Hiawatha National Forest
Non-native Invasive Plant Control Project

Environmental Assessment

Hiawatha National Forest
Alger, Chippewa, Delta, Mackinac, Marquette, and Schoolcraft counties, Michigan

April 2007

Spotted knapweed (*Centaurea biebersteinii*)

Responsible Official:

Thomas A. Schmidt
Forest Supervisor
Hiawatha National Forest
2727 North Lincoln Road
Escanaba, MI 49829

For Further Information Contact:

Kirk Piehler
Forest Wildlife Biologist
Hiawatha National Forest
2727 North Lincoln Road
Escanaba, MI 49829
(906) 789-3374

Cover Photograph Credits:

John M. Randall, The Nature Conservancy
Inset: USDA APHIS Archives
Both are spotted knapweed (*Centaurea biebersteinii*)

This document was printed on recycled paper.

TABLE OF CONTENTS

Vicinity Map – Hiawatha National Forest (HNF)

CHAPTER 1 – PURPOSE AND NEED FOR ACTION

INTRODUCTION

Since European settlement, non-native invasive plants (NNIP) have been intentionally and unintentionally introduced within the proclamation boundary of the Hiawatha National Forest (HNF). Over time, these species have spread by various means. Most NNIP have a competitive advantage over native plants that allows them to reproduce and spread rapidly. Because these plants have no natural pathogens and predators, some have become persistent, aggressive invaders of disturbed habitats and native plant communities. A species is considered invasive if it is not native to the ecosystem under consideration, and its introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112 issued 1999).

Next to habitat destruction, invasive species are the greatest threat to native biodiversity (USDA 2005, p. 231). Non-native invasive species spread was identified by the Chief of the Forest Service as one of the four threats affecting the health of our nation's forests and grasslands. The invasion of new areas and subsequent spread of NNIP is associated with humans, as well as natural processes. The introduction and spread of NNIP can be caused by roads and trails, timber harvests, recreation activities (OHVs, hiking, etc.), and natural events. Roads provide a means for weeds to be transported by vehicles. The construction of roads can result in the alteration of tree canopy structure and disturbance of soils along the right-of-way (Trombulak and Frissell 1999). The resulting disturbed, sunny locations are sites where NNIP can thrive and spread. Construction and maintenance equipment provide a source for transport of invasive weeds as they travel between sites. Timber harvests can cause the introduction and spread of NNIP through ground disturbance and canopy openings (Buckley et al. 2003, USDA 2005, p.231). Natural events can be associated with invasive plant movement through processes, such as wind, moving water and wildlife. When left untreated, some NNIP may become the dominant component of the vegetative community, thus reducing native plant diversity and affecting wildlife habitat, visual resources, overstory tree growth and future management of infested sites.

1.1 PROJECT AREA

The HNF is located in the central and eastern Upper Peninsula of Michigan, including portions of Alger, Chippewa, Delta, Mackinac, Marquette, and Schoolcraft counties (see Vicinity Map). The HNF proclamation boundary encompasses approximately 1.3 million acres and includes tracts of National Forest System land totaling approximately 895,000 acres (USDA FS 2006b, p. 3-5). A diversity of vegetation types, soils, and landforms are found on the HNF. The uplands are forested by various stands of northern hardwoods, hemlock, pine, aspen, spruce, and fir. Most other lands comprise a mixture of forested and non-forested upland openings and wetland habitats, including numerous streams and lakes. The HNF is home to a variety of animals and plants, ranging from common to rare.

1.2 PURPOSE AND NEED FOR ACTION

The HNF has identified 28 NNIP that are now or are expected soon to be impacting ecosystem function and integrity and degrading habitat for native plants and animals, including threatened and endangered species. Non-native invasive plants can affect ecosystems on the Forest by altering communities, nutrient cycling, hydrology and natural fire regimes. They can compete directly for light, water, nutrients, growing space, and by allelopathic interactions (USDA 2005, p. 231). Recent research has shown that non-native understory shrubs, such as honeysuckle, can significantly affect the growth rate of native overstory trees (Hartman and McCarthy 2007).

Forest Service policy identifies prevention of the introduction and establishment of NNIP species as an agency objective. This policy directs the Forest Service to: 1) determine the factors that favor establishment and spread of NNIP, 2) analyze NNIP risks in resource management projects, and 3) design management practices that reduce these risks (USDA 2001).

Although most invasive plants are not a severe problem at this time, some of them have become well established and are physically and economically impractical to control manually (e.g. leafy spurge, garlic mustard, St. Johnswort, spotted knapweed, and purple loosestrife). To eliminate or reduce the spread of existing NNIP populations, and of any new populations found in the future, the HNF needs an integrated strategy to prevent a more widespread and costly problem from developing.

The purpose of the project is to develop and implement a strategy for eliminating or reducing the spread of NNIP at known locations, and at new sites found through surveys and monitoring. By doing so, habitat for native plants and animals will be maintained and improved within the boundary of the HNF. The resiliency and integrity of natural communities on the HNF will be compromised as long as NNIP infestations are allowed to continue to spread and to invade previously unaffected areas. Management of invasive plants will help prevent the Forest from becoming a source of infestations for surrounding lands and slow the spread of invasive plants in proximity to the Upper Peninsula of Michigan.

1.3 PROPOSED ACTION (Alternative 2)

The HNF is proposing to implement a 5-year, Forest-wide, strategic NNIP management program using a combination of control methods on roughly 135 known sites, and at any new sites found through monitoring, within the Forest proclamation boundary. An average of approximately 40-70 acres a year would be treated. This amount may increase up to approximately 200 acres a year if funding is available to accomplish that level of treatments. Follow up monitoring would evaluate the success of treatments and determine whether additional control measures were necessary. Treatments would occur across the HNF wherever NNIP are identified. Most control efforts would occur within disturbed, upland habitats such as along roads, trails, and utility corridors, and in openings, forested stands, gravel pits and recreation sites. However, treatments could also occur in non-disturbed areas, including those along or within wetlands, and along or within lakes and streams.

Table 1-1 shows the priority NNIP species on the HNF. Hound's tongue (*Cynoglossum officinale*) has been added to the HNF list since scoping was completed. It is designated as a new species for the Forest with an "N" in the "Priority" column. Another species, giant hogweed (*Heracleum mantegazzianum*), has been identified as a "watch list" plant for the Forest (watch list plants are present on adjacent National Forests but have not been found on the HNF). The number of known sites and the area NNIP occupy are summarized in Table 1-2. The proposed treatment methods are summarized in Tables 1-3, 1-4, and 1-5.

Table 1-1. Priority non-native invasive plants (NNIP) on the Hiawatha National Forest

Priority	Common Name	Scientific Name
H	Garlic mustard	*Alliaria petiolata*
H	Japanese barberry	*Berberis thunbergii*
H	Spotted knapweed	*Centaurea biebersteinii*
H	Diffuse knapweed	*Centaurea diffusa*
H	Canada thistle	*Cirsium arvense*
H	Marsh (swamp) thistle	*Cirsium palustre*
H	Bull thistle	*Cirsium vulgare*
H	Leafy spurge	*Euphorbia esula*
H	Common St. Johnswort	*Hypericum perforatum*

H	Honeysuckle hybrids	*Lonicera x bella*
H	Morrow honeysuckle	*Lonicera morrowii*
H	Tartarian honeysuckle	*Lonicera tatarica*
H	Purple loosestrife	*Lythrum salicaria*
H	White sweet clover	*Melilotus alba*
H	Yellow sweet clover	*Melilotus officinalis*
H	Eurasian water milfoil	*Myriophyllum spicatum*
H	Wild parsnip	*Pastinaca sativa*
H	Reed canary grass	*Phalaris arundinacea*
H	Common reed/non-native genotype	*Phragmites australis*
H	Glossy buckthorn	*Rhamnus frangula*
H	Common buckthorn	*Rhamnus cathartica*
M	Common burdock	*Arctium minus*
M	Smooth brome	*Bromus inermis*
M	Crown vetch	*Coronilla varia*
M	Scotch pine	*Pinus sylvestris*
M	Common tansy	*Tanacetum vulgare*
N	Hound's tongue	*Cynoglossum officinale*
W	Giant hogweed	*Heracleum mantegazzianum*

H = high; M = medium; W = watch list; N = new invasive found on the HNF since scoping.
Note: This list of invasive species found on the HNF, and their priority for treatment, would be updated annually.

Table 1-2. Known abundance of various NNIP on the Hiawatha National Forest

Common Name	Number of Sites	Total Known Infested Acres
Garlic mustard	6	0.6
Common burdock	4	0.4
Smooth brome	1	1.0
Spotted knapweed	22	21.5
Non-native thistles	15	1.5
Leafy spurge	15	2.4
Common St. Johnswort	27	26.3
Purple loosestrife	27	28.8
White sweet clover	3	3.0
Eurasian water milfoil	2	Not documented
Wild parsnip	6	1.2
Reed canary grass	4	2.0
Scotch pine	1	0.1
Common buckthorn	1	0.5
Hound's tongue	1	10.0
TOTAL	**135**	**99.3**

Note: Approximately 500 additional sites exist; however, the site information was not sufficiently complete to include them at this time. Once precise location data have been acquired, these sites would be incorporated into the NNIP control project.

The NNIP project would also implement the management direction included in the HNF 2006 Forest Plan related to invasive species (UDSA 2006a, pp. 2-10, 2-14, 2-17, 2-21, and 2-22). The project would integrate several control methods. Control methods would include manual and mechanical techniques, herbicide applications, biological control (insect releases), or a combination of these. The method(s) initially used would depend on the species, location, population size, and other site-specific factors. Monitoring would determine what, if any, additional treatments were necessary in subsequent years.

