to water or in highly permeable soils.

The fungus *Lecanicillium muscarium,* currently being proposed for treatment is commercially listed as Mycotal and is registered in seven European Union countries, Turkey, and Japan. A Tier II evaluation for European registration, that included human health, environmental and ecotoxicological analysis was conducted for Mycotal's European registration, concluded that Mycotal is not considered harmful to the environment. The approved Material Safety Data Sheet (MSDS) for Mycotal lists no human health hazards associated with application.

Alternative 3

Potential effects to human health and safety would be similar to those described in Alternative 2 with the exception that there would no use of dinotefuran and therefore no risks associated with application of the chemical.

Cumulative Effects

All alternatives will still result in some level of hemlock mortality on the forest as not all trees will be treated. The level of mortality has the potential to be the greatest with Alternative 1 and less with Alternatives 3 and 2. Impacts of hemlock mortality and the threat from these trees being broken off or uprooted and falling on humans using the forests would add to the level of risk that always exists in the Forests for a tree to potentially fall on a person. This rarely occurs on the Forests.

Soil injection of imidacloprid for the treatment of hemlock woolly adelgid has been occurring on the forest since 2004. Individual trees are treated on a rotation of no less than two years. When proper application methods are used there are no cumulative risks to applicators associated with repeated exposure to approved pesticides.

Chapter 4 - Consultation and Coordination

The Forest Service consulted the following individuals, Federal, state and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment:

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Appendix A

Response to 30-Day Comments

Introduction

The 30-day comment period for the 2010 Hemlock Woolly Adelgid Suppression Project ended on May 17, 2010. Comments were received from 13 respondents. The individuals and organizations that provided comments are shown in Table 1.

Table 1. Respondents to 30-day comment period

	Respondent
1	Josh Kelly, Wildlaw
2	Hugh Irwin, Southern Appalachian Forest Coalition
3	Mike Schafale, NCDENR – Heritage Program
4	Jackson-Macon Conservation Alliance
5	J. Dan Pittillo
6	USDI Fish and Wildlife Service
7	Suzanne Jones
8	Ellen Kinnear
9	Marilyn G. McVicker
10	Richard E. Harris, Benton MacKaye Trail Association
11	Ralph S. Heller, Benton MacKaye Trail Association
12	Robert Webster, Great Smokey Mountains National Park
13	Ron Linville, NC Wildlife Resources Commission

Comment 1-1 Of the alternatives considered the proposed action is the one most likely to lead to success. I strongly believe that both Safari and fungal treatments are warranted methodologies in combating HWA. While fungal treatments are not yet proven, the lack of genetic diversity in North American HWA (they are essentially one cloned individual) make them potentially highly susceptible to pathogens such as *Lecancillium muscarium*.

Response *Comment noted.*

Comment 1-2 In my personal experience treating hemlocks on my family's land in southwestern Madison County, Safari has produced excellent results in improving the health of severely declined, large hemlocks, some up to 36" in diameter and 110' tall. Multiple imidacloprid treatments on those same trees in previous years had failed to produce any results. I therefore think that insecticides such as Safari are essential tools in saving the remaining hemlocks of ecological importance in western North Carolina, especially large and severely declined trees.

Response *While Safari has shown promising inmediate results for HWA control, imidacloprid will continue to be used in combination with Safari treatments as it is an effective treatment for long term suppression of HWA.*

Comment 1-3 The 20 ft buffer required on the Safari label was a condition of the EPA approving the SLN that allowed the use of Safari on hemlocks growing in forested areas. This buffer did not result from data showing greater soil movement or risk to aquatic organisms, but instead from the fact that at the time SLNs were approved, the EPA had not yet reviewed the use of dinotefuran for use in forestry sites. The risk to aquatic invertebrates from Safari, especially as labeled, is minimal to nonexistent.

