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Conservation of Eastern Hemlock by Suppression of Hemlock Woolly Adelgid Infestations

Chattahoochee-Oconee National Forests: **Banks, Dawson, Fannin, Gilmer, Habersham, Lumpkin, Murray, Rabun, Stephens, Towns, Union, and White Counties, Georgia**

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TABLE OF CONTENTS

CHAPTER 1

1.1 Background

The hemlock woolly adelgid (*Adelges tsugae* Annand), a non-native insect, is killing the two eastern US species of native hemlock; the Carolina hemlock (*Tsuga caroliniana* Engelm.) and the Eastern – or Canada – hemlock *(Tsuga canadensis)* in Georgia. There is no effective natural control with native biota or physical environmental factors.

Without active intervention, the forecast is for 90-percent of existing hemlock to be dead within five to ten years.

The adelgid was first discovered in Georgia in the Chattooga River gorge on the South Carolina-Georgia border in 2002. Since that time, the adelgid was spread southward and westward across the Blue Ridge Divide crest into the Little Tennessee, Hiwassee, and Chattahoochee River drainages. Tree death is already occurring in the Ellicott Rock Wilderness near the common corner of the SC-GA-NC state lines and in the upper reaches of the Chattooga Wild and Scenic River at the GA-SC state line. No natural resistance to the adelgid has been found in eastern hemlock to date, unlike western US species of hemlock.

Forest Supervisor Kathleen Atkinson has proposed to suppress the adelgid on selected areas throughout the hemlock range on the Chattahoochee National Forest. The proposal is a strategic and pro-active approach that identifies very important areas to protect in advance of adelgid infestation. The primary emphasis is on conserving hemlock genetic diversity. Treatment in units of the National Wilderness Preservation System is proposed. If treatment in Wilderness is ultimately chosen, the Deciding Official will be the Regional Forester, Charles L. Myers.

All hemlock on the Chattahoochee cannot feasibly be saved. Any decision must be made and implemented in the context of an environment of constraints. These constraints include lack of money, limited numbers of personnel, competing priorities, training and certification requirements, a narrow range of choice among available tools or technology, and regulatory requirements of many kinds. So the Forest will pursue a separate but related effort of hemlock germplasm collection for three purposes;

(1) provide the future ability to restore locally-adapted biological and genetically diverse material onto sites from which it was extirpated by HWA; given that HWA no longer threatened to the same degree,

(2) provide the ability to study the population structure and stability based on genetic variation in the Georgia hemlock population, and

(3) explore the feasibility of conferring resistance by cross-breeding with Western hemlock.

The Deciding Official makes his or her decision in this overall context even though germplasm collection and analysis is neither a condition of this decision or a pre-requisite for it. Rather this decision provides the foundation for those on-going efforts into the future.

1.2 Overview of Proposed Action

Within the Forest, the general area considered is the native range of hemlock in Georgia. The hemlock range includes;

(1) the Blue Ridge Mountain portion of the Forest, and

(2) the sheltered slopes of the deep gorges of the Savannah and Ogeechee River headwaters generally south of Turnerville, Georgia within the Piedmont-Mountain interface.

No area of National Forest ownership within hemlock range has been excluded from consideration, including the congressionally designated areas such as Wilderness or Wild and Scenic River.

Within this general area, we further scaled the effort to generally exclude developed recreation areas. We did this primarily because under Forest Service implementation procedures for the National Environmental Policy Act (NEPA), there is much greater flexibility for treating those areas than the undeveloped portions of the Forest generally considered here. There was a degree of risk of inordinate delays in treatment if they were to be combined. In addition, the readily accessible recreation sites can serve as test locations for new tools or techniques to make the entire effort more adaptable to changing conditions.

Suppression activities approved by the Regional Forester would begin in calendar year 2005 and continue annually or periodically until;

(b) predator beetle populations reach an equilibrium with the adelgid, each at a self-sustaining level not causing epidemic hemlock mortality, or

(c) monitoring shows that conditions have changed such that either;

(i) the decision is no longer the best way to meet the objectives, or

(ii) the objectives themselves need re-visited. An example might be the discovery of a new suppression method.

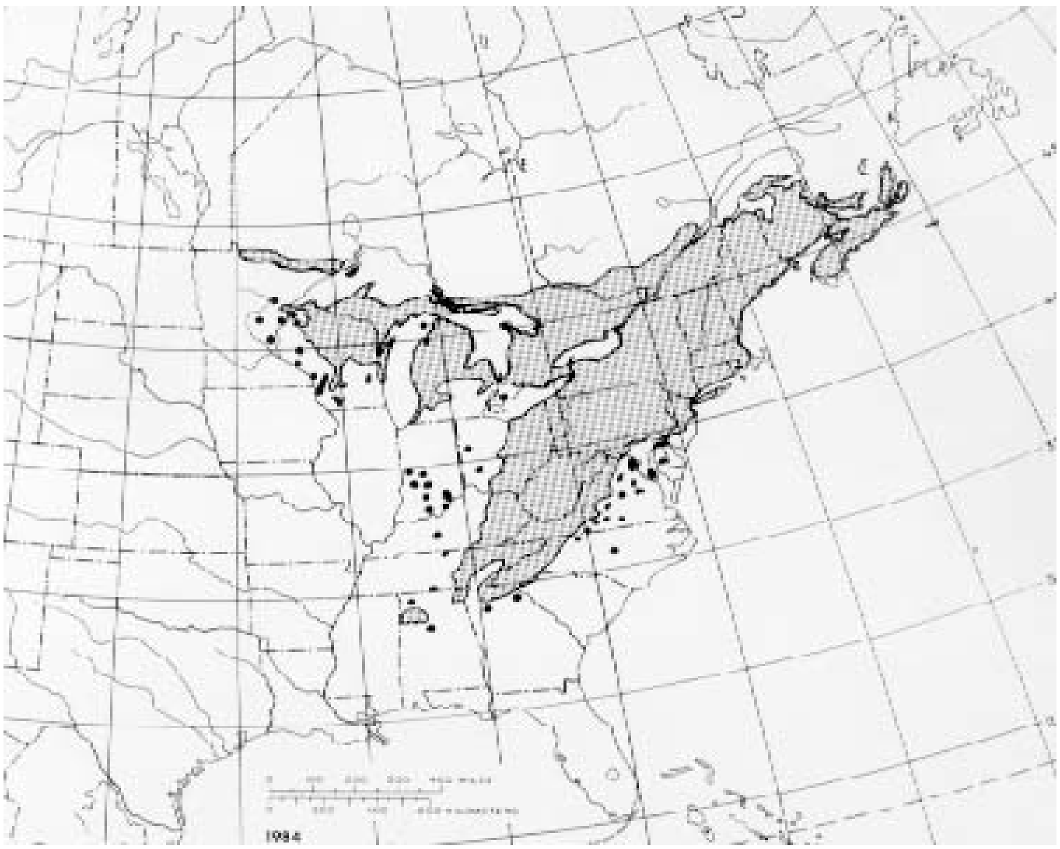
1.3 Need For The Proposed Action

The need for management action is critical for several reasons.

<u>Hemlock woolly adelgid is a threat through much of the range of hemlock.</u> Today, HWA infestations have spread to portions of 15 states from Georgia to Maine. Tree decline and mortality have been significant in many areas. (Onken, et al, 2002).

<u>Without conservation efforts, the genetic variability of the Georgia hemlock population will be lost.</u> The outlook for the native Eastern, or Canada, hemlock tree (*Tsuga canadensis)* in the Georgia wilds is for at least 90-percent of them to be dead within ten years. This projection is based on adelgid effects where it has been long established and not limited by winter temperatures such as Virginia and Pennsylvania. Local observation suggests that both the spread of the insect and the time from infestation to tree death may be shorter here at the warmer, southern edge of the hemlock range. The severity of winter weather is not a factor in adelgid survival. Annual drought stress in summer and periodic moderate to severe cumulative drought stress of hemlock is more likely, reducing tree vigor to withstand the adelgid.

<u>The Chattahoochee National Forest of north Georgia has most of the hemlock trees in Georgia.</u> Hemlock reaches the southern limits of its range in Georgia and the most common habitat of relatively large trees with their crowns into the main canopy layer is cool, moist locations such as stream banks, sheltered coves, and high elevation stream basins (above approximately 3000 feet) within the Blue Ridge Mountains. Hemlock occurs with declining numbers east, south, and west of the Chattahoochee as one moves out of the Blue Ridge and into either the Piedmont or the Ridge and Valley physiographic regions. At the Mountain-Piedmont interface hemlock extends in declining abundance downstream along Panther and Davidson Creeks southeast of US 441. At the Mountain-Ridge and Valley interface on the Cohutta Ranger District, hemlock occurs as scattered individuals along Mill, Emery, Sumac, and Rock Creeks. It also occurs on sheltered slopes and stream banks in the gorges of the Cumberland Plateau in Dade County, well to the west of any National Forest.



Source: Godman, R. M. and K. Landcaster, 1990. Web hosted online by the Northeastern Area, State and Private Forestry at:http://www.na.fs.fed.us/spfo/pubs/silvics_manual/Volume_1/tsuga/canadensis.htm

Figure 1: The native range of Eastern hemlock in North America.

<u>Hemlock is not abundant in Georgia.</u> Hemlocks typically occur on ecological units that in total make up only about 9-percent of National Forest within the Blue Ridge ecological Section (Plan FEIS, pages 3-74 thru 3-77). However, forest cover type mapping as of 1995 had classified vegetation communities as having enough hemlock to be wholly or partially characterized by it on only about 4-percent of approximately 685,000 acres of National Forest in the Blue Ridge and Mountain-Piedmont transition zone combined (Plan AMS, Forest Cover report p. 9). And of that 4-percent, about two-thirds of it (or 2.6-percent of the total range within National Forest) has hemlock as a minority species in mixed composition with hardwoods and white pine; that is, the most common occurrence of hemlock is in association with 'cove hardwoods' and white pine in narrow bands on each side of streams that flow year-round. Nineteenth and early twentieth century land uses of woods grazing and burning helped restrict hemlock – a fire intolerant species – to these generally 'fire proof'; that is, low fire intensity, locations.

1.4 Details of The Proposed Action

1.4.1 Objectives

We identified two preliminary objectives for a strategic HWA control effort. In priority order they are:

1. The conservation of biological and genetic variation within the GA-NC-SC-TN hemlock population by protecting groups of hemlock distributed in an approximate five mile by five mile network that will provide for pollen exchange among them. Hemlock groups will provide for pollen exchange across the State lines. This grid spacing has been chosen because of an estimated maximum dispersal distance for hemlock pollen flight.

2. The conservation of vegetation communities that;

   (a) are predominantly hemlock or have mixed composition that includes considerable hemlock, ***and***

   (b) are judged to be especially important for ecological reasons and some social reasons.

1.4.2 Selection of Treatment Areas

A Word about Terminology

Throughout this document several words are frequently used that could cause confusion. The intent is to use them with only one meaning but this may not have been achieved in every case.

So their intended meaning is supplied here as context.

'*Area*' means (1) a location mapped on the various Alternative maps to receive some type of protection treatment; or (2) a general location, or (3) a location dedicated to a type of use; for example, a developed recreation area or Wilderness area. The most common usage in this document is the first meaning. Individual areas may also be called a '*conservation area'*.

'conservation area' means an individual area in each alternative selected to be protected to conserve; (a) the hemlock tree species itself, or (b) other values associated with its presence, or (c) both. Also called simply 'area'.

'Genetic conservation areas' (abbreviated GCA) are a subset of all the 'areas' mapped in each Alternative and are the locations required to maintain pollen exchange and hedge against loss of genetic diversity.

‘*Genetic conservation group’* (abbreviated GCG) means a single contiguous location occupied by approximately 60 hemlock trees within a ‘*genetic conservation area*’. Selected individual hemlock trees within each ‘group’ would be treated with insecticide. Each ‘*genetic conservation area*’ would contain from one to three ‘groups’ with at least two groups per area being preferred to having only a single group.

‘*Site*’ a specific location, usually less than about 10 acres. As used in this document, it refers to a GCG that is being, or has been, configured to ground conditions to meet the project objective and simultaneously satisfy mitigation measures.

‘*Stand’* means a vegetation community classified and mapped in the Forest Service vegetation database as having the following characteristics: (1) contiguous area, and (2) uniformity in (a) species composition, (b) age, (c) structure, (d) site quality, and (e) management requirements. An ‘area’ in an Alternative typically includes multiple stands, some in whole and some in part.

Since the word ‘area’ is used with different meanings, if its adjectives are missing it could be misunderstood. We have tried to limit this circumstance to situations where the nature of the ‘area’ is clear by its context.

We have used our existing vegetation data; state Natural Heritage records; aerial photography; and the knowledge of employees, co-operators, contractors, retirees, and the general public to identify areas with ‘significant’ hemlock. For ‘significance’ we considered:

(1) ability of individual areas to contribute to an inter-active network of genetic conservation areas (GCAs). We have identified these GCAs distributed so as to allow for pollen exchange among them. Ideally, each GCA (except those on the absolute edge of hemlock natural distribution) would be able to interact with four others; that is, the design would be ‘robust’ with the maximum potential to continue to maintain interaction if some is lost. We were not always able to ensure that, but did try to be sure to have as many as feasible within National Forest ownership and the distribution of hemlock. This struggle to develop a robust network is one major way in which we differ from North Carolina.

    For genetic conservation, we considered the Metasedimentary Mountains ecological Subsection; that is, the Cohutta Mountains in Georgia and the Etowah Mountains in Tennessee (including the Cohutta Wilderness), as separate and distinct from the Southern Blue Ridge Mountains Subsection of the rest of the Forest because they are physically separated to the east by more than the five mile pollen exchange distance by private land along the I-575 corridor from Ellijay to Blue Ridge and to the north by the intermountain valley of the Ocoee River, more commonly called the ‘Copper Basin’.

(2) ecological value such as wildlife habitat, aquatic habitat, water quality, and occurrence of Proposed, Threatened, Endangered species under the Endangered Species Act and species on the Regional Forester’s Sensitive species list. (Together, these are referred to with the acronym ‘PETS’ species), also locally-rare species.

    For PETS and locally rare species, we proceeded as if the co-location of the species and hemlock together was of significance. This is not necessarily because there is a demonstrated use of hemlock by any of these species or a demonstrated dependence on hemlock. Rather it is a conservative approach as a precautionary measure against these

PETS and locally rare species potentially being stressed directly or indirectly by hemlock mortality in their current habitats.

(3) social value such as old growth, and scenic value;

1.4.3 Activities (How)

Common activities of any HWA suppression program are:

1. Annual monitoring for;

    a. new occurrences of HWA in areas to be protected,

    b. evaluation of success of past treatments and need for re-treatments, and

    c. consideration of whether new information or changed conditions show a need to revise the program, up to and including changing the original decision

2. Annual identification and prioritization of areas to receive treatment within the set of all areas previously chosen to be conserved based on technical criteria including the degree of HWA infestation and the health of the trees. Criteria are expected to be somewhat dynamic as new research findings become available and past treatment results become part of our experience both locally and in the Region.

3. An on-the-ground evaluation of each area for the best-suited treatment or combination of treatments based on site-specific characteristics.

4. Treatment of each area using one or a combination of:

    a. Release of bio-control agents; that is, predatory beetles. This would be the primary method for vegetation community conservation of especially important areas other than ‘core’ genetic reserve areas. Several hundred to several thousand beetles would be released per area, depending on established protocols for each beetle species. “Areas” potentially affected are up to approximately 125 acres in size, which is based on the effective dispersal distance of the predator beetles (¼ mile) and an assumption that they disperse uniformly in all directions from the point of release.

    b. Soil injection around selected individual hemlock trees within from one to three genetic conservation groups (GCGs), of at least 50 individuals – with a target of 60 individuals – in each. The preference would be to have at least two GCGs at each location so they could also exchange pollen locally, as well as with other, more-distant GCAs. Hemlock with their crowns into or above the general canopy height would be emphasized because they can release pollen into the general wind currents and are also more likely to produce cones and seed. However, a lesser number of smaller hemlocks would also be included to maintain vertical diversity for wildlife, scenic diversity, and to provide future beetle release and monitoring opportunities. (Both beetle release and monitoring are typically done on lower branches.) Injection rate is determined by the diameter of each tree at four-and-one-half feet above the ground and is therefore very specific to the number of trees and their sizes. The insecticide used is a synthetic nicotine-like chemical called imidacloprid. Treated area would be determined by the stipulated target number of trees required per GCG divided by the density of reproducing hemlock trees per acre at that location. Where hemlock is extensive enough, up to three GCGs would be treated within each larger genetic conservation area (GCA).

c. Combination soil injection & predator beetle release to provide a 'fail safe' system for maintaining hemlock with insecticide in the short term, but with the goal of switching off to predator beetle control only if and when beetles become established at a level that provides control.

d. Individual stem injection above ground of imidacloprid using a pressurized injection system in the rare cases where;

   a. very high interest areas with highly valued trees are involved, and
   b. neither beetle release or soil injection is available either because of inadequate beetle supply or site restrictions on soil injection.

1.5 Decision To Be Made

The Regional Forester must decide whether to:

1. carry out the proposed action (Alternative 2), or
2. take no action (Alternative 1), or
3. carry out a modification of the proposed action, (Alternatives 3, 4, or 5).

The Regional Forester has the authority to decide whether or not to include for treatment those important hemlock areas inside units of the National Wilderness Preservation System, and to determine the minimum tool needed for treatment in Wilderness.

1.6 Scoping

Forest Supervisor Kathleen Atkinson made the decision to do environmental analysis and prepare an environmental assessment in September 2004. In October 2004 she chartered a core six-member HWA Team of two certified silviculturists, a District Ranger, a District supervisory forester over the recreation program, the Forest GIS coordinator, and the Forest soil scientist. In addition, she designated a five-person team of consultants; the Forest hydrologist, Forest fisheries biologist, Forest planner, Forest ecologist/botanist, and a zone wildlife biologist. Following the retirement of the District recreation program manager, a Supervisor's Office recreation manager assumed that role.

Scoping began internally with a visit to NC in November, 2004. Forest Service personnel of the Forest Supervisor's Office there presented an overview of their approach and answered questions for the Chattahoochee HWA Team. At that time, an HWA suppression decision had not been made in NC and the Chattahoochee team continued to monitor those efforts. We did this both for efficiency and to make our approach consistent with theirs but modified by the differences in our ecological conditions. For instance, they have extensive areas with a higher frequency of hemlock occurrence than occurs in Georgia. Among the comments they received from the public was a request to expand the scale of their work to include the entire Southern Appalachians. The approach we have taken is consistent with that desire but more flexible and sensitive to our situation.

In December, 2004, the Chattahoochee Team requested from District employees nominations for hemlock sites to protect that met the three criteria for significance. Districts were encouraged to ask knowledgeable individuals outside the Forest Service as well but the time given was rather short. In spite of this, nominations from outside the Forest Service were received.

The HWA Team used the nominations and supplemental information in GIS to map proposed HWA suppression locations. Key to this step was the effort to develop an interactive network of genetic conservation areas that ensured pollen exchange among themselves and also with protected areas on the Nantahala NF in NC and the Cherokee NF in TN.

In February, 2005, a scoping letter and attached map was mailed to 1,040 addresses of presumed interested and/or affected parties. The mailing list used was developed from the Forest mailing list of those interested in the Final Environmental Impact Statement (FEIS) of the forest plan revision. The plan mailing list was used because it was for an action similar in geographic scope, time period of implementation, and affecting similar interests. It was also relatively current, having been developed in late 2004. Recipients represented a broad geographic reach, a wide cross-section of interests, and divergent points of view.

1.6.1 Significant Issues

About fifty comments were received. The trend was one of support for both the purpose and need of the action. Support was also broad-based, crossing traditional lines of disagreement. Evident among response was the connection with hemlock as a valued contributor to a wide range of woods experiences and values.

The HWA Team identified the following issues judged significant to shaping alternatives:

- Insecticide treatment near predatory beetle release sites may cause mortality of beetles when they disperse. (J.Gatins, HWA Team)

- Insecticide treatments need monitoring to detect possible contamination of water. (Sierra Club, Georgia Forest Watch)

- More than just the largest and tallest hemlocks should be included in protection. (M.Skeen, Georgia Forest Watch, Sierra Club)

    - This response was based in part on a misconception in that the scoping letter had asked people nominating sites to protect to not do so unless there were at least 50 hemlocks at least equal in height with associated species on an area of three acres or less. This direction was given in an attempt to place emphasis on reproducing hemlock. Beetle release would not allow selectivity for 'treated' stems and in fact beetle release is typically on the lower limbs of relatively small hemlock. However, insecticide treatment, being on a per stem basis, does allow selectivity and the concern was considered significant to project mitigations.

  Predator beetle release should be emphasized over insecticide use as being more nearly natural and effective. (M.Skeen, M.Taylor)

- Release of non-native species or insecticide use in Wilderness is ‘trammeling’ of the wilderness resource. (Forest Service)

1.6.2 Other Issues

The HWA Team also identified some issues that are non-significant to the proposed HWA suppression on the Chattahoochee.

Hemlock loss will cause stream bank erosion and lowered water quality through sedimentation. The loss of hemlock is not caused by the proposal. Rather the proposal is to protect hemlock from being killed. Putting priority on PETS and locally-rare species, including aquatic, also responses to this concern. The relatively low density of hemlock in most of the Chattahoochee riparian areas, the slow decline of hemlock giving associated vegetation time to expand its root systems, the proportion of hemlock that will uproot and fall exposing mineral soil to stream or rain erosion, and the generally rocky subsoil along mountain streams will all work to keep sedimentation due to hemlock loss less than catastrophic. Should bank erosion become a problem as a result of the adelgid, future projects will deal directly with it. (L.Fox)

The proposed action does not protect enough hemlock and will result in high mortality of hemlock in the future. We acknowledge that there will be many more hemlock killed by the adelgid than we will protect. Much of this is because of the response of hemlock to fire suppression since about 1920. We acknowledged in the scoping letter an inability to protect all hemlock; hence the need to select and prioritize. However, the context of ‘enough’ is our stated purpose and need; namely provision for genetic conservation and the protection of the most critical areas for ecological reasons outside developed recreation. (C.Briscoe, Georgia Forest Watch)

Developed recreation sites are not included in the proposed action and mortality in these areas will have social impacts. Developed recreation areas are specifically not being included because within Forest Service procedures for implementing NEPA these areas do not require the preparation of an environmental assessment while the areas addressed in the proposal do require an environmental assessment. There is more flexibility in developed recreation areas. To include them in this proposal would reduce flexibility and could potentially affect timely control measures. (Georgia Forest Watch, Sierra Club, B.Goldstrohm)

There are not enough beetle-rearing facilities to have beetles available for release on all sites so the Forest Service should fund additional rearing labs. The Forest Service receives an annual appropriation from Congress with funds allocated to specific portions of its operations or even earmarked to specific uses. We do not have the authority to move funds to use them outside the stated intent of Congress. In addition, funding requests are outside the scope of this proposal. The proposal, analysis and decision do; however, provide both a strategic and a tactical framework for budget requests to Congress. Funding is usually more readily available from all sources once a strategy is in place and working such that additional funding can support it. (Sierra Club, T.Govus, W.Warren, J.Walker)

Decision should be flexible enough to allow use of new and better control techniques as they become available. We agree that the best-laid plans are characterized by flexibility to adapt to changing circumstances. But, on the other hand, NEPA is not designed to make it possible to write a ‘blank check’, but rather requires sufficient site specificity for the Deciding Official to make a reasoned choice among alternatives considered. Monitoring of control efforts and on-going monitoring of new research findings will be used to keep the decision and activities current within

NEPA constraints. Depending upon the exact nature of changes, some could be insignificant, relatively simple and not time-consuming; others could be significant, perhaps requiring a new analysis and decision. The ability to speed up this process is limited even in the rare cases where there is broad consensus that an activity is a good thing to do. (Sierra Club, Forest Service)

Hemlock on the Armuchee Ranger District and part of the Chattooga Ranger District have been left out leading to total hemlock mortality in these areas in the future. The Armuchee Ranger District in the Southern Ridge and Valley ecological section is outside the natural range of hemlock. (See Figure 1) No hemlocks are known on National Forest there. All of the Chattooga Ranger District was considered due to the uniqueness of hemlock in this Southern Appalachian Piedmont ecological section and alternatives do include areas there. However, hemlock is declining in abundance in this area and typically is a minor species in terms of stem count. The scattered pattern of hemlock makes it difficult to create a conservation group in a contiguous area. It also is marginal for beetle release as they have few host trees to disperse to within the distance they are capable of flying. (Sierra Club, C.Turner)

Methods used should emphasize not releasing non-native species as predators. At the present time, only non-native species are available as predators. No Eastern US or Southeastern US species has been found that is an effective predator on HWA. While some native species may prey on them, they do not do so intensely enough to control them. Only one presumed US species is approved and it is ‘non-native’ to the region as it is from the US Pacific Northwest. Each predator beetle approved for release have been carefully studied to ensure that they will not become another pest in their own right before being approved for this use. Only biological control offers hope of a long-term self-sustaining control mechanism. (A.Hammond)

Mortality of hemlock will create openings needing reforestation. This may indeed be the case in a small subset of all areas where hemlock composition is high and mortality has been complete. However, decisions to site prepare and reforest are not yet ready to be made at this time and they are outside the scope of this proposal. They can be made site specifically as these needs are identified. Some form of scoping of these proposals would also occur before a decision is made. (A.Hammond)

The proposed action does not consider hemlock on private or other public sector lands which could add valuable areas to an overall conservation design. The Forest Service generally does not have the authority to conduct activities on non-National Forest land so the Deciding Official cannot make a decision to treat them. We do work co-operatively, both formally and informally, with many partners to achieve mutually desirable goals. The Forest Service Forest Health Protection unit supports private land forest health through the State and Private Forestry arm of the agency working through the Georgia Forestry Commission. However, formal agreements to partnership for an HWA control effort would likely slow this decision considerably were they to be made a pre-requisite to it. Nothing in the proposal would in any way preclude such co-operation in future. (J.Eberle, T.Doll, M.Taylor)

There needs to be a public education and information campaign about the hemlock wooly adelgid. We agree that there needs to be a heightened awareness of HWA in the Blue Ridge Mountain area. We used our scoping for this proposal in part as a means to raise this awareness. This is one reason we referred people to web resources to learn more about the adelgid. Georgia Forestry Commission employees, Georgia Department of Natural Resources employees, and county agents are well informed about this subject. Citizen groups such as Georgia Forest Watch, the Sierra Club, and others also inform their membership about forest health issues. We anticipate on-going efforts through office visits, phone calls, press releases, and some public presentations to various audiences to also inform the public. (J.Walker, G.Shepherd, Georgia DNR)

Treatments need to be targeted to streamside and riparian communities. Each action alternative does this, in large part because these are the areas where hemlock of the largest size and greatest density typically occurs. (GA DNR, L.Golsen, C.Briscoe)

Soil injection with imidacloprid may contaminate soil or water courses, reducing aquatic invertebrates and soil microbes. Imidacloprid is not applied in situations where the risk of entering water is unacceptable. Specifically, label directions stipulate that it is not to be soil injected in gravelly or rocky soils where it may reach ground water. Monitoring, as discussed previously, will be conducted to detect imidacloprid in streams on a sample basis. In addition, the duration and landscape extent of soil injection treatment is proposed to be a very tiny fraction of all riparian area soils or even riparian area with hemlock. It would also be a very tiny fraction of the riparian area within a watershed in all but the smallest perennial stream watersheds. (M.Skeen, HWA Team)

Trees treated with insecticide may be fed upon by non-target organisms causing them to be killed. We acknowledge this as a possible unavoidable impact of insecticide treatment. However, if there are species dependent on hemlock as food, the mortality caused by HWA without action would cause them to die just as surely. For non-dependent species, a foundational concept regarding this concern is that 'the dose makes the poison'. That is, the HWA feeds exclusively on hemlock and is not mobile as larvae. So it ingests the insecticide continuously when feeding and is therefore more likely to reach a lethal dose sooner compared to other species that do not feed exclusively on hemlock and/or are mobile. The combination of beetle release and insecticide treatment offers the best long-term chance of providing habitat for any such species, particularly if both treatments occur within a contiguous distribution of hemlock. In other words, the proposed action would be the best means currently available to conserve such a species in the wild. (M.Skeen)

Expanding the proposal to include field-based rearing is operated primarily by volunteers. While this technique may be available in the future, it is not well enough developed for use now. There is precedence for the use of field insectaries for propagation of biological control agents, though seldom in a forest environment. Kok and Salom (2002) report development of field insectaria for propagation of the HWA predator *Laricobius nigrinus* in a seed orchard in Virginia. They also report some problems associated with the use of field insectaries. If practical techniques are devised they could become part of a future proposed action.

CHAPTER 2

2.0 Alternatives Including The Proposed Action

In addition to a no-action alternative required by NEPA, four action alternatives were formulated for detailed analysis. Each action alternative was built around its ability to meet the purpose, need, stated objectives, and significant issues. The practical ability to implement it was also considered. Practicality included consideration of recent historic, current, and projected future budgets. The present expectation is that budgets will remain relatively unchanged over the next four years. It is important to note that the workload of survey, site evaluation, release or inject and then monitoring will be increasing each year until the adelgid has moved across the Chattahoochee, when it will stabilize with each mountain District likely to have some type or all types of HWA-related work every year at selected locations throughout the entire District. The purpose of this step was to identify any alternative that clearly either could not be implemented or, if implemented, would not meet the purpose.

The following alternatives were identified:

Alternative 1 - No-action – required by NEPA

Alternative 2 - The proposed action with the addition of mitigations from the decision for HWA control on the NFs in NC.

Alternative 3 – Modified proposed action but beetles only. This alternative includes modifications to the proposed action based on internal and external scoping responses but with only predator beetle release and no imidacloprid use anywhere (except for any separate decisions made for developed recreation areas or other developed sites).

Alternative 4 - Modified proposed action. This alternative includes modifications to the proposed action considering areas nominated as a result of scoping for;

(a) substitution with proposed genetic conservation areas (GCAs) while maintaining the network, or
(b) additions and
(c) the establishment of first and second priority treatment areas.

Alternative 5 – Modified proposed action but no Wilderness. This alternative includes modifications to the proposed action based on internal and external scoping responses, but with no areas treated with either beetle release or insecticide in designated Wilderness.

Mitigation measures for activities in each alternative, if any, are also described in this chapter. Table 2.0.1 summarizes the management activities for each alternative. All amounts are approximate.

Table 2.0.1 Summary of Alternatives Considered in Detail

Acres by Alternative and Treatment Type					
Treatment Type	Alternative				
	1	2	3	4	5
Predator beetle only	0	112	19,437	320	320
Insecticide only	0	72	0	374	287
Insecticide & Beetle	0	14,700	0	18,809	17,586
TOTAL	0	14,883	19,437	19,709	18,192

See Appendix C for a table listing specific areas and maps showing the approximate locations of treatment areas.

2.1 Alternatives Considered In Detail

2.1.1 Alternative 1 – No Action

This alternative proposes no forest-wide activities to meet the objectives shown in Chapter 1 (and repeated below):

1. To reduce hemlock mortality from HWA by establishing reproducing populations of predator beetles that feed on HWA;

2. To maintain reproducing populations of Eastern Hemlock throughout the historical geographic and elevational range across the Chattahoochee, and;

3. To ensure survival of certain ecologically and culturally important groups of hemlock.

The No Action alternative is required by NEPA. Its purpose is to serve as a standard for comparison for action alternatives. It is, however, available for selection by the Deciding Official.

2.1.2 Alternative 2 – The Proposed Action

1. **Releases of Predator Beetles That Eat HWA to Establish Long-Term Population Control**

   Hemlocks in 114 eastern hemlock areas would be potential areas for releases of the predator beetles *Sasajiscymnus tsugae*, *Laricobius nigrinus*, *Scymnus sinuanodulus* and *Scymnus ningshanensis.* Either single species or combinations of species could be released. Each year these areas would be prioritized for releases with consideration for geographic distribution. The number of releases each year would depend primarily on the available supply of beetles but would also consider monitoring results; HWA spread, infestation levels, and release priorities. The goal would be to release beetles at all areas covered by the decision that have trees sufficiently infested (showing evidence of adelgids at most leaflet intersections) to provide the necessary prey base for the released beetles.
   See Appendix C for a table listing specific areas and maps showing the approximate locations of treatment areas.

The 114 potential release areas were selected primarily to meet the requirements of a hemlock conservation network designed to capture community diversity within the distribution of known hemlock stands. The basis for the design is population biology as described in the final EA for HWA suppression on the National Forests in NC. Areas that would form the conservation network were selected with an emphasis on retaining potential old growth, maintaining habitat for sensitive or locally rare species and maintaining habitat for T & E species. Additional hemlock areas identified through internal and external scoping as having important ecological values were also considered. In several instances hemlock stands not recognized as having specific importance were added to the network to fill a gap in the design.

The number of beetles released at an area would vary by species according to established release protocols developed by Forest Health Protection and university researchers who study the insects. Current protocols call for several hundred to several thousand beetles to be released per area.

MITIGATIONS FOR BEETLE RELEASE

Specific hemlocks within the areas would be evaluated for suitability for releasing beetles. Evaluation criteria are:

- Trees that are infested with HWA to the degree that evidence of adelgids can be seen at most leaflet nodes.

- The trees themselves, as well as nearby trees, should still be healthy enough to be putting on new growth.

- The objective is to find a site with enough HWA so the beetles can successfully feed and reproduce, and where other similarly infested hemlocks are nearby so it is possible for the beetles to disperse and still have prey.

A representative sample of release areas would be monitored at six months and one year after release to determine if:

(a) the beetles are still present,

(b) they have successfully over-wintered,

(c) they have dispersed from the release site(s) and, if so,

(d) how far they have dispersed.

The condition of the release trees would also be noted.

In areas with combined beetle release and insecticide treatment, beetles will not be released within or in close proximity to insecticide-treated locations. The actual buffer distance will be site-specific and field-determined, using the advice of the Forest Health Protection Unit.

2. IMIDACLOPRID TREATMENT FOR MAINTAINING GENETIC RESERVES

From one to three specific groups of trees (GCGs) would be selected for imidacloprid treatment within each genetic conservation area (GCA). The areas of each Alternative selected to receive imidacloprid treatment within them are specified in Appendix C. Treatment areas (GCAs) were selected to meet the requirements of the hemlock conservation network for hemlock genetic diversity. A target of at least 60 trees per imidicloprid-treated group (GCG) would be treated to reach the desired number for genetic diversity within the hemlock conservation network, this number includes a 16-percent allowance for mortality due to natural events (fires, windstorms, etc.). Individual stems would be selected with an emphasis on hemlock with their crowns in the main forest canopy; that is, in either dominant or co-dominant crown class, and with evidence of cone production. Shorter hemlock; that is, not in the dominant and co-dominant crown class, would also be treated in lesser numbers with those having evidence of cone production favored over those that do not. But not all hemlock stems would be treated within each genetic conservation group (GCG). Insecticide treatment would ensure that genetically diverse hemlocks remain alive until bio-control takes effect; assuming that it does. For GCGs the treatment would be the systemic insecticide imidacloprid injected into the soil at the base of the tree ("soil injection") at a rate in accordance with its labeling. An exception would occur for trees unsuitable for soil injection due to their proximity to water or highly permeable soils. For these – if they are treated - imidacloprid would be injected directly into the trunk of the tree ("stem injection"). A case-by-case determination would be made; first to decide to use stem injection, and secondly, which stems would be so treated. Treatment would be repeated every other year for soil injection and every year for stem injection. The re-treatment timing with soil injection is not because imidicloprid is that persistent. It breaks down in the first year. However, there is a lag time before re-infestation occurs; due in part to the summer dormancy of the adelgid.

Insecticide treatment would cease when effective biocontrol agents become establsihed or the HWA threat is otherwise diminished, based on annual situation reports from Forest Health Protection (USDA Forest Service).

<u>MITIGATION FOR IMIDACLOPRID SOIL INJECTION</u>

Sites would be screened by the following process prior to application of soil injected imidacloprid.

i. Soil would be field sampled to determine the presence of highly permeable soils. The determination of 'highly permeable' would be per guidance given by the Forest Soil Scientist. The presence of highly permeable soils would disqualify the site for soil injection.

ii. The site would be scouted for the presence of any surface water or waterbodies (springs, creeks, ponds, bogs, etc.). Any tree with a direct vegetative connection to surface water would be eliminated from soil injection treatment. This situation would primarily be of water flowing around roots.

Records will be kept for each treatment area of sufficient detail to;

- ❑ complete the Annual Pesticide Use Report,
- ❑ document compliance with the decision, and
- ❑ recover each area for follow-up monitoring and re-treatment.

A representative sample of locations treated with imidaloprid would have water samples taken and analyzed for imidacloprid movement into streams. Should unacceptable levels be detected, field procedures will be further mitigated until subsequent monitoring shows the problem has been resolved.

A minimum of 10-percent but no more than 20-percent of the total number of trees treated with insecticide within each group will be of intermediate or suppressed crown classes.

Special standards for Wilderness for any treatment method. To ensure the least possible impacts to Wilderness character, wildness and naturalness the following standards will be applied within Wilderness:

1. No mechanized devices will be used to access Wilderness sites.

2. Monitoring in Wilderness;

   (a) shall be timed to avoid periods of high visitor use,
   (b) shall not leave behind any evidence of the activity, and
   (c) shall not employ any motorized transport or equipment.

3. For Wilderness areas, a thorough evaluation of the status of the HWA infestations, record of treatments, monitoring results including any impacts to Wilderness values of the treatments, and progress toward the goals of the suppression activities will be completed and presented to the Regional Forester for review by the end of the fifth calendar year beginning from the date of the decision. This HWA suppression evaluation report will serve as the basis for continuing treatments in Wilderness past five years.

Special Measures Applicable to Aquatic Threatened or Endangered (T & E) Species

Insecticide will not be applied within mapped treatment locations where aquatic T & E species are known to occur anywhere within the included stream reaches.

2.1.3 Alternative 3 – Modified Proposed Action But Beetles Only

1. Alternative 3 would include only releases of predator beetles that eat HWA to establish long-term population control. The locations are those of the proposed action plus changes made as a result of scoping and consist of 140 individual areas.

2.1.4 Alternative 4 – Modified Proposed Action

This alternative would use both predator beetle release and insecticide. A total of 144 individual areas are included.

1. Releases of Predator Beetles that eat HWA to Establish Long-Term Population Control

2. Imidacloprid Treatment for Maintaining Genetic Reserves

This alternative would also identify as first priority areas:

- ❑ the genetic conservation network,
- ❑ habitat for PETS and locally-rare species, and
- ❑ foreground area along the AT within the mapped treatment area at Three Forks on the Toccoa Ranger District.

Identification of PETS and locally-rare species habitat or AT foreground as first priority does not automatically mean that the conservation design will be altered in those situations to treat more or different area than described in the alternative description. However, real time, site specific information in these situations will be considered under the 'new information or changed conditions' procedure for NEPA implementation.

Remaining areas would be identified as second level priorities. These are of some degree of importance but are not necessary to a genetic conservation design nor needed as habitat for species of special concern:

1. scenic viewsheds from most public viewpoints,
2. potential old growth,
3. dispersed recreation areas,
4. private land viewsheds,

All mitigations identified for the proposed action (Alternative 2) would also apply.

2.1.5 Alternative 5 – Modified Proposed Action But No Wilderness

This alternative is very similar to Alternative 4 except that there would be no treatment in Congressionally-designated Wilderness areas. A total of 129 areas are included. Areas within inventoried roadless areas, even if recommended to Congress for study as additions to the National Wilderness Preservation system, would be treated. This alternative was added to address Forest Service internal concerns about insect suppression as 'trammeling' of the Wilderness resource. Public responses did not emphasize Wilderness avoidance.