1.3.1 Treatment Methods

Proposed Manual and Mechanical Methods

Table 1-3 describes the manual and mechanical control methods proposed for this project.

Table 1-3. Manual and mechanical control methods

Method	Description of Action
Pull	Hand-pull or dig up with a shovel the entire plant including roots – usually herbaceous plants. Leave plants on site, burn with a weed torch in a controlled area, or bag and remove if they have mature flowers or fruit. Normally used for shallow-rooted individual plants or small patches. This technique may be used for, but is not limited to, garlic mustard, knapweed, St. Johnswort, and white sweet clover.
Cut	Clip with pruning or lopping shears; cut with a saw, ax, brush cutter, weed whip, or mower; girdle bark, disking, blading, plowing, etc. - used alone or following sponge-applied systemic herbicide. Normally used for such plants as honeysuckle, buckthorn, and Japanese barberry.
Root Stab	Cut root just below surface with spade or similar tool. Normally used for individual plants/small patches, such as wild parsnip and thistles. Plants are usually left on site.
Scorch (flame)[1]	Use the flame of a propane weed torch to scorch or wilt green leaves. This is normally done either early or late in the growing season when NNIP are green and native perennials are mostly below ground. Scorching would kill one year's growth of annual and biennial weeds. It does not start a surface fire. This technique is especially useful for garlic mustard, sprouts of buckthorn, or similar NNIP.

[1] This project is not proposing to use prescribed surface fires as a control method.

Proposed Chemical (Herbicide) Methods

The objective of herbicide use would be to control NNIP infestations where manual or mechanical means would be less effective, cost-prohibitive or result in excessive soil disturbance or other resource damage. Potential herbicides were selected based on their effectiveness and low toxicity to non-target organisms. While there may be herbicides with greater effectiveness on the market, some have negative environmental effects or other properties that are undesirable. All herbicides proposed for use are approved by the U.S. Environmental Protection Agency (EPA) and are available without special permit (available at garden supply stores or off the Internet). Table 1-4 summarizes the chemicals proposed for use and their intended targets.

Herbicides would be applied by one of several methods. A controlled application method would be dabbing the chemical on the cut stump or brushing it on the basal bark of woody shrubs (Tu et al. 2001). Similarly, a wand or glove application may be used to wipe herbicide on foliage. For foliar spray applications, a backpack or hand-held apparatus that can direct a narrow spray of chemical on the target plant with minimal drift would be used (spot treatment). Herbicides would not be applied using airplanes or truck-mounted spray devices. Generally, there would be one chemical application per site per year with follow-up monitoring in subsequent years. The timing of treatment would vary by NNIP species in order to avoid negative impacts on non-target species. All herbicides would be applied according to label directions.

Table 1-4. Herbicides proposed for use on various NNIP species

Common Chemical Name	Some Examples of Trade Names	Application Method & Chemical Selectivity	Example Targeted NNIP Species [1,2]
Triclopyr	Garlon3A, Brush-B-Gone Habitat, Vine-X	Stump and/or basal bark treatment, foliar spot spray; broadleaf-selective	Buckthorn, barberry, honeysuckle, wild parsnip, crown vetch
Glyphosate	Roundup Pro, Roundup, Accord	Stump treatment, foliar spray; non-selective	Honeysuckle, buckthorn, barberry, garlic mustard, wild parsnip, St. Johnswort, crown vetch
Glyphosate (aquatic formulation)	Rodeo	Foliar treatment, weeds near water; non-selective	Purple loosestrife, swamp thistle, reed canary grass, common reed grass, and any species near open water
Dicamba	Banvel, Clarity, Vanquish	Foliar treatment, typically applied as mix with other herbicides; broadleaf selective	Knapweed, leafy spurge, thistle, tansy
Imazapic	Plateau, Plateau Eco-Pak, Cadre	Foliar treatment; non-selective	Leafy spurge
Clopyralid	Transline, Stinger, Confront	Foliar spray; broadleaf-selective	Canada thistle, swamp thistle, spotted knapweed, common burdock, crown vetch

[1]The label for each herbicide provides a list of plants and types of sites that can be treated.
[2]Trade names in this table are examples only.

Proposed Biological Control Methods

Biological control involves releasing insects that feed on or parasitize specific NNIP. The insects are typically native to Europe, Asia, or other parts of the world where the target plant occurs naturally, but have been approved for release in the United States by the United States Department of Agriculture (USDA). Biological control methods generally suppress host NNIP populations, but may not contain or eradicate them. Biological control of plants is a common practice on state, tribal, county, and private land in Michigan, Minnesota, and Wisconsin. The 1940's is considered the beginning of classical biological plant control efforts in the United States (Van Driesche et al. 2002). Galerucella beetles to control purple loosestrife were released in Michigan as early as 1995 (Landis et al. 2004).

The use of biological control on the HNF would be considered for infestations where eradication is difficult to achieve due to costs or where undesirable effects to non-target species could result from alternative control methods. Release of biological control agents (Table 1-5) could take place following site analysis wherever there is a NNIP infestation on the HNF. However, releases would only be appropriate for invasive plant sites that are large enough to support a population of insects (Van Driesche et al. 2002). Studies indicated a minimum of at least one acre of purple loosestrife (OFAH 2003), two acres of leafy spurge with moderately dense patches (60-90 stems per square yard) (TEAM 2003), and two acres of spotted knapweed (Wilson and Randall 2005) are required for a successful release. HNF inventory data lists about eight loosestrife sites over one acre in size that could support the Galerucella beetles. Other suitable insect release sites may be found in the future.

Figure 1-1. Purple loosestrife leaf beetle
(Photo: Eric Coombs, Oregon Department of Agriculture)

Insects used as biological control agents are generally released as adults (not eggs or larvae) between June and August. They may be released by simply emptying a container of insects at an NNIP site, or by placing an insect-bearing plant at the site. If a release is successful, then the insects will continue to live and reproduce at the site as long as the host plant remains. If the host plant is eliminated, the insects will die out. The biological control agents (all insects) proposed for use on the HNF are listed in Table 1-5. Figure 1-1 and Figure 1-2 show examples of adult insects.

Biological control techniques take advantage of the fact that many non-native plants have arrived without being accompanied by their natural enemies. The identification of these specialized insect predators and pathogens is the premise behind biological control of NNIP. As stated in Van Driesche et al. (2002), "Biological control is the science of reconnecting invasive plants with the specialized natural enemies that often limit their density in their native ranges. This process consists of surveys in the plant's area of origin to discover candidate natural enemies, studies on their biology and host specificity and release and evaluation of their impacts on the target plant. The U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) is responsible for controlling introductions of species brought into the United States for biological control of plants, in accordance with the requirements of several plant quarantine laws, the National Environmental Policy Act, and the Endangered Species Act. Petitions for release of plant biological control agents are judged by a Technical Advisory Committee (TAG), which represents the interests of a diverse set of federal and other agencies."

Figure 1-2. Lesser knapweed flower weevil
(Photo: USDA ARS Archives)

Table 1-5. Biological control agents (insects) proposed for NNIP control on the HNF

Biological Control Insect[1]	**Scientific Name**	**Target Plant**
Black-margined loosestrife beetle	*Galerucella calmariensis*	Purple loosestrife
Golden loosestrife beetle	*Galerucella pusilla*	Purple loosestrife
Loosestrife root weevil	*Hylobius transversovittatus*	Purple loosestrife
Knapweed root weevil	*Cyphocleonus achates*	Spotted knapweed
Lesser knapweed flower weevil	*Larinus minutus*	Spotted knapweed
Copper leafy spurge flea beetle	*Aphthona flava*	Leafy spurge
Brown-legged leafy spurge flea beetle	*Aphthona lacertosa*	Leafy spurge
Black dot leafy spurge flea beetle	*Aphthona nigriscutis*	Leafy spurge
Milfoil weevil	*Euhrychiopsis lecontei*	Eurasian water milfoil

[1] Note: Entries in this table are examples only. Other more effective biological agents may become available in the future and would be considered as appropriate.

All of the biological control insects proposed for NNIP on the HNF (Table 1-5) have been used successfully in Michigan or other states in the U.S., and approved for use by APHIS and TAG. For the

HNF, the list includes biological control insects for purple loosestrife (Van Driesche et al. 2002, pp. 149-157, Wilson et al. 2005), spotted knapweed (Van Driesche et al. 2002, pp. 169-180), Eurasian watermilfoil (Van Driesche et al. 2002, pp. 79-90), and leafy spurge (Van Driesche et al. 2002, pp. 181-194). The biological control insects in table 1-5 have all been permitted for use in the United States by the USDA, APHIS under the Plant Protection Act of 2000 (7 USC 7701 *et seq*.). The milfoil weevil is native to the U.S. Thus, the insect does not require a permit from APHIS.

1.3.2 Treatment Protocol

Alternative 2 is programmatic in nature to allow the use of integrated methods for the treatment of existing invasive plant infestations and those found in the future. Forest staff would determine which NNIP infestations to treat, and methods and timing to use based on the listed protocol and design criteria.