Response *The forest acknowledges that when used according to label direction Safari will have minimal effects to aquatic invertebrates. However, we also recognize that the use of pesticides adjacent to aquatic areas is a concern for some members of the public. Effects analysis in chapter 3 of the EA addresses the impacts of Safari and imidacloprid on aquatic wildlife.*

Comment 1-4 While I support the proposed alternative, I would prefer an alternative that went farther. A decision that allows the new treatment methods in Wilderness Areas is encouraged and needed, because hemlocks in Joyce Kilmer-Slickrock, Shining Rock, Linville Gorge, Southern Nantahala and Ellicot Rock Wilderness are so severely declined, if not dead. Linville Gorge in particular has many important and severely declined stands of Carolina hemlock that could be revived with Safari. Joyce Kilmer-Slickrock has a globally rare hemlock/silverbell forest type at high elevations that may still be in good enough condition to save.

Response *The forest recognizes the importance of treating hemlocks in Wilderness areas and will continue to treat with imidacloprid and beetle release as described in the 2005 HWA Suppression Decision. The scope of this project does not extend into Wilderness areas and therefore the use of fungus treatments and Safari application in Wilderness areas will be analyzed in a future EA.*

Comment 1-5 Another way in which the scoping is deficient is in failing to explicitly make the preservation of at least a few large groves a goal. Currently, the largest non-recreation site treated on the Nantahala-Pisgah is less than three acres. The maintenance of the ecological functions of hemlock forest is unlikely without treatment areas of many contiguous acres, as has been accomplished successfully in Great Smokey Mountains National Park. There are still opportunities to realize such a feat at places like the Nationally Significant Douglass Falls in Buncombe County and in areas of Madison, Mitchell and Yancey Counties. Making the commitment to preserve large areas of 40 acres or more would require a "can-do" attitude on the part of the Forest Service, and such an attitude is sorely needed when dealing with HWA.

Response *Hemlock conservation areas were designed to capture genetic diversity across the landscape. Conservation areas are intended to maintain important hemlock ecosystem functions such as stream shading, large woody debris production, and substrate for non-vascular species and to serve as a genetic reserve to maintain a diverse hemlock gene pool on the landscape.*

Comment 2-1 We [SAFC] are very supportive of the proposal to expand management options for suppression of Hemlock Woolly Adelgid (HWA) Infestations on Nantahala and Pisgah National Forests.

Response *Comment noted.*

Comment 2-2 We share your desire to get the above changes in place as tools for the HWA suppression effort as soon as possible. However, following approval of these measures and as an additional effort to address hemlock conservation within wilderness areas, we urge you to pursue expanded options within wilderness areas. It is important to keep hemlock as an important component of biological diversity and ecosystem representation within wilderness areas. Additional treatment options should be available within wilderness, and this should be pursued after the current expanded authority is approved.

Response *The forest recognizes the importance of treating hemlocks in Wilderness areas and will continue to treat with imidacloprid and beetle release as described in the 2005 HWA Suppression Decision. The scope of this project does not extend into Wilderness areas and therefore the use of fungus treatments and Safari application in Wilderness areas will be analyzed in a future EA.*

Comment 3-1 The Natural Heritage Program supports the Forest Service's efforts to control hemlock woolly adelgid and to protect hemlock trees. We also appreciate that the Forest Service is monitoring the effects of the ongoing treatments closely enough to tell which are not being effective.

Response *Comment noted.*

Comment 3-2 While the limited application near hemlock trees limits most non-target effects, this does bring increased risk of contamination of streams with insecticides. Both the use of imidacloprid closer to streams, and the use of the more mobile Safari in soils, increases this potential. We encourage the Forest Service to monitor treatment areas and streams near them to look for evidence of effects on aquatic insects, and to modify the treatment plans if damage is found.

Response *The forest has identified the need for monitoring of aquatic systems. When used according to label direction the effects on aquatic insects are minimal to nonexistent.*

Comment 4-1 Jackson-Macon Conservation Alliance supports Alternative 2, Proposed Action, trusting the USDA Forest Service to use Safari wisely in its application. We firmly believe in using all safe methods to combat HWA for the preservation of the hemlock species.

If J-MCA can be of any service to the Forest Service again on HWA related work, please let us know.

Response *Comment noted.*

Comment 5-1 If USFS managers are not familiar with the efforts that Patrick Horan has been conducting, you really need to do so. Some photos are available at Camp High Rocks <http://highrocks.com/news/2009/01/> and I attach one of Horan's short papers indicating he understands the interaction between predator and prey. The website with most information is <http://www.savinghemlocks.org/>

Response *Members of the interdisciplinary team are familiar with some of Patrick Horan's work. Based on forest monitoring and a review of the best available science the forest believes that a combination of biological and chemical treatments will provide the most effective treatment of HWA both in the short and long term.*

Comment 6-1 As we have stated in other letters regarding similar efforts to control the HWA, given the damage caused by the adelgid in the eastern United States and the imminent threat of the elimination of hemlocks throughout their natural range (including western North Carolina), we support Alternative 2.