2.2 Alternatives Considered, But Not Evaluated In Detail

2.2.1 Treatment by Spraying Insecticidal Soaps and Horticultural Oils

Insecticidal soaps and horticultural oils can be sprayed on hemlocks when the objective is immediate knock down of an insect pest. If complete coverage is achieved, these agents act by smothering all invertebrates on the tree at the time of treatment; that is, it is not selective in its effects. It offers no advantage it its effects to imidicloprid. There is no residual effect, so HWA could re-infest the tree immediately. With this method there is an increased risk of applicator contamination and increased concern with drift, since the product is sprayed. This treatment method is appropriate for smaller, more accessible single trees or small groups of trees that could be treated frequently such as roadside trees or landscape plantings. It would not be appropriate for treating large areas such as genetic conservation groups and tall or inaccessible trees. It would not meet the project objective of keeping HWA suppressed for months or years, as would be necessary to ensure tree survival.

2.2.2 Use of a Southeastern US predator

The use of a predator native to the ecological Domain (entire Eastern US) or Division (southeastern US) unit was not a feasible option with current knowledge or beetle availability. Although HWA-consuming predator beetles native to the Eastern United States do exist, studies have not shown they can respond to the adelgid with a population buildup and eat enough HWA to effectively prevent hemlock mortality. In part, this may be due to life-cycles that do not match in timing the HWA life-cycle (HWA Newsletter No. 3, Sept. 1998). In contrast, predatory beetles collected from China and Japan that naturally control HWA where it originated, and from the Pacific Northwest where western hemlock has survived HWA infestation have demonstrated potential to reduce HWA populations significantly. These species demonstrate a life-cycle more synchronous with HWA and more dependent upon it.

3.0 CHAPTER 3

3.0 Environmental Impacts

3.1 Physical

3.1.1 Watersheds

Eastern hemlock is strongly associated with riverine systems and riparian ecosystems. The impact of the removal of this important climax forest species on the ecology of the Appalachian forests is poorly understood, but has the potential for significant disturbance to biotic communities by changing energy inputs, micro-climate environments, and physical habitat structure available to other vegetation, bird, mammal, and aquatic communities (Snyder et al., 1998). Studies documenting effects to aquatic communities have been completed at Delaware Water Gap National Recreation Area (DEWA). Snyder et al. found that streams draining eastern hemlock forests support 37% more aquatic invertebrate taxa on average than comparable streams draining hardwood forests in DEWA. In addition, occurrence and abundance of brook trout were higher in hemlock dominated stream environments than in hardwood areas (Snyder et al., 1998). Recent unpublished studies indicate there are no strong linkages between hemlock and riparian amphibians (salamanders) (Evans, pers.comm.).

In North Georgia, the potential impact of eastern hemlock loss to aquatic and riparian systems is even less understood, but it's expected to be mitigated by several factors. Expected impacts to the Chattahoochee NF include increased understory and stream light levels and temperatures, increased fine coniferous needle litter input to streams, and increased biomass of understory plants. Leaf litter input increase is relative to the normal needle shedding of healthy hemlock. These effects will be mitigated on the Chattahoochee NF because hemlock occurs in relatively low density in most riparian areas and is at the southern end of its range. White pine and shade tolerant species like rhododendron will typically diffuse expected increases in light and mitigate some of the direct heating effects.

As hemlocks begin to defoliate and lose fine twig and branches, more light will reach the forest floor heating the cool, moist microclimate associated with hemlock stands. This light will increase productivity and promote understory biomass development. As hemlocks die slowly, they remain standing for several years, but eventually lose their larger branches. The result is a large hemlock snag that remains standing for some longer period of time (Evans, pers. comm.). Eventually when the root-wad is lost, bank stability will decrease. Loss of hemlock bank trees due to natural events such as flooding or wind throw may be accelerated by hemlock death. This will also add large woody debris (LWD) to stream systems. Understory development and opportunistic expansion from associated vegetation will help maintain bank stability and mitigate effects from hemlock death. Increased fine coniferous needle litter input to streams will have an indirect effect on aquatic macro invertebrates, with shredders increasing.

Proposed Treatments by Watershed

Hemlock treatment acres by watershed or 6th Level HUC are summarized in **Table 3.1.1**. A Hydrologic Unit Code (HUC) is a watershed of a specific scale or size used by multiple agencies to organize or catalogue hydrologic data. U.S. Geological Survey (USGS) developed these maps and associated codes to provide a standardized base for use by water resources organizations in locating, storing, retrieving, and exchanging hydrologic data, and for a variety of other applications. Treatment areas have been identified in 73 of approximately 195 sixth level HUCs that encompass the Chattahoochee NF, or about a third of the 6th Level HUCs. These 73 HUCs or watersheds are further concentrated in the mountain portion of the Forest.

Table 3.1.1. Acres of Hemlock Treatment by 6th Level HUC and Alternative

Management Area (5th Level HUC) Sub-watershed (6th Level HUC)	**Alt 1 (acres)**	**Alt 2 (acres)**	**Alt 3 (acres)**	**Alt 4 (acres)**	**Alt 5 (acres)**
Chattooga River – North, East, West Forks					
030601020101	940	265	700	710	625
030601020102	960	560	1160	1160	1160
030601020103	1480	1145	1315	1315	1315
Tugaloo River – Panther Creek					
030601020601	395	245	770	770	770
030601020602	580	210	425	425	425
030601020603	45	45	495	564	495
030601020604	100	100	100	100	100
030601020605	100	0	0	0	0
030601020606	360	605	605	605	605
030601020607	0	0	80	80	80
Tallulah River					
030601020701	1460	870	880	880	870
030601020702	325	15	120	120	120
030601020703	560	295	290	290	290
030601020704	95	95	200	200	200
030601020705	510	260	260	260	260
030601020706	260	180	240	240	240
030601020707	35	20	500	500	500
030601020708	140	125	125	125	125
Broad River – North and Middle Forks					
030601040101	25	25	25	25	25
Chattahoochee River – Chickamauga Creek					
031300010101	705	760	1015	1015	940
031300010102	1020	240	285	285	285
031300010103	125	75	275	275	225
031300010104	180	70	70	70	70
Soque River					
031300010201	385	90	250	250	45
Chestatee River – Dicks Creek					
031300010501	245	285	285	285	240
031300010502	90	0	0	0	0
031300010503	15	15	15	15	15
Chestatee River – Yahoola Creek					
031300010602	290	0	40	40	40
Conasauga River – Upper					
031501010101	253	110	145	296	5
031501010102	2340	640	660	691	305

031501010103	115	0	0	0	0
Conasauga River – Middle					
031501010202	520	35	35	35	35
031501010203	170	0	0	0	0
031501010208	130	135	150	150	150
Holly Creek					
031501010401	1630	265	380	380	380
031501010405	280	0	0	0	0
Cartecay River					
031501020102	105	150	150	150	150
Ellijay River					
031501020201	40	0	0	0	0
031501020202	0	25	25	25	25
Mountaintown Creek					
031501020301	420	15	15	15	15
031501020302	65	35	35	35	35
031501020303	85	0	0	0	0
031501020304	50	50	50	50	50
Coosawattee River – Carters Lake					
031501020403	40	0	40	40	40
Etowah River – Upper					
031501040101	245	110	110	110	110
031501040102	200	230	230	230	230
031501040103	40	0	0	0	0
Amicalola Creek					
031501040203	0	70	70	70	70
Little Tennessee River					
060102020101	595	595	595	595	595
060102020102	60	215	215	215	215
Hiawassee River – Chatuge Lake					
060200020101	890	760	820	820	820
060200020102	5	50	50	50	50
060200020103	100	110	130	130	130
060200020104	75	75	75	75	40
060200020105	70	70	75	75	75
Brasstown Creek					
060200020401	30	55	65	65	20
060200020402	120	0	0	0	0
Nottely River – Nottely Lake					
060200020801	640	375	375	375	320
060200020802	160	300	320	320	260
060200020803	0	170	170	170	170
060200020804	45	0	0	0	0
060200020805	180	170	170	170	170
060200020806	15	0	0	0	0
060200020807	75	0	0	0	0
060200020808	55	125	125	145	145
Toccoa River – Upper					
060200030101	450	620	620	620	620

060200030102	150	665	745	735	735
060200030103	215	525	665	665	665
060200030105	235	1105	1105	1105	1105
060200030106	150	310	310	310	310
Toccoa River – Middle					
060200030205	0	0	65	65	65
060200030207	95	0	0	0	0
060200030208	150	150	150	150	135

This provides a representative network of treatment areas across the mountain portion of the Forest, and helps insure genetic conservation of eastern hemlock through the riparian area network associated with these watersheds. Treatment areas occur in all major drainage basins that occur on the Chattahoochee NF, including the Savannah, Chattahoochee, Little Tennessee, and Coosa. The no-action alternative has less acreage by watershed than the action alternatives in some cases because only 4 hemlock or mixed-hemlock forest types were included in the no action alternative. Additional areas with other forest types were included in the action alternatives. Treatment acres by watershed are similar among most action alternatives, but there are reductions in acreage in several watersheds in alternative 5 due to wilderness exclusion. An example of this is seen in the "Conasauga River- Upper" watershed, which includes the Cohutta Wilderness. The number of treatment areas by 6th Level HUC is summarized in **Table 3.1.2**. Again, the number of treatment areas did not vary widely by alternative. The number of areas was reduced in alternative 5 due to wilderness exclusion. In both tables, there is some variation by alternative for the Chattooga River Watershed. This is the result of recent adelgid infestation in this Watershed. Hemlock stress and/or death have been documented and as a result, treatment options for this Watershed may vary. Even if treatments were effective in eliminating the adelgid, recovery of stressed trees is unlikely. This would in turn affect what treatments were prescribed for infected areas. For the three 6th Level HUCs included in the Chattooga River Watershed, the difference in proposed acres treated in alternative 2 compared to alternatives 3, 4, and 5 is due to additional information that came in after the scoping phase. In **Table 3.1.2**, some areas may have been counted twice if the treatment area is split into two 6th Level HUCs. However, this effect would be similar across alternatives in most cases.

Cumulative Effects

There are no expected cumulative effects of insecticide treatment at the watershed scale. Small areas (about 2 acres each) spread across several large watersheds or 5th Level HUCs are being treated, and this treatment will not occur on all acres at the same time. In these large watersheds, dilution of imidicloprid would occur very rapidly and therefore would not accumulate with other treated areas downstream. Further, HWA progression will be spread out over time, which is why treatment of all areas will not occur at the same time. Mitigation will prevent insecticide from reaching water, and monitoring will take place to insure that mitigation methods are effective.

Table 3.1.2. Number of Hemlock Treatment Areas by 6th Level HUC and Alternative

Management Area (5th Level HUC) Sub-watershed (6th Level HUC)	**Alt 2** (Num. Areas)	**Alt 3** (Num. Areas)	**Alt 4** (Num. Areas)	**Alt 5** (Num. Areas)
Chattooga River – North, East, West Forks				
030601020101	5	9	8	6
030601020102	4	6	6	6
030601020103	2	5	5	5
Tugaloo River – Panther Creek				
030601020601	4	6	6	6
030601020602	3	3	3	3
030601020603	1	2	3	2
030601020604	1	1	1	1
030601020606	3	3	3	3
030601020607	0	1	1	1
Tallulah River				
030601020701	4	5	5	5
030601020702	3	5	5	5
030601020703	2	2	2	2
030601020704	1	1	1	1
030601020705	2	2	2	2
030601020706	2	3	3	3
030601020707	1	1	1	1
030601020708	2	2	2	2
Broad River – North and Middle Forks				
030601040101	1	1	3	1
Chattahoochee River – Chickamauga Creek				
031300010101	2	3	2	1
031300010102	1	2	2	2
031300010103	1	2	2	2
031300010104	2	2	2	2
Soque River				
031300010201	2	3	3	2
Chestatee River – Dicks Creek				
031300010501	4	4	4	4
031300010503	1	1	1	1
Chestatee River – Yahoola Creek				
031300010602	0	1	1	1
Conasauga River – Upper				
031501010101	5	6	8	3
031501010102	6	6	7	5
Conasauga River – Middle				
031501010202	1	1	1	1
031501010208	2	3	3	3
Holly Creek				
031501010401	5	5	5	5
031501010405	1	1	1	1

Cartecay River				
031501020102	2	2	2	2
Ellijay River				
031501020202	1	1	1	1
Mountaintown Creek				
031501020301	2	2	2	2
031501020302	1	1	1	1
031501020304	1	1	1	1
Coosawattee River – Carters Lake				
031501020403	0	1	1	1
Etowah River – Upper				
031501040101	1	1	1	1
031501040102	1	1	1	1
031501040103	1	1	1	1
Amicalola Creek				
031501040203	1	1	1	1
Little Tennessee River				
060102020101	1	1	1	1
060102020102	2	2	2	2
Hiawassee River – Chatuge Lake				
060200020101	3	3	3	3
060200020102	2	2	2	1
060200020103	3	4	4	4
060200020104	2	2	2	1
060200020105	1	2	2	2
Brasstown Creek				
060200020401	2	3	3	3
Nottely River – Nottely Lake				
060200020801	3	3	3	2
060200020802	1	1	1	1
060200020803	1	1	1	1
060200020805	1	1	1	1
060200020808	2	2	1	1
Toccoa River – Upper				
060200030101	5	5	5	5
060200030102	6	7	7	7
060200030103	3	4	4	4
060200030105	1	1	1	1
060200030106	2	2	2	2
Toccoa River – Middle				
060200030205	0	2	2	2
060200030208	3	3	3	2

3.1.2 Soils

Affected Environment

None of the alternatives proposed for the treatment of areas being attacked by the hemlock wooly adelgid on the Chattahoochee-Oconee National Forest will cause soil disturbance. The proposed treatments will not cause disturbance that will result in soil erosion, compaction or reductions in soil productivity.

Eastern hemlock as a species is distributed over a wide range of sites across the landscape. The EA section on Forest Cover describes the range, silvics, distribution and associated species in detail. Because of its wide distribution, hemlock occurs over a wide range of soil types and conditions. However, the more common situation is to find large hemlocks thriving on sites near streams, shaded by higher terrain, and on soils characterized as moist, but with good drainage. Large diameter hemlocks can be found in narrow bands less than 200 feet wide along perennial streams that flow year round. These areas are generally known as riparian areas. The 2004 Chattahoochee-Oconee Forest Land Management Plan identifies these areas along perennial and intermittent streams as riparian corridors. Hemlocks in this landscape position commonly occur with species such as yellow poplar, northern red oak, white pine and beech, and with understory species such as rhododendron and dog hobble.

The soils occurring in the riparian areas and corridors have typically formed as a result of alluvial or colluvial deposition of materials from landscape positions on higher slopes. This deposition process typically forms soils that are deep (6 feet or more to hard bedrock), well drained, and can be moist throughout much of the growing season. Soil textures are typically loamy or sandy. Slopes are often gentle on the floodplains and stream terraces near streams. The gravel and stones found in these soils have been smoothed as they are tumbled downstream and deposited along the waterways.

Soil textures found in these soils can be variable; however the more common are coarse-loamy or sandy, often with moderate to high volumes of stones and rocks below the surface. Soils with more than thirty-five (35) percent by volume of rocks are classified as skeletal. This combination of soil structure and texture contributes to the drainage behavior within the sites, typically well drained due to the mixture of coarse (sandy) textured soil material and gravel or stones. Small pockets of clayey textured soils can also occur that have slower drainage and may actually hold surface water for periods of the year. The texture and structure of these soils also generally results in rapid infiltration of water, or moderate to high permeability.

<u>Effects Common to All Treatment Alternatives</u>

No soil disturbance resulting in soil erosion, soil compaction or decrease in soil productivity will occur in any of the alternatives proposing treatments with beetle releases or insecticide application. An indirect effect to the ground cover on the soils may occur as increased light to the forest floor occurs with hemlock decline. For more specific analysis of this effect refer to the section on forest cover.

Effects Common to Alternatives 2, 4 & 5

Alternatives 2, 4 and 5 propose the soil injection of systemic insecticides as a short-term treatment at the base of individual hemlock trees to control active adelgid infestations. These insecticides are dispersed into the soil and taken up via tree roots into the vascular tissue of each tree. These insecticides are not toxic to plants. Insecticides currently labeled, and in use throughout the range of HWA, for this type of treatment have the active ingredient Imidacloprid. This is a general use systemic chloronicotinyl insecticide utilized for control of a wide variety of aphid, lacewing and other garden pests. The ingredient works by causing interference or blockage of the transmission of impulses in the nerve system of insects, causing paralysis, and a cessation of feeding activity.

Soil injection involves the use of a tool called a "soil injector," or hand operated pump device. A common brand name is the Kioritz Soil Injector. This hand-held device delivers pre-measured and pre-mixed doses of liquid into the soil at a depth selected by the applicator up to a maximum of ten inches, generally into the top 4 to 6 inches of soil. Dosage rates as directed by the manufacturer's label direction will allow Imidacloprid to bind tightly to organic matter and soil particles, immobilizing the active ingredient so it can be more readily picked up by the tree's roots and minimizing movement to ground water or nearby aquatic environments (Cowles 2005).

The liquid is metered from the injector by depressing a pump handle, forcibly jetting the solution laterally (that is, 'sideways') through the soil where it is then taken up by the hemlock's root system. Injection locations are spaced evenly in a circle at a comfortable human working distance, or approximately 1 to 3 feet, around the base of the stem with each injection site receiving one ounce of solution. That is, the example 6-inch stem would have six injection sites located approximately sixty degrees apart.

To minimize the movement of systemic insecticides into ground or surface water; the following recommendations have been developed by the product manufacturer of Imidacloprid (Bayer, 2004):

- Applications should be made during the growing season to encourage uptake by root tissue.
- Discourage use in areas with shallow groundwater.
- Avoid application directly to water or in areas where surface water is present.

Use a soil injector to apply systemic insecticide beneath a tree (Kioritz).

The biodegradation rate of Imidacloprid 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 direct contact with the insecticide while it is still active in the soil would likely be impacted, but the properties of the soil itself would not change. Effects would be localized, because Imidacloprid is not highly mobile in most soils, and a clearance process would insure that it is not injected in soils where it could potentially move off site, such as highly permeable (sandy or gravelly) soils. Invertebrates would be expected to re-colonize 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.

Cumulative Effects

Since none of alternatives considered would cause erosion or compaction or impact soil productivity, this project would not contribute to any cumulative impacts from on-going activities or future activities.

In regard to the soil injection of Imidacloprid in Alternative 2, 4 and 5, some additional use is anticipated 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, as with Alternative 2, 4 and 5. There would be no additive or overlapping of impacts.

3.2 Biological

3.2.1 Forest Cover

Affected Environment

Hemlock Range

In general the complete range of Eastern or Canada hemlock *(Tsuga canadensis)* is a broad wedge-shaped area with the base formed by a line from Nova Scotia to Minnesota and the apex along the GA-AL state line west of Rome, Georgia. It reaches the southern limits of its natural range in Georgia and Alabama. Completely within this area is the natural range of a closely related species, Carolina hemlock *(Tsuga caroliniana)*. It is a southern Appalachian endemic limited to dry slopes and ridges from Virginia and West Virginia southward to Georgia. (Burns *et al*, 1990)

Hemlock Silvics

Eastern hemlock is usually thought of in connection with northern or central, rather than southeastern, forests. It is generally restricted to regions with cool, humid climates where it grows on moist but well-drained soils. It is a slow-growing but long-lived tree. It may take 250 to 300 years to reach maturity and live to 800 years or more. One of its most important characteristics is that it can establish as a seedling, survive and grow in the dense shade of other species; that is, it is very ***shade tolerant.*** In fact, it is the most shade tolerant of all tree species and can survive with as little as 5 percent full sunlight. (Burns *et al*, 1990) The bark is relatively thin and hemlock is killed by even low intensity fire until late in life and does not stump sprout if top-killed; that is, it is ***fire intolerant.*** (Brown *et al*, 2000) Other shade tolerant and fire intolerant woody species often associated with it in Georgia include American beech *(Fagus grandifolia*), Eastern white pine *(Pinus strobus)*, rhododendron *(Rhododendron maximum)*, mountain camellia *(Stewartia ovata)*, silverbell *(Halesia caroliniana),* mountain laurel *(Kalmia latifolia)* and blue beech *(Ostrya virginiana).* Of these, white pine and rhododendron are the most common associates. Rhododendron and other understory species are, however, greatly reduced with a canopy cover that is predominantly evergreen with continuous heavy shade. They are more prevalent in communities with some proportion of hardwoods allowing fall and winter light down to the forest floor after leaf fall.

The shade cast by hemlock crowns is typically dense year-round. In vegetation communities with a 50 percent and greater proportion of the count of stems forming the tallest canopy layer being hemlock, shrub and herb cover ranges from sparse to absent, temperature is cooler in summer and relative humidity is typically higher than nearby areas having greater air mixing and sun exposure. Hemlock needles are very small and thin, forming a very compact litter layer on the forest floor. Hemlock branches and twigs are fine textured, even on old trees. They also tend to be retained on the tree even when dead so that large woody debris in hemlock-dominated stands typically comes from the trunks of tree falls. Down logs somewhat frequently become ‘nurse logs’ for establishment of new seedlings, but seedlings rarely become established directly under the canopy of hemlock ‘mother trees’. Hemlock leaf, cone and branch fall does not create a high fuel loading and is not normally conducive to high intensity or fast spreading fires. An exception to this is with downed trees with the needles cured but still attached. Only with blow down events coupled with cured, low moisture content debris, such as with severe drought would hemlock-dominated stands be expected to have high intensity fire behavior.

Hemlock Distribution in Georgia

In Georgia, Eastern hemlock is generally restricted to the Blue Ridge Mountains and Southern Cumberland Plateau ecological sections where it reaches the southern limits of its contiguous native range. However, it does occur as ‘disjunct’ (non-contiguous) populations in gorges and ravines extending out into the ‘Upper Piedmont’. Two examples are the north-facing slopes of the steep sidewalls of the Chattahoochee River southwest of Helen, Georgia and the most sheltered terrain positions in the Panther Creek drainage southeast of Turnerville, Georgia.

Carolina hemlock has been reported in Georgia from the rim of the Tallulah Gorge south of US highway 441 on the coarse sandstone associated with the Tallulah Dome geologic feature along the Tallulah River. There is no National Forest closer than about one-quarter mile air distance and Carolina hemlock has not been confirmed as occurring on National Forest. It differs significantly in habitat from Eastern hemlock, being associated with dry, rocky soils with much less moisture and shelter than eastern hemlock habitat.

Hemlock Distribution on the Chattahoochee National Forest

On the Chattahoochee National Forest, Eastern hemlock occurs on the mountain Ranger Districts; that is, excluding the former Armuchee Ranger District in northwest Georgia in the Southern Ridge and Valley ecological section and the Oconee Ranger District of middle Georgia. It is most strongly associated with the Hot Continental climatic division that in turn is associated with the cooling effect of moving northward and with rising elevation as it moves from the Piedmont into the Blue Ridge Mountains. It is most frequent between about 2000 and 3000 feet in elevation, but is only climate limited on the low elevation end in the area of transition (ecotone) to the Humid Sub-tropic climatic division that generally characterizes the Southeastern US. Large trees that began life prior to fire suppression (greater than about 16” in diameter) typically occur in the most sheltered portions of the landscape; that is, in the most fire-resistant areas. The most common situation is for these large hemlocks to be in a mixture with yellow poplar, northern red oak, white pine and beech in narrow bands of less than 100 feet wide along year-round streams. Within the Forest Service, these are often called ‘riparian area stringers’. In the table below, this situation is best reflected by forest cover type 41 ‘cove hardwood-white pine-hemlock’.

Table 3.2.1. Hemlock Woolly Adelgid Host Acreage on All Forested Acres of the Chattahoochee National Forest

Forest Cover Type Code and Name	Acres	Percent of All Chattahoochee	Percent of Blue Ridge
04 - White pine-hemlock	1,564	0.2	0.2
05 - Hemlock	262	0.03	0.04
08 - Hemlock-hardwood	1,512	0.2	0.2
41 - Cove hardwood-white pine-hemlock	19,398	2.6	3.0
TOTAL	**22,736**	**3.03**	**3.4**

Source: (Forest Service, 2003) Report from C-O NF GIS stands data layer October 2002.

These forest cover type characterizations are for contiguous areas of at least ten acres and a minimum hemlock composition in trees reaching into the tallest tree canopy layer of approximately 30 percent of the stem count. Smaller land areas of hemlock – which do occur – are not reflected, nor are acres with less than about 30 percent hemlock composition in the tallest trees. This situation also somewhat commonly occurs on the landscape.

Effects of Past Land Use

Historically, burning by Native Americans and white settlers prevented hemlock survival on the uplands prior to the so-called ‘industrial logging era’ of about 1880 to 1930. Along the major ridge systems defining the large river watersheds such as the Savannah, the Tennessee, and the Coosa; and above approximately 3000 feet, fire intensity and frequency was severe enough to largely exclude hemlock even though the climate moderation with greater elevation would have otherwise increasingly favored it in sheltered terrain positions. During this farming and woods grazing period, hemlock was not highly valued for wood products but the bark was sought after for ‘acid wood’ used in leather tanning. The wood – if used at all - was used for local uses such as barns, fences, railroad trestles, sheds, and so forth. In the logging era from about 1900 to 1930, fires burning in logging slash were more intense than the low-intensity annual woods burning that had preceded it. Together, these two pressures confined hemlock to the most fire resistant areas of north or east-facing coves, toe slopes and valley bottoms.

In the logging era picture above, notice the ‘row’ appearance of dark hemlock and/or white pine crowns down the valley bottom and how closely they are associated with the stream. Notice also the ‘valley bottom’ location of the railroad and how gravity favors the movement of logs to the rails. High intensity and fast-moving fires appear to have swept the steep slope in the background judging by the sparse tree canopy and fine-textured ground cover.

With the establishment of fire suppression after about 1930, the shade tolerance of hemlock allowed it to begin to move both upslope and upstream from its streamside fire refuges. Today it occurs rather widely on the landscape as seedlings, saplings and small trees beneath other less shade tolerant and more fire tolerant species. In these situations it is an opportunistic invader into ecosystems adapted to lower moisture regimes and more frequent burning. The presence of hemlock is a yellow flag of caution that forest succession is preceding away from sustaining the present forest community. Infrequently these hemlocks are relatively dense and could readily respond to ‘release’ and form a new community if the tallest trees were removed. But more commonly, they are scattered individuals or small groups. Summer drought, wildfires and prescribed fire slow this encroachment into the uplands by preventing seedling establishment or killing seedlings by heat-girdling when they are small.

Current Amount in Georgia

Forest Inventory and Analysis (FIA) forest inventory date was used to estimate a Forest-scale hemlock population. FIA data has been collected since the 1920’s and is a statistically valid sampling of forests on all ownerships across the Nation. The data is collected by employees of the state of Georgia working in co-operation with the Southern Forest Experiment Station headquartered in Asheville, NC. All plots on the Chattahoochee and Oconee were selected initially and processed through software to summarize just the number of hemlock stems into four-inch diameter classes. A total of 127 plots were selected. Of these, 111 occurred in just the Blue Ridge Mountain portion of the Chattahoochee NF. FIA uses a ‘stratified sampling’ technique, meaning that the number of sample plots taken within specific forest community type groups; that is, ‘strata’, is proportionate to the area occupied by those strata on the landscape. Therefore, the assumption was made that plots were distributed on the landscape such that the proportion of plots with hemlock was an accurate estimate of the proportion of the Blue Ridge portion of the entire Chattahoochee having hemlock. Nineteen plots, or 17.12-percent of the 111 Blue Ridge plots, had hemlock of some size present. The proportion of plots with hemlock was calculated in the same way for each diameter class. That proportion was multiplied by an estimate of 650,000 acres in the Blue Ridge on NF to estimate the number of acres having trees within each diameter class. (*Note – acreages are **not** additive to the total acres with hemlock because multiple diameter classes occur on some acres, which would result in the same acre being counted multiple times if the acreages were simply added together.)* However, the estimate of the number of hemlock can be added across diameter classes to estimate a total hemlock population.

Table 3.2.2 below shows; (1) the number of FIA plots on the Forest with hemlock stems in each diameter class, (2) the total number of hemlock stems on these plots, (3) average number per acre of hemlock by each diameter class, and (3) the estimate of; (a) the total hemlock population on the Chattahoochee by diameter class, and (b) the total hemlock population. The estimate of the total hemlock population was generated by multiplying the average number of hemlock stems per acre in each diameter class by the estimated acreage with hemlock of that diameter present.

Table 3.2.2: Estimated Number and Size of Eastern Hemlock on the Chattahoochee NF as of 2004

	Summary Data by 4" Diameter Class					
	4"	8"	12"	16"	20"	24"
# of Plots with Hemlock in the Dia. Class	15	12	8	2	1	1
# of Hemlock on Plots	1,557	144	54	12	6	6
Avg. # of hemlock/acre	104	12	7	6	6	6
Estimated acres with hemlock in each dia. class	87,838	70,270	46,847	11,712	5,856	5,856
Estimated population in Dia. Class	9,140,000	840,000	330,000	70,000	40,000	40,000
Percent of total pop.	88%	8%	3%	1%	<0.5%	<0.5%
Estimated total hemlock population on Chattahoochee N.F.					***10,420,000***	

Source: Forest Inventory and Analysis (FIA) data available online at http://www.ncrs2.fs.fed.us/4801/fiadb/fiadb17_dump/fiadb17_dump.htm

A disclaimer must accompany the use of FIA data in this way. FIA sampling is designed to give statistically valid results at the scale of one million acres or more. The mountain portion of the Chattahoochee is approximately 650,000 acres. Using only nineteen plots to characterize hemlock could have a high error of the estimate of population numbers. This error potentially increases with each diameter class as the number of samples decreases. For this reason, the estimated population numbers were rounded to the nearest ten thousand and the number of acres occurring on NF in the Blue Ridge Mountains was also rounded. The value of this hemlock population estimate is not to provide highly accurate hemlock numbers but rather to accurately characterize the trend of stem distribution among size classes as the context for hemlock conservation.

Social Value of Hemlock

Hemlock is a much-loved tree throughout its range. In Georgia it is virtually a 'signature tree' of the Blue Ridge and signals to the visitor that they have reached 'the mountains'. Its deep green foliage, lacy texture and conical form are aesthetic highlights in any forest scene. As an indication of how desirable it is, there are reportedly 274 'cultivars' (horticultural varieties) of hemlock. Hemlock is also strongly associated with highly desirable mountain recreation settings such as the view shed of waterfalls, vista points, campgrounds and trails. Its strong association with water makes it a landscape feature in numerous recreation experiences such as canoeing, hiking, trout fishing, tubing and swimming. The open understory, dense shade and cooler temperatures within hemlock-dominated stands are each highly desirable in summer when people visit the mountains partly to escape the heat of the lowlands. In winter, when hardwoods are leafless and gray and the forest floor is brown, hemlocks are green accents on the landscape. Their deep crowns, with lowest limbs often nearly sweeping the ground, are dramatically different from all other conifers and add more vertical structure than associated species. It is especially beautiful when covered in snow.

Summary of Forest Cover Effects

The table below shows the approximate acreage that would be treated in each hemlock or hemlock-containing forest type in each alternative. Acreages are approximate because beetle dispersion will spread beyond 'hard' mapped boundaries provided hemlocks with adelgid are available for feeding beyond them.

For areas with both insecticide and beetle release, and assuming that the average number of hemlock per acre for the 12-inch diameter class and above are additive (that is, occur on the same plot with each plot representing an acre), then 2.4 acres would be needed to reach a target of 60 trees for a genetic conservation group because the average number of trees across these four diameter classes is 25 per plot. To reach three groups within one proposed treatment area would thus treat approximately 7 acres, with rounding for uncertainty. This assumption is obviously not true of the FIA plot data shown, since there are eight plots with trees in the 12" diameter class, only two plots with the 16-inch class, and only one plot each for the 20 and 24-inch classes. However, in the detail of the plot data, these do occur on the same plots except for one plot with six trees in the 16-inch class. So the assumption provides useful information and focus for a reasonable estimate.

Since Alternative 1 is No-Action, it shows all of the mapped acres on the Chattahoochee for each forest cover type. The other alternatives show the proportion of those total acres identified in areas to be protected.

Table 3.2.3: Hemlock Treatment Acres by Forest Cover Type and Alternative

	Acres By Alternative				
Forest Type Code and Name	**Alt. 1**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**
04-White pine-hemlock	1,564	664	664	664	516
05-Hemlock	262	29	50	50	50
08-Hemlock-hardwood	1,512	335	335	358	333
41-Cove hardwood-white pine-hemlock	19,398	8,778	10,279	10,594	10,421
Other - (not typed with hemlock)	n/a	5,076	8,109	7,882	6,967
Total	**22,736**	14,882	19,437	19,708	18,278

Source: GIS alternative maps and stands data layer as used for Forest Plan revision.

Effects Common to All Alternatives

One direct effect to forest cover of hemlock decline and death will be increased light to the forest floor throughout the year as the density of evergreen needles first gradually declines and then disappears entirely. In the most common situation of hemlock occurrence on the Chattahoochee, the canopy gaps created will be small because of the narrow, conical crown of individual hemlock. Even a very large hemlock of 30+ inches in diameter would be estimated to have a crown diameter covering less than 0.25 acre (a crown diameter of 120 feet). Hemlocks physically in proximity would result in larger canopy gaps and increased light. The table below shows the estimated decrease in canopy cover for each of the vegetation communities with a significant hemlock component. This decrease would occur irregularly as single-tree gaps, groups of several trees, and up to extensive areas of several acres. In approximately 90 percent of cases, canopy gaps would be either of single trees or small groups of several trees. In addition, the effect of the occurrence of hemlock in other vegetation communities where it is a minor (in terms of numbers) species is also shown.

Table 3.2.4: Estimated Percent Hemlock Canopy Cover Lost By Vegetation Community

Forest Cover Type Code and Name	Range of Percent Canopy Cover Lost
04 - White pine-hemlock	30 to 50%
05 - Hemlock	70 to 100%
08 - Hemlock-hardwood	50 to 70%
41 - Cove hardwood-white pine-hemlock	15 to 30%
Any other occurrences of dominant/co-dominant hemlock	5 to 30%

Source: Estimated from forest cover type definitions in Forest Service Region 8Comparttment Prescription FIELD Book June, 1992

The occurrence of hemlock in very sheltered topographic positions its relatively small crown diameters, and the typically low frequency of hemlock stems means that the increased light will typically be diffuse rather than strong and direct. That is, the sun will not typically shine directly down into the gaps created or – if it does – will do so for a relatively brief period each day. The combination of slow hemlock decline, increased diffuse light and no ground disturbance will favor the growth of established tolerant species, especially white pine *(Pinus strobus)*, beech *(Fagus grandifolia)* rhododendron *(Rhododendron maximum)*, and silverbell *(Halesia caroliniana)* in and on the periphery of the gaps. Because of a substantially faster height growth rate, white pine will usually be the tree species most favored by the conditions provided. But where a dense understory of rhododendron exists, there may be no new tree recruitment at all. Whittaker (Whittaker, 1956) noted this phenomenon in the Smokies following chestnut blight when chestnut was growing above a dense understory of rhododendron. Some associated species, particularly oaks, on the periphery of gaps will also extend their limbs out into the space and light made available. In single tree and ranging up to aggregate three or four tree gaps, crown extension can be expected to close over the gap before additional stems can grow up from the ground into the general canopy layer. In larger gaps, such as will occur in communities with a hemlock composition of 30 percent or more, hemlock can be expected to be replaced by some combination of its most closely associated species; including white pine *(Pinus strobus)* and yellow poplar *(Liriodendron tulipifera)*. Yellow poplar seed is stored in the forest floor leaf mould and responses to increased light and temperature. Research with oak regeneration has found this response to occur at above 15-percent of full sun. Where hemlock is the majority of the stems in a community and the canopy loss is approximately 50 percent and greater, conditions will be more conducive to the establishment of new seedlings of shade intolerants such as red maple (*Acre rubrum)* and black birch *(Betula lenta)*.

An indirect effect of hemlock death will be the subsequent fall of hemlock snags. Snags typically deteriorate in the order of; (1) fine twigs, (2) small branches, (3) large branches, (4) top portion of main stem, (5) upper to mid portion of main stem, and (6) fall of remaining main bole. The fall of the main bole – if it uproots - can be expected to create 'pit and mound' micro-relief with the 'mound' being the root ball and the 'pit' being the hole made by the soil removed with the root ball as the tree fell. Each of these features will provide micro-sites for establishment of new seedlings on mineral soil that otherwise will not be exposed. Provided the canopy remains open, this will favor the establishment of intolerant species such as black birch, yellow poplar, and possibly mesic site oak species such as northern red or white oaks. However, the lag time between tree death and uprooting will usually mean that re-growth will shade any mineral soil exposed by tree fall. Species composition can still be expected to remain that of the common hemlock associates.

Another indirect effect of hemlock snag fall will be the creation of moist 'nurse logs' on the forest floor. Some associated species will be able to establish seedlings on these logs once they have sufficiently deteriorated. Examples include black birch and rhododendron. Fungi, mosses, and insects will use these materials as feeding substrate. Salamanders and small mammals will use larger debris as cover.

Alternative 1: No-Action

Without any action to conserve the species, the experience in Virginia – the longest established occurrence of HWA in the East – shows that 90 percent of all hemlock will be dead within 5 to 10 years. About 4 percent of the Blue Ridge portion of the Chattahoochee, or 3 percent of the entire Chattahoochee, would have significant mortality. At least some of those actively involved with HWA research and control suspect the remaining 10 percent would eventually die as well, being temporarily protected only by their isolation. No natural resistance has been found to date in Eastern hemlock. No effective native predator has been found, although HWA has spread through approximately 30 percent of Eastern hemlock range. No environmental variable limits the spread here on the south end of the hemlock range, though spread in the north has been slowed – and may prove to be stopped – by winter temperatures.

The loss of the Eastern hemlock species throughout the Georgia range would eliminate the future possibility of: (1) characterizing the genetic variability, (2) natural re-establishment of the species from protected areas or (3) artificial restoration of the species by planting of seedlings grown from locally-adapted seed sources. These opportunities, once lost, cannot be recovered. If no conservation action is taken the only hope is that hemlocks of 'disjunct' populations will not be reached by adelgids. It is reasonable to expect that as surviving hemlock become fewer and fewer and adelgid population's decline, the chance of isolated individuals escaping increase. Such has been the case with chestnut blight; reproducing individuals have escaped at the very fringes of the range. But it is very risky to count on this as a conservation strategy and amounts to crossing our fingers. Rather, if such a scenario does come true, it supplements an active strategy that does not include protection of isolated individuals.

Alternative 2: The Proposed Action

Each area within this alternative is proposed for either insecticide only or insecticide and beetle release. Separate trials have demonstrated that soil injection of the insecticide imidacloprid was 99.9% and >98% effective in eliminating HWA from specific trees (Steward and Horner 1994, Stewart el al. 1998). An estimated 275 groups or about 700 acres would be treated with insecticide. Beetle release is less effective but researched estimates of its effectiveness were not found in a literature search. The data that does exist makes it reasonable to conclude that it will be less effective than insecticide, at least for several years. Release would partially protect approximately 14,000 acres.

About 43 percent or about 10,000 acres of existing hemlock or mixed cover with hemlock that occurs on ecologically suitable sites would receive a measure of protection. An additional 5,000 acres of 'other' forest cover with hemlock as a minority component; that is, below 30-percent, but judged to be significant within the criteria used would also be protected. Approximately 12,700 unprotected acres of hemlock or mixed types with hemlock; 57 percent of that cover or 2 percent of the land area of the Blue Ridge portion of the Chattahoochee, would lose their hemlock component. The loss would directly change the structure of those stands with greater than 30-percent canopy cover of hemlock by creating a range of gap sizes within the main canopy. Most small gaps (< approximately 1/4th acre) can be expected to close by extension of the limbs of adjacent trees. But where gaps are too large, hemlock replacement can be expected to be by regeneration of one or more of the hemlock associates in the pre-disturbance stand. A high to very high proportion of hemlock from one inch to ten inches in diameter at four-and-one-half feet from the ground would be lost to the adelgid on upland sites less well-suited to hemlock. Most of these trees do not extend into the main canopy and therefore their loss will not cause canopy gaps or the development of replacement trees. An interacting genetic conservation network would be provided across the Forest.

Unprotected acres would shift in forest cover type, primarily to forest cover type 09 – white pine-cove hardwood, or type 03 – white pine. Replacement trees reaching the main canopy, if any, would either typically be of these species or be such a minority component of overall composition as to not trigger re-classification.