1. The high-priority species listed in Table 1-1 would receive first consideration for treatment.
    - Of these high-priority species, the order of site treatment and methods would be determined by infestation size, location sensitivity, potential to spread, treatment urgency, and other factors.
2. High priority NNIP sites would be considered for treatment when infestations are identified as a resource concern.
    - Example sites include Regional Forester Sensitive Species (RFSS) and federal Threatened and Endangered Species (T&E)[1] occurrences, gravel pits, trailheads, and recreation sites.
3. All control treatments would be designed to be effective based on the species biology and life history, yet minimize impacts on non-target plants, wildlife, water, recreation, and other resources.
4. Prior to any treatments:
    - Forest staff in the areas of aquatics, wildlife biology, botany, soils, silviculture, and heritage resources would review the proposed actions covered in this EA.
    - Treatments would be designed to implement Forest Plan management direction and to minimize effects to associated resources.
    - The District Ranger for the corresponding sites would approve treatment actions pursuant to this EA. This could be accomplished in an annual treatment plan format.
    - A professional archaeologist would review treatment proposals to determine their potential to effect heritage resources, and any necessary field surveys would be conducted. If heritage resources are present, treatment proposals would be abandoned or modified as necessary to exclude any significant or potentially significant resources from areas of potential effects.[2]
    - Areas to be treated would be reviewed by Forest Service (FS) wildlife and botany staff to ensure that survey requirements for TES specified in the 2006 Forest Plan are satisfied.
5. All treatments would be designed to minimize undesired impacts on native vegetation.
    - Retain native vegetation and limit soil disturbance as much as possible. If exposed soil results from NNIP control actions, revegetate exposed soils promptly to avoid re-colonization by NNIP.
    - Use only approved seed mixtures and weed free mulch.
    - Field personnel involved in NNIP treatment actions must be able to distinguish target NNIP from non-target native plants.
6. Equipment, boots, and clothing would be cleaned thoroughly before moving to another treatment site to ensure that NNIP seeds and parts capable of starting new plants are not spread.

---

[1] RFSS and T&E are collectively known as threatened, endangered and sensitive (TES) species.

[2] A Memorandum of Agreement (MOA) between the HNF and the Michigan State Historic Preservation Officer (SHPO) regarding compliance with Section 106 of the National Historic Preservation Act (36 CFR 800) states: When an inventory (or records search of an area already inventoried) reveals that no cultural resources are present in the impact area of a project, or when the Forest Service assures avoidance of direct or indirect effects on any properties present, then the project will be considered to have "no effect" on cultural resources.

7. Mechanical/manual control activities:
   - Manual or mechanical methods would be the principal approach for shallow-rooted species, but single deep-rooted plants such as purple loosestrife, leafy spurge, or glossy buckthorn could be considered for herbicide treatments.
   - Mowing would be limited to roadsides or disturbed areas and timed to avoid spreading seeds.
   - Use of weed torches would be limited to times of low fire danger and when native vegetation is dormant, or only in areas that are already heavily disturbed. Wildland firefighters would be on site, as determined applicable after discussion with the Zone Fire Management Officer.
8. Herbicide use:
   - Herbicide use could be indicated for infestations where manual or mechanical means would be cost-prohibitive or result in excessive soil disturbance or other resource damage.
   - When herbicide treatment is indicated, spot treatments, such as a sponge, glove or wick applicator, would be used whenever possible over broadcast spraying and as required for circumstances specified in design criteria (pp. 14).
   - Herbicide label directions would be followed. This could include temporary closure of treatment areas for public health and safety.
   - Only formulations approved for aquatic-use would be applied in or adjacent to wetlands, lakes, and streams (see design criteria No 11, p. 13)
   - Notices would be posted near all areas that have recently been treated with herbicides.
   - Herbicide application would only occur when wind speeds were less than 10 mph, or according to label direction, to minimize herbicide drift.
   - All private landowners, residents, and lake associations of affected lakes would be notified in advance of plans for aquatic herbicide application.
   - One option to minimize impacts to non-target vegetation would be to spray foliar applications when native vegetation is dormant. However, few NNIP (e.g. garlic mustard) are actively growing when native non-target plants are not growing.
   - If treating NNIP within 45 feet of TES plants, use a precise application technique, (e.g. applicator wick, sponge, glove or other spot treatment) or manual method (e.g. pulling or cutting).
   - Set herbicide sprayers to a fairly large droplet size. 250-350 microns is best (Fischer 2006). Use a Drift Control additive according to label directions. Use a marker dye, as necessary, to distinguish if herbicide spray hits non-target organisms or objects (quality control).
   - Avoid herbicide application when temperatures exceed 85 degrees (F) (decreases volatilization).
   - Buffer distance in design criteria (No. 11, p. 13) below would be followed for herbicide not formulated to be used in or near waterways or areas with saturated ground conditions.
   - Use of herbicides in public use areas such as campgrounds, boat landings, hiking trails, etc., should be avoided during times of heaviest demand (e.g. summer holiday weekends).
9. Biological Control:
   - The use of biological control could be indicated for infestations where eradication would be difficult due to costs or undesirable effects of alternative control methods.
   - Adjacent landowners would be contacted before the release of biological agents at a site.
10. The HNF NNIP Strategy is one document guiding implementation of this project. The strategy indicated priorities and methods and addresses Prevention, Education, and Cooperation.
11. Follow Forest and Regional NNIP strategies regarding public education to prevent invasions.
12. Determination of coastal zone consistency will be completed for all activities occurring within one-quarter mile from the Great Lakes high water mark.
13. Michigan Best Management Practices (BMPs) for water quality would be implemented (MDNR 1994) (USDA 2006a, Chapter 2, p. 2-14, Riparian Ecosystem, Guideline 1).

1.3.3 Design Criteria

General

1. All treatments would be designed to ensure that they do not negatively impact threatened, endangered, or sensitive plants and animals (TES).
2. Surveys for Federal threatened and endangered species (T&E) and Regional Forester Sensitive Species (RFSS) would be conducted as needed to meet 2006 Forest Plan management direction. Existing information, suitability of habitat and extent of treatment would be considered before implementing surveys.
3. If any T&E or RFSS species are observed during implementation of NNIP control activities (other than raptors flying by overhead), work would stop until a FS wildlife biologist or botanist is consulted. Treatments would be revised as necessary to avoid impacts to the subject species.
4. When work is conducted in areas containing T&E or RFSS plants, those plants would be flagged or marked, and operators would be trained to visually recognize them. Where NNIP control activities occur within T&E plant sites a botanist would be present during treatment.
5. If new information such as survey data, observations by FS employees, the public, or other reputable source indicates TES species are present at the sites to be treated, the effects analysis in the biological evaluation (BE) and design criteria/protocol would be reviewed for adequacy.

Raptors

6. No treatments would be conducted within 1320 feet of known nests occupied by a bald eagle during the breeding season (February 14 – October 1). This distance includes all protection zones in the Northern States Bald Eagle Recovery Plan (NSBERP) (USFWS 2006, pp. 227-228).
7. No treatments would be conducted within 650 feet of known nests occupied by the northern goshawk, red-shouldered hawk, and short-eared owl during the breeding season (March 1 to August 31).
8. Should it be necessary to treat NNIP infestations using physical or chemical methods in the vicinity of a peregrine falcon nest, a wildlife biologist would be consulted for site specific recommendations to protect the nest. Generally, there are two protection zones around peregrine nest sites (eyries): a primary zone extending 660 feet from the cliff edge and below the nest and a secondary zone extending to 1,320 feet.

Wetlands/Shoreline/Dunes

9. Aquatic areas would be inspected for the presence of TES aquatic plant species before treatments are initiated in those areas. If TES plants are found a FS botanist would be consulted prior to initiating treatments.
10. A wildlife biologist and botanist would review treatments proposed along or within calcareous wetlands, along Great Lakes shorelines, dunes, inland lakes and any riparian zones to ensure that treatments would not harm TES species.
11. Buffer strips would be designated around water bodies (e.g. lakes, ponds, stream, wetlands, bogs, etc.) inside of which no chemical would be used that is not registered for aquatic use. The following table, based on topography, would be used to determine the appropriate width of a buffer strip.

SLOPE OF LAND ABOVE WATER BODY (%)	MINIMUM WIDTH OF STRIP (FEET)
0-10	100
10-20	115
20-30	135
30-40	155
40-50	175
50+	>175 – activity not advised

Based on information in the Michigan Water Quality Management Practices on Forest Land (MDNR 1994)

12. No NNIP control would be conducted where piping plovers are present in order to protect adults, nests and young.
13. No treatments would be conducted in Hine's emerald dragonfly habitat (i.e. wet meadows, fens, other wetlands) from the beginning of the second week in June through the end of August, and for RFSS dragonfly habitat from the beginning of the second week in April to the end of August. This would protect the dragonflies during their adult flight period.
14. When conducting control activities in known or potential Hine's emerald dragonfly or RFSS dragonfly habitats, movement and disturbance activities would be minimized.
15. Riparian habitats suitable for use by Blanding's turtle would be inspected by a wildlife biologist before NNIP treatments begin. Personnel working in riparian habitats would be trained to recognize Blanding's turtles and this species nests and eggs in order to avoid trampling or disturbing them. NNIP treatments would not be conducted between May 10 and June 30 in riparian areas occupied by Blanding's turtle.
16. Prior to initiating treatments in non-forested wetlands and lakes, check for the presence of black terns and trumpeter swans. A FS wildlife biologist would be notified if the species are observed prior to treatment. Adjustments to treatments would be made to prevent harm to the species.
17. No treatments would be performed within 650 feet of active black tern or trumpeter swan nests during the breeding season (April 1 to August 1).
18. For protection of RFSS snails, prior to NNIP treatments, a FS wildlife biologist would be consulted for sites that might provide suitable habitats, such as wetland sites, including tamarack-sedge wetlands, white cedar wetlands, fens and marl flats, and cliffs or exposed rock outcrops.
19. A FS wildlife biologist would be consulted prior to any treatments within areas known to be inhabited by Lake Huron locust, northern blue butterfly or suitable habitat for either species, such as dunes, Great Lakes shoreline, and open/dry beach areas. Any treatment in these habitats would be conducted by people who have been trained to identify the insects and associated rare plants.
20. In order to protect northern blue butterfly and Lake Huron locust, in suitable or occupied habitat, herbicide use would be restricted to spot applications with such methods as glove application and sponge, and only after the area has been surveyed for these species.