Response *Comment noted.*

Comment 6-2 Furthermore, we believe the calculated risks of introducing these specific exotic predatory insects are worth the potential benefits the species may have on controlling the adelgid. Similarly, we believe the threat posed by the adelgid justifies the use of pesticides on a large scale.

Response *Comment noted.*

Comment 6-3 We also recommend contacting the National Park Service (both the Blue Ridge Parkway and the Great Smoky Mountains National Park) as they have ongoing HWA control operations that may be able to be coordinated with your planned efforts for more efficient and effective use of resources.

Response *The forest silviculturist has been in contact with and will continue to work cooperatively with individuals from the Great Smoky Mountains NP and the Blue Ridge Parkway.*

Comment 7-1 Your proposal to use fungus treatments, Safari, predator beetles and continued use of imidacloprid all sound reasonable. Alternative 2 (proposed action) sounds the most promising to me.

Response *Comment noted.*

Comment 8-1 I am writing to encourage the Forest Supervisor to maintain the current management for the Carolina Hemlocks. The aerial application of fungus may have negative effects on non-target insects in the forest. Safari may have negative effects to the aquatic ecosystems.

It is my opinion that the current management , Alternative 1, No Action ,should be maintained to reduce the risk of further damage to the ecosystem.

Response *The forest acknowledges that when used according to label direction Safari will have minimal effects to aquatic invertebrates. Potential effects on aquatic ecosystems are disclosed in chapter 3 of the EA.*

Comment 9-1 I have been reading and following this issue for a long time. I feel strongly that the CURRENT MANAGEMENT procedures (Alt.1) should be followed. I am NOT in favor of adding Fungus Treatments OR the use of Safari to combat the HWA. It is clear that the use of pesticides (that bioaccumulate and affect non-target organisms) cause more to be lost than whatever can be gained by the mere prolonging of one species. I am totally AGAINST using pesticides, or the aerial application of fungicides. I understand that the loss of our great Hemlocks is grievous. However, our environment is too precarious to suffer the risks and losses of affecting non-target organisms. It is not to anyone's best interests to add more pollution and chemical substances to an already precarious environment. Please consider doing nothing to save the trees. It is a loss, but the use of noxious chemical substances is a far greater loss to all of us. Thank you.

Response *Both imidacloprid and Safari have a low risk of bioaccumulation due to their relatively high solubility in water. The proposed chemical and fungus treatments will not result in significant effects to non-target organisms (EA, Chapter 3).*

Comment 10-1 We wish to propose that the scoping document be amended as follows:

The corridor of the BMT through North Carolina's Nantahala National Forest be included as a treatment zone for the use of imidacloprid by soil injection. Our suggestion would be 50 feet to each side of the trail.

The Benton MacKaye Trail Association be given permission to treat the trees in this corridor using soil injection with imidacloprid in the manner as outlined on the ww.savegeorgiashemlocks.org website with Eric Eades under a $1/year contract with the USFS under the auspices of the BMTA. He would be present on all trips to treat hemlocks in the BMT corridor within North Carolina.

The USFS provide the chemical to the BMTA for this purpose. An alternative, if necessary, would be that the BMTA would provide part or all of the cost of the chemical.

Response *A primary objective of the 2010 HWA Suppression project was to focus treatments in conservation areas that were designed to capture community diversity within the distribution of known hemlock stands. There are currently no conservation areas identified along the Benton-MacKaye Trail. New treatment areas will be prioritized for treatment based on location, size, and degree of infestation.*

Comment 10-4 On those areas to be treated with Safari or fungus, we would ask that water quality monitoring be in place for the concentration of chemical or fungus in the streams and that the macroinvertebrate population also be monitored. The streams should not be allowed to reach a point where the survival of trout and other aquatic wildlife would be affected.