<u>Alternative 3: Modified proposed action but beetles only</u>

This alternative is the same as Alternative 4 except that no insecticide would be used.

About 43 percent or about 10,000 acres of existing hemlock or mixed cover with hemlock that occurs on ecologically suitable sites would have beetle release only. An additional 5,000 acres of 'other' forest cover with hemlock as a minority component; that is, below 30 percent, but judged to be significant within the criteria used would also be protected by beetle release. Approximately 12,700 unprotected acres of hemlock or mixed types with hemlock; 50 percent of that cover or about 2-percent of the land area of the Blue Ridge portion of the Chattahoochee, would lose their hemlock component by receiving no beetle release.

An interacting genetic conservation network would likely continue to be provided across the Forest, but the risk of losing individual areas within the network to the adelgid would be higher than with using both beetle and insecticide. The amount of risk cannot be quantified well with the present state of knowledge. The complex interaction of predator and prey with each other, with other biota, and with physical environmental factors cannot be easily or rapidly quantified and is the subject of on-going research. Loss of individual areas would weakened the network – except for those areas at the fringe – and create a higher risk into the future that adelgid or other events, such as blow down could remove additional areas, breaking the linkage.

As with Alternative 2, unprotected acres would shift in forest cover type, primarily to forest cover type 09 – white pine-cove hardwood, or type 03 – white pine. Replacement trees reaching the main canopy, if any, would either typically be of these species or be such a minority component of overall composition as to not trigger re-classification.

<u>Alternative 4: Modified Proposed Action</u>

Each area within this alternative is proposed for insecticide only, insecticide and beetle release, or just beetle release. An estimated 312 groups or about 800 acres would be treated with insecticide. Beetle release is less effective but researched estimates of its effectiveness were not found in a literature search. The data that does exist makes it reasonable to conclude that it will be less effective than insecticide, at least for several years. Release would partially protect approximately 18,700 acres.

About 51 percent or about 11,600 acres of existing hemlock or mixed cover with hemlock that occurs on ecologically suitable sites would receive a measure of protection. An additional 8,057 acres of 'other' forest cover with hemlock as a minority component; that is, below 30 percent, but judged to be significant within the criteria used would also be protected. Approximately 11,100 unprotected acres of hemlock or mixed types with hemlock, or 48 percent of the Blue Ridge portion of the Chattahoochee, would lose their hemlock component. The loss would directly change the structure of those stands with greater than 30 percent canopy cover of hemlock by creating numerous gaps with a relatively wide range of sizes. Most small gaps (< approximately 1/4th acre) can be expected to close by extension of the limbs of adjacent trees. But where they are too large, hemlock replacement can be expected to be by regeneration of one or more of the hemlock associates in the pre-disturbance stand. A high proportion of hemlock from one inch to ten inches in diameter at four-and-one-half feet from the ground would be lost to the adelgid on upland sites less well suited to hemlock. Most of these trees do not extend into the main canopy and therefore their loss will not cause canopy gaps or the development of replacement trees. An interacting genetic conservation network would be provided across the Forest.

Unprotected acres would shift in forest cover type, primarily to forest cover type 09 – white pine-cove hardwood, or type 03 – white pine. Replacement trees reaching the main canopy, if any, would either typically be of these species or be such a minority component of overall composition as to not trigger re-classification.

Alternative 5 – Modified proposed action but no Wilderness

Each area within this alternative is proposed for insecticide only, insecticide and beetle release, or beetle release only. An estimated 250 groups or about 600 acres would be treated with insecticide. Beetle release is less effective but researched estimates of its effectiveness were not found in a literature search. The data that does exist makes it reasonable to conclude that it will be less effective than insecticide, at least for several years. Release would partially protect approximately 17,700 acres.

About 50 percent or about 11,300 acres of existing hemlock or mixed cover with hemlock that occurs on ecologically suitable sites would receive a measure of protection. An additional 7,000 acres of 'other' forest cover with hemlock as a minority component; that is, below 30 percent, but judged to be significant within the criteria used would also be protected. Approximately 11,400 unprotected acres of hemlock or mixed types with hemlock; 50 percent of those cover types or 2 percent of the Blue Ridge portion of the Chattahoochee, would lose their hemlock component. The loss would directly change the structure of those stands with greater than 30 percent canopy cover of hemlock by creating gaps. Most small gaps (< approximately 1/4th acre) can be expected to close by extension of the limbs of adjacent trees. But where they are too large, hemlock replacement can be expected to be by one or more of the hemlock associates in the pre-disturbance stand. A high proportion of hemlock from one inch to ten inches in diameter at four-and-one-half feet from the ground would be lost to the adelgid on upland sites less well-suited to hemlock. Most of these trees do not extend into the main canopy and therefore their loss will not cause canopy gaps or the development of replacement trees.

Unprotected acres would shift in forest cover type, primarily to forest cover type 09 – white pine-cove hardwood, or type 03 – white pine. Replacement trees reaching the main canopy, if any, would either typically be of these species or be such a minority component of overall composition as to not trigger re-classification.

An effect of this alternative is to weaken the genetic conservation design. National Forest ownership within the hemlock range; that is, the Georgia Blue Ridge Mountains is in two distinct and separate blocks; west of I-575 and east of it. On the west is the Cohutta Mountains in the Metasedimentary Mountains ecological subsection. On the east is the Blue Ridge Mountains of the Southern Blue Ridge ecological subsection. Each of these areas has challenges for a genetic conservation design that excludes Wilderness.

The route of I-575, the Appalachian Highway, follows the geologic feature of the Hayesville Fault or the Murphy [NC] Marble Belt that separates the two mountainous areas. This Fault cuts a broad trough of relatively gentle terrain into the southern end of the Blue Ridge Mountains and within it there is very little National Forest ownership. One result is a physical separation of National Forest ownership east of it with that on the west of it by almost five air miles at their closest approach. And within National Forest even at the closest approach, hemlock occurrence is separated by more than five miles as hemlock decreases in abundance from the mountains into the lower elevations within the Fault. Therefore, hemlock conservation areas of the Cohutta Mountains west of the Fault cannot reliably exchange pollen with hemlock conservation areas east of the Fault. The Cohutta Mountains genetic conservation network must be developed independently of the remainder of the Chattahoochee.

The Cohutta Mountains include the Cohutta Wilderness, the largest Wilderness east of the Mississippi River. The Tennessee state line (also the boundary with the Cherokee National Forest) cuts through the northern end of this Wilderness. The total length of the state line on National Forest within the Metasedimentary Mountains subsection is 13.4 miles with 8.3 miles (62-percent) being in Wilderness. The Wilderness is generally U-shaped and much of its boundary is also the watershed divide of the headwaters of the Conasauga River. Unlike other Wilderness areas in Georgia, it is an entire river basin and located within that basin at the very headwaters with the highest elevations in the drainage, hence having the best hemlock habitat on two counts; elevation and mesic riparian area. The Wilderness is more than five air miles across on an east-west axis so that protecting areas on its fringe cannot ensure pollen exchange among them across the width of the Wilderness. In addition, hemlock occurrence is at relatively low frequency on both the east and west sides of the Cohutta Wilderness providing limited and low quality opportunities for hemlock conservation areas; really a thin ‘necklace’ only. On the west, elevations are decreasing rapidly into the Blue Ridge foothills at the Ridge and Valley interface. The Humid Sub-tropic Climatic Division boundary swings north to the vicinity of the Tennessee state line (a major reason the absence of hemlock on the Armuchee). To the east, elevations decrease into the inter-mountain valley of the middle Toccoa River; that is, the ‘Copper Basin’, historic land uses have more intensely disturbed the forest, there is much more non-forest land use, and contiguous areas of mesic habitat for hemlock are smaller than in the mountains. Hemlock occurrence on private land – especially with uncertainty about whether existing hemlock there will be protected from the adelgid – cannot be counted on to maintain pollen exchange across the valley.

East of the Hayesville Fault, National Forest occurs along the NC state line over a 33.4 mile stretch. Of this distance, 10.9 miles (32.6 percent) are in private ownership and 22.5 miles (67.4 percent) are in National Forest ownership. National Forest is in two large contiguous blocks separated by nearly 10 miles of private (except for two small areas of NF without significant hemlock composition). The eastern block is east of US 441, has 8.5 miles of NF with 2.2 miles (25.9 percent) being in the Ellicott Rock Wilderness. The western block is west of US 441, has 14 miles of NF with 11.1 miles (79.3 percent) being in the Southern Nantahala Wilderness. Pollen exchange with Nantahala NF genetic reserves must come from this area of National Forest in Georgia and with 59 percent of all NF along the state line being in Wilderness excluding hemlock in Wilderness would weaken the opportunity for pollen exchange.

Cumulative Effects

Cumulative effects are so similar for each alternative considered in detail that they are shown only once.

The Chattahoochee-Oconee Forest Plan, signed in January 2004, includes a prohibition against regeneration timber harvest is stands dominated by eastern hemlock during the 10 to 15 year life span of the Plan. The plan also requires the retention of all patches of living hemlock greater than one-quarter acre during silvicultural treatments. In addition, the riparian area management prescription, MRx 11, constrains activities within 100 feet of stream channels; that is, where much of the hemlock occurs. These prohibitions, coupled with concern about the loss of hemlock due to the adelgid, will ensure that hemlock removal by management actions will be very minor for years to come.

The primary activity cumulatively affecting hemlock abundance is prescribed burning needed to restore and maintain healthy upland ecosystems. The presence of hemlock and/or white pine in these ecosystems is an indicator of significant departure from historic conditions that prevailed before organized fire protection because they are shade tolerant and fire intolerant species in the understory of other species that are; (a) intolerant or moderately intolerant of shade, and (b) fire tolerant. On the mountain districts of the Chattahoochee, recent historic prescribed burning for all purposes has been about 4,000 acres/year. An approximate maximum within weather and personnel constraints would be about 8,000 acres/year. (These figures do not include the Armuchee District.) If it is assumed as a worst case that; (1) an HWA control decision would remain useable as much as ten years, (2) no burn acres would be repeat burns on the same area, and (3) hemlock occurs on every burned acre; the area affected would be a low of 40,000 acres or approximately 6 percent of the gross hemlock range on the Forest and a high of 80,000 acres or 12-percent of the gross hemlock range on the Forest. Seedling and sapling (less than 5" diameter at 4.5 feet above the ground) hemlock would be expected to be killed by the heat. Top-killed hemlock does not re-sprout.

However, as previously shown, HWA mortality is much more likely to have removed hemlock sooner and on all acres than prescribed burning on uplands.

3.2.2 Terrestrial Wildlife

The effects on wildlife from the hemlock woolly adelgid (HMA) and proposed treatments will be evaluated based on estimated impacts to the current management indicator species (MIS). MIS are selected and analyzed because they represent many other wildlife species that have similar habitat needs and requirements. By analyzing and discussing the MIS for each planned project, other terrestrial wildlife species on the forest receive some representation as well. The following list of MIS for the Chattahoochee-Oconee National Forest was considered for evaluation. A few on this list were eliminated from analysis because they are not present in the project areas of any of the alternatives. For more specific information regarding the selection of these species for analysis on the Chattahoochee-Oconee National Forest and the latest trend information, please refer to the MIS Trends for the Chattahoochee-Oconee NF (2005).

Acadian Flycatcher (*Empidonax virescens*)
Chestnut-sided Warbler (*Dendroica pensylvania*)
Field Sparrow (*Spizella pusila*)
Hooded Warbler (*Wilsonia citrine*)
Ovenbird (*Seiurus aurocapillus*)

Pileated Woodpecker (*Dryocopus pileatus*)
Pine Warbler (*Dendroica pinus*)
Prairie Warbler (*Dendroica discolor*)
Scarlet Tanager (*Piranga olivacea*)
Swainson's Warbler (*Limnothlypis swainsonii*) not evaluated – Oconee NF
Wood Thrush (*Hylocichla mustelina*)
Red-cockaded Woodpecker (*Picoides borealis*) Not evaluated – Oconee NF only
White-tailed Deer (*Odocoileus virginianus*)
Black Bear (*Ursus americanus*)
Smooth Coneflower (*Echinacea laevigata*) not evaluated – not in project area

In reporting the results of analysis here, separate effects sections are presented for each MIS species and then, within each species report, for each alternative in order. The identification of alternatives is the same as in Chapter 2.

3.2.3 Existing Conditions

Eastern hemlock is a shade tolerant conifer with a dense crown and an extensive root network (Evans et al. 1996). (*See also the 'Forest Cover' topic.)* It is widely dispersed in the northeastern United States, and the loss of the hemlock component in the eastern forest due to the introduced hemlock woolly adelgid will have long-term consequences for terrestrial and aquatic ecosystems (Ward 2002). At a landscape scale, hemlock patches add diversity to the predominately deciduous eastern forest. Within mixed hardwood stands, scattered hemlocks provide evergreen habitat structure that some birds are strongly associated with (Evans et al. 1996). Studies have also revealed that birds, deer, humans and wind can play an important role in the dispersal of the adelgids (McClure 1990).

Yamasaki et al. (2000) reported that 96 birds and 47 mammal species are associated with hemlock types in the northeastern US. A few of these are strongly associated with hemlock, but none are specifically limited to it. Jordan and Sharp (1967) found that eastern hemlock is an important cover species for ruffed grouse, wild turkey, white-tailed deer and rabbits.

Within the last few years, HMA infestations have reached the southern portions of Appalachian Mountains and are now occurring on the Chattahoochee National Forest (Keller 2004). Mahan (1999) stated that the loss of hemlock ecosystems in the Shenandoah National Park due to HMA may result in significant loss of biodiversity. Continued decline of eastern hemlock forests associated with HWA infestations will bring about major ecological changes according to Evans (2002). He feels that plant species most likely to expand into declining hemlock areas will be hardwoods and invasive alien species that will not provide habitat or ecological functions similar to the hemlocks. Defoliation and mortality of hemlocks means reduced local and landscape biodiversity, which may effect distribution and numbers of birds present (Evans 2002).

Since hemlock forests are recognized as nationally important bird areas by the American Bird Conservancy, lands administered by the U.S. Forest Service and National Park Service form one of the largest networks of contiguous forested habitat in the eastern U.S. and provide great quantities of habitat for numerous breeding birds. Therefore, changes in southern Appalachian forest ecosystems resulting from loss of hemlocks may have impacts on the distribution and demography of several avian species in the region (Keller 2004). A study by Tingley et al. (2002) showed that Acadian flycatcher is an avian species strongly associated with intact hemlock stands; that is, those that exhibited little or no mortality from HWA or other causes. The study also showed that the abundance of hooded warblers and several woodpeckers was highest in stands that showed 60% or more mortality from HWA in the Northeastern United States. Eastern hemlock has unique structural characteristics that provide important bird habitat in the northeastern U.S. Removal of hemlock by HWA may have a profound effect on avian communities, both positively and negatively, according to Tingley et al. (2002). However, hemlock forest type occurs on only 262 acres or 0.03% of the Chattahoochee National Forest. White pine-hemlock forest type occurs on 1,564 acres or 0.2% of the total acreage and cove hardwood-white pine-hemlock forest type occurs on 19,398 acres, or 2.6% of the forest. Given this information, along with the fact that no wildlife species on the forest are known to be dependent on hemlock, effects on avian communities from HWA infestations are expected to be less than profound.

Direct and Indirect Effects

Acadian Flycatcher

This neo-tropical migrant prefers heavily wooded deciduous bottomlands, swamps, riparian thickets, and the wooded ravines of drier uplands (Also p 2001). Moist deciduous forests with a moderate understory that occur near streams are a key habitat requirement (Hamel 1992). Within a general white pine-hemlock vegetation type for any successional stage identified by Hamel (1992), the Acadian flycatcher was listed as being provided suitable breeding habitat in that forest type. Tingley et al. (2002) reported that Acadian flycatchers were strongly associated with intact hemlock stands. But it should also be noted that Yamasaki et al. (2000) found that although several bird species show some strong association with hemlocks, none are known to be specifically limited to it. The forest trend data collected on the forest shows that the number of bird occurrences for the Acadian flycatcher has remained fairly stable with some slight increases in abundance in the last four years (Forest Service, 2005).

<u>Alternative 1 – No Action</u>

If the no action alternative occurs, the HWA is expected to continue to infest, stress and kill native hemlocks in the project area. This would generally result in a reduction of hemlock roosting and nesting habitat for the Acadian flycatcher. While no direct effects are expected, a slightly negative indirect effect (habitat) might result in the loss of hemlock trees on the forest for the Acadian flycatcher. White pine-hemlock forest type occurs on only 1,564 acres or 0.2% of the total acres on the Chattahoochee National Forest. Cove hardwood-white pine-hemlock type occurs on 19,398 acres or 2.6% of the total forest.

<u>Alternative 2 – The proposed action</u>

The release of predatory beetles in areas where HWA are found should help save some of the hemlocks across the forest. These beetles to be released eat only adelgids, and these very small insects (HWAs) have no other natural bio-control agent in the area. We can assume therefore, that the release of these predatory beetles on infested hemlocks will save some hemlock trees and help prevent the HWA from spreading to other nearby host trees. This proposed bio-control treatment will not completely stop or prevent the infestation of all HWAs on the forest, but it can help to prevent the loss of hemlock and slow the spread on selective and key sites identified.

By using this bio-control agent, Acadian flycatchers will be able to continue to use some hemlock trees in their preferred riparian habitat types for roosting and nesting trees during the breeding season. This should result in no direct effects, but a slightly positive effect to this bird species might occur from treatments action to save some hemlocks.

Use of Insecticide on Selected Hemlock Trees to Control HWA

Imidicloprid has been found to be highly toxic to the house sparrow, moderately toxic to upland game birds, and slightly to not toxic to waterfowl (NPTN, n.d.). These toxicities are for direct exposure. No direct exposure will occur in any of the action alternatives that include insecticide because of the method of application. The insecticide is either injected directly into the bole of the hemlock tree to be treated, or it is injected approximately 8-10 inches deep into the soil within six feet of the main bole of the tree.

Birds could be indirectly exposed to imidicloprid by eating insects feeding on treated hemlock trees. A study by Eiseback et al. (2005), allowed predatory beetles to be exposed to HWAs and hemlock branches that had been treated with Imidacloprid. Results showed that there was no significant difference in survival between beetles feeding on the control, and those that had been previously exposed to Imidacloprid treatments. This would indicate that birds that might feed on the predatory beetles that have previously fed on Imidacloprid treated HWAs, and exposed to the treated branches of hemlock would not significantly be effected, especially when it is applied at the recommended application rates. Therefore, this type of treatment will not have an indirect effect on this neo-tropical migratory bird. As hemlock trees are prevented from infestations of the HWA, the Acadian flycatcher would be able to retain some hemlock trees for roost and nest substrate. This might be considered a slightly positive indirect effect as more hemlocks for nesting substrate might be available.

Alternative 3 – Modified proposed action but beetles only

Since treatments are not expected to affect the Acadian flycatcher, there should be no direct effects on this bird. Indirect effects might be the loss of hemlocks for roost and nesting substrate because insecticides to maintain some genetic reserves for the future are not being utilized. Since predatory beetle releases are generally limited, not being able to utilize Imidacloprid might result in slightly negative indirect effects for the Acadian flycatcher.

Alternative 4 – Modified proposed action

The same effects of Alternative 2, only sites to be treated will be limited to those nominated by the general public during scoping; resulting is slight negative effect because fewer hemlocks would be protected.

Alternative 5 – Modified proposed action but no Wilderness

The same as Alternative 2, only with fewer areas treated. Wilderness area hemlocks would likely be infested and die. This would probably result in more hemlock death, which would mean less roosting and nesting substrate for the Acadian flycatcher.

Chestnut-sided Warbler

This neo-tropical migrant is typically associated with high elevation early successional habitat. Alsop, (2002) reported that it is somewhat declining in some areas as the forest becomes more mature. Hamel (1992) stated that this small bird's key habitat requirements are deciduous saplings, or open, middle-aged woods. For a general white pine-hemlock type with all age structures, the chestnut-sided warbler was reported to use this vegetation type only at a marginal rate where available, during the breeding season (Hamel 1992). According to bird monitoring data on the Chattahoochee National Forest, the chestnut-sided warbler's relative abundance is rather low. In addition, state-wide data is showing some declines as well (Forest Service, 2005). This is most likely because of a lack of early successional habitat at high elevations in Georgia.

Alternative 1 - No Action

If the no action alternative occurs, then hemlock trees would likely continue to be killed as the HWA infestations continue forest wide. This would probably have only a slight effect on this warbler as other deciduous trees are probably more important to this species anyway. Because it mainly prefers early successional habitat at higher elevations, the chestnut-sided warbler may even benefit slightly from hemlock die off as some short term early successional habitat would be created. Overall though, it would more than likely have little or no overall direct or indirect effect on this bird.

Alternative 2 – The proposed action

Chestnut-sided warblers are not expected to be directly effected by the release of predatory beetles and the Imidacloprid treatment. As with the Acadian flycatcher, retention of hemlocks within the higher elevation areas frequented by this species of bird may provide it with some roosting and nesting trees in the future, but the chestnut-sided warbler could find other nesting trees to use in its place. Therefore, little or no indirect (habitat) effects are expected for this MIS.

The use of Imidacloprid to help protect hemlocks from HWA attack is not expected to have a direct or indirect effect on this bird species. The application method is by injection into the tree and the soil surrounding the hemlocks to be treated. This should ensure that the chestnut-sided warbler would not come into contact with this insecticide. (For further discussion, see Alternative 2 for the Acadian flycatcher.)

Alternative 3 – Modified proposed action but beetles only

Same effects as Alternative 2 since the proposed insecticide should have no direct or indirect affect on this warbler.

Alternative 4 – Modified proposed action

Same general effects are expected as for Alternative 2, but more acreage of hemlock is being treated, retaining more area of only marginal habitat.

Alternative 5 – Modified proposed action but no Wilderness

This would probably result in more hemlock loss, which might provide less substrate for the chestnut-sided warbler to roost and nest in. However, other roost and nest trees in the area would be available to this neo-tropical migrant.

Field Sparrow

The field sparrow prefers old fields, idle croplands, and areas associated with early successional habitat. Abandoned fields and open areas in general with low shrubs is preferred habitat for the species (DeGraff et al. 1991). Natural occurring hemlock stands and mixtures of heavily forested deciduous and conifers are not considered acceptable habitat for field sparrows. Trend analysis information from bird monitoring points shows abundance numbers are low overall, both on the forest and statewide (Forest Service, 2005).

Alternative 1 – No Action

The no action alternative would likely result in the loss of hemlocks on the forest. Although this might improve the chances for creating some early successional habitat, replacement vegetation would quickly take over where the scattered infested trees once occurring. Considering the fact the hemlock stands are not field sparrow habitat, no direct or indirect effects are expected for this species under the no action alternative.

Alternative 2 - The proposed action

Because the field sparrow is not likely to be in areas where naturally occurring hemlock are found, there should be no direct or indirect on the species. If this sparrow was to occur in the proposed project area, neither the beetles nor the insecticide Imidacloprid would affect this bird. (For further discussion, see Alternative 2 for the Acadian flycatcher.)

Alternative 3 – Modified proposed action but beetles only

Same as Alternative 2; no direct or indirect would be expected.

Alternative 4 – Modified proposed action

Same effects as Alternative 2; no direct or indirect effects expected for the field sparrow.

Alternative 5 – Modified proposed action but no Wilderness

Same as Alternative 4; no direct or indirect effects expected.

Hooded Warbler

Hooded warblers are found in mature, mixed hardwood forests that are structurally diverse. This neo-tropical migrant bird is known to reside in thick foliage of the understory beneath tall deciduous trees (Also p 2001). It is not tied to hemlock specifically, but could be found within the areas to be treated. Monitoring information seems to indicate that the hooded warbler population has slightly increased on the forest and statewide (Forest Service, 2005).

Alternative 1 – No Action

The no action would result in the likelihood of continues loss of the hemlock trees on the forest. This would probably have a very small or slight impact on the hooded warbler. Other trees could be used for roosting or nesting by this species, especially since it does not seem to be tied to hemlock on the forest. Overall, no direct or indirect from the no action is expected.

Alternative 2 – The proposed action

Hooded warblers are not expected to be directly effected by the release of predatory beetles. The Imidacloprid treatment is also not expected to have any affect on birds in general. (For further discussion, see Alternative 2 for the Acadian flycatcher.) By using these treatments, we expect to retain hemlocks within the forest, which should provide these birds with hemlocks to roost or nest in if they so choose. However, other deciduous trees that are apparently more preferable would also be available to these birds. Therefore, no direct or indirect affects on the hooded warbler are expected with the preferred alternative.

Alternative 3 – Modified proposed action but beetles only

Same effects as Alternative 2, since Imidacloprid is not expected to have any affect on birds.

Alternative 4 – Modified proposed action

Same general effects as Alternative 2.

Alternative 5 – Modified proposed action but no Wilderness

This would likely result in more hemlock die off and loss. Effects to the hooded warbler however, would not be expected to be different either directly or indirectly, since the hooded warbler is not dependant on this tree.

Ovenbird

The ovenbird is strongly associated with mature forests that contain interior forest habitat. For breeding, it favors dry deciduous forests with moderately dense understory (Hamel 1992). It usually inhabits open, mature deciduous forests without thick brush or understory tangles (DeGraff et al. 1991). Relative abundance trends on the forest are showing a fairly high number or occurrences from the ovenbird, with statewide numbers slightly increasing also (Forest Service, 2005).

Alternative 1 – No Action

This alternative would result in the loss of hemlock trees on the forest. Generally, the ovenbird is not strongly tied to hemlock. Breeding usually occurs in deciduous or mixed forests (rarely pure pine) with moderate understory, preferably in uplands (Hamel 1992). The loss of hemlock is not expected to have a direct or indirect effect on the ovenbird, as other interior forest habitat more preferable should not be affected by hemlock loss from HWA.

Alternative 2 – The proposed action

The ovenbird is not expected to be directly effected by the release of the predatory beetles that feed on HMA. As with other neo-tropical songbirds previously discussed, retaining hemlocks within some uplands sites frequented by the ovenbird may provide it with some roost and nesting trees, but the overall direct and indirect effect should be negligible since other deciduous trees that are more preferable will also be available in the areas it frequents.

The use of Imidacloprid treatment for individual hemlock trees would take place in areas to protect the trees from future HMA infestation. The treatment application method is done by injecting the Imidacloprid directly into the bole of the tree, or injecting it into the soil within six feet of the tree for root uptake. The application method of treatment should also prevent the bird from coming into contact with this insecticide. (For further discussion, see Alternative 2 for the Acadian flycatcher.) Therefore, no direct or indirect effects to the ovenbird are expected with Alternative 2.

Alternative 3 – Modified proposed action but beetles only

Treatments under this alternative are limited to predatory beetle bio-control methods only. No direct effect for the beetle release is expected to the ovenbird. Indirect effects might be the loss of more hemlock trees because the insecticide will not be used, but since this bird is not dependant upon the hemlock trees in general, other deciduous nesting and roosting trees will still be available to the species. Therefore, no indirect effects are expected either.

<u>Alternative 4 – Modified proposed action</u>

The same effects as Alternative 2.

<u>Alternative 5 – Modified proposed action but no Wilderness</u>

Effects to the ovenbird would be the same as those under Alternative 2, only less areas would be treated since no wilderness areas would be involved. This would result in more loss of hemlocks, but again this should like impact on the ovenbird since it is not dependant on hemlock.

Pileated Woodpecker

The pileated woodpecker is found in a variety of forested habitats, from dense river bottoms to open upland forests of mixed forest types. Key habitat requirements for both breeding and wintering areas are mature and extensive forests with dead trees for nesting (Hamel 1992). It requires fairly large trees to produce dead snags that are excavated for nesting cavities by this large woodpecker. Nest tree are generally greater than 15 inches DBH and they use a variety of trees, including beech, yellow poplar, oak, hickory, maple, hemlock, and pine (DeGraaf et al. 1991). Bird monitoring data indicates that this woodpecker occurs in fairly high numbers overall, both on the forest and statewide (Forest Service, 2005).

<u>Alternative 1 – No Action</u>

With the no action alternative, we can expect the HWAs to infest more trees and increase the amount of dead hemlock trees on the forest. This would not directly affect the pileated woodpecker, but we could expect this bird to benefit indirectly from the no action alternative because of increased hemlock snag production. Of course these birds are not necessarily limited by a lack of large snags within their current range on the forest, but the HWAs are expected to provide a much greater number of these preferred snags, some of which will be large enough for nesting substrate. Therefore, there may be a slightly positive or beneficial effect for the pileated woodpecker by the no action alternative. However, the benefit would be hard to quantify because snags that currently occupy its habitat are probably at sufficient numbers for the territories that they defend. In addition, even with the preferred alternative proposed, there will still be many dead snags of hemlock on the forest from the HWAs, mainly because all trees infested or to be infested cannot feasibly be treated.

<u>Alternative 2 – The proposed action</u>

The release of host specific predatory beetle that feed on the HWAs will not have a direct or indirect effect on the pileated woodpecker. As previously stated, Imidacloprid treatments should not provide contact opportunities for this bird. (For further discussion, see Alternative 2 for the Acadian flycatcher.) No direct or indirect effect to this woodpecker is expected. Prevention of the death of selected hemlock stand and individuals, and maintaining genetic variation on portions of the forest is the main goal of this alternative. Although it would result in less dead hemlock snags in the forest, as mentioned in the no action alternative, there will still be plenty of other dead hemlock and other naturally occurring snags to provide this territorial bird species with more than enough nesting and foraging substrate.

Alternative 3 – Modified proposed action but beetles only

Same effects as Alternative 2 are expected, since Imacloprid should have no direct or indirect affect on the pileated woodpecker.

Alternative 4 – Modified proposed action

The same effects as those in Alternative 2 would be expected. Ultimately, this is likely to result in more hemlock snags in other non-treated sites, but as previously stated, an adequate number of snags will still be available for the pileated woodpecker anyway.

Alternative 5- Modified proposed action but no Wilderness

The effects to the pileated woodpecker are expected to be the same as Alternative 4.

Pine Warbler

As would be expected from its name, this warbler frequents mid to late successional pine forests throughout the year. It is tied to a variety of pine woods situations according to Hamel (1992). It also is reported to need open pine forests and generally avoids tall, moist and dense coniferous forests (DeGraff et al. 1991). Abundance trends are higher on the Armuchee-Cohutta Ranger District and the Oconee National Forest, where more pine type stands are found in general. These areas are each outside of the hemlock natural range and will therefore be unaffected by the HWA. Overall, the annual bird monitoring data shows fairly stable numbers of pine warblers on the forest, despite recent lost of some pine stands to the Southern Pine Beetle (Forest Service, 2005).

Alternative 1 – No Action

The no action alternative would result in more infestation and subsequent increased mortality for the hemlock. Since the pine warbler is not dependant or tied to the hemlock, little or no direct or indirect effect from increased hemlock loss would be expected. Although the loss of hemlock might result in long-term future replacement stands of white pine, the moist and less open stands that the no action created would still not be providing preferred habitat for the pine warbler.

Alternative 2 – The proposed action

Since the pine warbler is not generally tied to hemlocks, no direct or indirect effects from release of predatory beetles and Imidacloprid treatments are expected. (For further discussion, see Alternative 2 for the Acadian flycatcher). Even if the pine warbler were in the area treated by the Imidacloprid, treatment methods and a lack of bird toxicity would have no effect on the warbler.

Alternative 3 – Modified proposed action but beetles only

Same as Alternative 2, the beetle release would have no direct or indirect effect on the pine warbler.

Alternative 4 – Modified proposed action

Same effects as Alternative 2, but fewer sites treated would mean more potential hemlock lost. This should not have a bearing on the pine warbler's preferred habitat of pine woodlands.

Alternative 5 – Modified proposed action but no Wilderness

The same effects as Alternative 4 would be expected for the pine warbler.

Prairie Warbler

The prairie warbler prefers to nest in shrub-land habitats, usually associated with early successional habitats. It tends to avoid dense forests (DeGraaf et al. 1991). It is not normally associated with hemlocks, or the typical dense forests where most eastern hemlocks trees occur. Bird monitoring survey data (Forest Service, 2005) shows a relatively stable population with some fluctuations. Overall, the preferred habitat for this bird would not be expected to occur within the proposed project area for any of the alternatives. Therefore, direct and indirect effects to the prairie warbler are not expected within any of the alternatives.

Scarlet Tanager

The scarlet tanager favors mature deciduous forests, especially in uplands. Although it may breed in bottomlands, it is less numerous in mixed forests, and mature deciduous forests is considered key habitat (Hamel 1992). Bird monitoring trend abundance is fairly high on the Chattahoochee National Forest, and statewide data from Breeding Bird Surveys reveal a positive trend for this forest bird in Georgia (Forest Service, 2005).

Alternative 1 – No Action

With the no action proposal, more hemlock trees would likely be killed as the HWA infestation would not be controlled on the forest. The scarlet tanager mainly uses mature deciduous trees for key habitat and nesting, but hemlock could possibly be used also. However, since this forest bird is not dependant on hemlock for its habitat needs in general, other deciduous trees in the general forest area will provide nesting and roosting habitat adequate for this species. Therefore, the no action alternative should have any direct or indirect effect on the scarlet tanager.

Alternative 2 – The proposed action

Scarlet tanagers are not expected to be directly or indirectly affected by beetle releases designed to bio-control HWAs. The injection of Imidacloprid into individual hemlock treats to help control the HWAs should not have a direct or indirect on the scarlet tanager. Application methods are such that the insecticide should not come into contact with birds. (For further discussion, see Alternative 2 for the Acadian flycatcher.)

Alternative 3 – Modified proposed action but beetles only

Since treatments with Imidacloprid are not expected to directly affect the scarlet tanager, this would be similar to Alternative 2, only fewer hemlock trees would be retained and more would be expected to become infested and die. Since this bird can use, and even prefers to use deciduous trees for roosts and nests, this alternative that utilizes only bio-control treatments should not indirectly affect the scarlet tanager.

Alternative 4 – Modified proposed action

The same effects as 2 and 3, only fewer sites would be treated with control techniques.

Alternative 5- Modified proposed action but no Wilderness

This would likely result in more hemlock loss on the forest. However, other more preferred trees for use by the scarlet tanager would still be available in the general forest area. Therefore, no direct or indirect effect would be expected by not treating wilderness areas.

Wood Thrush

The wood thrush is common in moist deciduous or mixed deciduous-conifer woodlands, and often near water (Alsop 2001). Hamel (1992) reported that a white pine-hemlock vegetative type does provide suitable habitat for this neo-tropical migrant during breeding season. From bird monitoring data on the forest, trends have remained fairly constant on the Chattahoochee National Forest, and it is more frequent on the Oconee National. Statewide Breeding Bird Surveys show a slight decline in Georgia over the past few decades (MIS Trends for the Chattahoochee-Oconee NF, 2005).

Alternative 1 – No Action

The no action alternative is expected to continue to contribute to the future infestation and subsequent loss of hemlocks on the forest. This could result in a loss hemlock roosting and nesting habitat for the wood thrush. Although no direct effects to the species is likely, a possible habitat loss might occur. However, since this species is not specifically dependent on hemlock for habitat needs, only a slightly negative indirect effect to the species is expected, especially since other deciduous and conifer nesting trees will remain present within the wood thrush's niche.

Alternative 2 – The proposed action

The use of predatory beetles that eat HWAs should help save some hemlock trees and help prevent them from spreading to other nearby host trees. This bio-control agent treatment will not completely stop or prevent the infestation of all HWAs on the forest, but it can help prevent loss of the species and help slow the spread of the HWAs.

The use of Imidacloprid on individual hemlock trees will also help protect hemlocks from the HMAs. The application technique should prevent it from coming in contact with birds in general. (For further discussion, see Alternative 2 for the Acadian flycatcher.) Therefore, this alternative should have no direct effect on the wood thrush. Indirectly, some suitable hemlock habitat for this species may survive and be saved, providing potential roosting and nesting trees for the bird. This might be considered a slightly positive indirect effect as more hemlocks would be retained.

Alternative 3 – Modified proposed action but beetles only

Releases of predatory beetles are not expected to directly affect the wood thrush. Indirect effects of using only the beetles and not the Imidacloprid treatment might result in the loss of more hemlocks that could be used by this bird. Since beetle releases are generally thought to be limited, not being able to use Imidacloprid might result in slightly negative indirect effects for the wood thrush by causing more hemlock mortality.

Alternative 4 – Modified proposed action

The same effects as those to Alternative 2, but a slightly negative indirect effect since fewer hemlocks would be protected.

Alternative 5 – Modified proposed action but no Wilderness

The same as Alternative 2 only less area treated, and wilderness area hemlocks would likely become infested and die. This would probably result in more hemlock loss, which would mean less roosting and nesting trees for the wood thrush.

White-tailed Deer

The white-tailed deer population in the north Georgia Mountains is doing well, but it is somewhat limited by marginal habitat, poor soil fertility and intermittent mast failures. Early successional habitats, high quality, cool-season agricultural food plots, and areas of hard mast producing trees are all important components of year-round deer habitat (Kammermeyer et al. 1993). Although Jordan and Sharp (1967) found that eastern hemlocks are in important cover species for deer in the Northeast, rhododendron and laurel thickets provide suitable cover in the southern Appalachians. Deer populations remain fairly healthy in Georgia, and harvest data seems to indicate that populations are stable (Forest Service, 2005). This mammal is very adaptive and widespread throughout the state.

Alternative 1 – No action

With no action occurring on the forest, the HWAs are expected to continue to infest, stress and kill native hemlocks. Since this species is so opportunistic and adaptive within its range, and the white-tailed deer is not necessarily dependant on the hemlock for food and cover, the No Action will not directly or indirectly affect this MIS.

Alternative 2 – The proposed action

The release of predatory beetles to help control HWAs will not have a direct or indirect effect on the white-tailed deer.

Although Imidacloprid is moderately toxic to mammals, when used as directed by the label, little impact to any wildlife is expected (Florida Department of Agr. And Consumer Services). Hemlock trees are to be injected with Imidacloprid either into the bole of the tree or into the roots. Since deer are not necessarily dependent on the hemlock trees, there is no direct or indirect effect to the deer expected from the preferred alternative.

Alternative 3 – Modified proposed action but beetles only

Same effects expected as Alternative 2, since deer are not dependent on hemlock.

Alternative 4 – Modified proposed action

Same effects as Alternative 2, only more sites treated.

Alternative 5 – Modified proposed action but no Wilderness

Same as Alternative 2, only less area treated.

Black Bear

The black bear is a large mammal found in the southern Appalachian Mountains, usually in large areas free from human disturbances. It is omnivorous, eating insects and arthropods, fish, small mammals, carrion, berries, mast such as acorns, hickory and beechnuts and a variety of other fruits (Martin et al. 1961). Dens for the black bear can be a variety of habitats, including windrows in clear cuts, large root wads, rock outcrops and large tree cavities. Elevated tree dens in large trees seem to be preferred and provide the most protection for bear cubs. The bear population in North Georgia has been steadily increasing for the past 25 years, and most suitable habitat in the mountains of Georgia is presently occupied with bears (Forest Service, 2005).

<u>Alternative 1 – No action</u>

The no action alternative would likely result in the loss of hemlocks on the forest. This would probably not have a negative direct or indirect effect on the black bear. Although some hemlock cover used by bears might be lost in the short term, other types of cover would replace the hemlock in time. Food sources for the bears might even increase in the short term as replacement vegetation takes over. Although some large hemlock den trees might be produced from the no action, we also would expect some dens from the other alternatives because no matter which alternative strategy is used; all hemlock trees will not get treated. Therefore, stressed hemlock trees that may eventually provide snags will be present in all alternatives.

<u>Alternative 2 – The proposed action</u>

Black bears will not be directly affected by the release of predatory beetles to control HWAs. The beetle release should help to protect some hemlock trees from infestation and subsequent death, remaining in the forest as cover for the bears. However, under the no action alternative, replacement vegetation should also provide adequate cover, and since the bears are not actually dependant on the hemlock trees for specific food or cover needs, no indirect effect is expected form this alternative.