Open Areas/Thickets

21. Treatments proposed for permanent openings in proximity to known and historic leks (sharp-tailed grouse breeding sites) would be reviewed by a wildlife biologist prior to being implemented.
22. To protect nesting birds using thickets of NNIP, such as exotic honeysuckle and Japanese barberry, treatments would occur after August 1. Individual shrubs may be treated at any time if an inspection shows no nesting bird on or below the shrub.
23. NNIP treatments within or immediately adjoining jack pine stands occupied by Kirtland's warblers would not be accomplished during the breeding season (May 1 – September 15).

1.4 DECISIONS TO BE MADE

The Responsible Official for this decision is the Forest Supervisor. The decisions to be made include:

- Whether or not to prepare an Environmental Impact Statement (EIS);
- Whether to implement: (1) the activities as proposed; (2) portions of the proposed activities; or (3) any of the alternatives.
- Which design criteria would be required during implementation, should the Proposed Action be selected.

1.5 PUBLIC INVOLVEMENT

This project was first identified in the April 2006 Schedule of Proposed Actions and has been updated quarterly. In May 2006, approximately 180 letters were sent to the citizens, agencies and organizations on the Forest mailing list that have requested notification of all new projects. This scoping package was also posted on the HNF Internet site. A legal ad was published in the three newspapers of record (Escanaba Daily Press, Marquette Mining Journal, and the Sault Ste. Marie Evening News) on May 23, 2006.

1.6 ISSUE IDENTIFICATION

An issue is a point of discussion, dispute, or debate involving the Proposed Action described in terms of an effect on a physical, biological, social, or economic resource. Issues are used to formulate alternatives for the proposal, prescribe mitigation procedures if necessary, and analyze possible environmental effects. Concerns brought forth by the public about the Proposed Action, which are not considered issues are discussed only briefly, as allowed by National Environmental Policy Act (NEPA) regulations [40 CFR 1500.4(c) and 40 CFR 1502.2(b)].

Six letters were received from individuals or groups. All comments were reviewed and grouped by the inter-disciplinary team (IDT). Scoping comments and IDT responses to them are located in the project file. Based on the comments received, an alternative to the proposed action was not needed. All comments were addressed by one of the following categories:

- General comment/questions/comment in support of the project
- Comment or opinion outside the scope of this analysis
- Comment that drove effects analysis but not alternative development
- Comment addressed by design criteria or treatment protocol

CHAPTER 2 - ALTERNATIVES

2.1 ALTERNATIVES

2.1.1 Alternatives Considered But Eliminated From Detailed Study

Prescribed fire to control garlic mustard

The use of a prescribed ground fire was considered as a control method for an infestation of garlic mustard near Au Train Lake, verses the use of a weed torch as a means of killing plants and seeds in the leaf litter (Project record, July 2006). Four factors caused this proposal to be dropped. First, even a cool fire is damaging to some northern hardwood species (yellow birch, paper birch, beech, and sugar maple). Second, because of the higher humidity levels associated under northern hardwoods, it is unlikely that a ground fire would be of sufficient intensity to be effective against garlic mustard seeds in the organic layer. In the event a moderate intensity could be carried, there could be severe damage to the overstory trees and other ground flora, which are not tolerant of hot fires. Third, there is a dearth of scientific literature available to support the effectiveness of fire. Michigan Technological University established a study in 2006 in the Au Train area to study the effects of various techniques, including fire, on controlling garlic mustard (Lindsey 2006). Depending on their results, the Forest Service may propose using this method in the future after the appropriate environmental analysis is completed. However, prescribed fire is not being proposed as part of this NNIP Control Project Environmental Assessment (EA).

2.1.2 Alternative 1 – No Change

Under Alternative 1, the HNF would not implement an integrated program of treatments to control NNIP infestations. It is termed the "No Change" alternative because limited mechanical and manual treatment of NNIP infestations would likely continue to take place through separate decisions. It is anticipated that under this alternative approximately 30-50 acres would be treated annually through manual and mechanical methods, as is the current practice. Management direction in the 2006 Forest Management Plan would apply to Alternative 1. Design criteria and treatment protocol (Sections 1.3.2 and 1.3.3, pp. 11-14) would apply only to Alternative 2.

2.1.3 Alternative 2 – Proposed Action

This alternative consists of those activities outlined in Chapter 1. Under Alternative 2 (Proposed Action), the HNF would implement a Forest-wide, integrated NNIP control program on approximately 135 known sites, and at any new sites found through monitoring (Table 1-2). The HNF would treat on average approximately 40-70 acres, annually, and possibly up to 200 acres, annually, if funding allows. Follow-up monitoring would evaluate the success of treatments and determine whether additional control measures were necessary. Treatments could occur across the HNF wherever NNIP are identified. The majority of known infestations occur within disturbed, upland habitats such as roads, trails, utility corridors, openings, gravel pits, and recreation sites.

2.2 COMPARISON OF ALTERNATIVES

Table 2-1 shows the approximate acres to be treated on the HNF each year by the proposed methods in Alternative 2 (Proposed Action) and Alternative 1.

Table 2-1. Comparison of Alternatives for the Hiawatha National Forest Non-Native Invasive Plant (NNIP) Control Project

Alternative	Manual and Mechanical Control Acres*			Chemical Control Acres*		Biological Control Acres*
	Hand Treatment	**Weed Torch**	**Mowing, Cut Trees**	**Land Herbicide Treatment**	**Riparian Herbicide Treatment**	**Biological Control**
Alternative 1 (No Change)	50	0	0	0	0	0
Alternative 2 (Proposed Action)	35	1	5	10	5	10

* - Projected approximate acreages are based on input from HNF staff

CHAPTER 3 – AFFECTED ENVIRONMENT and ENVIRONMENTAL EFFECTS

INTRODUCTION

The HNF is located in the Eastern Upper Peninsula of Michigan, including portions of Alger, Delta, Chippewa, Mackinac, Marquette, and Schoolcraft counties. The HNF proclamation boundaries encompass approximately 1.3 million acres, about 895,000 acres (USDA FS 2006b, p. 3-6) of which are tracts of National Forest System land. The remainder of the HNF consists of non-federal land, primarily privately-owned commercial timber and residential land.

The HNF contains a wide diversity of vegetation types, soils, and landforms derived from Wisconsian age glacial processes. Most uplands within the HNF are forested by stands of northern hardwoods, pine, aspen, spruce, fir, or oak. Soil textures are primarily sandy, but range from sand to clay. Landforms encompass end moraines, ground moraines, both clayey and sandy glacial lake plains, outwash plains, bedrock exposures, steeply dissected river valleys, and post glacial erosional benches and drainways. The National Wetland Inventory (NWI) maps show approximately 39 percent of the HNF as wetland/water of various classes. Most of these are a mixture of forested and non-forested wetland habitats as well as numerous streams, lakes, and other open water habitats. The HNF is home to a variety of animals and plants, ranging from common to rare species. There are hundreds of lakes, thousands of acres of wetlands, and thousands of miles of streams. Together the flora, fauna, soil, and water of the HNF form a resilient ecosystem that provides a variety of habitats, recreation opportunities, and forest products.

Part of an Environmental Assessment (EA) is a presentation of effects from proposed actions to the human environment (40 CFR 1508.9). Components of the human environment include physical (land, water, air), biological (plants and animals), economic (money passing through society), and social (the way people live) (FSH 1909.15 section 15). Through the scoping process, the government is directed to emphasize those environmental issues relevant to the proposed action and de-emphasize insignificant issues, narrowing the scope of the environmental analysis (40 CFR 1501.1). Following a review of the proposed action and public comments, the following resource areas will be emphasized.

- Land Use, Recreation, and Aesthetics
- Air Quality
- Soils, Hydrology, and Water Quality
- Biological Environment
- Human Health and Safety
- Cultural Resources
- Socio-economics

The following sections describe the environmental condition of areas and resources within the HNF potentially affected by Alternatives 1 and 2 described in this EA. Under Alternative 1, the U.S. Forest Service would not implement an integrated NNIP Control Program on the HNF. It is called the "No Change" alternative because it is likely limited mechanical and manual treatment of NNIP would still take place through separate decisions, not associated with this EA. Over the last several years (2003-2006), the HNF has accomplished an average of approximately 30-50 acres of NNIP removal annually. In the effects analysis for Alternative 1, it was assumed that the HNF would continue to accomplish a similar annual acreage, focusing that effort on high priority sites. We projected these assumptions out through a

5-year span of time, similar to the 5-year duration of the NNIP control program in Alternative 2, for the purpose of estimating potential impacts of NNIP infestations. Alternative 2 (Proposed Action) calls for NNIP control activities at multiple locations within the HNF over a 5-year period. The specific location of treatments would depend upon the severity and future spread of NNIP populations. Thus, Chapter 3 provides a programmatic description of the affected environment and environmental effects on federally-owned lands within the HNF. The content focuses on those resources that might be most affected by the alternatives.

3.1 LAND USE, RECREATION, AND AESTHETICS

3.1.1 Land Use Affected Environment

Extensive clearcutting followed European settlement of the region. Catastrophic slash fires followed this in the late 19^{th} and early 20^{th} centuries. Continued settlement brought moderate amounts of agricultural clearing, much of which was abandoned and reclaimed by forests. The suppression of wildfires, which began with increased settlement, is a continuing practice shaping land use on the Forest (USDA 2006b, pp. P-2 and 3-6). The current land cover within the HNF boundary, both on NFS lands and on lands in other ownerships, is predominantly forest vegetation. Dominant land uses are currently outdoor recreation, wildlife habitat, and production of lumber and wood fiber (USDA 2006b, p. P-2).