Response *The forest has identified the need for monitoring of aquatic systems. When used according to label direction the effects on aquatic insects are minimal to nonexistent.*

Comment 12-1 The Alternative 2, Proposed Action, would be the logical step to take with the new EA, as these measures would be based on sound scientific backing and the ability to recover the remnants of the Hemlock Forest are fast fading.

Response *Comment Noted.*

Comment 13-1 Due to the overwhelming need to protect hemlock forests, the alternative with the most flexibility for the USFS should be given priority. An adaptive management strategy or approach could be the best option to move forward with any proposed alternative as this concerted process should provide ongoing information about hemlock ecosystems and species therein plus increase knowledge on the efficacy of treatments.

Response *The 2010 HWA Suppression project allows for adaptability of treatments within conservation areas. Consistent monitoring of tree health and treatment efficacy will enable forest managers to utilize the most appropriate treatments and application methods to effectively suppress the HWA.*

Comment 13-2 Our wildlife diversity staff has suggested at least one specific area for treatments to preserve viable habitats for the Carolina Northern Flying Squirrel (CNFS), *Glaucomys sabrinus coloratus* (NCE, FE). This area includes the higher elevations of the Unicoi Mountains Geographic Recovery Area in Graham County. These high elevation hemlocks were apparently omitted in the 2005 Environmental Assessment site list despite the presence of a federally listed species that thrives in a mix of conifers and hardwoods. NCWRC has since accumulated additional evidence demonstrating the importance of eastern hemlock to this population for food and den sites.

Response *The current proposal includes sites in the vicinity of Whigg cove of the Unicoi Mountains.*

Comment 13-2 In terms of chemical treatment of hemlocks within the range of Carolina Northern Flying Squirrel (CNFS) in the Unicoi Mountains, treatment is recommended using a modified application of stem injection, which is recommended rather than soil injection at sites in the Unicoi Mountains to a) avoid direct ingestion of the chemical in large quantities by CNFS foraging on fungi around the root systems of hemlocks and b) avoid mortality of crayfish, a prey item of the northern flying squirrel. If the faster acting Safari can be applied via stem injection, high elevation areas in the Unicoi Mountains should be treated as soon as possible as the trees have declined rapidly since 2006.

Response *The effects analysis in chapter 3 of the EA discloses effects to the Northern Flying Squirrel. While the 2005 analysis described stem injection as a potential treatment method, current monitoring shows that stem injection is not as effective as soil injection and is a more costly method of application.*

Comment 13-3 We are concerned about the potential for direct ingestion of a larger quantity of the chemical than the Material Safety Data Sheets might evaluate, given the northern flying squirrel's foraging habits. It is our understanding that CoreTect®, a new imidacloprid delivery system in tablet form seems promising. This may be the preferred method to use in remote areas as the soil does not need as much, if any, watering to encourage uptake. In order to avoid delaying treatment further and losing hemlocks entirely, we recommend treatments move forward using a modified application of the chemical (Stem injection) to reduce the potential for exposure to Carolina northern flying squirrels foraging at the base of the treated hemlocks.

Response *Chapter 3 of the EA discloses potential effects of chemical treatments on the northern flying squirrel. While there is a recognition that northern flying squirrels may* *be exposed to minimal levels of chemical treatments, the greater threat to the squirrel is the loss of hemlock habitat that would result with no treatment. The Forest currently uses CoreTect tablets as one method of treatment and will continue to do so in areas that are more remote. While the 2005 analysis described stem injection as a potential treatment method, current monitoring shows that stem injection is not as effective as soil injection and is a more costly method of application.*

Comment 13-4 If these chemicals can move through the soil or are water soluble and toxic to crayfish, the chemicals could affect this prey item of the Carolina northern flying squirrel. Although the latest scoping provides recent data from Coweeta indicating there may be less movement through the soil, it still needs to be determined whether or not there are risks to crayfish, whose burrows are present on streambanks in Whigg Cove's braided stream channels. If this is a legitimate concern, then stem injection would also be the better choice to minimize impacts to the prey item.

Response *Potential indirect effects to the Carolina northern flying squirrel are addressed in Chapter 3 of the EA. While there may be some minimal contact with imidacloprid or dinotefuran either directly or indirectly through prey, it is not likely to adversely affect the Carolina northern flying squirrel.*