The use of Imidacloprid to protect hemlock trees from the HWAs should not have a direct effect on the black bears. The insecticide will be injected into the bole of the tree, or it is injected into the soil for root absorption by the hemlock tree. Imidacloprid will not be applied in such a way for bears to ingest it. Although it is considered moderately toxic to mammals, when used as directed and according the labeling, little impact to any wildlife is expected (Florida Department of Agr. and Consumer Services). Therefore, no direct effect to bears from this treatment is expected. Indirect effect on the habitat for bears is not expected either, for the same reasons cited in the above paragraph.

<u>Alternative 3 – Modified proposed action but beetles only</u>

The same effects as Alternative 2 are expected, only less area will be treated. Predatory beetles are not expected to have a direct or indirect effect on the black bear.

<u>Alternative 4 – Modified proposed action</u>

The same effects as Alternative 2, only more areas will be treated.

<u>Alternative 5 – Modified proposed action but no Wilderness</u>

The same effects as Alternative 4, only less areas will treated since wilderness areas would be excluded. Since bears are not directly or indirectly dependent on hemlock in their habitat, no effects are expected.

Cumulative Effects

Cumulative effects resulting from the habitat changes brought on by the Hemlock Woolly Adelgid will continue at a greater rate if the no action alternative is allowed to occur. Death of hemlock trees will probably result in more sunlight reaching the forest floor for the short term. This in turn will affect understory species and species composition at those localized levels on the Chattahoochee National Forest. This however will probably be only for a short period of time, as other native vegetation is expected to replace these trees in the understory, mid-story and eventually the overstory. All other alternatives will also result in some stressed, dying and dead hemlock trees, but to a lesser extent. Some canopy gap creation and some short-term early successional habitat may occur on the forest under the no action alternative. It would more than likely be short lived, as other natural vegetation would quickly replace the hemlock. The plan provides for no regeneration of hemlock types, so any significant early successional habitat in those hemlock die-off areas would not be sustained.

With the implementation of the forest plan standards and guidelines, such as snag and mast requirement, water quality standards and guides, riparian corridor standards and Georgia BMPs, avoiding adverse cumulative effects to the MIS is expected with all the alternatives. All activities, either related or cumulative in the future will have minimal effect on the MIS because of plan provisions. In addition, any future management activities and projects in the proposed project areas will be analyzed for the MIS status and re-reviewed at that time. Mitigation measures will be implemented where needed to ensure that suitable habitat for the indigenous MIS occur throughout the forest, both at the present, and in the future.

Therefore, past, present and reasonably foreseeable actions in the project area are not expected to result in any adverse cumulative effects to the MIS under any of the alternatives proposed.

.**Summary of Indirect Effects of All Alternatives on MIS**					
MIS	**Alt. 1**	**Alt.2**	**Alt. 3**	**Alt. 4**	**Alt. 5**
Acadian Flycatcher	-	+	-	-	-
Chestnut-sided Warbler	0	0	0	0	0
Field Sparrow	0	0	0	0	0
Hooded Warbler	0	0	0	0	0
Ovenbird	0	0	0	0	0
Pileated Woodpecker	+	0	0	0	0
Pine Warbler	0	0	0	0	0
Prairie Warbler	0	0	0	0	0
Scarlet Tanager	0	0	0	0	0
Wood Thrush	-	+	-	-	-
White-tailed Deer	0	0	0	0	0
Black Bear	0	0	0	0	0

\+ = Slightly Positive or Beneficial Indirect Effect Expected
0 = No Indirect Effect Expected
\- = Slightly Negative Indirect Effect Expected
None of the MIS are expected to be directly affected by any of the alternatives.

3.2.4 Aquatic Resources

Environmental consequences to the aquatic resources are evaluated based on impacts to the aquatic communities, which represent the role of management indicator species. The aquatic communities of consequence for this assessment are the fish, salamanders and macro-invertebrate communities. The habitat of focus for this assessment is the upper headwater stream sections. Within these sections of stream, the fish community is primarily brook trout or rainbow trout, no other fish is usually associated with brook trout and only a few species with rainbow trout, such as dace, sculpin and chub. There are a number of upper headwater streams without any fish present.

Salamanders, either totally aquatic or semi-aquatic are dependent upon aquatic habitats for part of their life history. Salamanders are common within these upper headwater sections. Salamanders occur within these upper headwater streams in the presence or absence of either trout. The topography of these stream sections on the Chattahoochee NF are typically within deep ravines, very steep in gradient, have the highest occurrence of waterfalls and typically have little to no exposure to full sun.

3.2.5 Existing Condition

Approximately 1,000 miles of streams and rivers flowing through the Chattahoochee National Forest have been defined as coldwater habitats (Georgia Department Natural Resources, Lee Keefer). 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 EPA). Cold water streams are approximately 85% of the total stream and river mileage across the Chattahoochee National Forest. There are 80 streams across the Forest with brook trout totaling approximately 150 stream miles. Of these 80 streams, 38 have had brook trout genetically typed as to southern, northern or hybrids genetic strain. Brook trout with the southern strain are the only native salmonid to the Southern Appalachians. Thirty-five of the 80 streams have had brook trout tissue taken from 20 brook trout and the genetic analysis is pending. Currently, only 8 streams are known to be of the native southern strain, five of which occur in the Tennessee watershed, one in the Savannah watershed, one in the Conasauga watershed and one in the Chattahoochee watershed. The greatest density of hemlock stands are within the headwater streams (cold water).

Approximately 200 miles of streams and rivers flowing through the Chattahoochee National Forests have been defined as cool water habitats. 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 EPA). Cool water streams are approximately 15% of the total stream and river mileage across the Forest. In general, these streams are wider, of lower gradient and are not enclosed by canopy cover in comparison to cold water streams. Cool water streams are occupied by rainbow and brown trout, as well as redeye bass. These streams are at the most southern edge of the rainbow and brown trout distribution on the Forest.

None of the warm water streams within the Piedmont eco-region on the Forests are associated with hemlock communities.

Large woody debris (LWD) constitutes the major organic input to cold water 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 will be most affected from the decline of LWD due to the loss of hemlock species. This influence of LWD from the loss of hemlock will be less observable in larger cool water systems due to the lower density of hemlock within these cool water streams.

No Action Alternative

Left untreated, stands containing hemlock have the potential to lose all or part of the hemlock from damage from the hemlock wooly adelgid. When this hemlock is associated with riparian habitats, the potential to affect several parameters important to stream and riparian health and function exists. First, LWD transport to stream channels will increase as infested trees die. And second, the loss of all or part of the shading on a stream will affect primary productivity and water temperature. These direct effects to the stream channel and habitats could result in indirect effects in aquatic community composition and health within the stream, and cumulative effects on landscape-level community structure and species viability.

As hemlocks are affected and LWD enters streams, aquatic invertebrate populations will respond with increases in species, which utilize wood, including borers, gougers, and scrapers, and several groups which utilize wood surfaces (e.g. Chironomidae, Heptageneidae, Baetidae, Nemouridae, Peltoperidae, Perlodidae, Limnephilidae, Rhycophilidae) (Dudley and Anderson 1982). As LWD decomposes and is utilized by aquatic invertebrates, its usefulness diminishes, which results in the gradual return to pre-LWD community structure. In systems dependent on colder water temperatures (such as trout streams), shade may be affected until riparian conditions (particularly streamside shading) return to pre-infestation levels. In this analysis, it is the aquatic insect community, salamanders and trout populations that stand to be affected. Even though the hemlock component is highest within these headwater (cold water) stream types, the overall amount of hemlock is relatively low in comparison to other tree species and it is unlikely that such effects as the increase in water temperature would be measurable and attributable to the loss of hemlock.

In discussion in April 2005, with Larry Mohn (Virginia Department of Game and Inland Fisheries, Fisheries Program Manager) he states that it would be an unusual circumstance for the loss of hemlock to lead to significant increases in water temperature due to the loss of shading by this tree species. Even in wilderness streams in Virginia where hemlock is the dominant cover, and the streams are on southern slopes, there has not been a change in the fisheries composition or abundance based on state surveys pre- and post the HWA. In addition, the Shenandoah National Park has seen no changes in fisheries due to the gradual loss of the hemlocks, due to the hemlocks slowly thinning over time. One stream where gypsy moth came prior to the HWA and wiped out the hardwoods, and then the HWA wiped out the hemlocks, the stream temperature went to 80 degrees and the native brook trout local population was greatly reduced. In surveys in this stretch where the temperature went to 80 degrees, a few brooks were always found. Currently, 5-6 years after the entire loss of hemlocks, the brook is back in high numbers. This decrease in high numbers of brook trout only occurred on this 1 stream within the entire state of Virginia.

Furthermore, discussion with Lee Keefer (Georgia Department of Natural Resources, Regional Fisheries Biologist), whom is responsible for brook trout in the state, and has surveyed more brook trout streams than anyone in the state has stated that there would likely be no impact to these headwater streams from the loss of hemlocks. This is due to the fact that there is no stream on the Forest where hemlock is extensive, that the occurrence of hemlock is spotty. And if there was any increase in temperature due to the loss of hemlocks, the streams would recover thermally quickly due to underground water sources and the influence of tributaries. Stream temperatures in these headwater streams generally range from 15-17 degrees Celsius. From 8 streams in the Chattooga watershed, thermograph readings during the summer and fall months of 2003 ranged with the average maximum temperature from 15.5 to 16.7. In addition, in the headwaters of the

Chattahoochee River watershed, of 6 headwater streams the average temperature in the summer and fall of 2004 ranged from 14.97 to 18.25 degrees Celsius. The presence of trout is determined with the variable water temperature; this threshold is at 22 degrees Celsius. Even with an increase in temperature, these headwater streams would most likely remain below 22 degrees or if any increase did occur, the temperature would quickly recover.

To understand if there would be impacts to the abundance and diversity of salamanders in regard to the loss of hemlock trees, a discussion with Dr. Camp (Piedmont College, Biology Professor) occurred in April 2005. Dr. Camp has published numerous peer review papers and has extensive field knowledge of the Chattahoochee NF. Dr. Camp stated that the highest abundance of salamanders will be in the hardwood coves not in stands with hemlock as a component. Based on his best professional judgment, there should not be any significant loss or change to the salamander diversity or abundance due to the loss of hemlocks. This should hold true for occurrences within the riparian corridor as well as in spray cliffs and waterfall sites. In addition, the loss of hemlocks would not result in an increase in stream temperature due to the majority of streams having a random and sparse distribution of hemlocks. Where there are stream sections with a high component of hemlock, even with the loss of these trees, the water temperature is not expected to increase due to underground water percolation reducing any increase, as well as the ability of other tree species or rhododendron to take advantage of this loss and either immediately or within time provide shading and canopy cover.

The loss of hemlock will result in even less of an impact to rainbow and brown trout and redeye bass populations, since cool water streams are not as associated with hemlock as are higher order streams (coldwater).

As with many groups of organisms, fish community dynamics have been proven to be cyclic and adaptable to surrounding conditions. For example, habitat suitability for a particular species may be improved with the input and retention of LWD, which is reflected in increased population levels of that species. But as the microhabitat (e.g. surface of the log) deteriorates and becomes less suitable, population levels respond accordingly. This process can take anywhere from several weeks (if environmental conditions cause rapid breakdown of woody material) too many years, and is thought to occur more rapidly with hemlock and other soft wood species than with hardwood species (Webster 1977).

In the HWA situation, the loss of hemlock trees will not occur at one time, but will be over an extended period of years. Because of this gradual loss and the fact that many trees will remain standing after they die, the input of LWD to the stream will not be a concentrated event. Because of the random distribution of hemlock trees, the influence on the stream with regard to the invertebrate community that utilizes wood, the change in their population levels, will not likely be measurable. In addition, the input of LWD of hemlock trees will not likely alter the channel due to its random distribution and gradual loss. The number of dead hemlocks that will fall into the channel as a result of high wind events will also not likely alter the channel due to the fact they are characteristically very random and sparse in their distribution. In the more rare case, where the number of hemlocks that fall is concentrated within the channel, there is the possibility of channel alterations but with the relatively rapid decomposition of hemlock wood, any negative impact to the channel will be short-lived in duration.

Hall and Baker (1975) summarize many of the beneficial and adverse effects of organic debris on fish habitat. Most of the adverse effects concern water quality, particularly intragravel dissolved oxygen, and stream channel instability. Concerns about water quality involve increased biological oxygen demand (BOD) from large deposits of decomposing fine particulate organic matter, which can potentially affect fish spawning success. In most cases, this fine organic matter is flushed downstream before problems with BOD reach problem levels.

Although debris has been cited as a problem for instream fish movement (Merrell 1951, Holman and Evans1964), this may have been overstated, as there is a plethora of literature documenting the benefits of LWD to habitat diversity and fish production, particularly addressing spawning and nursery areas and juvenile and adult instream cover (Narver 1971, Sheridan 1969, Hall and Baker 1975, Boussu 1954, Bryant 1981, et al.). Studies also clearly demonstrate that increased habitat diversity results in more diverse, stable fish communities (Fraser and Cerri 1982, Bisson and Sedell 1984). Results of these and other studies clearly document the importance of LWD for fish habitat.

Habitat for brook, brown, and rainbow trout, dace, sculpin and redeye bass would likely be improved as LWD enters the system through tree mortality. The influx of LWD would likely allow slight increases in aquatic invertebrates that fish eat, and may result in site specific increases in fish population levels. Such improvements would continue until LWD is decomposed or flushed downstream by high flows (Lisle 1986). Stream temperatures may increase slightly at very site specific localities, that is to say that if temperatures do increase, they will only increase in the immediate vicinity of the down hemlock and only if this loss creates an opening in the canopy cover. However, due the hemlock distribution being random and of low density and these streams are typically within deep ravines, very steep in gradient, have a high occurrence of waterfalls and typically have little to no exposure to full sun, the amount of increase would likely be slight. In addition, any increase will be negated by underground percolation, the influence of tributaries and commonly high water velocities. Furthermore, the loss of hemlocks will allow succession of other tree or shrub species and within a relatively short amount of time these opportunist trees will provide shade. Overall, any increase in LWD transport from hemlock decline will benefit aquatic systems; fisheries habitat and macro-invertebrate usage.

Stream temperatures in these headwater streams are generally ranging from 15-17 degrees Celsius. From 8 streams in the Chattooga watershed, thermograph readings during the summer and fall months of 2003 ranged of the average maximum temperature from 15.5 to 16.7. In addition, in the headwaters of the Chattahoochee River, of 6 headwater streams the average temperature in the summer and fall of 2004 ranged from 14.97 to 18.25 degrees Celsius. The threshold of trout is temperatures that remain over 22 degrees Celsius for an extended period of time (usually a 7 day period of every day being over 22 degrees Celsius). Even with an increase in temperature, these headwater streams would most likely remain below 22 degrees or recover quickly. In general, those streams at higher elevations have the lowest water temperatures. Streams lower than 2800 feet in elevation are more likely to have increases in temperatures that could result in increases above the threshold. These lower elevation streams are inherently higher in water temperature than those at higher elevations.

Brook trout are more sensitive to warmer temperatures than the rainbow and brown trout. Brook trout streams that are below 2,800 feet in elevation should be given special consideration if hemlock is more than a sparse occurrence within these streams. As well as streams with southern strain brook trout should also be given special consideration if hemlock is more than a sparse component. Brook trout are a short-lived species, usually only living to age 3, and at the local level, potential losses on the gene pool for southern strain brook trout could be possible with increased temperatures. However, at the landscape level, long-term survival of the habitats and trout species would continue without any measurable impacts.

Effects Common to All Treatment Alternatives

Predator Beetles

The use of predator beetles will have no measurable direct or indirect effects on any of the aquatic or semi-aquatic species considered or their habitat. It is likely that the success of the predator beetles may be greater than projected, resulting in an increase in the area of coverage and prevent less loss of hemlocks. Although, even with potentially increased coverage of hemlocks, the number of trees that the predator beetles will prevent from dying is relatively few in comparison to the total number of hemlocks which currently exist. Therefore, the utility of the beetles will not significantly differ from that of no action. It is likely that treatment of riparian hemlock stands with predator beetles would result in a slight reduction of potential effects from hemlock loss on aquatic resources and slow the rate of recruitment of LWD if the beetles are relatively successful at controlling the HWA.

Effects Common to Action Alternatives

Imidacloprid

Imidacloprid is moderately toxic to fish and highly toxic to aquatic invertebrates. It has a long half-life (>31 days) at pH 5, 7, and 9, which represents most of the soil and water conditions across the Forest. Additionally, the chemical is moderately mobile in some soils. 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.

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, as well as other fish species occurring in the affected stream would likely be affected. The immediate local aquatic invertebrate community could be lost entirely. Within a short amount of time, the chemical would be rapidly diluted to a level of no observable effect. It is important to note that the loss of one population of brook trout or other fish species or one local aquatic invertebrate community will not affect the overall population trends across the Forest. In addition, the local stream reach that could be affected by an accidental spill would be quickly decolonized by fish populations either from upstream or downstream post dilution.

Cumulative Effects

Potential local and landscape level effects are discussed above. Even though the southern most range of the brook trout is on the Chattahoochee NF, it is also the southern most distribution of hemlocks. In turn, the loss of the hemlocks, because there are sparse and random in their distribution upon this Forest, will have a lessen effect on water temperature changes from loss of shading by the hemlocks than in more northern areas where hemlock is at higher densities. Currently, the conservation, preservation, habitat enhancement and restoration of the native brook trout have become a priority in the fisheries management of State, Federal, and local governments, as well as concerned private organizations. Within this framework of emphasis, the Chattahoochee NF will use the available tools stated above to treat hemlocks in those most vulnerable streams (below 2800 feet in elevation and those of the southern strain of brook trout) where this tree species has more than only a sparse occurrence. However, as mentioned above, long-term survival of the habitats and species (particularly brook trout) would continue, although with potentially lower population levels at the immediate sites where the loss of hemlocks was concentrated.

Beetle Releases and Imidacloprid Treatments

There will not be a drastic difference with potential impacts in the no-action and the action alternatives. This is due to the scale of the HWA, with all or most of the hemlocks across the Forest becoming infested and the number of trees which can be feasibly treated is on a relatively small scale. With the Action Alternative, with only a relatively small amount of the Forest able to be treated, the areas of priority where hemlock occurrence is greater than a sparse occurrence, from an aquatic resources standpoint are those streams lower than 2,800 feet in elevation and those with the southern strain of brook trout. A number of these streams with lower elevation and/or with the southern strain of brook trout are already proposed for action due to other reasons, recreational, etc. The following are trout streams that are below 2,800 and have a component of hemlock that have not been included: Helton, Winkley, Dover, Wolf Pen, Walnut Fork, Billingsley, Hicks, Jasus, Vandiver, and Laurel. Of these lower elevation streams, Dover, Walnut Fork, Billingsley, and Hicks are brook trout streams of northern or hybrid strains. The 8 streams that are known to be of the southern genetic strain of brook trout are: Tennessee watershed (High Shoals, Keener, Logan, Bryant, and Gizzard); Savannah watershed (Ammons); Conasauga watershed (Rough Creek); and Chattahoochee watershed (Left Fork Soque). Ones already proposed for Action are: Logan, Gizzard, High Shoals and Keener. This leaves the streams of southern strain brook trout that are in need of treatment of: Left Fork Soque, Bryant (upper section) and Ammons. However, there is only a sparse distribution of hemlock in Rough Creek area, so there is no need to include it within an Action Alternative.

Imidacloprid

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

Predator Beetles

Since releasing predator beetles will have no measurable direct or indirect effects on aquatic resources, this action would not add cumulatively to effects on aquatic habitats or populations from all other sources.

3.2.6 T & E and Forest Concern Species

Existing Condition:

Habitat conditions in HWA -infected stands have been and will continue to be altered by the adelgid infestation. Even with proposed HWA control measures, it is not feasible to protect every hemlock individual across the Forest. In areas where hemock comprises a large portion of the overstory, loss of hemlock could result in a significant reduction in the amount of overstory shading. Rare species requiring a shaded environment may not survive the additional sunlight or the competition from the increased weedy vegetation that would become established. Species that require more open conditions could become established after death of the adelgid-killed trees.

On the Chattahoochee National Forest, there are no rare plants or rare terrestrial vertebrates or invertebrates known to be dependent on the presence of hemlock. The LR red squirrel (*Tamiasciurus hudsonicus*) however, appears to be closely associated with hemlock, at least in Georgia (Wharton 1968, C.Wentworth personal observation) where the species is on the southern limits of its range. Wharton's 1968 paper quotes Sherman (1937) as stating the red squirrel is "partial to hemlock". The paper also states: "Older residents associated a former abundance of red squirrels in northern Georgia with corresponding stands of hemlock, usually with rhododendron (*Rhododendron maximum*)".

Carolina hemlock (*Tsuga caroliniana*) is a Regional Forester sensitive species. It is known to occur in Georgia on private land in the Tallulah Gorge area. In 2004, seed was collected from this population and stored by the State Botanical Garden of Georgia. During 14 years of plant inventories across the Chattahoochee, this hemlock has not been found on Forest Service land. However, it has potential to occur in some steep, mesic sites primarily in Rabun County, Georgia (Matt Elliott, personal communication). At the time of the draft EA, these potential sites had not been inventoried. Subsequently, Matt Elliott and Jess Riddle surveyed these areas, but did not find Carolina hemlock. They currently believe it is restricted to the Tallulah Gorge area (Matt Elliott personal communication).

Species Evaluated:

There are currently 126 species, 24 federally listed (T&E) and 102 Regional Forester's Sensitive (S) species on the Chattahoochee-Oconee TES list. In addition, the Forest maintains a list of locally rare (LR) species that may be fairly common throughout their range, but are not common in Georgia where they often are on the periphery of their range. There are currently 84 species on the Forest LR list. These TES and LR species either have potential to occur or are known to occur on the Forest. Potential occurrences are based on known locations on private land in habitat that occurs on nearby Forest land. Some of the records of species with known occurrences on the Chattahoochee-Oconee are historical (i.e. greater than 20 years old).

All of the 126 TES and 84 LR species were initially considered during this evaluation. Many were dropped from further consideration due to their habitat requirements and the fact they would not have potential to occur in stands affected by the HWA. Species addressed in this document were chosen due to known occurrences in habitat with an eastern hemlock component (four forest types: white pine-hemlock; hemlock; hemlock-hardwood; cove hardwoods-white pine-hemlock). However, most of these species also occur in sites without hemlock. As already noted, none of these rare plants or terrestrial animals is entirely dependent on the presence of hemlock.

The database shows 40 occurrences (EORs) of 23 TES/LR species in hemlock Forest Types (FT). **Table 3.2.6.1** lists these species with the number of their occurrences by alternative, in hemlock stands proposed for treatment. It should be noted that the scale for purposes of forest typing is 10 acres or greater. Often, these rare species occur in microsites within the stand that may or may not be surrounded by the forest type species, i.e. species shown in the database as occurring in hemlock stands may be in sites with little hemlock surrounding them. **The TES species will be discussed in more detail in the Biological Evaluation for this project.**

Table 3.2.6.1 Per Database, Forest TES/LR species located in hemlock FT's and number occurring in treated sites by alternative.

					Number of EORs Treated

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5
T	*Isotria medeoloides*	Small Whorled Pogonia	32	3	0	3	3	3	3
S	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	3	1	0	1	1	1	1
S	*Myotis leibii*	Eastern Small-footed Myotis	2	1	0	1	1	1	1
S	*Megaceros aenigmaticus*	A Hornwort	3	3	0	3	3	3	3
S	*Plagiomnium carolinianum*	Mountain Wavy-leaf Moss	4	1	0	1	1	1	1
S	*Carex radfordii*	Radford Sedge	2	1	0	0	1	1	1
S	*Carex roanensis*	Roan Mountain Sedge	1	1	0	1	1	1	1
S	*Shortia galacifolia*	Oconee Bells	1	1	0	1	1	1	1
S	*Waldsteinia lobata*	Piedmont Barren Strawberry	4	2	0	1	2	2	1
LR	*Eumeces anthracinus*	Coal Skink	6	2	0	2	2	2	2
LR	*Tamiasciurus hudsonicus*	Red Squirrel	16	2	0	2	2	2	2
LR	*Neotoma floridana haematoreia*	Southern Appalachian Woodrat	7	1	0	0	1	1	1
LR	*Trichomanes petersii*	Dwarf Filmy Fern	2	1	0	0	1	1	1
LR	*Huperzia appalachiana*	Fir Clubmoss	3	1	0	1	1	1	1
LR	*Carex manhartii*	Manhart Sedge	43	4	0	1	1	1	1
LR	*Carex platyphylla*	Broadleaf Sedge	2	1	0	0	0	0	0
LR	*Carex scabrata*	Sedge	30	4	0	4	4	4	4
LR	*Cymophullus fraserianus*	Fraser’s Sedge	8	1	0	1	1	1	0
LR	*Cypripedium parviflorum var. pubescens*	Large-flowered Yellow Ladyslipper	50	2	0	2	2	2	2
LR	*Juncus gymnocarpus*	Naked-fruit Rush	26	3	0	1	2	2	2
LR	*Melanthium latifolium*	Broadleaf Bunchflower	38	2	0	1	2	2	2
LR	*Hydrastis canadensis*	Goldenseal	9	1	0	0	0	0	0
LR	*Hydrophyllum macrophyllum*	Largeleaf Waterleaf	2	1	0	0	0	0	0
LR	*Leiophyllum buxifolium*	Sand-myrtle	3	2	0	0	2	2	2
	TOTAL	**23**	**288**	**40**	**0**	**25**	**33**	**33**	**33**

When the database was queried, the species in **Table 3.2.6.1** were listed because they are located in stands that are in one of the four forest types mentioned above as having an important hemlock component. Because these stands cover 10 acres at a minimum, and plants unlike animals are not mobile, the plant species in Table 4 were further analyzed by consulting records of the habitat in the microsites where they are located. This habitat review indicated that some sites do not have a significant hemlock component in the immediate vicinity of the plants. For example, goldenseal (*Hydrastis canadensis*) is found in rich, mesic woods with or without hemlock. One out of nine sites documented on the Forest is in a stand typed as containing significant hemlock. From the site records for the goldenseal it was determined that the plants located in the hemlock stand are not surrounded by hemlock. The site is described as a rich, north facing hardwood forest with limestone boulders, in the Alaculsy Valley. Other species occurrences with the same situation are: *Carex roanensis, Shortia galacifolia,* one of the 2 EORs for *Waldsteinia lobata* (the other EOR will be carried through in the analysis), *Carex platyphylla*, *Hydrophyllum macrophyllum*, and *Leiophyllum buxifolium*. Note that the *Carex platyphylla*, and *Hydrophyllum macrophyllum*, are located in the same location as the goldenseal discussed above. Because hemlock is not a major component in the immediate area of these plants, they will not be further analyzed and none of the alternatives would have any impacts to these species.

Analyses in the following sections assume that the treatments (beetles or beetles and insecticides) will prevent death of the hemlock stands due to HWA infestation. At the same time, the reality is that there is no guarantee of treatment success. The methods have not been utilized for a long enough period to obtain definitive data on their success.

Alternative 1

This alternative proposes no action to halt the spread of the hemlock woolly adelgid, and untreated hemlock stands could lose the majority of their hemlock component. Because there would be no treatment activities, there would be no direct effects to any TES or LR terrestrial species. However, indirect impacts to the TES and LR plant species listed in Table 1 could potentially occur in this alternative by an increase in light intensity and decrease in relative humidity in the immediate area as a result of hemlocks dying. Vegetation requiring low light conditions could succumb to the additional sunlight entering the site and might not be able to withstand the competing vegetation that would come into the area. Conversely, Alternative 1 would create conditions favoring the potential establishment of TES and LR plant species requiring more open habitat.
This alternative could result in an increase of snags providing habitat for cavity-dependent species.

An analysis of number of occurrences on the Forest for each species was conducted to determine which of the species, if any, were at greatest risk of extirpation if no action was taken to control HWA. For analysis purposes, occurrence numbers were broken down using The Nature Conservancy and State Heritage Program relative rarity groupings as follows: species with greater than 20 occurrences on the Forest (**Table 3.2.6.2**), species with six to 20 occurrences (**Table 3.2.6.3**), and those with five or less documented occurrences on the Forest (**Table 3.2.6.4**). Species with five or fewer occurrences on the Forest were felt to be most at risk, primarily due to gene flow limitations. Their rarity could put them at risk regardless of HWA control treatments.

Table 3.2.6.2. TES/LR with 21 or greater occurrences

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 1
T	*Isotria medeoloides*	Small Whorled Pogonia	32	3	0
LR	*Carex manhartii*	Manhart Sedge	43	4	0
LR	*Carex scabrata*	Sedge	30	4	0
LR	*Cypripedium parviflorum var. pubescens*	Large-flowered Yellow Ladyslipper	50	2	0
LR	*Juncus gymnocarpus*	Naked-fruit Rush	26	3	0
LR	*Melanthium latifolium*	Broadleaf Bunchflower	38	2	0

The small-whorled pogonia (*Isotria medeoloides*) is a federally listed threatened species. The occurrence sites listed as hemlock in the database were analyzed further for this orchid. The three sites are predominantly hemlock, and loss of the species in this alternative could result in a large increase in light intensity, with the potential to adversely affect these populations. Under the Endangered Species Act, this alternative would require consultation with US Fish and Wildlife Service.

The remaining species in **Table 3.2.6.3** are plants with numerous occurrences on the Forest. *Carex scabrata* and *Juncus gymnocarpus* are found growing in streams and along the edges of streams and ditches. The rush is often seen in seeps and boggy areas. Light intensity in these sites varies greatly, with some occurring in sunny areas and some in shade with dappled sunlight. Due to the plants' ability to grow in various light regimes and their presence in wet areas, death of hemlock and resulting increase in light and decrease in relative humidity with this alternative would not likely impact these species.

Carex manhartii, *Cypripedium parviflorum var. pubescens,* and *Melanthium* latifolium could have individuals indirectly impacted by loss of hemlock in their immediate vicinity. Again, this would be due primarily to increased light in the immediate area and possible increase of competing vegetation. However, due to the number of documented sites for these species, persistence of the species on the Forest would not be a concern.

Table 3.2.6.3. TES/LR with 6 – 10 occurrences

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 1
LR	*Cymophyllus fraserianus*	Fraser's Sedge	8	1	0
LR	*Eumeces anthracinus*	Coal Skink	6	2	0
LR	*Neotoma floridana haematoreia*	Southern Appalachian Woodrat	7	1	0
LR	*Tamiasciurus hudsonicus*	Red Squirrel	16	2	0

Fraser's sedge (*Cymophyllus fraserianus*) is listed as State Threatened. One of the Fraser's sedge sites on the Forest has a significant hemlock component. Loss of hemlock in the immediate vicinity of the sedge could indirectly impact individuals of the population. This would occur primarily due to the increased sunlight and drying effects in the immediate area of the plants, as well as the increase of competing vegetation.

The coal skink (*Eumeces anthracinus*) requires mesic, but not necessarily riparian, conditions (Camp, personal communication). They are found in many forest types and are not dependent on hemlock. A site where the skink was found in abundance in Habersham County, Georgia (not FS land), was densely covered with English ivy (*Hedera helix*) and mixed hardwoods and pine in the overstory (Hotchkin et al. 2001). Two of the six documented sites on the Forest are in hemlock forest types. One of the two hemlock sites dates from the early 1950's. If the two skink sites became too dry with the loss of hemlock, the animal could relocate to a more suitable area. Therefore, this alternative should not impact this species.

The southern Appalachian woodrat (*Neotoma floridana haematoreia*) is associated with extensive rock areas such as talus slopes, rock cliffs and rock outcrops in deciduous woods (Webster et al.1985). The woodrat is not a hemlock dependent species. Only one of the seven known occurrences is in a hemlock forest type. Death of hemlocks around an inhabited rock outcrop could make the habitat unsuitable for the animal, but it could easily relocate to other rocky sites. Therefore, this alternative should have no impact on the woodrat.

The death of eastern hemlocks could also have adverse impacts to the LR red squirrel (*Tamiasciurus hudsonicus*). Although only two of the occurrences for the species are shown in the database as being hemlock stands, the squirrel does seem to be strongly associated with hemlock as mentioned in the introduction. The hemlock is heavily used for a food source (hemlock cones), cover and nesting. Loss of hemlock could have some negative impacts on this species.

Table 3.2.6.4. TES/LR with 5 or less occurrences on the Forest.

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 1
S	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	3	1	0
S	*Myotis leibii*	Eastern Small-footed Myotis	2	1	0
S	*Megaceros aenigmaticus*	A Hornwort	3	3	0
S	*Plagiomnium carolinianum*	Mountain Wavy-leaf Moss	4	1	0

S	*Carex radfordii*	Radford Sedge	2	1	0
S	*Waldsteinia lobata*	Piedmont Barren Strawberry	4	1	0
LR	*Trichomanes petersii*	Dwarf Filmy Fern	2	1	0
LR	*Huperzia appalachiana*	Fir Clubmoss	3	1	0

The Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and eastern small footed bat (*Myotis leibii*) are not dependent on hemlock, and loss of hemlock in this alternative should not impact these species. The Rafinesque's big-eared bat hibernates primarily in caves and old buildings, usually near permanent water (Webster et al. 1985), with maternity colonies primarily found in old buildings (Harvey 1992). These EOR's date from 1950, and the locations were mist-netted for bats by Dr. Susan Loeb in 2001 and 2002. Neither of these two species was netted at or near these locations during her surveys. For these reasons, this alternative would not adversely impact these species.

The hornwort (*Megaceros aenigmaticus*) has been recently found in Georgia and occurs in and along streams and waterfalls, often underwater (P. Hyatt, personal communication). Because of their proximity to water, they would be less prone to impacts of humidity decrease from the loss of hemlock. They are also shaded by dense midstories of Rhododendron. Therefore, they should not be adversely impacted by the death of hemlock.

Review of the remaining species listed in Table 1-3 as occurring in hemlock stands, indicated the presence of hemlock near the plants. The plants could be impacted by death of the hemlock from the increased sunlight, resulting weedy competition, and decrease in relative humidity. These species are: *Plagiomnium carolinianum; Carex radfordii; Waldsteinia lobata; Trichomanes petersii;* and *Huperzia appalachiana.*

Impacts of the no action alternative are listed below for all of the species in **Table 3.2.6.5.**

Table 3.2.6.5. Summary of impacts of Alternative 1

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Effects of Alternative 1
T	*Isotria medeoloides*	Small Whorled Pogonia	32	3	**May affect**
S	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	3	1	No impact
S	*Myotis leibii*	Eastern Small-footed Myotis	2	1	No impact
S	*Megaceros aenigmaticus*	A Hornwort	3	3	No impact
S	*Plagiomnium carolinianum*	Mountain Wavy-leaf Moss	4	1	**May impact**
S	*Carex radfordii*	Radford Sedge	2	1	**May impact**
S	*Waldsteinia lobata*	Piedmont Barren Strawberry	4	1	**May impact**
LR	*Eumeces anthracinus*	Coal Skink	6	2	No impact
LR	*Tamiasciurus hudsonicus*	Red Squirrel	16	2	**May impact**
LR	*Neotoma floridana haematoreia*	Southern Appalachian Woodrat	7	1	No impact
LR	*Trichomanes petersii*	Dwarf Filmy Fern	2	1	**May impact**
LR	*Huperzia appalachiana*	Fir Clubmoss	3	1	**May impact**
LR	*Carex manhartii*	Manhart Sedge	43	4	**May impact**
LR	*Carex scabrata*	Sedge	30	4	No impact
LR	*Cymophyllus fraserianus*	Fraser's sedge	8	1	**May impact**
LR	*Cypripedium parviflorum var. pubescens*	Large-flowered Yellow Ladyslipper	50	2	**May impact**
LR	*Juncus gymnocarpus*	Naked-fruit Rush	26	3	No impact
LR	*Melanthium latifolium*	Broadleaf Bunchflower	38	2	**May impact**

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Alternative 2

In this alternative, areas as proposed in the public scoping letter would be treated with the insecticide imidacloprid and the release of predatory beetles that feed exclusively on the hemlock woolly adelgid. The insecticide would be injected into the soil around the hemlock, with the possibility of some stem injection if necessary (e.g. in a high interest area where the ground is too rocky for soil injection). Because the beetles feed only on the woolly adelgid, and the chemical is an insecticide and not an herbicide, these control activities would have no direct effects on the TES/LR species considered.

The number of species' occurrences documented on the Forest, the number occurring in hemlock forest types, and the number treated in Alternative 2 are shown in **Tables 3.2.6.6; 3.2.6.7; and 3.2.6.8.**

Table 3.2.6.6. TES/LR with 21 or greater occurrences

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 2
T	*Isotria medeoloides*	Small Whorled Pogonia	32	3	3
LR	*Carex manhartii*	Manhart Sedge	43	4	1
LR	*Carex scabrata*	Sedge	30	4	4
LR	*Cypripedium parviflorum var. pubescens*	Large-flowered Yellow Ladyslipper	50	2	2
LR	*Juncus gymnocarpus*	Naked-fruit Rush	26	3	1
LR	*Melanthium latifolium*	Broadleaf Bunchflower	38	2	1

Because the three hemlock sites for the federally listed *Isotria medeoloides* would receive treatment for the adelgid and the chemical used would be an insecticide and not a herbicide, the proposed activities in Alternative 2 would not affect the orchid. All occurrences of *Carex scabrata* and one occurrence of the *Juncus gymnocarpus* in hemlock forest types would be in treatment sites. For these reasons as well as those discussed in Alternative 1 (occurrence in wet environments), this alternative would have no impacts to these two species. Both locations of the yellow lady's slipper would be in beetle release areas, thus there would be no adverse impacts to this species.

As in Alternative 1, there could be adverse impacts to individuals of *Carex manhartii* and *Melanthium latifolium* in this alternative. Impacts would be slightly less than in Alternative 1 because for this alternative, one of the hemlock locations for each species is in an area to be treated. Due to the number of documented sites for these plants, persistence of the species on the Forest would not be a concern.

Table 3.2.6.7. TES/LR with 6 – 10 occurrences

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 2
LR	*Cymophyllus fraserianus*	Fraser's Sedge	8	1	1
LR	*Eumeces anthracinus*	Coal Skink	6	2	2
LR	*Neotoma floridana haematoreia*	Southern Appalachian Woodrat	7	1	0
LR	*Tamiasciurus hudsonicus*	Red Squirrel	16	2	2

There would be no adverse impacts of Alternative 2 to individuals of *Cymophyllus fraserianus*, due to the fact the hemlock site would be treated for the adelgid in this alternative. Suppression methods would have no detrimental impacts to the plants because imidacloprid is an insecticide and not an herbicide, and the beetles only eat the adelgid.

Effects of Alternative 2 on the woodrat would be the same as in Alternative 1. There would be no impacts to the coal skink for the reasons discussed in Alternative 1, as well as the fact the locations associated with hemlock would be treated in this alternative. The red squirrel locations in hemlock would be protected by release of the beetle in Alternative 2.

Table 3.2.6.8. TES/LR with 5 or less occurrences on the Forest.

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 2
S	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	3	1	1
S	*Myotis leibii*	Eastern Small-footed Myotis	2	1	1
S	*Megaceros aenigmaticus*	A Hornwort	3	3	3
S	*Plagiomnium carolinianum*	Mountain Wavy-leaf Moss	4	1	1
S	*Carex radfordii*	Radford Sedge	2	1	0
S	*Walsteinia lobata*	Piedmont Barren Strawberry	4	1	1
LR	*Trichomanes petersii*	Dwarf Filmy Fern	2	1	0
LR	*Huperzia appalachiana*	Fir Clubmoss	3	1	1

The species in **Table 3.2.6.8** occurring in sites not receiving treatment are: *Carex radfordii* and *Trichomanes petersii*. Impacts to these species would be the same as discussed in Alternative 1.

Because of the reasons discussed in Alternative 1, there would be no impacts to the two bat species or to the hornwort as a result of implementing Alternative 2.

Alternative 2 would protect the sites of *Plagiomnium carolinianum, Waldsteinia lobata,* and *Huperzia appalachiana* by treatment of the hemlocks. Therefore, there would be no impacts to these plants from this alternative.

Impacts for Alternative 2 are summarized in **Table 3.2.6.9**.