3.1.2 Recreation and Aesthetics Affected Environment

The HNF offers numerous opportunities for dispersed and developed recreation. Recreationists visit the area for the outstanding fisheries, hunting, boating, and sightseeing opportunities, and for winter sports activities. Private lands within the Forest boundary support numerous camps and summer homes that attest to the desirability of the area for rest, relaxation and recreation enjoyment (USDA 2006b, p. 3-239).

Twenty-one campgrounds are accessible by roads and offer sites for tent or trailer camping. Many are located beside lakes or streams, and offer opportunities for swimming, boating or fishing. Interpretive trails are available, as well as short trails leading to points of interest such as waterfalls. Other, longer trails are also available for hiking, cross-country skiing, snowmobiling and ATV riding. Hunting is another popular activity. Game species present on the HNF include deer, bear, turkey, grouse and waterfowl. Auto touring is popular during the fall color season. Several historic lighthouses also draw many visitors.

3.1.3 Land Use, Recreation, and Aesthetics Direct and Indirect Effects

The boundary for analysis of direct and indirect effects to land use, recreation and aesthetics will be the infested acres on the HNF. Direct and indirect effects are expected to be confined to these acres because any treatment activities would be confined to these acres.

Alternative 1: Using only manual or mechanical treatments to control NNIP species would have little, if any, immediate adverse impacts on land use, recreation, and forest aesthetics. Manual digging of exotic vegetation could leave disturbed and exposed soil, as could mechanical treatments such as disking, blading or plowing. This disturbance would be apparent only for the short-term, as native vegetation would reclaim these sites within a growing season. However, failure to control the spread of NNIP species effectively could adversely affect future land use. The establishment of dense thickets of exotic buckthorns could interfere with hiking, birding, and other recreation in forested areas. The spread of monocultures of visually striking species such as purple loosestrife could substantially alter the natural aesthetics of some natural areas. Visitors wishing to experience visually the typical natural landscape of the Upper Peninsula may be distracted by the visible dominance of exotic plants. Some NNIP species, particularly wild parsnip and spotted knapweed, can cause dermatitis on exposed human skin. Continued expansion of such species could reduce the ability of people to enter and enjoy portions of the HNF. Other NNIP such as purple loosestrife may take over wetland areas, including lakeshores, affecting the use of lakes for fishing, boating or swimming.

Alternative 2: As with Alternative 1, manual or mechanical control activities would have little, if any, adverse impact on land use, recreation, or forest aesthetics. Manual digging of exotic vegetation could leave disturbed and exposed soil, as could mechanical treatments such as disking, blading or plowing. As with Alternative 1, this disturbance would be apparent only for the short-term, as native vegetation would reclaim these sites within a growing season. Herbicides, cutting, and pulling would generally leave the killed, cut or uprooted exotic plants on site to die. In some cases, such as with mature garlic mustard, the plants would be bagged and removed. The weed torch could visibly singe individual plants but would not visibly char areas of the landscape as would a controlled burn. Most invasive plant sites are small and treatments would likely not be encountered by the public, although larger areas would be more noticeable, especially if near campgrounds, or roads or trails used by the public. Regardless of the short-term effects, natural succession and the growth of native plants left behind, seeded, or planted would return treated areas to a more natural appearance. Temporary visual impacts such as small bare spots or browned or singed vegetation would generally be expected to last no longer than a single growing season, after which they would be expected to be obscured by naturally growing vegetation.

Most scientists and much of the public would consider the elimination of NNIP species as aesthetically beneficial. However, some people might prefer the aesthetic appearance of NNIP species to that of natural vegetation. For example, purple loosestrife forms visually attractive masses of reddish-purple flowers in late summer, and honeysuckle shrubs form aesthetically attractive flowers in spring and red berries in fall. Those people could consider the elimination of such species from the landscape as an aesthetically adverse impact. However, the long-term aesthetic benefits from replacing near monocultures of exotic plants with a diverse mix of native plant species should outweigh any short-term adverse effects.

Some physical treatments might interfere with developed recreation for a short time. For example, ground-disturbing activities such as mowing, disking, or blading would temporarily alter the physical appearance of treated areas. However, any such activities would be limited to areas of prior physical disturbance such as roadsides, former borrow pits, or non-forested openings. Such visual impacts would be temporary and expected to last no more than a single growing season, as natural succession and the growth of native plants left behind, seeded, or planted would return treated areas to a more natural appearance.

Consistent with product label instructions and State of Michigan regulations, some areas where herbicides had been applied might have to be temporarily closed to the public to prevent people from contacting wet herbicide solutions on treated foliage, soil, or in lake water (Table A-1). The boundaries of treated areas near campgrounds or other areas heavily used by the public would be posted with signs or tape alerting the public to the presence of herbicides. Remote areas of herbicide use would be posted with at least one sign in a conspicuous location. Herbicide treatments would be avoided in public use areas during times of heaviest demand, such as summer holiday weekends (treatment protocol No. 8, p. 12).

Waters treated with aquatic herbicides might have to be temporarily closed to fishing and swimming following application. The Forest Service would follow label direction for all herbicide applications, including swimming and fishing restrictions. The Michigan Department of Environmental Quality (DEQ) may require additional restrictions as part of their permitting process, including disabling of water wells near treatment areas, such as those found at some boat launches. Signs alerting the public to aquatic herbicide use would be conspicuously posted at public entry points to treated waters such as boat ramps and road crossings. However, the anticipated acreage of treatment of aquatic habitats is expected to be infrequent (Table 2-1). Thus, the locations where temporary closures and other restrictions would be required would be very low.

Release of biological control agents would not require any temporary land use restrictions. The Forest Service would strive to educate visitors regarding the use and purpose of biological control agents via notices in visitor centers or outdoor signage, but any such educational efforts would be for information only and not be necessary to ensure public safety. All of the proposed biological agents have a history of successful and safe use in the Midwestern United States. None of these biological control agents have become a nuisance (Van Driesche et al. 2002).

3.1.4 Land Use, Recreation, and Aesthetics Cumulative Effects

The boundary for analysis of cumulative effects to land use, recreation, and aesthetics will be the HNF boundary, including both NFS lands and lands in other ownerships, because the degree of success on the treated acres would contribute to controlling of NNIP on all acres within the Forest boundary.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2), and sites along roadsides, gravel pits, and recreation areas. This is because treatment acreage would likely be limited to historic average levels of 30-50 acres a year using manual and mechanical methods. Some infestations of NNIP would likely go untreated. However, spread of NNIP would be patchy over the anticipated period of this project and impart minimal effects on resources. Therefore, the direct and indirect effects of actions under this alternative would be both negligible and short-term, and so their contribution to cumulative effects would also be negligible and short-term. Thus, Alternative 1 would not contribute measurably to any cumulative loss of land use, recreation activities, or aesthetics in the foreseeable future.

Alternative 2: The proposed control activities would result in minimal short-term adverse effects. Considering the limited extent of control activities proposed each year, the adverse incremental effects on land use, recreation, or aesthetics from the proposed control activities would be temporary and minimal. As the effects from these activities are minimal and negligible, there would be no cumulative effects to land use, recreation, or aesthetics when combined with impacts of other past, present and reasonably foreseeable future activities outlined in Table 3-3. However, the range of treatment options available under this alternative (manual, mechanical, chemical and biological) and the greater maximum acres of treatment would constitute a more effective strategy to reduce and control the spread of NNIP within the boundaries of the HNF than Alternative 1.

3.2 CLIMATE AND AIR

3.2.1 Climate and Air Affected Environment

Average annual precipitation on the HNF ranges from 29 to 36 inches, occurring largely during the summer period. Average total snowfall ranges from a low of 46 inches near Escanaba to 146 inches in Munising, Sault Ste. Marie, and other areas along the snowbelt near Lake Superior (Midwest Regional Climate Center, 2006). Temperatures range from average lows of 7.3 degrees F in January to average highs of 72 degrees F in July (Midwest Regional Climate Center, 2006). Based on the available data, air quality on the HNF and most of the Upper Peninsula is considered good (MDEQ 2002).

3.2.2 Climate and Air Direct and Indirect Effects

The boundaries used for direct and indirect effects were the proclamation boundaries of the HNF, including National Forest System lands and lands in other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary has been used because of the minimal disturbance expected from manual, mechanical, chemical and biological treatments, limited volatilization from the chemicals proposed to be used given the treatment protocol, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Alternative 1: NNIP plants do not generally affect air quality; hence limiting invasive plant treatment and failure to achieve their control would not measurably affect air quality. Because there would be no change in the current level of NNIP treatment on the HNF in this alternative, there would be no direct or indirect effects on climate or air quality. In addition, the presence or absence of NNIP species does not affect air quality; hence, failure to achieve their control would not affect air quality.

Alternative 2: The proposed manual and mechanical methods of treating invasive plant infestations would have no more than minimal direct or indirect effects on air quality. Manual and mechanical control would consist of cutting, pulling, or digging up invasive plants and would not produce any air emissions. Plowing, disking, or blading could occur in some already-disturbed sites such as gravel pits and would leave temporary areas of bare soil that would generate minor short-term wind-borne soil erosion. Any areas of soil left bare of vegetation following treatment would be seeded with a mix of fast growing grasses, forbs, legumes, and/or shrubs recommended for soil stabilization and erosion control by the Forest botany program (design criteria, pp. 12-14). Manual and mechanical NNIP control using motorized equipment such as vehicles, saws, line trimmers, and mowers, would generate minor amounts of exhaust emissions. Trace amounts of ground level ozone would be produced by operation of these vehicles equipment with internal combustion engines. Considering the small extent of acreage to be treated annually under the proposed program and the current levels of vehicular traffic within forest boundaries, any increased ground level ozone production would be negligible and not measurably greater than that associated with present vehicular activities. Consistent with State burning regulations and permitting requirements, some minor smoke and ash emissions would be generated from burning cut brush.

Most of the herbicides proposed for use under this alternative are not volatile; that is, they are unlikely to vaporize and be carried by wind (drift) to unintended locations (Table A-3). The exceptions are dicamba and certain ester formulations of triclopyr. When drift or misapplication occurs, plants that were not intended to receive herbicide may be affected (Putnam et al. undated). Growth-regulating herbicides such as triclopyr can drift if applied inappropriately (Kansas State University 2001). The potential for these herbicides to volatilize increases with increasing temperature and soil moisture (Tu et al. 2001). Given the cool nature of the HNF climate and treatment protocol to not apply on hot days (No. 8, p. 12), volatilization**,** would be insignificant. The salt formulations of both herbicides are less likely to vaporize than the ester formulations, and use of the salt formulations could be a desirable alternative to the ester formulations in some instances (Tu et al. 2001, Tu et al. 2003). Forest Service staff would consider prevailing weather conditions and would use lower volatility formulations when necessary to prevent significant volatilization.

Different methods of application can have substantially different effects on air quality. Most problems associated with herbicide drift are related to application by aircraft. As discussed in Chapter 1, Alternative 2 does not allow aerial application. Most of the proposed herbicide treatment would consist of manual application to stumps and cut surfaces of woody vegetation (spot spraying), which would result in little or no drift because the applications are made close to the ground surface. Spraying using booms from vehicles or tractors (broadcast spraying) would have greater impacts because of less selectivity than spot spraying. Broadcast spraying would be limited to disturbed areas, roadsides, and other non-forested areas. The treatment protocol (pp. 11-12) calls for herbicides to be sprayed only when wind conditions meet specifications on the manufacturer's label, for example 10 miles per hour or less.

Spot treatment and broadcast spraying may result in temporary, localized odors that may persist at the spray site for several hours or days. These herbicide formulations would be applied cautiously and only under appropriate climatic conditions. For example, herbicides would only be sprayed when wind is less than 10 miles per hour (following label direction), and volatile herbicide formulations would not be applied on hot days (greater than 85ºF). Therefore, the use of herbicides would not result in a substantial direct or indirect impact to air quality.

Alternative 2 would not have any direct or indirect impacts on climate within the HNF because NNIP do not alter overall temperature or precipitation patterns within an area.

3.2.3 Climate and Air Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including National Forest System lands and lands in other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary has been used because of the minimal disturbance expected from manual and mechanical treatments, limited volatilization from the chemicals proposed to be used given the project protocol, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Because there would be no direct or indirect effects associated with implementing Alternative 1, there would be no cumulative effects when combined with the effects of past, present, or reasonably foreseeable future activities.

Alternative 2: Given the limited area that would be involved, and the rapid decomposition of the proposed chemicals, Alternative 2 would have minimal and insignificant direct and indirect effects. Because the direct and indirect effects of implementing Alternative 2 would be minimal and insignificant, there would be no cumulative effects.

3.3 SOILS AND GEOLOGY

3.3.1 Soils and Geology Affected Environment

The HNF is contained within Section 212H, the Northern Great Lakes, of the National Terrestrial Ecological Unit Mapping (McNab and Avers 1994). This area is level to gently rolling lowlands (glacial ground moraines) and flat outwash or lacustrine plains, with dune fields near the Great Lakes. Cropping out of the lowlands and plains are partially buried end moraines and mounded ice-contact hills that tend to parallel the Great Lakes. Most of Section 212H is covered by Pleistocene (Wisconsinan) stratified drift, primarily as outwash sands. Lacustrine deposits occur between morainal and ice-contact ridges and are widespread in the eastern Upper Peninsula (U.P.). Pleistocene and Holocene sand dunes occur near the Great Lakes. Silurian and Devonian limestone and dolomite outcrops are common, especially along Lakes Huron and Michigan. Upper Proterozoic and Cambrian sandstones crop out along Lake Superior (McNab and Avers 1994).

The landforms of Michigan's U.P. are a product of the glaciers that occupied the region during the Pleistocene Epoch. During the Wisconsinan glacial stage the entire U.P. was covered with a thick sheet of ice that extended as far south as southern Indiana and Ohio. A massive deposition of glacial drift and the subsequent melting of the glacial ice combined to create a variety of landforms including beach ridges and dunes, ground moraines, till plains, outwash plains, glacial drainage channels, glacial deltas, sandstone benches, several types of bedrock controlled landforms, and others. Glacial depositions throughout the U.P. range from 0 to over 500 feet thick (Jerome 2006).

Although there are a few areas of silt loam and clay loam soils, the soils on the HNF are primarily sandy or loamy sand with mucks and peats in the wetland areas.

3.3.2 Soils and Geology Direct and Indirect Effects

The boundaries used for direct and indirect effects were the proclamation boundaries of the HNF, including National Forest System lands and lands in other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary has been used because of the minimal disturbance expected from manual and mechanical treatments, the treatment protocol limiting impacts, the rapid degradation and limited mobility of the chemicals proposed to be used, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Alternative 1: The no change alternative to control NNIP infestations would not result in any direct or indirect effects to soils or geological features. Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2). This is because treatment acreage would likely be limited to historic average levels of 30-50 acres each year using only manual and mechanical methods. Some infestations of NNIP would likely go untreated. However, spread of NNIP would be patchy over the anticipated period of this project and impart minimal effects on resources. As many NNIP species are aggressive, they can affect soils by removing nutrients and increasing soil erosion by crowding out other species. Further, invasion of wetlands by dense stands of some NNIP, such as purple loosestrife, reed canary grass, and common reed, can alter hydrological flow patterns (Gries, personal observation). Allelopathic chemicals released by certain exotic plants, such as exotic buckthorns and barberries into the soil could inhibit the establishment of native plants. However, these effects would be minimal over the next 5-year period. Over the long-term (greater than 5 years), failure to take aggressive action to control NNIP infestations on the HNF could eventually result in adverse impacts to soil resources.

Alternative 2: Under the proposed alternative, some ground disturbing control methods, such as digging, plowing, disking, or blading could temporarily increase the potential for soil erosion at some sites in limited locations. Given the small area anticipated to be disturbed per year, particularly when compared to other on-going activities, the results would be negligible. Further, according to project protocols (pp. 11-12), areas of soil left bare of vegetation following treatment would be re-seeded with a mix of fast growing grasses, forbs, legumes, and shrubs recommended for soil stabilization and erosion control by the Forest botany staff. These could include native plants or non-aggressive exotic plants intended to stabilize the soil until longer-lived native species re-colonize the site or can grow large enough to sufficiently compete.

The use of herbicides as a control method would not increase erosion since herbicides kill but do not physically remove plants and their root systems. The root systems of the dead plants would offer short-term soil stabilization to protect against erosion until new plants can be re-established either naturally or via seeding or planting. Where herbicides kill most of the standing vegetation, re-seeding as described above would stabilize the soil and to prevent NNIP in the seed bank from re-establishing. Treating cut stumps of woody NNIP species such as exotic buckthorns and honeysuckles with herbicides would discourage re-sprouting without the soil disturbance required to manually remove the stumps.

Spraying herbicides inevitably results in the short-term accumulation of herbicide residues in soil. Once in the soils, herbicides can migrate via gravity, leaching, and surface runoff to other soils, groundwater, or surface water (for discussion of transport in water, see Section 3.5.2). To determine the level of risk for accumulation of herbicide residues on soils and possible contamination of ground and surface water, factors such as persistence (measured in half-life), mobility, and mechanisms for degradation have been reviewed (Table A-3 and Table A-4). Examples of factors influencing herbicide persistence can be broken into three classes: soil factors, climatic conditions, and herbicidal properties (Hager et al. 1999). Factors of persistence interact and are thus not easily broken into one of these three classes; however, they include issues such as pH, cation exchange capacity (CEC), soil moisture, organic matter, organisms present, and molecular binding of chemicals to organic and soil particles (Hager et al. 1999, Miller and Westra 2004a, Tu et al. 2001). Precipitation patterns following application also heavily influence potential effects to soils, and potential contamination of groundwater and surface waters. Further, different formulations of the same herbicides (salts vs. esters or varying surfactants or formulations) would also alter persistence, degradation pathways, and mobility in soil (Miller and Westra 2004b, Miller and Westra 2004c, Tu et al. 2001, Tu et al. 2003, Tu et al. 2004).

Of the herbicides considered in this assessment, dicamba is not generally absorbed by the soil but it does have a short half-life. It has been noted in landscaping applications to be absorbed by tree roots extending beneath the treated lawn (Putnam et al. undated). However, given the rapid decomposition rate there would be only minimal environmental effects.

The persistence of a herbicide is defined as the length of time that residues from an application remain active in the soil. This is typically measured in terms of half-life, which is the time it takes to degrade 50 percent of the herbicide to harmless products. The herbicides proposed for use have half-lives that range from 14 days to up to six months (Table A-4). In general, the herbicides proposed for use have relatively short persistence in the soil and soil microbes readily degrade each of the proposed herbicides. Herbicides that are more persistent could offer longer suppression of invasive plants, including less re-establishment from existing seed in the soil; however, these herbicides would also pose a greater risk to the environment and were therefore not considered for use in this project. Future chemicals may be developed and proposed for use. As long as their persistence is as short or shorter and toxicology is less than those being proposed in this assessment, they would result in minimal and insignificant effects to soils and geology on the HNF.