Table 3.2.6.9 Summary of impacts of Alternative 2

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Effects of Alternative 2
T	*Isotria medeoloides*	Small Whorled Pogonia	32	3	No affect
S	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	3	1	No impact
S	*Myotis leibii*	Eastern Small-footed Myotis	2	1	No impact
S	*Megaceros aenigmaticus*	A Hornwort	3	3	No impact
S	*Plagiomnium carolinianum*	Mountain Wavy-leaf Moss	4	1	No impact
S	*Carex radfordii*	Radford Sedge	2	1	**May impact**
S	*Waldsteinia lobata*	Piedmont Barren Strawberry	4	1	No impact
LR	*Eumeces anthracinus*	Coal Skink	6	2	No impact
LR	*Tamiasciurus hudsonicus*	Red Squirrel	16	2	No impact
LR	*Neotoma floridana haematoreia*	Southern Appalachian Woodrat	7	1	No impact
LR	*Trichomanes petersii*	Dwarf Filmy Fern	2	1	**May impact**
LR	*Huperzia appalachiana*	Fir Clubmoss	3	1	No impact
LR	*Carex manhartii*	Manhart Sedge	43	4	**May impact**
LR	*Carex scabrata*	Sedge	30	4	No impact

LR	*Cymophyllus fraserianus*	Fraser's Sedge	8	1	No impact
LR	*Cypripedium parviflorum var. pubescens*	Large-flowered Yellow Ladyslipper	50	2	No impact
LR	*Juncus gymnocarpus*	Naked-fruit Rush	26	3	No impact
LR	*Melanthium latifolium*	Broadleaf Bunchflower	38	2	**May impact**

Alternative 3.

Alternative 3 encompasses the same sites as Alternative 2, with additional areas proposed for treatment as a result of responses to the scoping letter for the original proposal. This alternative would attack the HWA with predatory beetles only, and no use of insecticide.

The number of species' occurrences documented on the Forest, the number occurring in hemlock forest types, and the number treated in Alternative 3, are shown in **Tables 3.2.6.10; 3.2.6.11; and 3.2.6.12.**

Table 3.2.6.10. TES/LR with 21 or greater occurrences

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 3
T	*Isotria medeoloides*	Small Whorled Pogonia	32	3	3
LR	*Carex manhartii*	Manhart Sedge	43	4	1
LR	*Carex scabrata*	Sedge	30	4	4
LR	*Cypripedium parviflorum var. pubescens*	Large-flowered Yellow Ladyslipper	50	2	2
LR	*Juncus gymnocarpus*	Naked-fruit Rush	26	3	2
LR	*Melanthium latifolium*	Broadleaf Bunchflower	38	2	2

The effects of Alternative 3 on *Isotria medeoloides*, *Carex manhartii*, *Carex scabrata*, *Cypripedium parviflorum* var. *pubescens* and *Juncus gymnocarpus*, would be the same as Alternative 2. Because both hemlock associations of *Melanthium latifolium* would receive treatment to protect the hemlocks in Alternative 3, this alternative would not have adverse impacts to individuals the bunchflower.

Table 3.2.6.11. TES/LR with 6 – 10 occurrences

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 3
LR	*Cymophyllus fraserianus*	Fraser's Sedge	8	1	1
LR	*Eumeces anthracinus*	Coal Skink	6	2	2
LR	*Neotoma floridana haematoreia*	Southern Appalachian Woodrat	7	1	1
LR	*Tamiasciurus hudsonicus*	Red Squirrel	16	2	2

Effects of Alternative 3 on the Fraser's sedge, coal skink and red squirrel, would be the same as in Alternative 2. The woodrat would be protected for the reasons given in Alternative 1 as well as the fact the location associated with hemlock would be treated in this alternative.

Table 3.2.6.12. TES/LR with 5 or less occurrences on the Forest.

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Number of EOR's treated ALT 3
S	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	3	1	1

S	*Myotis leibii*	Eastern Small-footed Myotis	2	1	1
S	*Megaceros aenigmaticus*	A Hornwort	3	3	3
S	*Plagiomnium carolinianum*	Mountain Wavy-leaf Moss	4	1	1
S	*Carex radfordii*	Radford Sedge	2	1	1
S	*Waldsteinia lobata*	Piedmont Barren Strawberry	4	1	1
LR	*Trichomanes petersii*	Dwarf Filmy Fern	2	1	1
LR	*Huperzia appalachiana*	Fir Clubmoss	3	1	1

Effects of Alternative 3 on the two bats, *Megaceros aenigmaticus, Plagiomnium carolinianum, Waldsteinia lobata* and *Huperzia appalchiana*, would be the same as Alternative 2.

Addition of sites for treatment in Alternative 3, resulted in the one hemlock associated occurrence each of *Carex radfordii* and *Trichomanes petersii,* being located in a HWA control site. Therefore, this alternative would have no adverse impacts to these plants.

Impacts for Alternative 3 are summarized in **Table 3.2.6.13**

Table 3.2.6.13. Summary of impacts of Alternative 3

STATUS	SCIENTIFIC NAME	COMMON NAME	Total EORs	EORs in Hemlock	Effects of Alternative 3
T	*Isotria medeoloides*	Small Whorled Pogonia	32	3	No affect
S	*Corynorhinus rafinesquii*	Rafinesque's Big-eared Bat	3	1	No impact
S	*Myotis leibii*	Eastern Small-footed Myotis	2	1	No impact
S	*Megaceros aenigmaticus*	A Hornwort	3	3	No impact
S	*Plagiomnium carolinianum*	Mountain Wavy-leaf Moss	4	1	No impact
S	*Carex radfordii*	Radford Sedge	2	1	No impact
S	*Waldsteinia lobata*	Piedmont Barren Strawberry	4	1	No impact
LR	*Eumeces anthracinus*	Coal Skink	6	2	No impact
LR	*Tamiasciurus hudsonicus*	Red Squirrel	16	2	No impact
LR	*Neotoma floridana haematoreia*	Southern Appalachian Woodrat	7	1	No impact
LR	*Trichomanes petersii*	Dwarf Filmy Fern	2	1	No impact
LR	*Huperzia appalachiana*	Fir Clubmoss	3	1	No impact
LR	*Carex manhartii*	Manhart Sedge	43	4	**May impact**
LR	*Carex scabrata*	Sedge	30	4	No impact
LR	*Cymophyllus fraserianus*	Fraser’s Sedge	8	1	No impact
LR	*Cypripedium parviflorum var. pubescens*	Large-flowered Yellow Ladyslipper	50	2	No impact
LR	*Juncus gymnocarpus*	Naked-fruit Rush	26	3	No impact
LR	*Melanthium latifolium*	Broadleaf Bunchflower	38	2	No impact

Alternative 4.

Alternative 4 is the same as Alternative 3 (beetle release) with the addition of insecticide treatment as described in Alternative 2. Sites to be treated would be the same as in Alternative 3, and the impacts to all species would be primarily the same as discussed in that alternative. Since there is no guarantee the beetle release will completely protect the hemlocks, the addition of insecticide in selected sites would increase the potential for survival of the hemlocks.

Alternative 5.

This alternative is the same as Alternative 4, but excludes Wilderness areas. The one occurrence of the *Cymophyllus fraserianus* is located in Wilderness. Therefore, the impacts of this alternative would be the same for the sedge as those of Alternative 1. The rest of the species'occurrences listed in **Table 3.2.6.1** are not located in Wilderness areas, and for them the impacts from this alternative would be the same as in Alternative 4.

Cumulative Effects

Implementation of Forest standards and guidelines assists in avoiding adverse cumulative effects to TES and LR species. Adherence to these standards and guides also aids in protecting and maintaining habitat for TES and LR species at the Forest level. Surveys have been and continue to be conducted in portions of the Forest to determine presence and distribution of various small mammals, birds, amphibians and reptiles, aquatic species, and TES and LR plants. Plant inventories have been conducted on the Forest since 1991 in sites of proposed ground disturbance. When significant (determined on a case-by-case basis) populations of the species discussed above as well as other TES/LR species are found, they are protected from adverse impacts. The Georgia National Heritage Program (GNHP) records are checked for known occurrences of PETS and LR species in project areas, and close contact is maintained between the Heritage biologists and Forest Service biologists for sharing of new information. Forest Service records and other agencies' biologists and records (in addition to GNHP) are also consulted for occurrences. Future management activities and project locations will be analyzed utilizing any new information available on TES and LR species. Effects to federally listed species will be avoided. For Forest sensitive and LR species, mitigating measures will be implemented where needed to maintain habitat for these species on the Forest, and to prevent future listing under the Endangered Species Act. For the reasons discussed above, past, present, and reasonably foreseeable future actions in the project area are not expected to result in any adverse cumulative effects to TES or LR plants, or to terrestrial and aquatic vertebrate or invertebrate species

Where these species occur in hemlock stands on private lands, there is a possibility some will be negatively impacted by death of the hemlocks if not treated. If HWA control treatments additionally do not occur on Forest Service land, these species could be further impacted. The cumulative effects of the impacts could lead to viability concerns for some of the species in Georgia. These effects could extend range-wide depending on HWA control efforts on private and public land throughout their range.

3.3 Social and Cultural

3.3.1 Scenery

Affected Environment

The users of and residents surrounding the Chattahoochee NF are concerned about the quality of their visual environment. The "Landscape Aesthetics" is a basic resource to be "treated as an essential part of and receive equal consideration with the other basic resources of the land" (Forest Service Manual 2380, *Landscape Management*). The forest, therefore, has established an inventory of the visual resource and has developed measurable standards for the management of this resource.

A visual inventory was mapped in the late 1970s utilizing the Forest Service nationwide *Visual Management System* (VMS). With that inventory, the 1986 Chattahoochee-Oconee National Forest LRMP established standards for visual management called Visual Quality Objectives (VQO's). This VMS does not exist as a GIS database. With over 20 years of research and experience, the VMS was replaced in 1995 by the *Scenery Management System* (SMS). This system provides for improved integration of aesthetics with other biological, physical, and social/cultural resources in the planning process. This inventory is an existing layer in the Forest's GIS database.

This section will disclose the effects from project activities on the Landscape Character and the Scenic Integrity Objective (SIOs) as determined in the Forest Plan Revision using the Scenery Management System (SMS). The SMS makes use of scenic classes based on the relative value and importance of the landscape to the viewing public, on a scale of one through seven. Scenic classes are derived by combining the scenic attractiveness of the area (which includes landscape character and existing scenic integrity) with landscape visibility (which includes concern levels, distance zones, and travel way importance).

Scenic Integrity Objectives (SIOs) assign a desired level of excellence for visual quality based on physical and sociological characteristics of an area. SIOs refer to the degree of acceptable alterations of the characteristic landscape. Objectives include Very High, High, Moderate, and Low.

Very High SIO generally provides for only ecological changes in natural landscapes and complete intactness of landscape character in cultural landscapes.

High SIO indicates that human activities are not visually evident. Activities may only repeat attributes of form, line, color, and texture found in the existing landscape character.

Moderate SIO indicates that landscapes appear slightly altered. Noticeable deviations must remain visually subordinate to the landscape character being viewed.

Low SIO indicates that landscapes appear moderately altered. Deviations begin to dominate the valued landscape character being viewed, but borrow from valued attributes such as size, shape, edge effect, and pattern of natural openings, vegetative type changes, or architectural styles outside the landscape being viewed.

The bounds of analysis in this section will include effects of actions on the scenic quality from typical observer positions, including the secondary travel ways and any use areas within or nearby the project areas.

Hemlock component of Scenery Resource on the Chattahoochee National Forest

Hemlocks tend to be a significant vegetative component in many landscapes such as scenic stream and river corridors, campgrounds, trail 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.

One hundred twenty seven hemlock plots were selected on the Chattahoochee National Forest. These plots tend to be in visually important locations as indicated by the fact that over 55% are in locations with Very High or High SIOs. Over 50% of the plots are in Scenic Class 1.

The Scenic Classes and Scenic Integrity Objective Acres within each Alternative can be found in the tables below. The percent figures in Alternative 1, the No-Action alternative, are based on the acreage of forest cover types with hemlock composition occurring within each scenic class. For some scenic classes, the percent values in one or more of the action alternatives exceed the value for No-Action. In those cases, the increase over No-Action is because District and/or public site nominations were made for acres in the scenic class that did not have a forest cover composition with >= 30-percent hemlock canopy cover. In other words, the areas were judged worthy of protection based on values other than only genetic conservation. Action alternatives thus show sensitivity to social, cultural, or ecological values in area selections.

Table 3.3.1.1: Hemlock Treatment Acres by Percent Scenic Class and Alternative

Alternative/Units of Comparison	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Scenic Class					
1	51%	60%	57%	57%	54%
2	36%	27%	31%	31%	33%
3	7%	9%	8%	8%	9/%
4	1%	1%	1%	1%	1%
5	5%	3%	3%	3%	3%
	100%	100%	100%	100%	100%

Source: GIS alternative maps and scenery management data layer as used for Forest Plan revision.

Table 3.3.1.2: Hemlock Treatment Acres by Percent Scenic Integrity Objectives and Alternative

Alternative Comparison by acres	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Scenic Integrity Objectives					
Very High	27%	25%	25%	25%	20%
High	27%	34%	34%	34%	36%
Moderate	42%	38%	36%	36%	39%
Low	4%	3%	5%	5%	5%
Very Low	0%	0%	0%	0%	0%
	100%	100%	100%	100%	100%

Source: GIS alternative maps and scenery management data layer as used for Forest Plan revision.

<u>Effects common to All Alternatives</u>

Hemlock decline and death would visually degrade many distinctive landscapes within campgrounds, along rivers, and on trails. The deep cooling green velvety colors and soft feathery texture of these plants would be lost from the forest composition. This loss would decrease the visual variety, texture, and tonal color of the forest. The Landscape Character of these areas would move toward a white pine/hardwood more open character, and away from the densely populated enclaves of cooling retreat. The existing scenic integrity would be altered beyond the historic range, as we have known it in our lifetimes.

<u>Alternative 1: No-Action</u>

Without any action to conserve the species, the experience in Virginia shows that 90-percent of all hemlock will be dead within 5 to 10 years. About 4 percent of the Blue Ridge portion of the Chattahoochee, or 3-percent of the entire Chattahoochee, would have significant mortality. Many distinctive landscapes would be degraded visually by the loss of hemlocks. This would degrade the Scenic Integrity Objectives set for these areas, moving them away from the desired future conditions. The Scenic Classes would remain the same; however, it would be more difficult to bring the area into compliance with the Scenic Integrity Objectives.

The Landscape Character would also be changed, as the hemlocks would be taken out of the Landscape Character mix. This would be very evident to visitors at many 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, many dead patches would appear in the landscape in drainages and near rock outcrops.

Alternative 2: The Proposed Action

Each area within this alternative is proposed for either insecticide only or insecticide and beetle release. An estimated 275 groups or about 700 acres would be treated with insecticide. Beetle release would partially protect approximately 14,000 acres.

About 43 percent or about 10,000 acres of existing hemlock or mixed cover with hemlock that occurs on ecologically suitable sites would receive a measure of protection. An additional 5,000 acres of ‘other’ forest cover with hemlock as a minority component would also be protected. Approximately 12,700 unprotected acres of hemlock or mixed types with hemlock would lose their hemlock component.

There is a good chance of protection of some hemlock populations in key places, including some distinctive and sensitive landscapes, since 59% of the treatments are located in areas with SIO’s of Very High and High. However, many areas will remain untreated and will result in effects similar to those in Alternative 1. Hemlock populations may be able to recover much quicker if some key stands remain in place. There would be more flexibility for future recovery as knowledge of HWA and treatments improve.

Alternative 3: Modified proposed action but beetles only

About 50 percent or about 11,000 acres of existing hemlock or mixed cover with hemlock would have beetle release only. An additional 8,000 acres of ‘other’ forest cover with hemlock as a minority component would also be protected by beetle release. Approximately 11,500 unprotected acres of hemlock or mixed types with hemlock would lose their hemlock component by receiving no beetle release.

The effects are similar to Alternative 4 although the retention of some key hemlock sites will not be as assured as in Alternative 4 because of the lack of chemical treatment.

Alternative 4: Modified Proposed Action Alternative

Each area within this alternative is proposed for insecticide only, insecticide and beetle release, or just beetle release. An estimated 300 groups or about 800 acres would be treated with insecticide. Beetle release would partially protect approximately 18,700 acres.

About 51 percent or about 11,600 acres of existing hemlock or mixed cover with hemlock would receive a measure of protection. An additional 8,057 acres of ‘other’ forest cover with hemlock as a minority component would also be protected. Approximately 11,100 unprotected acres of hemlock or mixed types with hemlock, or 48 percent of the acres with hemlock in the Blue Ridge portion of the Chattahoochee, would lose their hemlock component.

There is a good chance of protection of some hemlock populations in key places, including some distinctive and sensitive landscapes, since 59% of the treatments are located in areas with SIO's of Very High and High. However, many areas will remain untreated and will result in effects similar to those in Alternative 1. Hemlock populations may be able to recover much quicker if some key stands remain in place. There would be more flexibility for future recovery as knowledge of HWA and treatments improve.

Alternative 4 would less impact most Landscape Characters than Alternative 1, 2, 3, or 5. The Landscape Characters would be more likely to be sustained, and remain in the limits of historic ranges. Areas of Scenic Classes 1 through 7, or High existing scenic integrity would be altered, although minimally.

Restoration of Scenic Integrity could be more readily achieved than Alternative 1, 2, 3 or 5. The identity and self-image of local communities would be helped as ecosystems are helped to return to normal. Restoration of scenic integrity would begin, although integrity would be negatively impacted from standing dead trees.

Alternative 5 – Modified proposed action but no Wilderness

Each area within this alternative is proposed for insecticide only, insecticide and beetle release, or beetle release only. An estimated 250 groups or about 600 acres would be treated with insecticide. Beetle release is less effective but researched estimates of its effectiveness were not found in a literature search. The data that does exist makes it reasonable to conclude that it will be less effective than insecticide, at least for several years. Release would partially protect approximately 17,700 acres.

About 50 percent or about 11,300 acres of existing hemlock or mixed cover with hemlock would receive a measure of protection. An additional 7,000 acres of 'other' forest cover with hemlock as a minority component would also be protected. Approximately 11,400 unprotected acres of hemlock or mixed types with hemlock would lose their hemlock component.

Areas of Scenic Class 1, Very High SIO would be significantly altered. There are about 125,000 acres in wilderness prescriptions; these acres would visually affect with loss of the hemlock component. These areas have a Scenic Integrity Objective of Very High, which generally provides for ecological change only. Natural change is assumed to be visually acceptable and no active management is directed at moderating visual contrasts. Evidence of human intervention in the appearance of the landscape is minimal and would normally be overlooked by most visitors. Human-caused change may be specifically mitigated to be made less obvious.

The Landscape Character of Wilderness is that of naturally evolving. Although natural processes are a normal occurrences in wilderness, the spread of this epidemic beyond wilderness could be expected if no measures where taken to contain the wilderness component.

Cumulative Effects

All cumulative effects are tied to the indirect effects on scenery over time except the presence of Forest Service personnel occasionally administering treatments and monitoring conditions over time in Alternatives 2, 3, 4 and 5.

Alternative 1. It is likely that hemlock mortality will approach or reach 100% over time. Most distinctive landscapes near streams, rivers, and rock outcrops will permanently lose part of their distinctive character. It is also likely that non-native invasive species will occupy some of the void left by the extirpation of the hemlock and further diminish visual distinctiveness of these landscapes.

Alternative 2. Some distinctive landscapes near streams, rivers, and rock out will retain enough hemlock components to not lose their distinctive character. Recovery of the remainder of the forest will likely be faster than without treatment.

Alternative 3. The cumulative effects would be similar to Alternative 2 except that retention of hemlocks in some key areas would not be as assured.

Alternative 4. Some distinctive landscapes near streams, rivers, and rock out will retain enough hemlock components to not lose their distinctive character. Recovery of the remainder of the forest will likely be faster than without treatment.

Alternative 5. The cumulative effects would be similar to Alternative 1 in Wilderness areas. Some distinctive landscapes near streams, rivers, and rock out will retain enough hemlock components to not lose their distinctive character. Recovery of the remainder of the forest will likely be faster than without treatment.

3.3.2 Recreation

Hemlocks are a valuable contributor to some of the most desirable Blue Ridge Mountain recreation settings. In addition to their visual distinctiveness, hemlocks help provide a cool, desirable microclimate. Their presence in riparian areas shades streams and helps produce a healthy trout fishery. In dense stands, hemlock typically has an open forest floor providing the ability to see well through the forest, a compact litter layer, and often relatively flat terrain; each a feature of value to dispersed recreation settings.

The geographic scale of this recreation effects analysis is primarily the general forest area (GFA); that is, outside developed recreation areas. Dispersed recreation effects were estimated by analyzing for the co-location of any portion of each protected area in each alternative occurring within 300 feet of a road. The 300-foot value is an estimate of the average maximum distance campers will carry tents, coolers, chairs, etc away from their vehicle. Given the strong correlation of hemlock with riparian area, it was assumed that a stream was also nearby providing the 'big three' for dispersed recreation; access, water, and reasonably flat terrain. Results of the data analysis are reflected in **Table 3.3.2.2**. Acres in the table are *only* those acres within the 300 foot buffer distance of a road, not a sum of acres within conservation areas in which any portion met those criteria.

The one exception to dispersed recreation analysis is where developed areas are also; either in whole or in part, a genetic conservation area. Six developed recreation areas will have hemlock wooly adelgid treatments either through insecticide or biological control. **Table 3.3.2.1** outlines these areas and treatment by alternative.

Table 3.3.2.1 Developed Recreation Area Treatment by Alternative

Developed Recreation Area	Type Treatment Alternative 2	Type Treatment Alternative 3	Type Treatment Alternative 4	Type Treatment Alternative 5
Tate Branch CG	Insecticide/Beetle Release	Beetle Release only	Insecticide/Beetle Release	No Dev Rec Sites in Wilderness
Tallulah River CG	Insecticide/ Beetle Release	Beetle Release only	Insecticide/ Beetle Release	No Dev Rec Sites in Wilderness
Panther Cr. Picnic Area	Insecticide/Beetle Release	Beetle Release only	Insecticide/ Beetle Release	No Dev Rec Sites in Wilderness
Hemlock Falls	Insecticide/ Beetle Release	Beetle Release only	Insecticide/ Beetle Release	No Dev Rec Sites in Wilderness
Dockery Lake CG	Insecticide/ Beetle Release	Beetle Release only	Insecticide/ Beetle Release	No Dev Rec Sites in Wilderness

Table 3.3.2.2 Number of Treated Conservation Areas by Alternative and Treatment Type in Dispersed Recreation Settings 300 Feet from a Road

Type Treatment Altern. 2	Acres	Conser Areas	Type Treatment Altern. 3	Acres	Conser Areas	Type Treatment Altern. 4	Acres	Conser Areas	Type Treatment Altern. 5	Acres
Insecticide & Beetle Release	3,481	82	Beetle Release only	4,325	94	Insecticide & Beetle Release	4,425	95	None in Wilderness	None

Effects Common to All Alternatives

The effect of hemlock mortality on recreation; both developed and dispersed, will be the reaction of recreationists to hemlock mortality. The basis for any reaction will be the desirability of the site post-HWA as compared to its desirability pre-HWA. 'Desirability' includes both physical and emotional elements. Physical characteristics provide the setting and include the physical hazard associated with dead trees. Emotional factors such as family tradition or treasured memories also help form an attachment. Perception of the degree of risk posed by dead trees is a facet of emotional desirability. Because desirability is a subjective determination by each individual, precise effects cannot be determined. Rather, it is reasonable to assume that effects are in approximate proportion to the dominant hemlock canopy cover that existed prior to the adelgid within these areas because the degree of change in physical setting correlates with this and also because risk does as well. There would be a continuum ranging from little to no effect (no change in behavior) with few and scattered dead hemlock up to area abandonment.

- At hemlock canopy cover of up to 15 to 20 percent the effect will likely be minor repositioning to simply avoid hemlock snags. Recreationists with a strong emotional attachment to a location will continue to use the area as in the past. Stands with hemlock at these densities are not classified as hemlock forest cover types and no dramatic or intense physical change in setting will occur. Many visitors would not realize an extraordinary event had occurred. Because HWA-caused mortality is gradual, over a period of years, repeat visitors would adjust to the changing conditions. Small snags and down woody debris may actually be a positive because of the ready availability of firewood.

- At hemlock canopy cover between approximately 20 to 50 percent, localized relocations of recreation sites within a general area; such as along a single stream, are likely. This range of hemlock canopy cover corresponds to forest cover type 41 'cove hardwood-white pine-hemlock' and is the most common vegetation community with hemlock on the

Chattahoochee. (*See 'Forest Cover' topic.)* Recreationists with a strong attachment to an area would resist abandoning it altogether. Rather an attempt would be made to recover the desirable features that existed pre-adelgid. The added sunlight and fallen tree trunks would tend to limit areas of formerly dense hemlock for recreational activities such as camping. The mortality of hemlock with low-hanging limbs creates an open area effect that potentially reduces isolation and privacy. This has a negative impact on the individual's recreation experience unless understory shrubs such as rhododendron or terrain shape continues to provide effective screening. Possible abatement could occur as recreationists shift to adjacent more desirable locations in the same general vicinity. A likely candidate is white pine or white pine-hardwood mixtures because white pine provides some of the same characteristics as hemlock; evergreen shade, open forest floor, compact litter layer, and a relatively deep crown. The presence of white pine as a major component species in type 41 demonstrates the practicality of such a response. On the other hand, such sites may be more attractive than previously from a birding or wildlife viewing perspective, as the forest canopy is in essence thinned or "day-lighted" by the removal of overstory, midstory, and understory hemlock.

- At hemlock canopy cover percentages of above approximately 50 percent; area abandonment because of safety concerns and other deterioration of the setting is likely. Recreationists with a weak or only moderately strong emotional attachment are likely to leave the general area until vegetation has re-established a mostly closed canopy. Only recreationists with a strong to very strong attachment would be expected to remain with physical safety perhaps being more of a determining factor in a decision to leave than setting quality.

Recreation experiences will be affected differently. In the short (less than five years) to medium (five to ten years) term post-HWA; trout fishing will likely become more difficult because of downed woody debris in streams as well as along stream banks within untreated areas. Long term (more than ten years post-HWA) the large woody debris has potential to increase aquatic insect populations and thus indirectly fish populations. Canoeing, inner tube floating, and other related water based activities would likely also become more difficult in the medium term due to the physical obstruction of fallen hemlocks.

From a recreation manager's perspective, the dead and dying hemlocks will impose a direct safety risk to the recreationists. The risk posed by falling hemlock killed by hemlock adelgid infestations will become a driving emphasis for the recreation manager to act. Options range from the extreme measure of closing the impacted recreation site through a Forest Supervisor's Order, through entering the area and cutting the affected hemlock down, to warning the public with signs or brochures. (*Refer to Human Health and Safety topic.*) Cutting of hazardous trees would not be an option in Wilderness.

Direct and Indirect Effects

There are no direct effects specific to only recreation from the actions of the Alternatives. Neither beetle releases nor chemical treatment would directly affect recreation settings since the beetles are inconspicuous and the insecticide would be applied either in the soil or in the treated hemlock. The following discussion describes indirect effects over time.

Alternative 1. This Alternative will result in the most negative change in dispersed recreation settings and the greatest safety risk. The value of hemlock to creating and maintaining 'favorite places' in the general forest will be lost at least for many decades or – in the worst case – forever.

There will be many downed trees along trails, rivers, and other places on the Chattahoochee National Forest where people may recreate.

Alternative 2. This alternative provides the potential to protect recreational physical character at key places where visitors may be present. The alternative protects about 31 percent of the Forest land area with more than 50 percent hemlock canopy cover and 45 percent of the Forest land area with approximately 15 to 50 percent hemlock canopy cover. Many of the 114 selected hemlock conservation reserve areas are in or near developed recreation areas, trailheads, or areas of dispersed concentrated use. Of the 114 hemlock conservation areas, 82 areas, or72 percent, and 3,481 acres within those areas are located within 300 feet of a road corridor conducive to dispersed recreation pursuits by the recreating public. The high percentage of selected areas estimated to be suitable dispersed recreation sites demonstrates the influence recreation had in choosing these areas. These dispersed concentrated use areas are primarily camping areas or stream-associated day use areas for fishing or swimming. Often these areas exhibit a combination of these uses. There will be many downed trees along trails and other areas but less than if there are no treatments.

Alternative 3. This alternative – like Alternative 2 – protects about 31 percent of the Forest land area with more than 50 percent hemlock canopy cover and 45-percent of the Forest land area with approximately 15 to 50 percent hemlock canopy cover. Of 140 selected areas in this alternative, 94 areas, or 67 percent, are estimated to be dispersed recreation use sites. However, though the percent of the number of areas of dispersed recreation decreases from Alternative 2, the land area affected actually increases by 844 acres. This apparent contradiction arises from combining small and scattered areas, as originally proposed, into larger and more effectively treated blocks. This alternative is therefore better than Alternative 2 at including dispersed recreation locations. But there is less assurance of protecting recreational physical character at key places because predator beetles are not expected to be as effective as chemical treatments.

Alternative 4. This alternative has the same basic effects as Alternative 3. The same areas are included. Like Alternatives 2 and 3, it protects about 31 percent of the Forest land area with more than 50 percent hemlock canopy cover and 54 percent of the Forest land area with approximately 15 to 50 percent hemlock canopy cover. However, the addition of insecticide will afford the greatest potential protection for dispersed recreation areas in the short to medium term. In addition, the natural reforestation with hemlock from existing seed source is more certain; provided the adelgid was no longer a threat.

Alternative 5. Outside of Wilderness, this alternative is the same as Alternative 4 and would have the same effects. Within Wilderness hemlock would be lost as a vegetation component. However, the difference between Alternative 4 and Alternative 5 is only eight areas and approximately 1200 acres. (*See the 'Wilderness' topic.)* The difference in recreation effects between Alternative 4 and 5 is a decrease of only 4 percent of the Forest land area with greater than 50 percent hemlock canopy cover being protected; that is, 27-percent versus 31 percent. There is no difference (54 percent in each) for the proportion protected with approximately 15 to 50 percent hemlock canopy cover.

Cumulative Effects

For developed recreation areas not included in a hemlock genetic conservation area, HWA treatments will be performed through NEPA decisions implemented through categorical exclusion process of documentation (FSH 1909.15 Section 31.12). It is expected that these areas will be protected thus generally protecting the developed recreation settings throughout the Blue Ridge

Mountains. These decisions and actions will supplement the genetic conservation design of this proposal and further hedge against loss of genetic diversity. Readily-accessible developed recreation sites are prime candidates for field testing new technologies or tools, collecting pollen or cones for propagation, monitoring of treatments, public education, or collecting sample materials for genetic variability testing. Each of these activities adds to the effectiveness of this proposal.

In the medium to long term, successful predator beetle release areas (provided parameters other than the tree cover are also acceptable) will likely become even more highly desirable as recreation settings. This effect is also possible with insecticide treated areas but to a lesser extent because; (1) the areas treated will be individually small and also scattered, (2) areas treated will be selected in large part for hemlock density, not recreation setting desirability, and (3) avoidance of water will ensure these areas not being the most-preferred recreation setting. A greatly reduced land area with hemlock cover in turn has potential to cause overuse and user conflicts. A countervailing factor would be if avoidance is caused by signing notifying the public of treatment with a biodegradable insecticide and/or the tagging / painting band on individual treated trees. Notification signs would be designed to get the public's attention. For this reason, there is the likelihood that they would detract from the emotional aspect of the desirability of the recreation setting.

The loss of hemlock from much of the forest removes our most tolerant species from forest succession. Until the adelgid, the successional trend has been an increase in the number and distribution of hemlock. Much of this change was favorable to the scenic quality and to the recreation setting. The great shade tolerance of hemlock made it very adaptable to the low or very low intensity vegetation management activities typically associated with recreation. Recreation setting quality will be more difficult to maintain in its absence. Other pending issues such as non-native pest like gypsy moth, dogwood anthracnose, and sudden oak death; non-native invasive plants; recurrent southern pine beetle epidemics; and advancing age and declining vigor of the forest generally cumulate with HWA to create a trend of declining recreation setting quality. Conversely, prescribed burning of uplands improves recreation setting by increasing distance views through the forest, stimulating herbaceous vegetation such as grasses, and making cross-country foot travel easier.

HWA-caused mortality creates a need for future hemlock restoration through planting of locally adapted seedlings. It adds to the many needs that already exist and those that will develop in the future, thus forcing prioritization of some things at the expense of others. Preparing for operational hemlock reforestation is expensive and time-consuming. Historic budgets and staffing will not be capable of preparing for hemlock reforestation in the medium term nor of planting hemlock long term, even if the adelgid were controlled and seedlings were available. Other insect or disease problems and invasive plants make this problem worse.

3.3.3 Wilderness

Wilderness is defined in Section 2 (c) of the Wilderness Act of 1964: "A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the community of life is untrammeled by man, where man himself is a visitor who does not remain." An area of wilderness is further defined by the Wilderness Act of 1964 to mean "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements and habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historic value."

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).

Wilderness has recognized "existence value" that is independent of actual use by an individual holding the existence value. Part of the existence value is to understand there are areas not manipulated by humans; that is - in the words of the enabling legislation- "*untrammeled*" by man. "Trammeling" does not mean "trampling"; rather it means "*enmesh, restrain, confine or hamper the freedom of*" (Webster's, 1984). In this specific case, it refers to the interference with natural processes. By this value, it is discouraging that even wilderness cannot be left alone.

The National Wilderness Preservation System now includes over 105 million acres in 44 states. Individual Wildernesses range in size from some that are millions of acres in Alaska and the Western United States to others that are much smaller in the eastern United States. Wildernesses also vary greatly in the amount of human influences surrounding them and affecting them.

Special provisions are in place within the Wilderness Act of 1964 to address forest health issues within a designated wilderness area. Section 4(d) (1) states that "*such measures may be taken as may be necessary in the control of fires, insects, and disease subject to such conditions as the Secretary deems desirable*." Supplemental to this direction, Section 2324.12 of the Forest Service Manual (FSM) states: "*Do not control insect or plant disease outbreaks unless it is necessary to prevent unacceptable damage to resources on adjacent lands or an unnatural loss to the wilderness resource due to exotic pests*."

The dilemma of how Wilderness can be "protected and managed so as preserve its natural conditions" while at the same time remaining "untrammeled by man" is recognized as a key topic in the Forest Service's *Wilderness Agenda: Thinking like A Mountain.* Exotic pests, both plants and other organisms, have the potential to drastically alter the natural processes in Wilderness. The question of whether or not to take management action to counteract an exotic pest or other unnatural influence is a difficult one. *In Naturalness and Wildness: The Dilemma and Irony of Managing Wilderness* (Landres, et. al. 2000) this is described as an emerging dilemma between managing for these two values which are both central to the concept of Wilderness. While it is important to manage this entity for both maintaining natural and wild character, large-scale ecological changes caused by unnatural influences such as exotic pests present difficult choices for the management of Wilderness. A decision either to act or not to act will have consequences for the natural or wild conditions of wilderness.

The U. S. Forest Service, Chattahoochee National Forest is weighted with the pending dilemma of leaving wilderness " untrammeled" versus meeting its' responsibility for providing for the viability of native plant and animal species and to maintain the " naturalness" of wilderness.

The enabling wilderness legislation recognizes "naturalness" as a basic, intrinsic characteristic of wilderness. The natural condition of wilderness in the Blue Ridge Mountains of Georgia is to have hemlock. The adelgid infestations would remove the Eastern hemlock species from the wilderness areas. Wilderness throughout the Blue Ridge Mountains ecological section without the characteristic hemlock species will be uncharacteristic, unnatural, and less desirable. For example, the demise of American chestnut has created forests that are now viewed differently by individuals who can remember forests with chestnut trees. This is in direct contrast to those individuals now who have never seen a native forest with chestnut.

Wilderness areas are unique forested ecosystems only in the sense that they were purposely designated because of outstanding characteristics associated with the landscape. The hemlock wooly adelgid, introduced as an exotic pest in North America by humans, is now unavoidably a component of the process of ecological succession. This is relevant to wilderness management as a forested landscape is expected to change in time and space. One of the underlying values of hemlock is that of the scenic beauty this tree species affords the wilderness recreation user. The image of the hemlock affording a scenic view, or providing a protective canopy under which one may camp is one prevailing concept coupled with the wilderness solitude factor. As such, general flat terrain, pools of water and absence of appreciable forest litter associated with hemlock communities, afford prime camping areas for the recreationist.

Initially there was a predisposition not to intervene in wilderness with respect to hemlock woolly adelgid: especially not with non-native species or synthetic chemicals. The major reason for this is neither biological nor ecological but human perception. It is not so much the effects in the environment of well–studied tools or techniques, but rather the impact to people in knowing that wilderness has had these activities take place. The effects and projected progression of infestation are projected to eventually reach up to 100% mortality of both Eastern and Carolina hemlock species.

Existing Conditions

In terms of meeting the purpose and need of genetic conservation, national forest ownership on the Chattahoochee is in two distinct and separate areas. (Refer to the ‘Forest Cover’ topic.)

In Georgia, within the Chattahoochee National Forest 117,378 acres have been Congressionally designated as Wilderness. These Wildernesses include Big Frog, Blood Mountain, Brasstown, Cohutta, Ellicott Rock, Mark Trail, Raven Cliffs, Rich Mountain, Southern Nantahala, and Tray Mountain.

In addition, the Chattahoochee National Forest has eleven areas encompassing approximately 8,100 inventoried acres that have been recommended for wilderness under the 2004 Forest Plan. The eleven areas include Ben Gap, Cedar Mountain, Duck Branch, Ellicott Rock Addition, Foster Branch, Helton Creek, Ken Mountain, Shoal Branch, Tate Branch and Tripp Branch, and Wilson Cove. These areas are managed to protect the roadless attributes until Congress determines whether or not to include them in the National Wilderness Preservation System. Such areas are places that have retained or are regaining a natural untrammeled appearance; any signs of prior human activity are disappearing or being muted by natural forces. These recommended additions to existing wilderness study areas satisfy the definition of wilderness found in Section 2(c) of the 1964Wilderness Act (FSH 1909.12, Chapter 7, and Item 7.1).

Hemlock conservation areas exist within the inventoried roadless areas. This is not to say that 100% of all these hemlock conservation area acres are in essence “recommended” wilderness study areas. The Forest Plan recommended that Congress study about 8,100 acres of the inventoried roadless areas for addition to the National Wilderness Preservation System.

Hemlocks and hemlock related plant communities are a substantial component of most of the designated wilderness areas in Georgia. Hemlock conservation areas are located in all the wilderness areas in Georgia with the exception of the 89 acre Big Frog Wilderness. The primary portion of the Big Frog Wilderness (7,993 acres) is located in Tennessee on the Cherokee National Forest.

Table 3.3.3.1 displays the number and type treatments proposed in the wilderness by alternatives.

Table 3.3.3.1: Number of Treated Areas in Wilderness and Recommended Wilderness by Alternative and Treatment Type

Wilderness Area	**Type Treatment Alternative 2**	**Acres**	**Conser Areas**	**Type Treatment Alternative 3**	**Acres**	**Conser Areas**	**Type Treatment Alternative 4**	**Acres**	**Conser Areas**	**Type Treatment Alternative 5**	**Areas**	**Conser Areas**
Blood Mountain	Insecticide & Beetle Release	43	1	Beetle Release only	43	1	Insecticide and Beetle Release	43	1	None	0	0
Brasstown	Insecticide & Beetle Release	150	4	Beetle Release only	150	4	Insecticide and Beetle Release	150	4	None	0	0
Cohutta	Insecticide & Beetle Release	472	7	Beetle Release only	506	7	Insecticide only	39	2	None	0	0
Cohutta							Insecticide and Beetle Release	622	7			
Ellicott Rock	Insecticide only	26	2	Beetle Release only	80	4	Insecticide only	42	3	None	0	0
Ellicott Rock							Insecticide and Beetle Release	38	1			0
Mark Trail	Insecticide & Beetle Release	125	2	Beetle Release only	131	3	Insecticide and Beetle Release	131	3	None	0	0
Raven Cliffs	Insecticide & Beetle Release	3	1	Beetle Release only	53	2	Insecticide and Beetle Release	53	2	None	0	0
Rich Mtn.	Insecticide & Beetle Release	1	1	Beetle Release only	1	1	Insecticide and Beetle Release	1	1	None	0	0
Southern Nantahala	Insecticide & Beetle Release	19	1	Beetle Release only	19	1	Insecticide and Beetle Release	19	1	None	0	0
Tray Mtn.	Insecticide & Beetle Release	40	1	Beetle Release only	203	2	Insecticide and Beetle Release	203	2	None	0	0
Recommended wilderness areas	Insecticide & Beetle Release	350	5	Beetle Release only	350	5	Insecticide and beetle release	350	5	None	0	0
Total		**1,229**	**25**		**1,536**	**30**		**1,691**	**32**			

Effects of Alternatives

The hemlock populations and associated plant communities are a distinct visual attribute contributing to wilderness character. The "naturalness" and value of wilderness as a biological benchmark is threatened if the great majority or all of the hemlock population is extirpated and former plant associations with hemlock no longer occur. However, chemical treatments or biological control of the hemlock wooly adelgid result in diminishing the "wildness" of the wildernesses with the direct intervention of technology to mitigate a large-scale outbreak of an exotic pest. Trammeling will be a direct consequence of human activity through calculated chemical and biological treatments performed to manipulate the ecological process.

Chemical treatments inside wilderness should be carefully considered because of their potential effects on the total biological complex.

It is the potential level of adelgid infestation with resultant hemlock mortality that will ultimately influence the recreational values associated with Georgia's wilderness areas as with the roadless areas that could be recommended as wilderness areas. It is upon this contention that treatments were encompassing insecticide or beetle release techniques were stated in Alternatives 2, 3, and 4. As outlined earlier in this section, roadless areas are, from a criteria analysis standpoint, areas that fulfill the definition of wilderness. It is appropriate; therefore, in the direct and indirect effects analysis that these roadless areas be implied as wilderness.

Direct and Indirect Effects

Effects Common to All Alternatives

Hemlock mortality will occur in Wilderness and recommended wilderness in each alternative. This mortality will occur because of a non-native species becoming established in Wilderness. This effect is unavoidable with current knowledge and tools. It is also reasonable to expect that non-native predator beetles introduced outside Wilderness or wilderness study will be transported into Wilderness. Additionally, no alternative will prevent a decline in the quality of recreation settings in Wilderness or wilderness study on untreated areas. 'Naturalness' will be reduced because sites ecologically suited to hemlock and currently having hemlock will lose this element of their species diversity.

Effects Common to Action Alternatives

The presence of Forest Service personnel administering treatments or conducting monitoring would be a direct effect on "wildness" for those recreationists who encounter them. Any evidence of treatment or monitoring when Forest Service personnel are not present would be subtle. Encounters with Wilderness users will be mitigated in each action alternative by the timing of activities to occur in off-peak use periods. Even with the implied objective to conduct treatments at times of projected low wilderness visitation there will be the innate possibility that individuals will be concerned. This concern may be expressed both from a mental of emotional standpoint that the use of a synthetic chemical has been utilized or that non-native species has been released to control another non-native species. Posting of wilderness trailhead information boards informing wilderness recreationists of treatments and mitigating measures with respect to treatment applications may serve to reduce this potential for concern. Treated hemlocks may be tagged or painted to designate them as a tree for monitoring after initial treatment efforts. The physical imprint left on the hemlock of stem injection will have a direct effect upon the wildness, naturalness, and trammeling as this artificial interaction is abhorrent to the wilderness ecosystem

Naturalness will be maintained though these same alternatives should either chemical or biological treatments will be initiated. If no treatments were to occur, the naturalness would be retained as the wilderness plant communities would restore site species "naturally" replacing the hemlock mortality. Trammeling as used in the Wilderness Act enabling legislation would be compromised in Alternatives 2, 3, and 4 as treatments in wilderness areas would be a manipulation on the part of human interaction within wildernesses to suppress the adelgid infestations. Also, the direct biological effects of chemical and biological treatments in Alternatives 2 and 4 and biological control measure only in Alternative 3 are described under "biological effects" at the beginning of Chapter 3. Other effects on the wilderness resource are primarily indirect.

Alternative 1. Hemlock mortality will likely approach or reach 100% over time with a number of resulting effects.

The value of wildernesses as a biological benchmark of conditions least altered by total human influence will be reduced.

Wilderness character will be altered to a high degree because of visual changes.

The overall "naturalness" of the wildernesses will be negatively affected to the highest degree in this alternative by the disruption of natural processes. The extirpation of a native tree species by a non-native will render the affected portion of Wilderness un-natural in species composition.

All the older groups of hemlocks; that is, potential or existing old growth, that now exist would likely be lost.

The current level of "wildness" of the wilderness resource would remain unaltered because of the lack of direct human intervention to mitigate the effects of hemlock wooly adelgid. Following the mortality of the entire host, the HWA would also die, removing this non-native from the Wilderness setting. Without its host, non-native predator beetles will not become established. They would be expected to be dispersed by wind, flight, etc into Wilderness but – finding no host – they would die out. The net effect would thus be to lose one tree species that could be re-introduced by planting rather than introduce up to five non-native insect species in perpetuity; that is, the adelgid plus up to four non-native predators. Due to the silvical characteristics of hemlock, it is a species that could feasibly be under-planted in Wilderness should the adelgid threat no longer apply.

Trammeling efforts would not be incurred as no manipulative action would take place. The hemlock mortality would be unabated by the intercession of human induced treatments.

Alternative 2. This alternative proposes treatment in 25 hemlock conservation areas - a total of 1,229 acres (1.0% of the total wilderness area). The overall chances of faster recovery of hemlock populations and hemlock associated plant communities in wildernesses are best in this alternative. This provides the lowest proposed level of protection to the "naturalness" of the wilderness resource. Hemlock mortality would still likely approach 70-80% because much of the hemlock population would remain untreated. Some of the more easily accessible key groups of older hemlocks could be chemically treated to give them the best chance of long-term survival. Also, the majority of conservation reserve areas in wilderness are in the vicinity of trails. The treatment of these areas would likely result in less downed hemlock near trails.

However, the process of chemical treatment brings an inherent reduction in the "wildness" of the wilderness resource because the treatment process would involve repeated human interventions even though it is intended to reduce the degradation of the biological and visual aspects of wilderness character. The introduction of the non-native beetles is also a human intervention with the intent of reducing biological degradation. The biological control to check the spread of the non-native hemlock wooly adelgid involves a compromise of choosing the non-native beetles to combat the non-native adelgid. The treatments would be virtually invisible except for technical experts occasionally administering treatments or monitoring vegetation. The overall effect on "wildness" would generally be subtle, especially if the beetles prove to be highly effective and all chemical treatments can eventually be curtailed. Trammeling would be paramount as human intervention is initiating treatments.

Alternative 3. The direct and indirect effects are similar to Alternative 2 in relation to the introduction of the beetles. In terms of conservation areas treated, 30 areas would receive treatment for a total of 1,536 acres (1.3% of the total wilderness area). The "naturalness" of the wilderness will be affected only in terms of the infested adelgid not serviced by the predator beetles. Unabated disruption of the natural process would occur as a result of hemlock tress not saved through adelgid/ predator beetle interaction. Natural retention of key remnant stands and older hemlocks would not be as assured, but the repeated human intervention with chemical treatments and its inherent reduction in the "wildness" of the wilderness resource would *not* be a factor in this particular alternative. The human intervention would be slightly more subtle because only the beetles would be introduced as a treatment. Trammeling would be the same as in Alternative 2.

Alternative 4. In alternative 4, treatment of 32 conservation areas would occur - totaling 1,691 acres (1.4% of the total wilderness area). As in Alternative 2, the probability/chance of recovery of hemlock population is greatest in this alternative. Additionally, this alternative would be ideally treating the greatest number of hemlock component acres. This alternative provides the highest proposed level of protection to the "naturalness" of the wilderness resource. As in Alternative 2, hemlock mortality would be high – approaching as in alternative 2 and 3, 70-80% because even in this alternative as in alternatives 2 and 3 where insecticide/ predator beetle actions are initiated, hemlock component stands would remain untreated. As in Alternative 2 the proximity of the hemlock conservation areas adjacent to or in the vicinity of established trail corridors will result in less downed hemlock on or near the trail as a result of their treatment.

As in Alternative 2, the use of insecticide/predator beetle release methods to suppress hemlock wooly adelgid infestations will have a negative impact to the "wildness" characteristic- influenced to a great extent as in Alternative 2 by human "intrusion" to either perform the chemical treatment or to release the predator beetles. Further treatments through biological control methods would impact the "wildness" aspect only from the standpoint of occasional repetitive treatments and or monitoring activities. Subtle effects would be placed on the "wildness" as in Alternative 2 - with the anticipation of the effectiveness of the beetle release taking precedence over the chemical treatments.

Trammeling would be present through human endeavors to artificially induce treatments to impede the adelgid infestations.

Alternative 5. The same value of wilderness will be expressed in this alternative as in Alternative 1 since no treatments in Wilderness occur. The efficacy of the genetic conservation design would be weakened in this alternative in comparison to the other action alternatives. In particular, the genetic network would be greatly weakened in the Metasedimentary Mountains ecological section of the Chattahoochee-Oconee National Forests.

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 (1, 2, 3, 4 or 5) is implemented. Trammeling would be present in alternatives 2, 3 and 4 where treatment interaction is taken to treat adelgid infestations.

Alternative 1. Based on observations in the Northeast, one could expect losses of over 90% to occur within the next ten years, and perhaps 100% over a longer time, although the exact timeframe cannot be accurately predicted. As the hemlock dies, it is likely that non-native invasive species will replace them in some locations. This is likely to occur with aggressive species such as *Pawlonia* in areas where dead hemlocks tip over leaving disturbed ground provided seed will be vectored to these sites. Over time this will further degrade the “naturalness” of the wilderness resource and create problems in removing these additional non-native invasive species.

Alternative 2. There will be similar effects in some parts of the wildernesses because most of the hemlock population won’t receive treatment unless more cost-effective methods are found or the beetles spread to keep the adelgid in check faster than anticipated. However, because of more of the populations of hemlock being in place, the recovery of the hemlock population will likely be much faster than if it were completely extirpated from the wildernesses. There will be some reduction in the “wildness” of wilderness because of the continuing chemical treatments and the monitoring of beetle releases. However, the effects to wildness from these actions would be of very short duration and unnoticeable once the activity is complete. There is a chance chemical treatments would be curtailed if beetle releases are highly successful.

Alternative 3. There will be effects along the lines to those in Alternative 2. The lack of chemical treatment may result in a smaller hemlock population being present in the future and may slow long-term recovery of the hemlock populations. This will consequently result in more areas impacted by non-native invasive species. The lack of chemical treatment will entail a slightly more subtle overall human influence in the wilderness environment over time.

Alternative 4. As in Alternative 2 and 3, emphasis is on the rate of spread of the predator beetle and the efficiency it has in combating the hemlock wooly adelgid. Cost/effectiveness ratios will dictate the success of the suppression effort of the hemlock wooly adelgid. As in Alternative 2, chemical treatment will reduce the “wildness” due to the impact of human intrusion in the wilderness setting. Cost effectiveness may be circumvented in the reality predator beetle release is highly effective with chemical treatments taking a secondary or even absent role from the treatment process as in Alternative 2.

Alternative 5. As with Alternative 1, losses within the wilderness area theoretically could be 90- to 100% as no treatment measures either chemically or biologically would be implemented. The same concern as in Alternative 1 would be a relevant concern-that of invasive species of a non – native nature becoming established plant communities in the wilderness areas with detrimental effects on the “natural” character of the wilderness.

3.3.4 Old Growth

The Southern Region has a policy to identify and retain a network of old growth blocks of small (<100 acres), medium (100 to 2,499 acres) and large (> 2,499 acres) sizes (Forest Service, 1997). The Forest Plan allocated lands to meet the Regional 'large' and 'medium' old growth block size requirements. But it also provided a strategy to allocate 'small'; that is, less than 100 acre, blocks of old growth at the project level. Within the regional and Forest framework, an HWA control strategy appropriately includes consideration of small blocks for incorporation into the overall strategy.

There is no plant or animal species known to be 'obligate'; that is, totally dependent on, old growth conditions in the Southeastern US. However, old growth has a social value and also has a diversity of vegetation characteristics that makes it especially varied in plant and animal habitat niches.

The Regional old growth guidance recognized a group of seven characteristics that taken all together, or in some combination, distinguish old growth from younger communities.
These characteristics are:

(1) large trees for the species and site;
(2) wide variation in tree size and spacing;
(3) accumulations of large-sized dead standing and/or fallen trees in amounts that are high in comparison to earlier growth stages within the same community;
(4) decadence in the form of broken or deformed tops or boles and root decay;
(5) multiple canopy layers;
(6) canopy gaps and
(7) understory patchiness.

These characteristics are inter-related. The older a stand becomes the greater probability it either has or will experience weather, insect, or disease disturbance; or combinations of them. Physiological changes occur with age often stressing or physically weakening trees and making them more vulnerable to these disturbances. The death of trees creates the canopy gaps, variation in spacing, and the accumulation of dead and fallen trees that are characteristic of old growth. Gaps, in turn, raise the light intensity within them and in a zone around them supporting greater photosynthesis for the development of multiple canopy layers.

The seven old growth characteristics were reduced to a set of three defining biological operational criteria for old growth. A fourth defining operational criteria was added that is not a biological characteristic. The four criteria are:

(1) a minimum age in the oldest age class,
(2) a minimum basal area (a measure of stem density) in stems 5" in diameter at 4.5 feet above the ground (called 'diameter at breast height or 'd.b.h.),
(3) a minimum diameter at d.b.h., and
(4) no obvious evidence of human-caused disturbance that conflicts with old growth characteristics.

The Regional old growth policy also gave operational definitions for sixteen old growth community types that, among them, encompassed all of the forest cover types in the Southeast US. Forests retained some flexibility in matching their vegetation data to each old growth type to reflect local ecological differences.

The four forest cover types associated with hemlock (*see 'Forest Cover' topic*) have been cross-walked on the Chattahoochee to old growth community type number 5 – 'mixed mesophytic'. Farther north within its range, hemlock would reasonably be associated with old growth type 2 – conifer-northern hardwoods. However, on the Chattahoochee the 'northern hardwoods' such as aspen (*Populus sp.),* yellow birch (*Betula lutea),* pin cherry (*Prunus pennsylvanica)* and mountain ash (*Sorbus americana)* occur as occasional individuals associated with high elevations and moist conditions rather than as an extensive tree cover. And hemlock, as discussed in the 'Forest Cover' topic, is most abundant at mid-elevations outside the natural distribution of 'northern hardwoods' in Georgia. The other cover types within old growth type 5 are: (a) 09 – white pine-cove hardwood, (b) 50 – yellow poplar, and (c) 56 – yellow poplar-white oak-red oak.

Within the Blue Ridge Mountains and on the Chattahoochee, old growth type 5 had about 6,500 acres of potential old growth as of 1994 (Forest Service, 2004). Within this amount, potential old growth stands with greater than 30 percent hemlock composition in the main canopy are 7 percent.

The defining biological criteria for old growth type 5 are:

(1) minimum age in oldest age class of 140 years,
(2) a minimum basal area of stems greater than or equal to 5 inches d.b.h. of 40, and
(3) the d.b.h. of the largest trees greater than or equal to 30 inches.

(Note that, unlike age, diameter is of the largest trees, not the oldest.) As context for comparison, a basal area of 40 could be; (a) 37 trees of 14-inch d.b.h. per acre with an average spacing of 34 feet, or (b) only 8 trees of 30-inch d.b.h with an average spacing of 74 feet, or (c) any other combinations amounting to 40 basal area so long as it included 30-inch d.b.h. trees. The old growth guidance also stipulated that, in general, "*… the criteria for the d.b.h.'s of the largest trees are applicable when at least 6 to 10 trees per acre …are present.*" That is, 6 to 10 trees of the minimum d.b.h.

Using 2005 as the base year, all old growth type 5 stands with a 'birth year' in the CISC vegetation database of earlier than 1866 would be potential old growth. (It is 'potential' because the other three criteria must also be met before it meets 'existing' old growth.) The vegetation database uses an 'AGE_YEAR' data field to show the best estimate of the year the vegetation community began life; that is, a 'birth year'. This permits a dynamic calculation of the age of the community at any point in time. The birth year is field-determined by extracting a slender 'core' from the tree using a hollow steel bit and counting the annual growth rings into the center of the stem. It should be considered an estimated age rather than actual because; (a) the borer may miss the tree center, (b) trees may not have a growth ring every year if greatly stressed, (c) a few years are added to the count for the time it took the tree to grow up to the point where it is cored, but this number is an estimate, (d) there may be damage to the rings such as a fire scar or internal rot, or (e) the tree, or trees, chosen to be bored is, or are, assumed to be representative of the entire vegetation community. Because of the great shade tolerance of hemlock, it can have very dense and hard to count rings, also the age of trees growing even in close proximity can vary very widely and diameter is not a reliable indicator of age as it is with intolerant trees that maintain more uniform growth rates.

Region 8 operational guidance for field age determination prior to the release of the old growth policy in 1997 was to age for the *predominant* condition. Particularly in the Blue Ridge Mountains, a two-age structure is not uncommon with the oldest trees being relics from the so-called 'logging era' of about 1880 to 1930. Since old growth determination requires aging the oldest trees, the 'AGE_YEAR' data can be expected to underestimate for potential old growth.

Nevertheless it is the best available data. That is one reason why internal and external outreach was done to identify additional areas.

It should also be recognized that each of Alternatives 3, 4, and 5 include acres that are not classified as a hemlock forest cover type nor as a mixed forest cover type with significant hemlock; that is, they should not have more than 30-percent canopy cover of hemlock. These areas were identified by internal scoping and by public comment. Their locations and size typically do not correspond to entire mapped stands. They may be a smaller area within a large stand or be a sub-area within several stands. In either case, given the great shade tolerance of hemlock, we did not assume that the age shown in the vegetation database was correct for the hemlock component. If individual hemlocks are survivors of historic logging and fire, they likely are of great age. In the individual area listing in Appendix C acres without a hemlock or mixed hemlock forest cover type are shown with an age of "0". Also, given the low number of stems per acre in the oldest age class that can qualify a stand for old growth, the numbers shown here from the CISC database should be considered a very conservative estimate of potential old growth. Their importance is to provide an ability to compare the alternatives relative to each other

We queried the vegetation database used for the Forest plan revision for stands having a forest cover type of 04, 05, 08, or 41 and an age of 140 or greater. Only ten stands met these criteria. A summary of the acres of potential old growth within each of these types is presented in the table below.

Table 3.3.4.1 Potential Old Growth Acres with Hemlock by Forest Cover Type

Forest Type	Forest Type Name	Number of Stands	Acres
04	White pine-hemlock	2	31
05	Hemlock	1	21
08	Hemlock-hardwood	1	16
41	Cove hardwoods-white pine-hemlock	6	404
	Total	10	472

Source: Continuous Inventory of Stand Condition (CISC) database as modified for Plan revision 2002.

Effects Common to All Alternatives

The primary direct negative effect on potential old growth of taking no action will be to very soon lose that portion of the hemlock population that is already at or beyond the minimum old growth age. Since the Regional old growth policy calls for determining the age of the oldest trees in each vegetation community, if hemlock trees are those oldest trees HWA-caused mortality could convert a community meeting all criteria for existing old growth to a condition no longer meeting all criteria. That is, both existing and potential old growth would be lost. In situations where hemlock are also now the largest trees in the community, the largest trees will be lost and the variation in tree size will be reduced immediately; that is, the range in diameters from the smallest to the largest stems will be reduced. However, where white pine is an associate, it has a much faster growth rate and can be expected to be the largest trees. HWA attack will negatively affect decadence of hemlock as an old growth characteristic because the hemlock will not survive.

Mortality of hemlock will also have positive direct effects to old growth characteristics.

> Canopy gaps, one of the features of old growth, will be created. Depending upon the exact nature of vegetative response in these gaps, multiple canopy layers and understory patchiness -

two more characteristics of old growth - will occur in the future within some; but not all, situations. If regeneration of other woody species is stimulated in the gaps created, a wide variation in tree sizes and spacing - an old growth characteristic - will again gradually develop as regeneration moves through seedling, sapling, and pole stages in mixture with large trees that existed pre-HWA. Where a dense understory of rhododendron currently exists, it may largely prevent the development of new regeneration so new canopy layers will not be formed. Where heavy shade created by dense hemlock has suppressed the development of an understory, patches of shrub layer will be stimulated.

The death of hemlock will immediately and directly result in an accumulation of large-sized snags compared to both current and previous conditions in the same community; another old growth characteristic. As snags fall in the future, there will be an accumulation of large down woody debris; another old growth characteristic. The fall of hemlock snags may break limbs or tops and wound the boles of other associated tree species as those snags fall. This damage would contribute to future decadence and deformity of those trees and so indirectly positively affect that characteristic of old growth.

The overall diversity, both species richness and structural, within old growth type 5 would decrease. Hemlock would gradually disappear as a component species. Vertical structural diversity would decrease for two reasons; (a) the great shade tolerance of hemlock makes it a valuable contributor to the 'multiple canopy layers' characteristic of old growth, and (b) since hemlock is slow to self-prune it typically has a much greater proportion of its bole in live crown compared to its associates.

The death of hemlock would result in a re-categorization of some of the acres affected into old growth type 2 – conifer-northern hardwood. Only one forest community type – white pine – is assigned to this old growth type on the Chattahoochee. Existing forest type 04 – white pine-hemlock would shift to type 03 – white pine and old growth type 2. However, only about 1,500 acres would be affected in this way.

Reclassification of other acres following the loss of hemlock would keep them within old growth type 5. For example, existing forest type 41 – cove hardwoods-white pine-hemlock would likely become forest cover type 09 – white pine-cove hardwood. Old growth types 2 and 5 are similar in the parameters for existing old growth. The loss of hemlock is not the same as the loss of old growth type 5 because there are numerous other moist site species forming complete vegetation communities included within the group. These include; northern red oak (*Quercus rubra),* yellow poplar (*Liriodendron tulipifera),* buckeye (*Aesculus octandra),* basswood (*Tilia americana),* and white pine (*Pinus strobus).*

The death of hemlock will affect the ability to maintain old growth characteristics into the future. One of the values of hemlock to old growth is its great longevity, as much as 800 years, much longer than its associates. In addition, prior to the introduction of the adelgid and another insect called hemlock scale, hemlock had few natural enemies that could cause mortality. And its extreme shade tolerance allowed it to sustain itself in the absence of disturbance, unlike many other intolerant or only moderately tolerant species. Its core habitat of the most sheltered locations also tends to protect it from weather-related disturbance and it is resistant to snow and ice breakage.

Overall, the major effect of hemlock loss on old growth will be one of a loss of quality because of a loss of species diversity; that is, the quality of old growth type 5 will be lessened by the absence of one of its component species. This will affect the social value of old growth more than biological values. And these ties with the values people have for hemlock generally, regardless of its age or connection to broader landscape characterizations. This underscores another value for a genetic reserve system, that of maintaining representation of the full suite of species for the ecological unit. (Note, 'unit' is being used generically to mean any appropriate scale.)

Summary of Potential Old Growth by Alternative

The table below shows how much potential old growth is protected in each alternative. Alternative 1 – the No-Action – shows the total amount of hemlock or mixed types with hemlock potentially qualifying for being existing old growth from the CISC database. Then each succeeding alternative shows the subset it would protect, first as acres then as a percent of the whole.

Table 3.3.4.2: Amount of Potential Old Growth Type 5 – Mixed Mesophytic – Protected By Alternative

Potential Old Growth Acres Treated By Alternative				
Alt. 1	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**
473	134	121	504	454
100%	28%	26%	107%	96%

Source: GIS stands data layer as used for Forest Plan revision.

<u>Alternative 1 - No action</u>

An estimated maximum of 68 acres of potential old growth would be lost. Thirty acres of this would be lost by a shift into old growth type 2. The remaining thirty acres would be expected to be lost by mortality being so heavy in the affected stands that they would no longer meet old growth criteria. The remaining approximately 400 acres of potential old growth in forest cover type 41 would have their overall old growth characteristics enhanced in both the near and the medium term, unless the hemlock component is either; (a) the oldest trees, or (b) the largest trees, or (c) both. However, several associated species in this cover type have a much faster growth rate; for example, northern red oak, yellow poplar, and especially white pine. The most likely case is that hemlock would be the oldest age class and their death could, for a time equal to the difference between the age of other species and 140 disqualify a stand as existing old growth.

<u>Alternative 2: The proposed action</u>

Only 28 percent of the potential old growth with hemlock would be protected; that is, hemlock retained. The remaining 72 percent of it would have no treatment and hemlock would be lost. The 28 percent is in forest cover type 41 where hemlock mortality is unlikely to preclude meeting old growth criteria. Therefore the effects are similar to the No-Action. An estimated maximum of 68 acres of potential old growth would be lost. Thirty acres of this would be lost by a shift into old growth type 2. The remaining thirty acres would be expected to be lost by mortality being so heavy in the affected stands that they would no longer meet old growth criteria. The remaining approximately 270 acres of unprotected forest cover type 41 would have their overall old growth characteristics enhanced in both the near and the medium term, unless the hemlock component is either; (a) the oldest trees, or (b) the largest trees, or (c) both. However, several associated species in this cover type have a much faster growth rate; for example, northern red oak, yellow poplar, and especially white pine. The most likely case is that hemlock would be the oldest age class and their death could, for a time equal to the difference between the age of other species and 140 disqualify a stand as existing old growth.

Alternative 3: Modified proposed action but beetles only

The effects of this alternative are the same as for alternative 4 except that the very limited area protected with about 98 percent effectiveness with insecticide could also have some hemlock mortality with complete reliance on predator beetles. At the present time with current knowledge, this effect cannot be reliably quantified.

Alternative 4: Modified proposed action

This alternative protects all potential old growth stands and in addition includes acres identified by the public as being potential old growth. The true importance of the numbers is not their precise value but rather they demonstrate that Alternative 4 is superior to each of the others in conserving old growth type 5. Some mortality can yet be expected outside of insecticide treated groups, but probably not enough to result in disqualifying a stand from meeting old growth criteria. Mortality of lesser degree will actually enhance old growth characteristics.

Alternative 5: Modified proposed action but no Wilderness

Based on CISC, only one area of approximately 20 acres of potential old growth would be left unprotected if there were no treatment of any kind in Wilderness. This is 4 percent of the potential old growth with hemlock composition and only 0.3 percent of the potential old growth in old growth type 5 in the Blue Ridge Mountains and on National Forest. When public input for potential old growth areas is also considered, excluding Wilderness would fail to protect approximately 106 acres in the Cohutta Wilderness. The primary effect would not be a loss of old growth resource but a small decline in the overall quality of the Wilderness setting at the scale of the entire Forest. This is because of the cultural values held for first Wilderness, then for old growth, then specifically for hemlock and the compounding effect of these with each other.

Cumulative Effects

As identified in the 'Forest Cover' topic, planned management effects to hemlock are limited to prescribe burning and the major effect is hemlock mortality. However, this mortality would be occurring in the small diameter hemlock encroaching into the uplands. This hemlock is not a component of the appropriate old growth community type of the stands now on these uplands. Much of this hemlock is of less than 5-inch diameter and therefore does not contribute to meeting the old growth basal area requirement in these stands. It is also neither the largest diameter stems nor the oldest age class. Its contribution to old growth in these circumstances is to contribute to the 'multiple canopy layers' old growth characteristic. However, this characteristic is reliably met by other species that are both more fire tolerant and better ecologically suited to the upland locations.

3.3.5 Heritage Resources

The proposed project has no potential for effect, adverse or beneficial, to heritage resources, and therefore is exempt from full Section 106 review. 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.

3.3.6 Road Management

Woolly Adelgid affects the forest system roads indirectly. There will be an increase in standing dead timber if the infestation if not treated. Standing dead timber adjacent to the roadway increases the amount of hazard trees, which must be removed using either force account, work force or through public works contracts.

3.3.7 Human Health and Safety

Key concepts to the discussion of this topic are the difference between 'hazard', 'exposure' and 'risk'. In non-technical communication, these terms are often used inter-changeably though they refer to distinctly different concepts.

- "Hazard" is defined as *'a source of danger'* (Webster, 1984). Standing dead trees are a hazard whether people are present or not. But not all trees are equally hazardous. Small trees are less hazardous than large ones.
- "Exposure" is '*the condition of being subject to some condition or effect'* (Webster, 1984). Even if trees are hazardous, if no people are present, human exposure is zero.
- "Risk" is defined as *'probability of loss or injury'* (Webster, 1984). Risk results from exposure to a hazard such as people being present within a tree height of a standing dead tree.

Taken together, hazard plus exposure to it causes risk. Both hazard and exposure are dynamic; that is, they can each change through space and time. Environmental conditions can increase hazard; for example, dead trees are increasingly hazardous until they fall. Human behavior can increase exposure; for example, camping for several days among dead trees. An increase in either hazard or exposure increases risk. Humans routinely make judgments about acceptable and unacceptable levels of risk; in part because we know that zero risk is not possible. Mitigation of risk typically involves either: (a) reducing hazard, reducing exposure, or both; or (b) removing hazard, removing exposure or both. An example of removing the hazard is felling dead trees. An example of removing the exposure is closing areas to human use. Ultimately, as already pointed out, it is impossible to reduce risk to zero.

For imidacloprid, the active ingredient in several products potentially used for HWA control, hazard does not change for a specific formulation. EPA registration procedures have ensured rigorous, lengthy, and expensive analysis of the hazards associated with the material itself. Exposure is the variable subject to change and is the pertinent source of risk. Exposure arises from transporting, mixing, applying, and post-application use of treated areas. Of these, transporting, mixing, and applying are under Forest Service control and affect only applicators. Label restrictions are designed to reduce applicator exposure to a level with a wide margin of safety for human health effects. However, indirect exposure of members of the public who use the area is possible.

For untreated areas with HWA-caused hemlock mortality, the hazard is dead trees. Exposure is the presence of humans within the tree height of any dead tree. Risk is the probability that; (a) a dead tree or branches/bark on the tree will fall, combined with (b) a person being struck. There is a certainty that dead trees will fall eventually. The probability of people being present is highest with popular traditional dispersed recreation use such as camping along popular trout streams. More remote areas without road or trail access have the lowest probability of people being present. Hunting and fishing are dispersed recreation uses that can be reasonably expected to bring visitors to the more remote settings but in each activity the recreationist is mobile so exposure time is limited. Additionally, party size would be smaller, generally one to three people. Even in popular areas, the number of people present varies by factors such as time of year, day of the week, desirability of the setting, their perception of risk, etc. Perception of risk is in part a result of the effectiveness of public education to make people aware of the hazard. The probability of dead trees falling is greater with extenuating factors such as: high winds, water-saturated soil conditions, internal decay in a tree, shallow soils, etc. The probability a person could be struck varies by factors such as the number of people present at the time, the number of dead hemlock within a tree height's distance of their locations, their alertness, and their physical agility to avoid falling material. *(See 'Recreation' topic.)*

The association of hemlock with desirable or highly desirable recreation settings means that humans are likely to visit both some insecticide treated sites and untreated sites. For treated sites, the potential for visits is expected to increase with time because areas with living hemlock will be more desirable as a recreation setting in contrast to other areas where hemlock has died; especially if in untreated locations hemlock trees have already begun to fall down.

Summary of Alternative Effects

The greatest potential for human exposure to various risks of action or inaction regarding HWA is in dispersed recreation sites. Alternatives vary in the proportion of the area estimated to be suitable for dispersed recreation that they seek to protect. The Table below summarizes an estimate of the gross acres of desired dispersed recreation settings of the alternatives.

Table 3.3.7.1: Area and Percent of Estimated Dispersed Recreation Sites Treated and Untreated in Each Alternative

Variable	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Treated Acres	0	3,481	4,325*	4,356*	4,279*
Treated Percent	0	90	111	112	110
Untreated Acres	3,885	405	0	0	0
Untreated Percent	100	10	0	0	0

Source: GIS analysis od stands data layer, roads layer, and alternative maps.

- *Note: Acres exceed No-Action because of including more land area without a hemlock or hemlock-mixed forest cover type.*

For analysis purposes – as explained in the '*Recreation'* topic – dispersed recreation sites in action alternatives were estimated to be only those acres that were: (a) within a selected conservation area, and (b) within 300 feet of a road. In Alternative 1 – No-Action - the analysis was of forest cover types containing hemlock within 300 feet of a road. Action alternatives could exceed that figure by including more land area within 300 feet of a road that have some hemlock trees but not classified into a forest cover type reflecting hemlock composition; that is, below 30 percent canopy cover of hemlock. Alternative #2 reflects only acres which include hemlock in the type classification (acres with greater than 30% of the crown area being hemlock) while alternatives #3, #4, and #5 reflect acres with hemlock 'present' as described in the description of the alternative itself. The difference among the acreages proposed for treatment in the four action alternatives is very small.

Effects Common to All Alternatives

The primary direct effect of hemlock mortality on human health and safety will be heightened risk in untreated areas, or in unsuccessfully treated areas, of being hurt by falling limbs or boles of dead hemlock in the aftermath of infestation by the HWA. This effect occurs with all alternatives because no alternative attempts to save every hemlock. Alternatives differ in this respect only in the total amount of area proposed for protection; that is, not just dispersed recreation sites but all acres. Across the alternatives, the range is rather broad; from 100-percent untreated in No-Action to a low of 49 percent untreated in Alternative 4. This is the primary effect because, in comparison to treated areas, there is; (a) more land area affected, (b) more hemlock stems involved, therefore (c) more potential exposure of humans resulting in greater risk to visitors in untreated areas. At the scale of the entire Forest, the hazard can be expected to increase steadily to a maximum a few years after HWA has spread throughout the Forest when dead trees have deteriorated enough to be easily broken. It will then decline more or less steadily until either dead hemlock uproot and fall or break off and become relatively stable as short snags.

The period of greatest hazard is likely to begin about 2010 and continue until about 2015 or so. Risk can be expected to be highest on any one location a few years after HWA-caused mortality occurs. At that time, tree fall will have begun but not progressed to the point where the quality of the setting has declined so much as to cause people to seek a more desirable location. That is, the hazard is present but behavior has not been voluntarily modified so as to reduce risk.

Alternative 1

No treatment of any kind takes place outside of developed areas. Human health and safety would be at risk, especially in areas commonly used as dispersed recreation sites. The greatest risk would be for campers and at night because they are stationary and not alert to the threat. On a relative scale of hazard; that is HWA-affected areas compared among themselves, hazard would be greatest in areas with large hemlock and within these areas especially those where hemlock is also dense. An intermediate degree of hazard would occur with dense but small hemlock or areas with scattered large hemlock. Lowest hazard would be in areas with small and scattered hemlock. Effective public education about the hazard could mitigate the risk to a degree by informing people to avoid standing snag areas. Human preference for areas without hemlock mortality would also be expected to shift usage away from high-risk locations further reducing exposure. However, this voluntary behavior is not likely to completely avoid risk because; (a) not everyone will move to unaffected areas, and (b) preferred recreation sites (in the riparian area) are highly likely to have at least some hemlock nearly everywhere. Felling of hazardous trees, a common mitigation in developed recreation areas, is impractical in most dispersed recreation situations due to the high costs. This factor is particularly applicable in areas designated as Wilderness because motorized equipment is prohibited and the labor-intensive alternative would be crosscut saws.

Effects Common to Alternatives 2, 4, and 5

Each of these alternatives includes the use of the insecticidal chemical imidacloprid. The most common form of application would be soil injection at the rate of one ounce of dilute solution per inch of treated tree diameter at four-and-one-half feet above the ground. This analysis assumes the use of the Merit 75 WP product (that is, 75% of the product is imidicloprid) with 2 ounces of the powder, or 1.5 ounces of the imidicloprid active ingredient, diluted in 60 ounces of water. Each injection site would therefore receive 0.025 ounces of active ingredient. A 6-inch tree would therefore receive (6 X 0.025 ozs.) 0.15 ounce of active ingredient in an area of approximately seven square feet of soil.

Imidacloprid is referred to as a 'neonicotinoid, meaning that it has a physiological behavior similar to nicotine. Its mode of action is to bind to nerve receptors in such a way as to make them more active, causing – loosely speaking – an insect 'nervous breakdown'. However, behavior in vertebrates is different and it is classed as a low toxicity material to humans. It is available in some formulations over the counter to untrained and unlicensed applicators. It has an established food residue tolerance. After a review of the following toxicities: acute oral, acute dermal, acute inhalation, acute neurotoxicity, sub-chronic dermal, sub-chronic inhalation, sub-chronic diet, carcinogenicity, developmental, and reproductive diet; one environmental toxicologist characterized it as follows:

"***In summary, imidacloprid risk to humans seems nil even when all exposure sources are considered. Since imidacloprid poses no hazard by dermal and inhalation exposure, workers should face minimal risk as well****."(*Felsot, 2001)

This conclusion was based on typical imidicloprid use in agriculture; that is, foliar application typically by spraying, not soil injection as in a forest environment. The source document for this citation is available online at "*http://aenews.wsu.edu.*"

The primary direct effect of concern to human health and safety in the action alternatives is direct exposure to the insecticide imidacloprid by those using it. Soil injection and stem injection of imidacloprid would be performed by; (a) USDA Forest Service employees, (b) private contractors, or (c) both. Any such application would be under the supervision of a certified pesticide applicator trained and approved to use pesticides safely in a forest environment. All application will be in compliance with the insecticide label. Potential safety issues include: accidental spills of the product and accidental contamination of skin or clothing of the applicators.

The product currently proposed for use is Merit 75 WP. The name shows that it has 75 percent active ingredient and is a water-soluble powder (WP). Non-permeable gloves and a paper dust mask are standard personal protective equipment (PPE) worn when mixing.

A potential indirect effect of activities of Alternatives 2, 4, and 5 is post-application exposure to the imidacloprid insecticide of members of the public. Because the insecticide application is either into the tree stems or into the soil at the base of the tree, exposure does not occur with merely the presence of people at a treated site. These methods of injection eliminate the most common potential source of indirect user exposure; dislodging insecticide from treated foliage to skin is not possible when foliar treatment is not being used. However, there are several possible scenarios for which indirect exposure must be considered:

- A stem-injected tree cut into and the wood handled
- Soil around a soil-injected tree dug up and handled
- Twigs and needles of a stem or soil-injected tree eaten or chewed
- Free water directly contacted with the insecticide is handled or drunk.

The probability of any one of these behaviors occurring is at least low and likely very low even without cautionary signs. National Forest visitors are usually aware that cutting living vegetation without authorization is subject to a fine. Recreational information commonly available in published brochures, web resources, or on posters at trailheads or developed recreation sites make this clear and have done so for many years. The days of 'woodcraft' with lean-tos, beds, fire holes, etc made from native materials are a thing of the past, both by design and by the gradual shift of population away from rural life-styles. Similarly, the consumption of wild edibles is not a common activity. The greatest use of wood by recreationists is in campfires but living trees are not suitable for firewood.

There is no reason to expect that soil with imidacloprid would be dug up for any purpose. Soil injection is done close around the base of the tree, in a location that – even in the unlikely event a person were digging – would not be a location of choice. Even if digging occurred as a sanitary measure, such holes are still typically above the level of imidacloprid injection. The probe on a Kioritz soil injector is approximately 10 inches in total useable length. Imidacloprid solution is ejected near the tip and jets out to each side. Although the 'foot' on the soil probe is adjustable, injection will always be occurring below the surface of the soil and also below the forest floor leaf litter. Even in the very unlikely event that campers pitched a tent on top of a soil-injected area, they will not come into direct contact with imidacloprid.