The soil mobility (movement through the soil) of the proposed herbicides is varied (Table A-4). Glyphosate and ester formulations of triclopyr bind rapidly to the soil. Most formulations of dicamba do not bind rapidly to the soil but are rapidly degraded by soil microbes, light, or a combination of effects;

and have short half-lives in soil. Clopyralid does not bind strongly to the soil and has a longer half-life of 40 days in soil, and thus could leave longer lasting residues in the soil. However, as long the proposed herbicides are used as directed by label specifications and in accordance with the design criteria, minimal effects would result.

3.3.3 Soils and Geology Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including National Forest System lands and lands in other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary has been used because of the minimal disturbance expected from manual and mechanical treatments, the treatment protocol limiting effects, the rapid degradation and limited mobility of the chemicals proposed to be used, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Implementing Alternative 1 would not result in any direct or indirect effects to soils or geological features. Because there would be no direct or indirect effects associated with implementing Alternative 1, there would be no cumulative effects.

Alternative 2: Alternative 2 would not result in effects other than those discussed for the direct and indirect effects. Because of the small size of areas to be treated by mechanical control methods, the short half-life of the herbicides proposed for use, and the limited area to be treated overall, the direct and indirect effects would be minimal, and insignificant. Thus, because the direct and indirect effects associated with Alternative 2 are minimal and insignificant, there would be no cumulative effects when combined with the effects of past, present, or reasonably foreseeable future activities outlined in Table 3-3.

3.4 MINERALS

3.4.1 Minerals Affected Environment

Mineral resources on the HNF are associated with the geology of the eastern U.P. There are two major features that represent the geology of the HNF, the Michigan Basin and the Niagara Escarpment. The Niagara Escarpment cuts through most of the HNF. This long curving feature is a bedrock high formed by the erosion of resistant limestones and dolomites. There are many karst features, such as caves and sink holes, associated with the Niagara Escarpment. Most of these karst features are found in the Engadine dolomite, a Silurian age carbonate bedrock group, which is likely to dissolve in weak acid in water where the glacial deposit is very thin to non-existent. The Pleistocene Epoch left glacial deposits in the HNF area. These deposits include outwashes, lacustrine, and moraines and can range anywhere from 0 feet to over 500 feet thick. These deposits consist of mineral materials such as sand, gravel, and clay. The amounts of each of these materials in a deposit vary drastically by location and by type of deposit.

Common variety mineral resources, such as sand, gravel, stone, and clay, are currently being extracted from Forest Service pits. Sand and gravel are used as road fill and surfacing in construction and reconstruction of Forest Service roads. The local counties and the public also use these common variety minerals. Sand and gravel pits on the HNF are a source for NNIP. Non-native invasive plants are common in mineral pits on the HNF. They are found everywhere from the stock piles to the banks and surrounding areas of the pits.

3.4.2 Minerals Direct and Indirect Effects

The boundaries used for the direct and indirect effects for minerals were the proclamation boundaries of the HNF, including National Forest System lands only. This boundary has been used because of the location of mineral pits spread across the Forest and the process of applying the minerals to Forest Service transportation routes.

Alternative 1: There would be no direct or indirect effects on HNF minerals associated with implementing Alternative 1**.** Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2). These efforts would likely include pits. Some infestations of NNIP would likely go untreated and continue to be a source for spread and colonization of uninfested locations as the gravel and sand are distributed on Forest transportation routes.

Alternative 2: Manual and mechanical methods of plant removal, such as mowing and hand pulling would disturb the top 6-18 inches of ground. This activity would have no effect on mineral resources. Some of the herbicides proposed for use are acidic. However, all herbicides proposed for use, except for clopyralid, either bind readily with the soil, giving low mobility, or rapidly degrade so there is limited movement (see Section 3.3.2). Studies have shown that under "worst case" experimental conditions, clopyralid was found in soil water samples approximately 6 feet below the surface (Elliot 1998). Due to the thickness of the ground moraine, any potential leaching of clopyralid to the "worst case" depth of 6 feet below the bottom of the gravel pit would not likely reach the bedrock, and would therefore not contribute to the formation or erosion of karst features. Thus, there would be no direct or indirect effects from implementing Alternative 2.

3.4.3 Minerals Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including all minerals, regardless of ownership. This boundary has been used because of the stewardship responsibilities the Forest Service maintains for the surface on lands it manages.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Implementing Alternative 1 would not result in any direct or indirect effects to minerals on the Forest. Because there would be no direct or indirect effects associated with implementing Alternative 1, there would be no cumulative effects.

Alternative 2: Alternative 2 would not result in any direct or indirect effects. Thus, because there are no direct or indirect effects associated with Alternative 2, there would be no cumulative effects when combined with the effects of past, present, or reasonably foreseeable future activities outlined in Table 3-3. However, Alternative would likely provide for more NNIP treatment in pits than Alternative 1, due to the higher acreage threshold in Alternative 2. This could result in slower spread and reduced new infestations on the HNF.

3.5 HYDROLOGY AND WATER QUALITY

3.5.1 Hydrology and Water Quality Affected Environment

Lakes and streams are common across the HNF. In addition to touching three of the Great Lakes (Superior, Michigan, and Huron), the HNF includes over 3,000 inland lakes and ponds ranging in size from Brevort Lake at over 4,300 acres to numerous small ponds which are less than 0.1 acre. There are also approximately 3,300 miles of streams as well as abundant springs and ephemeral ponds. Within the HNF Proclamation Boundary there are approximately 497,000 acres (39% of area) of wetlands, including marsh, wet meadow, fen, bog, conifer swamp, hardwood swamp, and shrub thickets (National Wetland Inventory Maps). Not all of these are on HNF lands proposed for treatment.

In addition to the large number of small streams and creeks, there are a number of principal rivers within the HNF, draining the watersheds shown in Figure 3-1. The Rapid, Whitefish, Sturgeon, Fishdam, Tacoosh, and Indian rivers empty into Lake Michigan. The Carp and Pine rivers empty into Lake Huron. The Au Train, Rock, and East Branch Tahquamenon rivers empty into Lake Superior. The 5th and 6th level watersheds are shown in Figure 3-1.

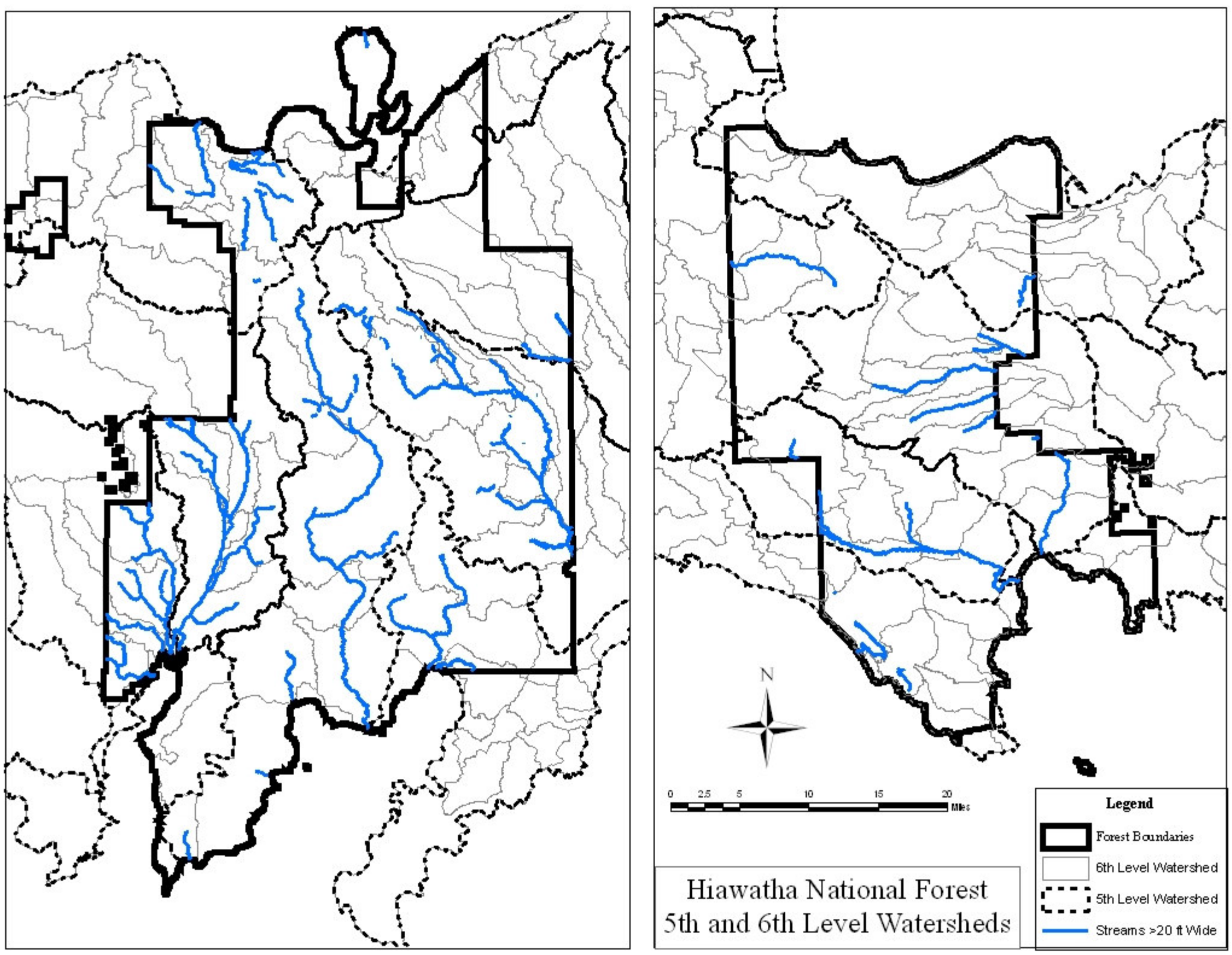

Figure 3-1. Watersheds of the Hiawatha National Forest.