The worst-case scenarios are if visitors were to brew and drink 'hemlock tea'; a woodsman's drink made with hemlock needles. It is conceivable that a rare individual would choose to brew some on a camping trip. It could easily be argued that such an event is remote and speculative but is useful as a 'worst-case'. From personal experience, the flavor of hemlock tea is very strong. Brewing the tea requires at most two teaspoons of needles in about a quart of water. Even those who made such a tea would be highly unlikely to drink as much as a six-ounce cup full. The acute toxicity 'reference dose' (RfD) for imidacloprid is a 42 mg/kg/day with a 'no observable adverse effect level,' (NOAEL) divided by a safety factor of 100 for humans, of 0.42 mg/kg/day. EPA applies a further 3X safety factor as well as a further margin to hedge for susceptible individuals such as children or the elderly. The Population Adjusted Dose (PAD) therefore becomes 0.14 mg/kg/day; that is, 42 mg/kg/day divided by 300. A risk assessment for imidicloprid is currently under contract by the Forest Service and is expected by late summer 2005 but it was not available for this analysis. In the interim, a preliminary risk assessment developed by certified pesticide applicators shows that the PAD is not even close to being exceeded if an individual were to drink hemlock tea with needles taken from a treated tree.

Mitigation measures in each alternative using imidacloprid are designed to both avoid using it where sub-surface free water is present within the injector probe reach and where treated trees have root contact with surface water. As described in the mitigations for each alternative, a site-specific determination of soil permeability is required and will also serve to detect ground water. In addition, imidacloprid is held by soil particles strongly enough to not leach but not so strongly as to not be taken up by hemlock's active transport mechanisms. EPA has reported that groundwater monitoring in California and Michigan showed imidacloprid residues of 0.1 to 0.2 ppb (parts per billion). In Long Island, New York a residue of 1.9 ppb was found. These amounts *"… are hundreds of thousands of times lower that levels that EPA said it would be concerned about.*" (Felsot, 2001) In the reference cited, the amount of imidacloprid used and the application method are not specified. However, it is probable that the monitoring was of agricultural applications.

Alternative 3

The effects of this alternative to human health and safety are limited to hazard, exposure and subsequent risk of falling trees. Of 140 selected areas in this alternative, 94 areas, or 67 percent, are estimated to be dispersed recreation use sites. However, though the percent of the number of areas of dispersed recreation decreases from Alternative 2, the land area affected actually increases by 844 acres. This alternative is therefore better than Alternative 2 at including dispersed recreation locations. But there is less assurance of protecting recreational physical character at key places because predator beetles are not expected to be as effective as chemical treatments.

Cumulative Effects

For all alternatives hazardous trees will become a common feature of the landscape in a subset of preferred recreation settings. The risk to humans will rise in comparison to the present. This risk increase is not completely avoidable with current knowledge and techniques.

Hemlock mortality is cumulative with southern yellow pine mortality from the latest southern pine beetle epidemic from 1999 through 2002. Although the species affected in these two catastrophes are not usually associated on the same site, the joint effect is to produce a greater degree of risk than previously existed on affected acres. And because now both uplands and riparian areas are affected, the risk is more widespread on the landscape. Beetle-killed trees have begun to fall in large numbers as of 2005 but likely will have largely fallen before hemlock fall is well underway. In addition to risk for recreationists, heavy fuel loadings, standing snags, and the resistance of wildfires in heavy fuels to being controlled poses risk for fire management for years to come.

No management actions are proposed, or likely to be proposed, that would cause further cumulative effects. Sites treated for HWA are highly unlikely to have other pesticide applications. The possible exception could be for suppression of any other non-native invasive that affected the same sites. No such pest is known or expected to occur in the near term; that is, prior to the 5-year monitoring report.

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APPENDICES

APPENDIX A

Hemlock Woolly Adelgid History and Biology

The hemlock woolly adelgid (or 'HWA') gets its common name from two facts; (1) it feeds on species of hemlock, and (2) it is covered by a white woolly secretion for much of its life. It is in the same insect group as the balsam woolly adelgid that has killed millions of Fraser fir at the highest elevations of the Southern Appalachians.

The adelgid is a tiny insect, less than 1/16th inch long; smaller than a single letter in this sentence. Because it is so small, wind, birds, and even mammals such as deer can move it. Once positioned on a hemlock, it feeds by inserting its piercing mouthparts into young branches and stems, usually near the base of the needles, and then sucking up the tree sap. Feeding in late winter and early spring slows, reduces, or even stops the normal spring flush of new growth. As continued feeding removes water and nutrients, existing needles turn color, dry up, and fall from the branches. Individual limbs may die first but with severe infestation, the entire tree crown turns grayish-green and thin. Without relief, trees die within about three to five years. With reduction or elimination of the adelgid, trees can recover if they have not been too weakened. Other opportunistic feeders can attack weakened trees.

The hemlock woolly adelgid was first described by Annand in 1924 from the US Pacific Northwest where it was collected on western hemlock (*Tsuga heterophylla*, Sargent). In 1937 the same species was collected from both Formosa and Japan leading to the conclusion that it is a non-native species to the US. The method and timing of its first introduction into America is unknown. In the Pacific Northwest and in Asia, the adelgid does not cause significant tree death.

In 1951 HWA was found near Richmond, VA.; believed to have been transported from the Pacific Northwest on infested nursery stock. Richmond is near the eastern edge of the contiguous hemlock range and initially spread was very slow. Until the 1980's, the threat was only to landscape plantings. Beginning in the 1980's and expanding rapidly thereafter, HWA spread westward, northward, and southward into and along the Southern Appalachians. The first confirmed occurrence in Georgia was in 2002. HWA is now firmly established in Rabun, Towns, and Habersham Counties within the Chattooga River, Tallulah River, Chattahoochee River, and Hiwassee River drainages. In 2003 and 2004, infestations were treated on a case-by-case basis as they were detected; that is, reactive, but the forecast for the future makes it clear that a more comprehensive pro-active effort is needed.

Based on the historic knowledge of the species, the search for biological controls has been – and continues to be – in Southeast Asia and in the Pacific Northwest. So far, predator beetles have shown the most promise. Currently, there are four of these; three Asian species (*Sasajiscymnus tsugae, Scymnus sinuanodulus* and *Scymnus ningshanensis);* and *one* presumed US species (*Laricobius nigrinus)* from the Pacific Northwest. Each of these species have had their biology and environmental safety thoroughly evaluated. They 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). As of 2004, all four beetles had been released simultaneously in only one location in the US; in northeast Georgia on the Chattahoochee National Forest.

The adelgid life cycle is highly complex and characterized by several life forms. It involves at least two generations per year each with new life forms and including a winged migratory form. Over-wintering adult females lay eggs within spherical woolly ovisacs with about 50 eggs in each over a period of about four months beginning in the late winter/early spring. In Connecticut egg lying begins in mid-February and lasts until mid-June. In about two months, the oldest eggs begin hatching into 'crawlers', or – more technically – first instar nymphs. These crawlers are only actively moving for a few days but while unattached can be blown by the wind or picked up on the legs or body of birds. Within four weeks of hatching, the nymphs have progressed through four 'instars' or life stages before becoming an adult. Adult forms are of two different types; a wingless form and a winged migratory form. The winged migratory form has been found to feed on an alternate host, the spruces; however there is no alternate spruce host on the Chattahoochee National Forest. Adults of the wingless spring generation lay a second generation of eggs at the rate of approximately 50 percent of the first generation; that is, about 25 eggs per ovisac. Again in Connecticut these eggs are laid from mid-June through mid-July. The first instar nymphs; that is, 'crawlers' hatching from these second generation eggs attach to young branches then go dormant through the summer and resume development during the fall and winter, maturing in late winter or early spring to begin another cycle. In Connecticut the break of dormancy occurs in October. (McClure, 1987)

A single over-wintering female would be capable of producing approximately 62,500 offspring in a single year if; (a) all offspring are female, (b) she and each of her descendants produce only one ovisac, (c) each ovisac has only the average number of eggs, and (d) provided that all eggs and off-spring survive. This obviously is the maximum and cannot be expected to actually occur, but the tremendous increase potential is evident if as few as 50 percent survive. It is the cumulative effect of the feeding by hundreds of thousands to millions of these tiny insects that overwhelms each hemlock.

APPENDIX B

List of Preparers

Name	Title	Unit
Ron Stephens	Forest Silviculturist	Forest Supervisor’s Office
Mike Hurst	Forest Wildlife Biologist	Forest Supervisor’s Office
Dick Rightmyer	Forest Soil Scientist	Forest Supervisor’s Office
Cindy Wentworth	Forest Ecologist/Botanist	Brasstown Ranger District
Carolyn Hoffmann	Forest Landscape Architect	Forest Supervisor’s Office
Tom Fearrington	Forest Recreation Planner	Forest Supervisor’s Office
Mitzi Cole	Forest Fisheries Biologist	Forest Supervisor’s Office
Charlene Breeden	Forest Hydrologist	Forest Supervisor’s Office
John Mayer	Forest Archaeologist	Forest Supervisor’s Office
Deborah Byrd	Civil Engineer	Forest Supervisor’s Office
Steve Cole	District Silviculturist	Tallulah Ranger District

APPENDIX C

Treatment Area Details of Alternative 2

No.	District	Birthyear	Forest Type	Acres	Treatment
1	Tallulah	1907	41	18	Insecticide Only
2	Tallulah	1900	4	8	Insecticide Only
3	Tallulah	1920	41	58	Insecticide and Beetle Release
4	Tallulah	1890	41	120	Insecticide and Beetle Release
5	Tallulah	0	0	97	Insecticide and Beetle Release
6	Tallulah	1923	41	1291	Insecticide and Beetle Release
7	Tallulah	1895	4	62	Insecticide and Beetle Release
8	Tallulah	1980	41	146	Insecticide and Beetle Release
9	Tallulah	1920	41	167	Insecticide and Beetle Release
10	Tallulah	1942	41	42	Insecticide and Beetle Release
11	Tallulah	0	0	83	Insecticide and Beetle Release
12	Tallulah	0	0	197	Insecticide and Beetle Release
13	Tallulah	1920	41	46	Insecticide and Beetle Release
14	Tallulah	1922	41	19	Insecticide and Beetle Release
15	Tallulah	1910	41	79	Insecticide and Beetle Release
16	Tallulah	1936	41	596	Insecticide and Beetle Release
17	Tallulah	1877	8	12	Insecticide and Beetle Release
18	Tallulah	1928	41	93	Insecticide and Beetle Release
19	Tallulah	1900	41	99	Insecticide and Beetle Release
20	Tallulah	1920	41	48	Insecticide and Beetle Release
21	Tallulah	0	0	4	Insecticide Only
22	Tallulah	1890	41	47	Insecticide and Beetle Release
23	Tallulah	1900	41	143	Insecticide and Beetle Release
24	Tallulah	1900	41	20	Insecticide and Beetle Release
25	Tallulah	1908	41	22	Insecticide and Beetle Release
26	Tallulah	1900	41	50	Insecticide and Beetle Release
27	Tallulah	1928	41	131	Insecticide and Beetle Release
28	Tallulah	1925	4	105	Insecticide and Beetle Release
29	Chattooga	1897	41	290	Insecticide and Beetle Release
30	Chattooga	1870	41	95	Insecticide and Beetle Release
31	Chattooga	1880	41	218	Insecticide and Beetle Release
32	Chattooga	1885	8	12	Insecticide and Beetle Release
33	Chattooga	1894	41	23	Insecticide Only
34	Tallulah	1890	41	232	Insecticide and Beetle Release
35	Tallulah	1951	41	18	Insecticide Only
36	Tallulah	1928	41	17	Insecticide and Beetle Release
37	Tallulah	1925	41	806	Insecticide and Beetle Release
38	Tallulah	1933	41	89	Insecticide and Beetle Release
39	Brasstown	0	0	9	Insecticide and Beetle Release
40	Brasstown	1920	41	42	Insecticide and Beetle Release
41	Brasstown	1937	41	71	Insecticide and Beetle Release
42	Brasstown	1974	41	58	Insecticide and Beetle Release
43	Brasstown	1950	41	37	Insecticide and Beetle Release
44	Brasstown	0	0	44	Insecticide and Beetle Release
45	Brasstown	0	0	47	Insecticide and Beetle Release
46	Tallulah	1920	41	174	Insecticide and Beetle Release
47	Tallulah	1910	41	87	Insecticide and Beetle Release
48	Brasstown	1945	41	342	Insecticide and Beetle Release
49	Chattooga	1915	41	75	Insecticide and Beetle Release
50	Chattooga	1885	41	68	Insecticide and Beetle Release
51	Chattooga	1899	41	240	Insecticide and Beetle Release

52	Brasstown	1940	41	303	Insecticide and Beetle Release
53	Brasstown	0	0	116	Insecticide and Beetle Release
54	Brasstown	0	0	45	Insecticide and Beetle Release
55	Brasstown	1940	41	16	Insecticide and Beetle Release
56	Brasstown	1921	41	107	Insecticide and Beetle Release
57	Brasstown	0	0	12	Insecticide and Beetle Release
58	Brasstown	0	0	301	Insecticide and Beetle Release
59	Chattooga	1895	41	762	Insecticide and Beetle Release
60	Chattooga	0	0	76	Insecticide and Beetle Release
61	Chattooga	1896	41	0	Insecticide and Beetle Release
62	Brasstown	1910	41	171	Insecticide and Beetle Release
63	Brasstown	0	0	168	Insecticide and Beetle Release
64	Brasstown	0	0	275	Insecticide and Beetle Release
65	Brasstown	1910	41	46	Insecticide and Beetle Release
66	Brasstown	0	0	52	Insecticide and Beetle Release
67	Chattooga	1940	41	16	Insecticide and Beetle Release
68	Chattooga	1910	41	120	Insecticide and Beetle Release
69	Brasstown	0	0	88	Insecticide and Beetle Release
70	Brasstown	0	0	82	Insecticide and Beetle Release
71	Brasstown	0	0	82	Insecticide and Beetle Release
72	Brasstown	0	0	33	Insecticide and Beetle Release
73	Brasstown	0	0	43	Insecticide and Beetle Release
74	Brasstown	0	0	259	Insecticide and Beetle Release
75	Toccoa	1925	41	154	Insecticide and Beetle Release
76	Brasstown	0	0	43	Insecticide and Beetle Release
77	Brasstown	0	0	119	Insecticide and Beetle Release
78	Brasstown	0	0	257	Insecticide and Beetle Release
79	Toccoa	0	0	88	Insecticide and Beetle Release
80	Toccoa	1905	4	259	Insecticide and Beetle Release
81	Toccoa	0	0	127	Insecticide and Beetle Release
82	Toccoa	0	0	140	Insecticide and Beetle Release
83	Brasstown	1910	8	66	Insecticide and Beetle Release
84	Brasstown	0	0	132	Insecticide and Beetle Release
85	Toccoa	0	0	198	Insecticide and Beetle Release
86	Toccoa	1920	8	110	Insecticide and Beetle Release
87	Toccoa	0	0	25	Insecticide and Beetle Release
88	Toccoa	0	0	1104	Insecticide and Beetle Release
89	Toccoa	1900	41	112	Beetle Release Only
90	Toccoa	0	0	228	Insecticide and Beetle Release
91	Toccoa	0	0	71	Insecticide and Beetle Release
92	Toccoa	1910	41	84	Insecticide and Beetle Release
93	Toccoa	0	0	64	Insecticide and Beetle Release
94	Cohutta	1981	41	34	Insecticide and Beetle Release
95	Cohutta	1900	41	25	Insecticide and Beetle Release
96	Cohutta	1957	41	155	Insecticide and Beetle Release
97	Cohutta	1940	5	18	Insecticide and Beetle Release
98	Cohutta	1902	4	178	Insecticide and Beetle Release
99	Cohutta	1939	41	15	Insecticide and Beetle Release
100	Cohutta	1915	8	59	Insecticide and Beetle Release
101	Cohutta	1907	8	76	Insecticide and Beetle Release
102	Cohutta	0	0	128	Insecticide and Beetle Release
103	Cohutta	0	0	135	Insecticide and Beetle Release
104	Cohutta	0	0	55	Insecticide and Beetle Release
105	Cohutta	1920	41	37	Insecticide and Beetle Release
106	Cohutta	0	0	27	Insecticide and Beetle Release
107	Cohutta	1910	41	18	Insecticide and Beetle Release
108	Cohutta	0	0	24	Insecticide and Beetle Release

109	Cohutta	1913	41	141	Insecticide and Beetle Release
110	Cohutta	1918	41	125	Insecticide and Beetle Release
111	Cohutta	1886	5	12	Insecticide and Beetle Release
112	Cohutta	1914	4	52	Insecticide and Beetle Release
113	Cohutta	1936	41	69	Insecticide and Beetle Release
114	Cohutta	1934	41	52	Insecticide and Beetle Release
				14,883	

Treatment Area Details of Alternative 3

No.	District	Birthyear	Forest Type	Acres	Treatment
1	Tallulah	1907	41	18	Beetle Release Only
2	Tallulah	1900	4	8	Beetle Release Only
3	Tallulah	1920	41	58	Beetle Release Only
4	Tallulah	1890	41	227	Beetle Release Only
5	Tallulah	0	0	97	Beetle Release Only
6	Tallulah	1923	41	1291	Beetle Release Only
7	Tallulah	1895	4	62	Beetle Release Only
8	Tallulah	1980	41	544	Beetle Release Only
9	Tallulah	1920	41	121	Beetle Release Only
10	Tallulah	1942	41	42	Beetle Release Only
11	Tallulah	0	0	300	Beetle Release Only
12	Tallulah	0	0	197	Beetle Release Only
13	Tallulah	1920	41	46	Beetle Release Only
14	Tallulah	1922	41	19	Beetle Release Only
15	Tallulah	1910	41	79	Beetle Release Only
16	Tallulah	1936	41	596	Beetle Release Only
17	Tallulah	1877	8	12	Beetle Release Only
18	Tallulah	1928	41	198	Beetle Release Only
19	Tallulah	1900	41	99	Beetle Release Only
20	Tallulah	1920	41	48	Beetle Release Only
21	Tallulah	0	0	4	Beetle Release Only
22	Tallulah	1890	41	47	Beetle Release Only
23	Tallulah	1900	41	397	Beetle Release Only
24	Tallulah	1900	41	499	Beetle Release Only
25	Tallulah	1908	41	22	Beetle Release Only
26	Tallulah	1900	41	50	Beetle Release Only
27	Tallulah	1928	41	131	Beetle Release Only
28	Tallulah	1925	4	105	Beetle Release Only
29	Chattooga	1897	41	290	Beetle Release Only
30	Chattooga	1870	41	95	Beetle Release Only
31	Chattooga	1880	41	218	Beetle Release Only
32	Chattooga	1885	8	12	Beetle Release Only
33	Chattooga	1894	41	23	Beetle Release Only
34	Tallulah	1890	41	232	Beetle Release Only
35	Tallulah	1951	41	18	Beetle Release Only
36	Tallulah	1928	41	17	Beetle Release Only
37	Tallulah	1925	41	806	Beetle Release Only
38	Tallulah	1933	41	89	Beetle Release Only
39	Brasstown	0	0	9	Beetle Release Only
40	Brasstown	1920	41	42	Beetle Release Only
41	Brasstown	1937	41	71	Beetle Release Only
42	Brasstown	1974	41	58	Beetle Release Only
43	Brasstown	1950	41	37	Beetle Release Only
44	Brasstown	0	0	44	Beetle Release Only
45	Brasstown	0	0	47	Beetle Release Only
46	Tallulah	1920	41	174	Beetle Release Only
47	Tallulah	1910	41	87	Beetle Release Only

48	Brasstown	1945	41	342	Beetle Release Only
49	Chattooga	1915	41	75	Beetle Release Only
50	Chattooga	1885	41	68	Beetle Release Only
51	Chattooga	1899	41	240	Beetle Release Only
52	Brasstown	1940	41	303	Beetle Release Only
53	Brasstown	0	0	173	Beetle Release Only
54	Brasstown	0	0	45	Beetle Release Only
55	Brasstown	1940	41	16	Beetle Release Only
56	Brasstown	1921	41	107	Beetle Release Only
57	Brasstown	0	0	12	Beetle Release Only
58	Brasstown	0	0	319	Beetle Release Only
59	Chattooga	1895	41	850	Beetle Release Only
60	Chattooga	0	0	76	Beetle Release Only
61	Chattooga	1896	41	0	Beetle Release Only
62	Brasstown	1910	41	171	Beetle Release Only
63	Brasstown	0	0	168	Beetle Release Only
64	Brasstown	0	0	275	Beetle Release Only
65	Brasstown	1910	41	46	Beetle Release Only
66	Brasstown	0	0	52	Beetle Release Only
67	Chattooga	1940	41	16	Beetle Release Only
68	Chattooga	1910	41	120	Beetle Release Only
69	Brasstown	0	0	88	Beetle Release Only
70	Brasstown	0	0	82	Beetle Release Only
71	Brasstown	0	0	82	Beetle Release Only
72	Brasstown	0	0	33	Beetle Release Only
73	Brasstown	0	0	43	Beetle Release Only
74	Brasstown	0	0	259	Beetle Release Only
75	Toccoa	1925	41	154	Beetle Release Only
76	Brasstown	0	0	43	Beetle Release Only
77	Brasstown	0	0	119	Beetle Release Only
78	Brasstown	0	0	257	Beetle Release Only
79	Toccoa	0	0	88	Beetle Release Only
80	Toccoa	1905	4	259	Beetle Release Only
81	Toccoa	0	0	127	Beetle Release Only
82	Toccoa	0	0	157	Beetle Release Only
83	Brasstown	1910	8	66	Beetle Release Only
84	Brasstown	0	0	132	Beetle Release Only
85	Toccoa	0	0	198	Beetle Release Only
86	Toccoa	1920	8	110	Beetle Release Only
87	Toccoa	0	0	25	Beetle Release Only
88	Toccoa	0	0	1104	Beetle Release Only
89	Toccoa	1900	41	112	Beetle Release Only
90	Toccoa	0	0	228	Beetle Release Only
91	Toccoa	0	0	71	Beetle Release Only
92	Toccoa	1910	41	84	Beetle Release Only
93	Toccoa	0	0	64	Beetle Release Only
94	Cohutta	1981	41	34	Beetle Release Only
95	Cohutta	1900	41	25	Beetle Release Only
96	Cohutta	1957	41	155	Beetle Release Only
97	Cohutta	1940	5	38	Beetle Release Only

98	Cohutta	1902	4	178	Beetle Release Only
99	Cohutta	1939	41	15	Beetle Release Only
100	Cohutta	1915	8	59	Beetle Release Only
101	Cohutta	1907	8	76	Beetle Release Only
102	Cohutta	0	0	128	Beetle Release Only
103	Cohutta	0	0	135	Beetle Release Only
104	Cohutta	0	0	55	Beetle Release Only
105	Cohutta	1920	41	37	Beetle Release Only
106	Cohutta	0	0	27	Beetle Release Only
107	Cohutta	1910	41	18	Beetle Release Only
108	Cohutta	0	0	24	Beetle Release Only
109	Cohutta	1913	41	258	Beetle Release Only
110	Cohutta	1918	41	125	Beetle Release Only
111	Cohutta	1886	5	12	Beetle Release Only
112	Cohutta	1914	4	52	Beetle Release Only
113	Cohutta	1936	41	69	Beetle Release Only
114	Cohutta	1934	41	52	Beetle Release Only
115	Brasstown			38	Beetle Release Only
116	Cohutta			34	Beetle Release Only
117	Tallulah			17	Beetle Release Only
118	Tallulah			274	Beetle Release Only
119	Chattooga			78	Beetle Release Only
120	Tallulah			267	Beetle Release Only
121	Tallulah			38	Beetle Release Only
122	Brasstown			21	Beetle Release Only
123	Tallulah			9	Beetle Release Only
124	Toccoa			28	Beetle Release Only
125	Toccoa			34	Beetle Release Only
126	Chattooga			43	Beetle Release Only
127	Brasstown			10	Beetle Release Only
128	Cohutta			16	Beetle Release Only
129	Cohutta			41	Beetle Release Only
130	Toccoa			120	Beetle Release Only
131	Tallulah			10	Beetle Release Only
132	Tallulah			154	Beetle Release Only
133	Tallulah			547	Beetle Release Only
134	Tallulah			181	Beetle Release Only
135	Tallulah			61	Beetle Release Only
136	Tallulah			95	Beetle Release Only
137	Chattooga			163	Beetle Release Only
138	Chattooga			166	Beetle Release Only
139	Chattooga			201	Beetle Release Only
140	Brasstown			79	Beetle Release Only
				19,437	

Treatment Area Details of Alternative 4

No.	District	Birthyear	Forest Type	Treatment	Acres
1	Tallulah	1907	41	Insecticide Only	18
2	Tallulah	1900	4	Insecticide Only	8
3	Tallulah	1920	41	Insecticide and Beetle Release	331
4	Tallulah	1890	41	Insecticide and Beetle Release	227
5	Tallulah	0	0	Insecticide and Beetle Release	97
6	Tallulah	1923	41	Insecticide and Beetle Release	1291
7	Tallulah	1895	4	Insecticide and Beetle Release	62
8	Tallulah	1980	41	Insecticide and Beetle Release	544
9	Tallulah	1920	41	Insecticide and Beetle Release	121
10	Tallulah	1942	41	Insecticide and Beetle Release	42
11	Tallulah	0	0	Insecticide and Beetle Release	300
12	Tallulah	0	0	Insecticide and Beetle Release	197
13	Tallulah	1920	41	Insecticide and Beetle Release	46
14	Tallulah	1922	41	Insecticide Only	19
15	Tallulah	1910	41	Insecticide and Beetle Release	79
16	Tallulah	1936	41	Insecticide and Beetle Release	596
17	Tallulah	1877	8	Insecticide Only	12
18	Tallulah	1928	41	Insecticide and Beetle Release	198
19	Tallulah	1900	41	Insecticide and Beetle Release	99
20	Tallulah	1920	41	Insecticide and Beetle Release	48
21	Tallulah	0	0	Insecticide Only	4
22	Tallulah	1890	41	Insecticide and Beetle Release	47
23	Tallulah	1900	41	Insecticide and Beetle Release	397
24	Tallulah	1900	41	Insecticide and Beetle Release	499
25	Tallulah	1908	41	Insecticide Only	22
26	Tallulah	1900	41	Insecticide and Beetle Release	50
27	Tallulah	1928	41	Insecticide and Beetle Release	131
28	Tallulah	1925	4	Insecticide and Beetle Release	105
29	Chattooga	1897	41	Insecticide and Beetle Release	290
30	Chattooga	1870	41	Insecticide and Beetle Release	95
31	Chattooga	1880	41	Insecticide and Beetle Release	218
32	Chattooga	1885	8	Insecticide Only	12
33	Chattooga	1894	41	Insecticide Only	23
34	Tallulah	1890	41	Insecticide and Beetle Release	232
35	Tallulah	1951	41	Insecticide Only	18
36	Tallulah	1928	41	Insecticide Only	17
37	Tallulah	1925	41	Insecticide and Beetle Release	806
38	Tallulah	1933	41	Insecticide and Beetle Release	89
39	Brasstown	0	0	Insecticide Only	9
40	Brasstown	1920	41	Insecticide and Beetle Release	42
41	Brasstown	1937	41	Insecticide and Beetle Release	71
42	Brasstown	1974	41	Insecticide and Beetle Release	58
43	Brasstown	1950	41	Insecticide and Beetle Release	37
44	Brasstown	0	0	Insecticide and Beetle Release	44
45	Brasstown	0	0	Insecticide and Beetle Release	47
46	Tallulah	1920	41	Insecticide and Beetle Release	174
47	Tallulah	1910	41	Insecticide and Beetle Release	87

48	Brasstown	1945	41	Insecticide and Beetle Release	342
49	Chattooga	1915	41	Insecticide and Beetle Release	75
50	Chattooga	1885	41	Insecticide and Beetle Release	68
51	Chattooga	1899	41	Insecticide and Beetle Release	240
52	Brasstown	1940	41	Insecticide and Beetle Release	303
53	Brasstown	0	0	Insecticide and Beetle Release	173
54	Brasstown	0	0	Insecticide and Beetle Release	45
56	Brasstown	1921	41	Insecticide and Beetle Release	143
57	Brasstown	0	0	Insecticide Only	12
58	Brasstown	0	0	Insecticide and Beetle Release	319
59	Chattooga	1895	41	Insecticide and Beetle Release	850
60	Chattooga	0	0	Insecticide and Beetle Release	76
62	Brasstown	1910	41	Insecticide and Beetle Release	171
63	Brasstown	0	0	Insecticide and Beetle Release	168
64	Brasstown	0	0	Insecticide and Beetle Release	275
65	Brasstown	1910	41	Insecticide and Beetle Release	46
66	Brasstown	0	0	Insecticide and Beetle Release	52
67	Chattooga	1940	41	Insecticide Only	16
68	Chattooga	1910	41	Insecticide and Beetle Release	120
69	Brasstown	0	0	Insecticide and Beetle Release	88
70	Brasstown	0	0	Insecticide and Beetle Release	82
71	Brasstown	0	0	Insecticide and Beetle Release	82
72	Brasstown	0	0	Insecticide and Beetle Release	33
73	Brasstown	0	0	Insecticide and Beetle Release	43
74	Brasstown	0	0	Insecticide and Beetle Release	259
75	Toccoa	1925	41	Insecticide and Beetle Release	154
76	Brasstown	0	0	Insecticide and Beetle Release	43
77	Brasstown	0	0	Insecticide and Beetle Release	119
78	Brasstown	0	0	Insecticide and Beetle Release	257
79	Toccoa	0	0	Insecticide and Beetle Release	88
80	Toccoa	1905	4	Insecticide and Beetle Release	259
81	Toccoa	0	0	Insecticide and Beetle Release	127
82	Toccoa	0	0	Insecticide and Beetle Release	157
83	Brasstown	1910	8	Insecticide and Beetle Release	66
84	Brasstown	0	0	Insecticide and Beetle Release	132
85	Toccoa	0	0	Insecticide and Beetle Release	198
86	Toccoa	1920	8	Insecticide and Beetle Release	110
87	Toccoa	0	0	Insecticide Only	25
88	Toccoa	0	0	Insecticide and Beetle Release	1104
89	Toccoa	1900	41	Beetle Release Only	112
90	Toccoa	0	0	Insecticide and Beetle Release	228
91	Toccoa	0	0	Insecticide and Beetle Release	71
92	Toccoa	1910	41	Insecticide and Beetle Release	84
93	Toccoa	0	0	Insecticide and Beetle Release	64
94	Cohutta	1981	41	Insecticide and Beetle Release	34
95	Cohutta	1900	41	Insecticide Only	25
96	Cohutta	1957	41	Insecticide and Beetle Release	155
97	Cohutta	1940	5	Insecticide and Beetle Release	38
98	Cohutta	1902	4	Insecticide and Beetle Release	178
99	Cohutta	1939	41	Insecticide Only	15

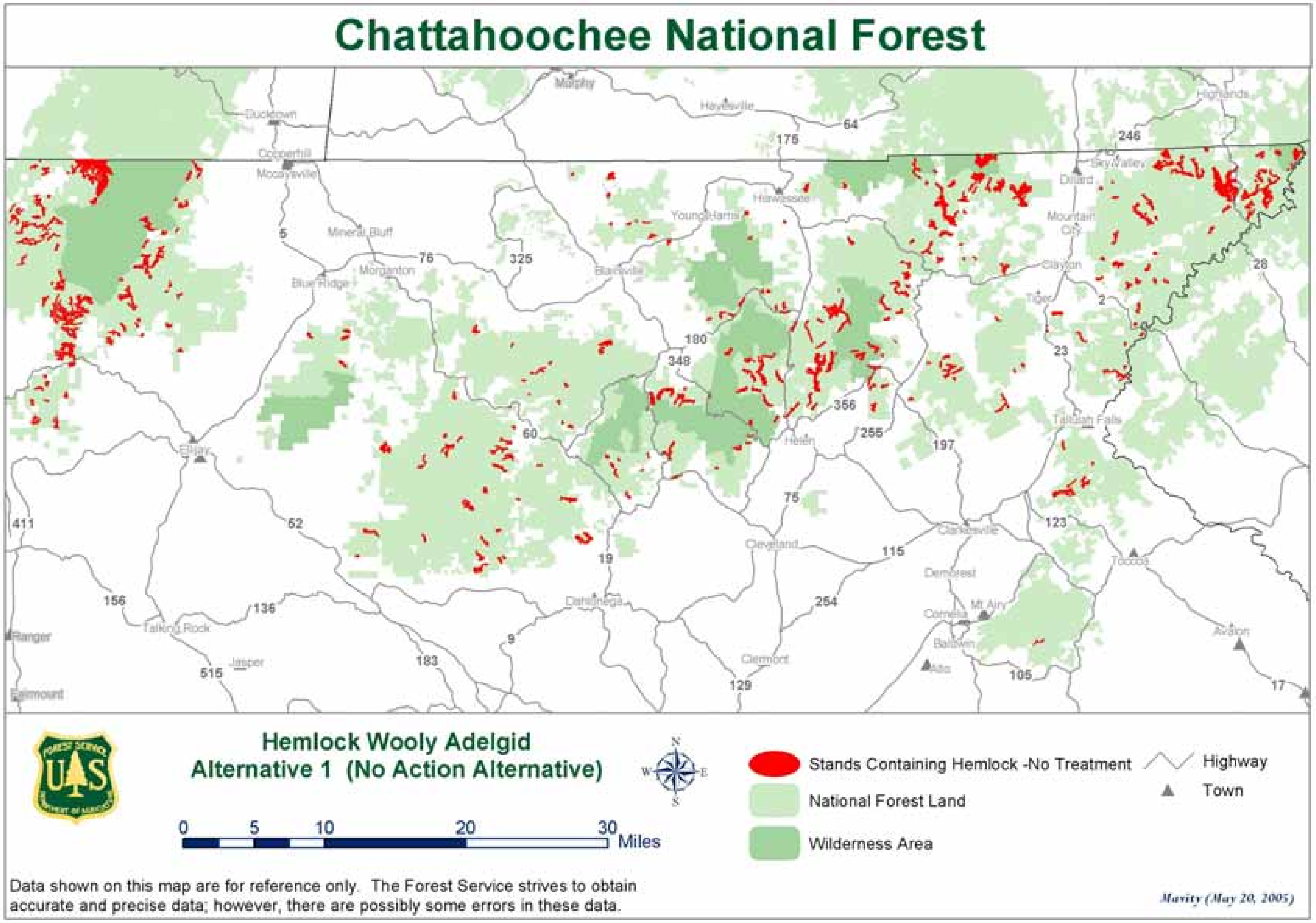
100	Cohutta	1915	8	Insecticide and Beetle Release	59
101	Cohutta	1907	8	Insecticide and Beetle Release	76
102	Cohutta	0	0	Insecticide and Beetle Release	128
103	Cohutta	0	0	Beetle Release only	135
104	Cohutta	0	0	Insecticide and Beetle Release	55
105	Cohutta	1920	41	Insecticide and Beetle Release	37
106	Cohutta	0	0	Insecticide and Beetle Release	75
107	Cohutta	1910	41	Insecticide Only	18
108	Cohutta	0	0	Insecticide Only	24
109	Cohutta	1913	41	Insecticide and Beetle Release	258
110	Cohutta	1918	41	Insecticide and Beetle Release	125
111	Cohutta	1886	5	Insecticide Only	12
112	Cohutta	1914	4	Insecticide and Beetle Release	52
113	Cohutta	1936	41	Insecticide and Beetle Release	69
114	Cohutta	1934	41	Insecticide and Beetle Release	52
115	Brasstown	0	0	Beetle Release Only	38
116	Cohutta	0	0	Insecticide and Beetle Release	34
117	Tallulah	0	0	Insecticide Only	17
118	Tallulah	0	0	Insecticide and Beetle Release	274
119	Chattooga	0	0	Insecticide and Beetle Release	78
121	Tallulah	0	0	Insecticide and Beetle Release	38
122	Brasstown	0	0	Insecticide Only	21
123	Tallulah	0	0	Insecticide Only	9
124	Toccoa	0	0	Insecticide and Beetle Release	28
125	Toccoa	0	0	Insecticide and Beetle Release	34
126	Chattooga	0	0	Beetle Release Only	43
127	Brasstown	0	0	Insecticide Only	10
128	Cohutta	0	0	Beetle Release Only	16
129	Cohutta	0	0	Beetle Release Only	41
130	Toccoa	0	0	Insecticide and Beetle Release	120
131	Tallulah	0	0	Insecticide Only	10
132	Tallulah	0	0	Insecticide and Beetle Release	154
133	Tallulah	0	0	Insecticide and Beetle Release	547
134	Tallulah	0	0	Insecticide and Beetle Release	181
135	Tallulah	0	0	Insecticide and Beetle Release	61
136	Tallulah	0	0	Insecticide and Beetle Release	95
137	Chattooga	0	0	Insecticide and Beetle Release	163
138	Chattooga	0	0	Insecticide and Beetle Release	166
139	Chattooga	0	0	Insecticide and Beetle Release	201
140	Brasstown	0	0	Release Only	71
141a	Cohutta	1920	8	Insecticide and beetle release	23
141b	Cohutta	1930	41	Insecticide and beetle release	8
142	Cohutta	0	0	Insecticide and beetle release	66
143	Cohutta	0	0	Insecticide and beetle release	40
144	Tallulah	0	0	Insecticide and beetle release	69
					19,710

Treatment Area Details of Alternative 5

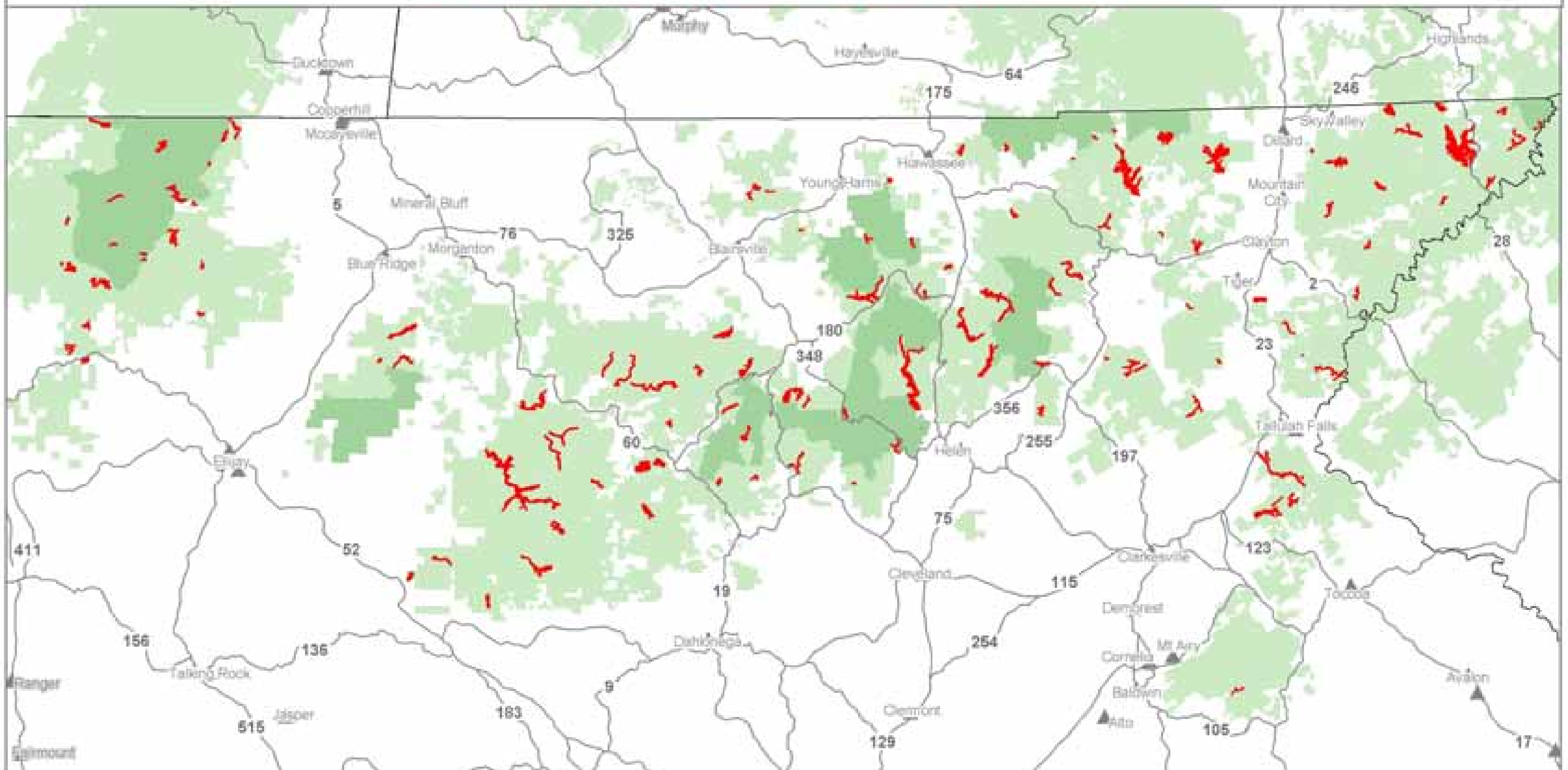
No.	District	Birthyear	Forest Type	Treatment	Acres
2	Tallulah	1900	4	Insecticide Only	0
3	Tallulah	1920	41	Insecticide and Beetle Release	331
4	Tallulah	1890	41	Insecticide and Beetle Release	227
5	Tallulah	0	0	Insecticide and Beetle Release	97
6	Tallulah	1923	41	Insecticide and Beetle Release	1291
7	Tallulah	1895	4	Insecticide and Beetle Release	62
8	Tallulah	1980	41	Insecticide and Beetle Release	544
9	Tallulah	1920	41	Insecticide and Beetle Release	121
10	Tallulah	1942	41	Insecticide and Beetle Release	42
11	Tallulah	0	0	Insecticide and Beetle Release	300
12	Tallulah	0	0	Insecticide and Beetle Release	197
13	Tallulah	1920	41	Insecticide and Beetle Release	46
14	Tallulah	1922	41	Insecticide Only	19
15	Tallulah	1910	41	Insecticide and Beetle Release	79
16	Tallulah	1936	41	Insecticide and Beetle Release	596
17	Tallulah	1877	8	Insecticide Only	12
18	Tallulah	1928	41	Insecticide and Beetle Release	198
19	Tallulah	1900	41	Insecticide and Beetle Release	99
20	Tallulah	1920	41	Insecticide and Beetle Release	48
21	Tallulah	0	0	Insecticide Only	4
22	Tallulah	1890	41	Insecticide and Beetle Release	47
23	Tallulah	1900	41	Insecticide and Beetle Release	397
24	Tallulah	1900	41	Insecticide and Beetle Release	499
25	Tallulah	1908	41	Insecticide Only	22
26	Tallulah	1900	41	Insecticide and Beetle Release	50
27	Tallulah	1928	41	Insecticide and Beetle Release	131
28	Tallulah	1925	4	Insecticide and Beetle Release	105
29	Chattooga	1897	41	Insecticide and Beetle Release	290
30	Chattooga	1870	41	Insecticide and Beetle Release	95
31	Chattooga	1880	41	Insecticide and Beetle Release	218
32	Chattooga	1885	8	Insecticide Only	12
33	Chattooga	1894	41	Insecticide Only	23
34	Tallulah	1890	41	Insecticide and Beetle Release	232
35	Tallulah	1951	41	Insecticide Only	11
36	Tallulah	1928	41	Insecticide Only	17
37	Tallulah	1925	41	Insecticide and Beetle Release	806
38	Tallulah	1933	41	Insecticide and Beetle Release	89
39	Brasstown	0	0	Insecticide Only	9
40	Brasstown	1920	41	Insecticide and Beetle Release	42
41	Brasstown	1937	41	Insecticide and Beetle Release	71
42	Brasstown	1974	41	Insecticide and Beetle Release	58
43	Brasstown	1950	41	Insecticide and Beetle Release	37
44	Brasstown	0	0	Insecticide and Beetle Release	0
45	Brasstown	0	0	Insecticide and Beetle Release	47
46	Tallulah	1920	41	Insecticide and Beetle Release	174
47	Tallulah	1910	41	Insecticide and Beetle Release	87
48	Brasstown	1945	41	Insecticide and Beetle Release	342

49	Chattooga	1915	41	Insecticide and Beetle Release	35
50	Chattooga	1885	41	Insecticide and Beetle Release	68
51	Chattooga	1899	41	Insecticide and Beetle Release	240
52	Brasstown	1940	41	Insecticide and Beetle Release	303
53	Brasstown	0	0	Insecticide and Beetle Release	173
54	Brasstown	0	0	Insecticide and Beetle Release	0
56	Brasstown	1921	41	Insecticide and Beetle Release	143
57	Brasstown	0	0	Insecticide Only	12
58	Brasstown	0	0	Insecticide and Beetle Release	258
59	Chattooga	1895	41	Insecticide and Beetle Release	771
60	Chattooga	0	0	Insecticide and Beetle Release	72
62	Brasstown	1910	41	Insecticide and Beetle Release	171
63	Brasstown	0	0	Insecticide and Beetle Release	168
64	Brasstown	0	0	Insecticide and Beetle Release	275
65	Brasstown	1910	41	Insecticide and Beetle Release	46
67	Chattooga	1940	41	Insecticide Only	16
68	Chattooga	1910	41	Insecticide and Beetle Release	120
69	Brasstown	0	0	Insecticide and Beetle Release	45
70	Brasstown	0	0	Insecticide and Beetle Release	82
71	Brasstown	0	0	Insecticide and Beetle Release	82
72	Brasstown	0	0	Insecticide and Beetle Release	33
73	Brasstown	0	0	Insecticide and Beetle Release	43
74	Brasstown	0	0	Insecticide and Beetle Release	259
75	Toccoa	1925	41	Insecticide and Beetle Release	154
76	Brasstown	0	0	Insecticide and Beetle Release	43
77	Brasstown	0	0	Insecticide and Beetle Release	119
78	Brasstown	0	0	Insecticide and Beetle Release	257
79	Toccoa	0	0	Insecticide and Beetle Release	88
80	Toccoa	1905	4	Insecticide and Beetle Release	259
81	Toccoa	0	0	Insecticide and Beetle Release	127
82	Toccoa	0	0	Insecticide and Beetle Release	157
83	Brasstown	1910	8	Insecticide and Beetle Release	66
84	Brasstown	0	0	Insecticide and Beetle Release	132
85	Toccoa	0	0	Insecticide and Beetle Release	198
86	Toccoa	1920	8	Insecticide and Beetle Release	108
87	Toccoa	0	0	Insecticide Only	25
88	Toccoa	0	0	Insecticide and Beetle Release	1104
89	Toccoa	1900	41	Beetle Release Only	112
90	Toccoa	0	0	Insecticide and Beetle Release	228
91	Toccoa	0	0	Insecticide and Beetle Release	71
92	Toccoa	1910	41	Insecticide and Beetle Release	84
93	Toccoa	0	0	Insecticide and Beetle Release	64
94	Cohutta	1981	41	Insecticide and Beetle Release	34
95	Cohutta	1900	41	Insecticide Only	25
96	Cohutta	1957	41	Insecticide and Beetle Release	155
97	Cohutta	1940	5	Insecticide and Beetle Release	38
98	Cohutta	1902	4	Insecticide and Beetle Release	37
100	Cohutta	1915	8	Insecticide and Beetle Release	59
101	Cohutta	1907	8	Insecticide and Beetle Release	76
103	Cohutta	0	0	Insecticide and Beetle Release	50

105	Cohutta	1920	41	Insecticide and Beetle Release	37
107	Cohutta	1910	41	Insecticide Only	18
108	Cohutta	0	0	Insecticide Only	0
109	Cohutta	1913	41	Insecticide and Beetle Release	258
110	Cohutta	1918	41	Insecticide and Beetle Release	125
111	Cohutta	1886	5	Insecticide Only	12
112	Cohutta	1914	4	Insecticide and Beetle Release	52
113	Cohutta	1936	41	Insecticide and Beetle Release	69
114	Cohutta	1934	41	Insecticide and Beetle Release	52
115	Brasstown	0	0	Beetle Release Only	38
117	Tallulah	0	0	Insecticide Only	1
118	Tallulah	0	0	Insecticide and Beetle Release	274
119	Chattooga	0	0	Insecticide and Beetle Release	78
121	Tallulah	0	0	Insecticide and Beetle Release	0
122	Brasstown	0	0	Insecticide Only	21
123	Tallulah	0	0	Insecticide Only	9
124	Toccoa	0	0	Insecticide and Beetle Release	28
125	Toccoa	0	0	Insecticide and Beetle Release	34
126	Chattooga	0	0	Beetle Release Only	43
127	Brasstown	0	0	Insecticide Only	10
128	Cohutta	0	0	Beetle Release Only	16
129	Cohutta	0	0	Beetle Release Only	41
130	Toccoa	0	0	Insecticide and Beetle Release	120
131	Tallulah	0	0	Insecticide Only	10
132	Tallulah	0	0	Insecticide and Beetle Release	154
133	Tallulah	0	0	Insecticide and Beetle Release	547
134	Tallulah	0	0	Insecticide and Beetle Release	181
135	Tallulah	0	0	Insecticide and Beetle Release	61
136	Tallulah	0	0	Insecticide and Beetle Release	95
138	Chattooga	0	0	Insecticide and Beetle Release	166
139	Chattooga	0	0	Insecticide and Beetle Release	152
140	Brasstown	0	0	Release Only	71
					18,279


Chattahoochee National Forest
Ducktown
Copperhill
Mccaysville
Murphy
Hayesville
Highlands
Mineral Bluff
Morganton
Blue Ridge
Blairsville
Young Harris
Hiawassee
Dillard
Sky Valley
Mountain City
Clayton
Tiger
Tallulah Falls
Helen
Ellijay
Cleveland
Clarkesville
Demorest
Cornelia
Mt Airy
Baldwin
Alto
Toccoa
Avalon
Dahlonega
Clermont
Talking Rock
Jasper
Ranger
Fairmount
Hemlock Wooly Adelgid
Alternative 1 (No Action Alternative)
Stands Containing Hemlock -No Treatment
National Forest Land
Wilderness Area
Highway
Town
0 5 10 20 30 Miles
Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.
Mavity (May 20, 2005)

Chattahoochee National Forest



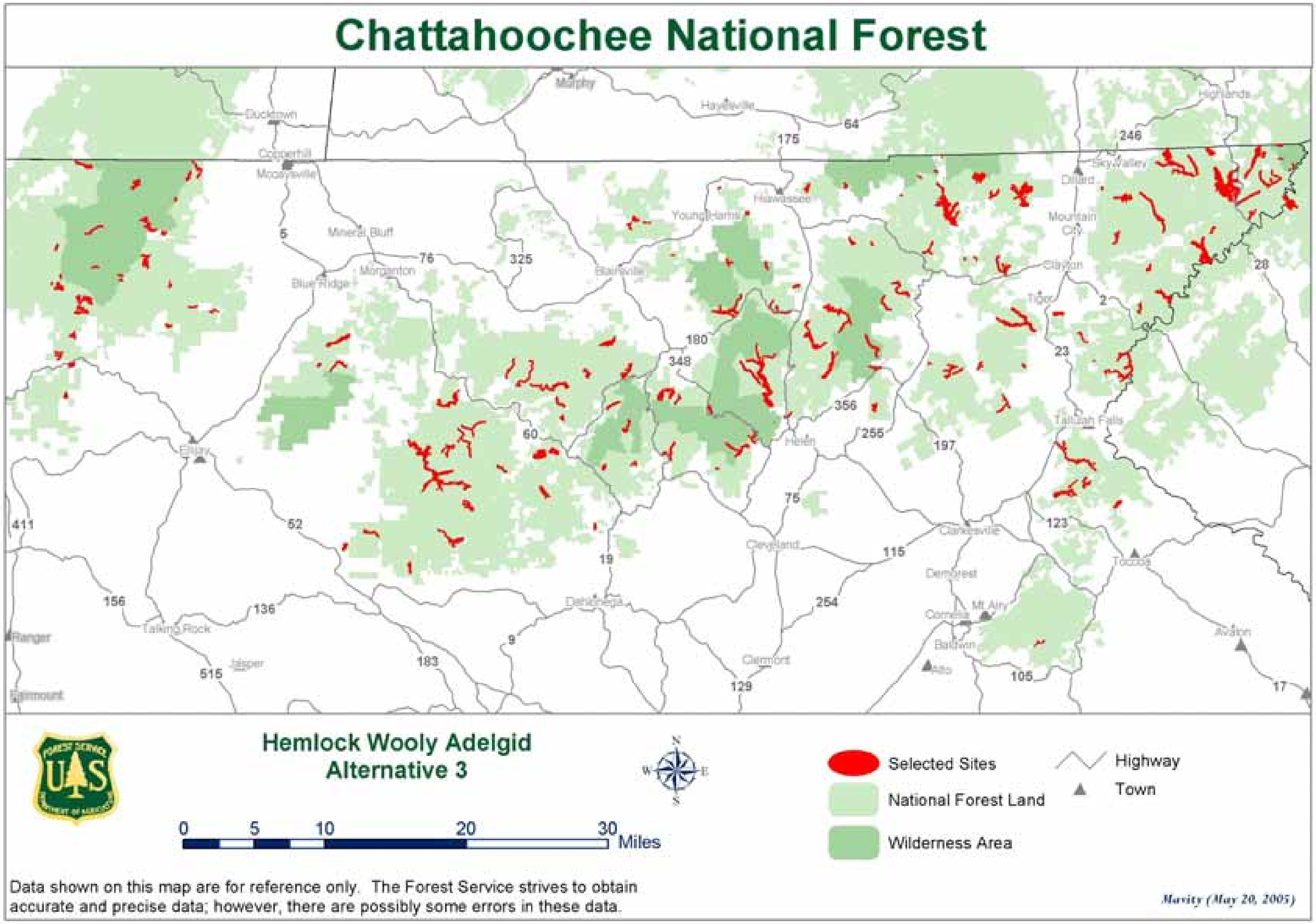
Hemlock Wooly Adelgid
Alternative 2

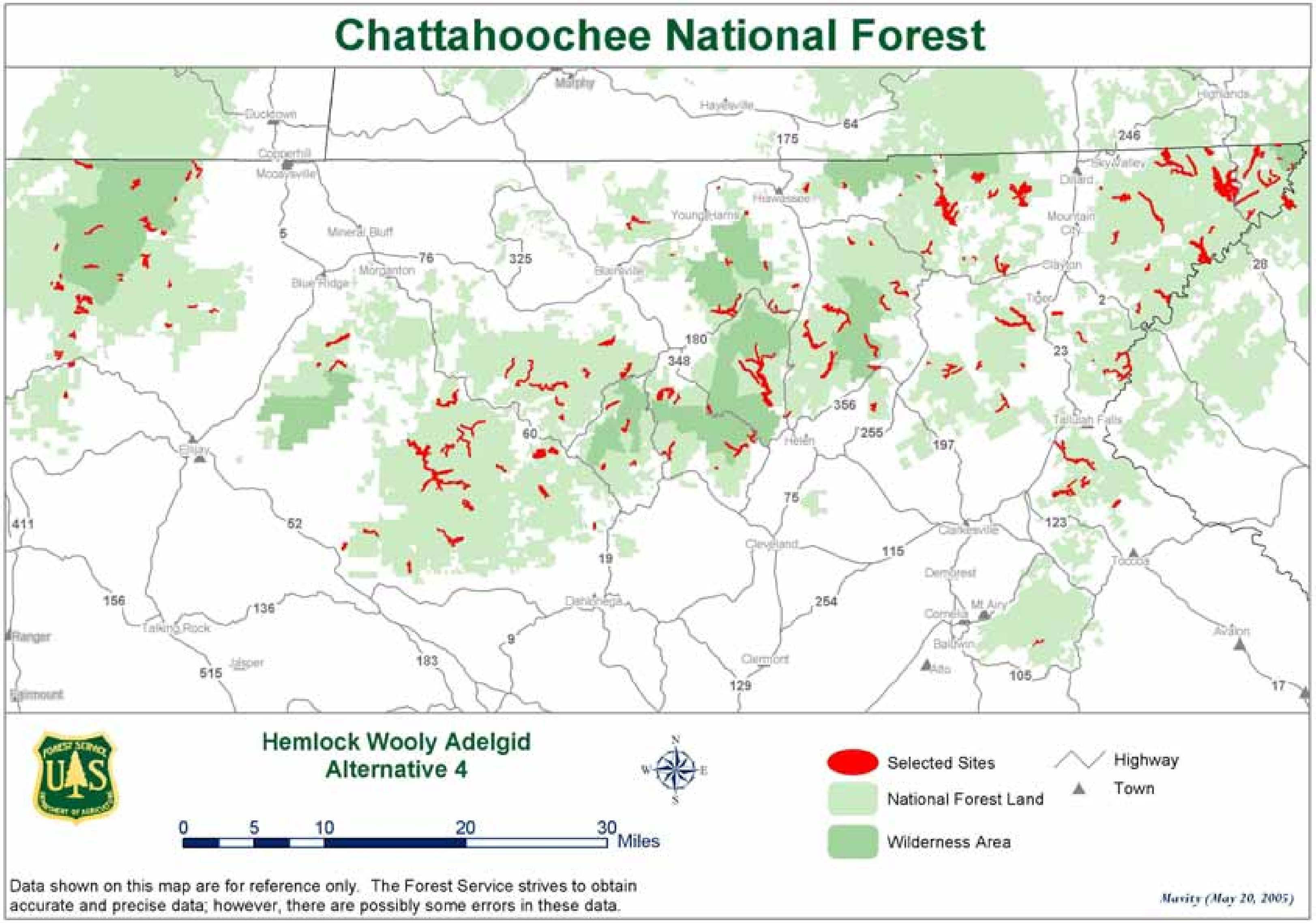
0 5 10 20 30 Miles

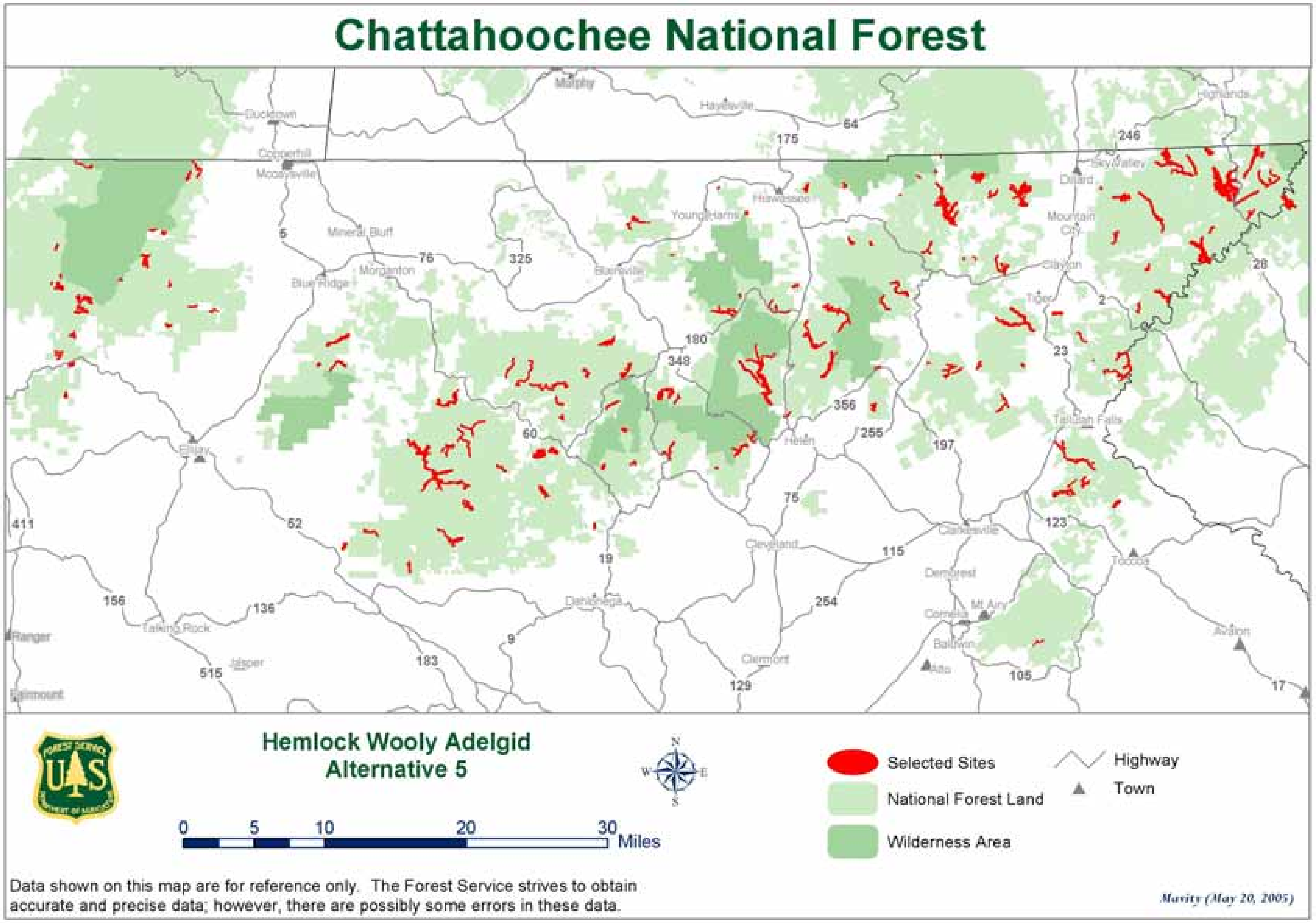
- Selected Sites
- National Forest Land
- Wilderness Area
- Highway
- Town

Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.

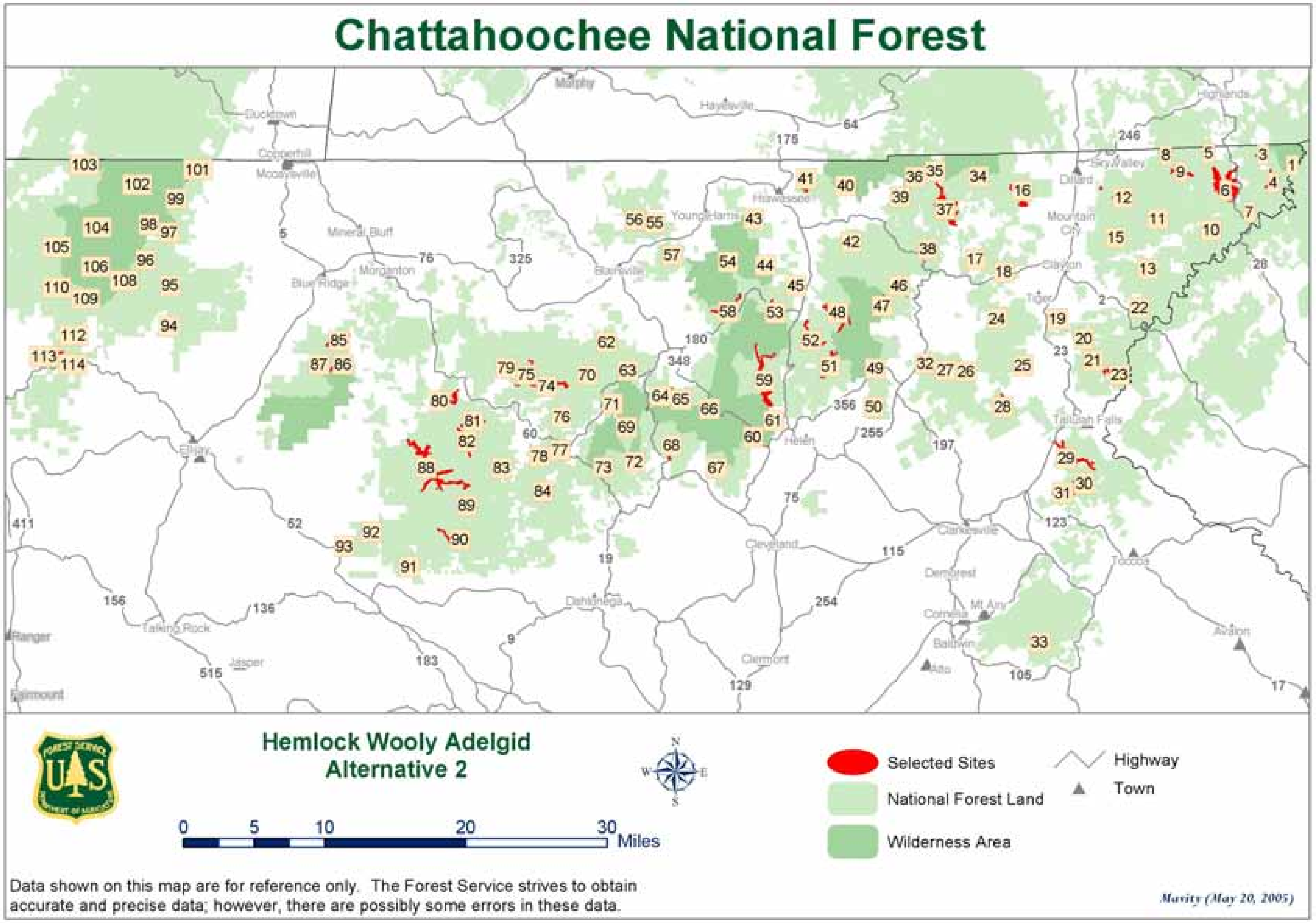
Mavity (May 20, 2005)


Chattahoochee National Forest
Ducktown
Copperhill
Mccaysville
Murphy
Hayesville
Highlands
Mineral Bluff
Morganton
Blue Ridge
Young Harris
Hiawassee
Blairsville
Sky Valley
Dillard
Mountain City
Clayton
Tiger
Tallulah Falls
Helen
Ellijay
Cleveland
Clarkesville
Demorest
Mt Airy
Cornelia
Baldwin
Alto
Toccoa
Avalon
Dahlonega
Talking Rock
Jasper
Clermont
Ranger
Fairmount
76
325
175
64
246
5
180
348
356
255
197
60
75
23
2
28
123
115
52
19
411
156
136
9
183
515
129
254
105
17
Hemlock Wooly Adelgid
Alternative 3
N
S
E
W
0
5
10
20
30
Miles
Selected Sites
National Forest Land
Wilderness Area
Highway
Town
Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.
Mavity (May 20, 2005)

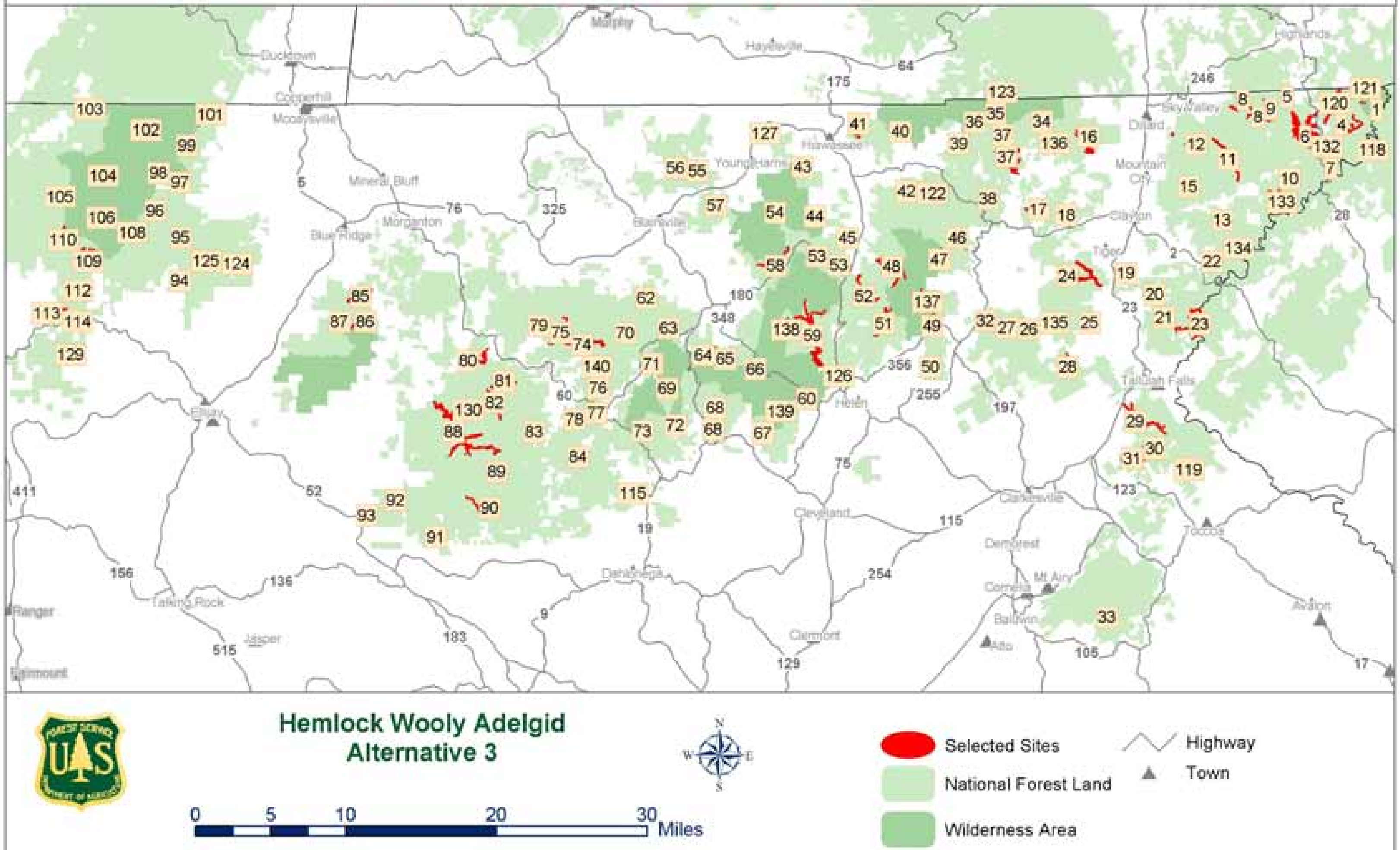

Chattahoochee National Forest
Murphy
Hayesville
Highlands
Ducktown
Copperhill
McCaysville
Mineral Bluff
Blue Ridge
Morganton
Blairsville
Young Harris
Hiawassee
Sky Valley
Dillard
Mountain City
Clayton
Tiger
Tallulah Falls
Helen
Ellijay
Cleveland
Clarkesville
Demorest
Cornelia
Mt Airy
Baldwin
Alto
Toccoa
Avalon
Dahlonega
Clermont
Talking Rock
Jasper
Ranger
Fairmount
Hemlock Wooly Adelgid
Alternative 4
0 5 10 20 30 Miles
Selected Sites
National Forest Land
Wilderness Area
Highway
Town
Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.
Mavity (May 20, 2005)



Chattahoochee National Forest
Hemlock Wooly Adelgid
Alternative 5
Selected Sites
National Forest Land
Wilderness Area
Highway
Town
0 5 10 20 30 Miles
N
S
E
W
Ducktown
Copperhill
Mccaysville
Mineral Bluff
Morganton
Blue Ridge
Murphy
Hayesville
Young Harris
Hiawassee
Blairsville
Helen
Cleveland
Dahlonega
Clarkesville
Demorest
Cornelia
Mt Airy
Baldwin
Alto
Clermont
Tallulah Falls
Tiger
Clayton
Mountain City
Dillard
Sky Valley
Highlands
Toccoa
Avalon
Ellijay
Talking Rock
Jasper
Ranger
Fairmount
Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.
Mavity (May 20, 2005)

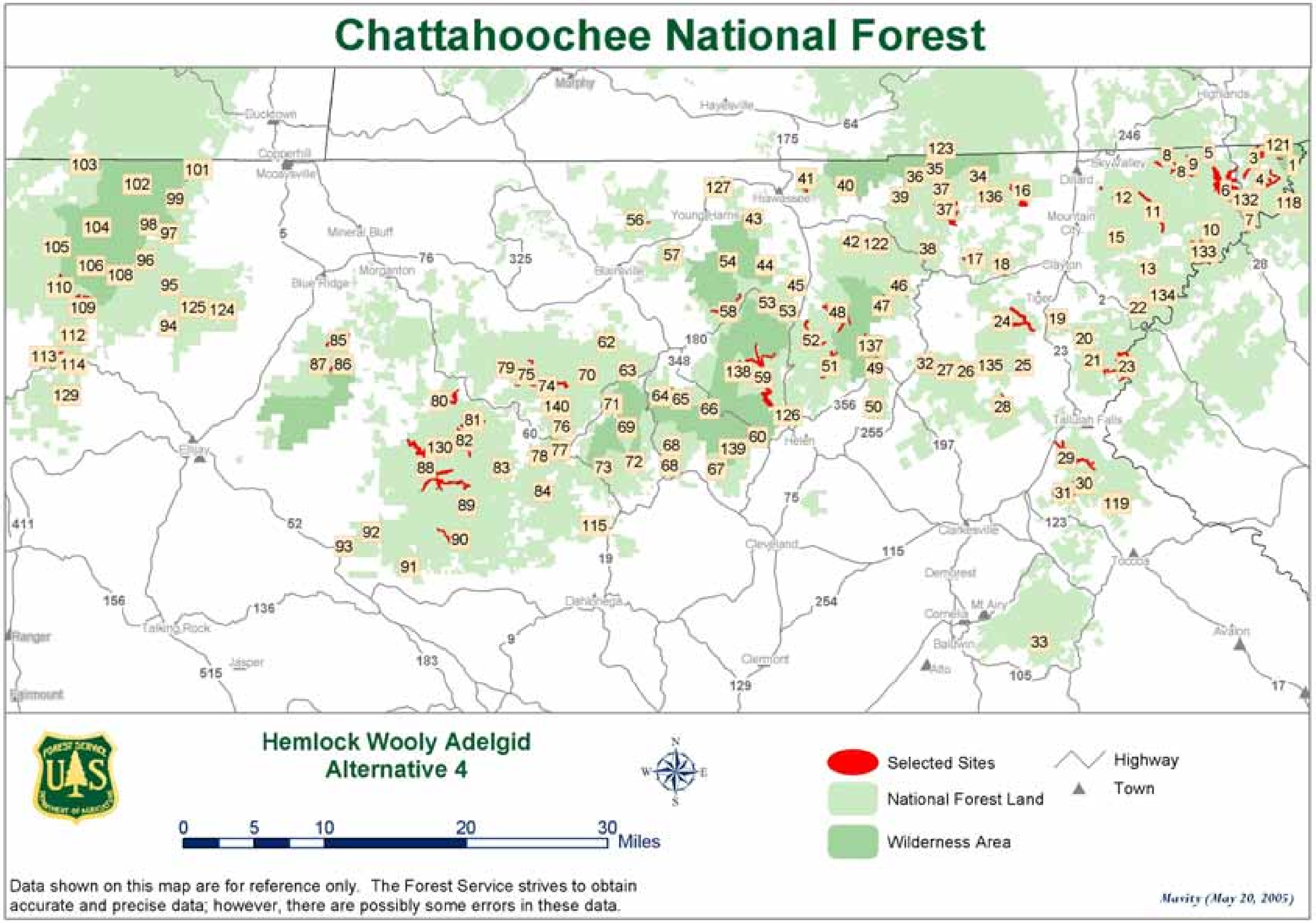

Chattahoochee National Forest
Hemlock Wooly Adelgid
Alternative 2
Selected Sites
National Forest Land
Wilderness Area
Highway
Town
0 5 10 20 30 Miles
Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.
Mavity (May 20, 2005)

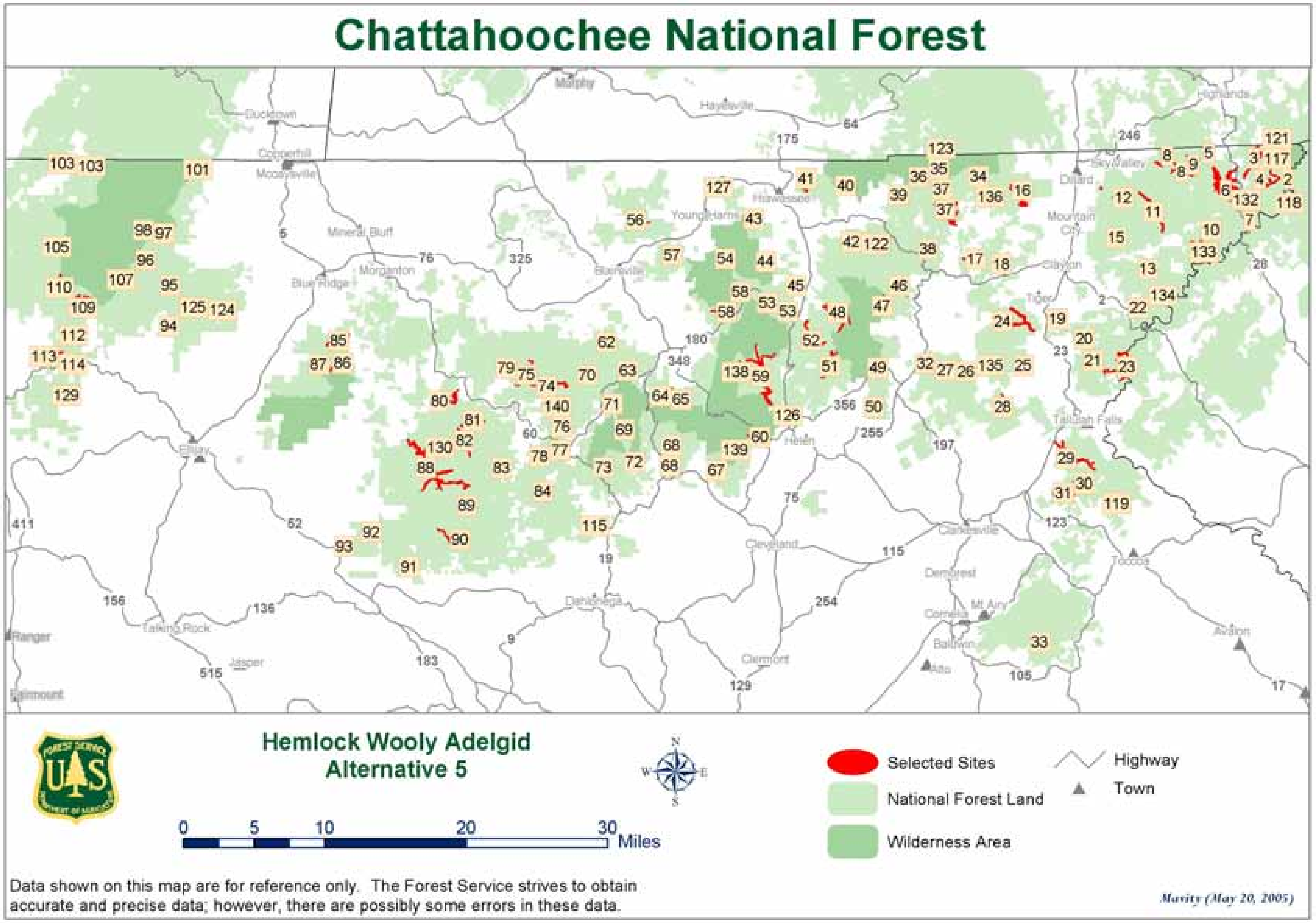
Chattahoochee National Forest



Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.

Mavity (May 20, 2005)


Chattahoochee National Forest
Murphy
Hayesville
Ducktown
Copperhill
McCaysville
Mineral Bluff
Blue Ridge
Morganton
Blairsville
Young Harris
Hiawassee
Sky Valley
Dillard
Mountain City
Clayton
Highlands
Tiger
Tallulah Falls
Helen
Clarkesville
Cleveland
Demorest
Mt Airy
Cornelia
Baldwin
Alto
Clermont
Dahlonega
Ellijay
Talking Rock
Jasper
Toccoa
Avalon
Ranger
Fairmount
Hemlock Wooly Adelgid
Alternative 4
0 5 10 20 30 Miles
Selected Sites
National Forest Land
Wilderness Area
Highway
Town
Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.
Mavity (May 20, 2005)


Chattahoochee National Forest
Hemlock Wooly Adelgid
Alternative 5
Selected Sites
National Forest Land
Wilderness Area
Highway
Town
0 5 10 20 30 Miles
Data shown on this map are for reference only. The Forest Service strives to obtain accurate and precise data; however, there are possibly some errors in these data.
Mavity (May 20, 2005)