High flows during the spring and fall and low flow during summer periods characterize the majority of streams and rivers. Most streams are underlain by deep sandy outwash deposits, limestone, sandstone, or shale. Numerous lakes and wetlands have formed in low-lying areas, often blocked glacial drainways, or in kettles formed over stranded glacial ice blocks (McNab and Avers 1994).

Ground water is relatively plentiful on the HNF. Much of the land within the Forest boundary is over the aquifer of Great Lakes Superior, Michigan, and Huron. Although most of the land within HNF boundary has watertable depths within 15 feet, permanent water table depths range from zero (in the wetlands and near the Great Lakes) to more than 75 feet in the glacial till or bedrock (MDEQ 2006b). Perched water tables fed by rain and snowmelt may be encountered in sub-irrigated sites (within 10 feet of the surface), in soils with clayey textures, or those having a fragipan (dense or cemented soil layer) within 3 feet of the surface.

In general, water quality within the HNF is considered to be good although there are some streams in which mercury and PCB contamination has been identified (MDEQ 2004). Although some mercury occurs naturally, the majority of this contamination is from historic uses or sites outside of the HNF. It is likely that much of the mercury found in waterways on the HNF results from upwind fossil-fuel power plants. The State of Michigan has scheduled Total Maximum Daily Load (TMDL) development for mercury in accordance with Clean Water Act 303(d) requirements as administered by the EPA. All inland lakes in Michigan have fish consumption advisories due to high mercury levels (MDCH 2004).

Other problems identified in some of the streams include lack of large woody debris (LWD) and heavy sediment loads. The lack of LWD is a result of historic land use and extensive logging that occurred in the 1800s and early 1900s. These areas are currently in the process of recovering from these impacts although long periods are required for riparian systems to grow large trees that are capable of falling into the streams to create large woody debris. Sedimentation has a number of sources. Some occurs naturally in those streams flowing through sand or clay landforms. Other sedimentation originates from management activities that occurred prior to the establishment of the HNF. The main sources of continuing, management-induced, sedimentation are roads and road/stream crossings (USDA 2006b). For both of the alternatives considered, the HNF would be implementing BMPs for water quality per Forest Plan Riparian Ecosystem Guideline 1 (USDA 2006a, Chapter 2) (for Alternative 2, protocol No. 13).

3.5.2 Hydrology and Water Quality Direct and Indirect Effects

The boundaries used for the direct and indirect effects were the proclamation boundaries of the HNF, including National Forest System lands and lands in other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary has been used because of the minimal disturbance expected from manual/mechanical treatments, treatment protocol and design criteria to prevent chemicals from entering water systems, the limited mobility of the herbicides proposed to be used and the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Alternative 1: Implementing Alternative 1 to control NNIP infestations would not have direct or indirect effects on water quality. Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2), as well as recreation areas, roadsides and gravel pits. Because treatment acreage would likely be limited to historic average levels of 30-50 acres each year using only manual and mechanical methods, some infestations of NNIP would likely go untreated. Some NNIP, especially Eurasian water-milfoil, reed canary grass, and purple loosestrife, form dense stands in shallow waters or wetlands that sometimes alter hydrologic flow patterns. This can force water out of existing channels resulting in loss of bank stabilization and increased erosion. Further, although monocultures such as many NNIP form can stabilize soils and sediments, mixed stands of vegetation are less susceptible to rapid die-off that could suddenly leave large areas of unstable soil or sediment until new vegetation can reestablish. However, these effects would be minimal over the next 5-year period, because, to date, NNIP sites are limited to sites with ground disturbance, such as recreation sites, utility corridors, and openings (USDA 2006b, 3-66).

Alternative 2: Manual and mechanical control methods would have minimal direct or indirect effects on water quality. Work performed in aquatic or wetland settings could temporarily suspend sediment in the water, but given the small size of the areas proposed for treatment each year and the required use of Best Management Practices (BMP) and the project protocol (No. 13, p. 12), effects, such as erosion and sedimentation, would be brief, localized and minimal in magnitude. Mowers and other vehicles would not be operated in wetlands while the ground surface is inundated or saturated or otherwise unable to support the equipment (USDA Forest Service, 2006a).

Chemical control methods involving spraying herbicides could expose soils and surface water to herbicides, even when label directions are followed. Herbicides that fall on soil during spray operations can leach into groundwater or be transported via surface runoff that could result in affects to unintended locations. However, the small areas proposed for treatment each year under Alternative 2 would not allow for more than localized migration of small quantities of herbicides. Further, modern herbicides are designed to rapidly break down into inactive products in soils and water (see herbicide half-life data in Tables A-3 and A-4 and the soils discussion in Section 3.3.1). Project design criteria in Alternative 2 required buffers around wet areas to ensure that only those herbicides with formulations approved for aquatic use can be used (criteria No. 11, p. 13). The design criteria is based on guidance in Michigan BMPs (MDNR 1994). The minimum buffer is 100 feet in width.

When herbicides enter surface water, concentrations quickly decline due to mixing (dilution), volatilization, and degradation by sunlight and microorganisms. Although herbicides become more diluted in surface waters, there is still the potential that even in low concentrations they can upset the ecological balance, result in toxicity, or cause contamination of drinking water supplies (van Es 1990). In addition to the design criteria being implemented to minimize this effect, all of the herbicides proposed for use under this Alternative have been demonstrated to pose little toxicological risk to fish, aquatic invertebrates, or wildlife when used at specified rates and per the label directions (see Section 3.6.3). Certain formulations of triclopyr are toxic to fish and aquatic invertebrates and care must be taken during application to ensure that these herbicides are not introduced into aquatic ecosystems. Only formulations approved for aquatic use by the State of Michigan would be used near wetlands or other waters (treatment protocol No. 8, p. 12 and design criteria Nos. 11-15). Following these practices would ensure that and state and federal water quality laws are complied with and the use of water resources are protected.

None of the proposed herbicides contain, or are formulated with mercury or PCB. The alternative would therefore not have any appreciable effect on contaminant concentrations in streams or lakes. Because herbicide treatment in riparian areas would follow label directions, design criteria, and the protocols presented in Chapter 1, there would be minimal and insignificant effects to groundwater and surface waters.

3.5.3 Hydrology and Water Quality Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including National Forest System lands and lands in other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary has been used because of the minimal disturbance expected from manual and mechanical treatments, treatment protocol and design criteria (pp. 11-14) to prevent chemicals from entering water systems, the limited mobility of the herbicides proposed to be used and the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Implementing Alternative 1 to control NNIP infestations would not have direct or indirect effects on water quality. Because there would be no direct or indirect effects associated with implementing Alternative 1, there would be no cumulative effects.

Alternative 2: Because of the small size of areas to be impacted by manual and mechanical control methods, the short half-life of the herbicides proposed for use, the limited area to be treated overall, and the extensive protocols and design criteria relative to water quality, there would be minimal and insignificant effects associated with activities in Alternative 2. Thus, because there are minimal and insignificant effects associated with Alternative 2, there would be no cumulative effects when combined with the effects of past, present, or reasonably foreseeable future activities outlined in Table 3-3.

3.6 BIOLOGICAL ENVIRONMENT

3.6.1 Native Plant Communities Affected Environment

This section addresses native plant communities. The affected areas are all lands on the HNF susceptible to infestation by non-native invasive plants. The invasive plant species are themselves components of the affected vegetation, in addition to the native plants and plant communities they disrupt. The affected area lies in six counties in northern Michigan, including portions of Alger, Chippewa, Delta, Mackinac, Marquette, and Schoolcraft counties. The threatened and sensitive plants analysis is located in section 3.6.4.

Current NNIP

The NNIP sites on the HNF are generally small in size (most are much less than an acre) and distributed across the Forest. The Environmental Impact Statement (EIS) for the 2006 Forest Plan indicates that most of the NNIP infestations occur in disturbed sites (e.g. roadsides, skid trails, parking areas and utility corridors) (USDA 2006c, p. 3-66).While NNIP inventory data is still incomplete, some extrapolations can be made based on the current database. Based on the current 135 sites totaling 100 acres, an estimated additional 500 sites would cover about 375 additional acres. Together this gives an estimate of 475 infested acres for those sites, which is 0.05% of the total HNF acreage. However, this figure underestimates the actual area of infestation, which is 5,000+ acres (D. LeBlanc, personal communication, 2007). Even so, the HNF is in an early stage of infestation, a good time to initiate a control program. Without more aggressive control efforts, the number of acres infested would grow rapidly. Invasive plants are often spread by human activities associated with vehicles and roads, recreation, forestry, and agricultural practices, but human disturbance is not always required for establishment of the plants. The HNF implements an equipment cleaning provision for forestry equipment, such as dozers and skidders, which requires operators to remove soil and other material that could transport NNIP from infested sites. Birds and animals can also carry seeds from an infested area to an uninfested one. Past control efforts by HNF personnel have been limited to some hand-pulling, especially at threatened, endangered and sensitive (TES) plant sites, and in piping plover habitat (endangered bird). During a 4-year period, 2003-2006, the average annual acreage of NNIP treated was reported at 37 acres, with a range of 26 acres in 2004 to 49 acres in 2006 (project record 2007).

Native plant community

The HNF supports a diverse mixture of native plant communities, ranging from swamps and bogs to mesic hardwood forest to bedrock glades underlain with limestone. To evaluate the susceptibility of native plant communities to invasion, they were grouped in broad categories based on the species of NNIP that can invade them (Table 3-1). All plant communities are susceptible to invasion by one non-native plant or another though not to the same extent or by the same NNIP. For example, a closed canopy forest is not likely to be invaded by species such as white sweet clover or leafy spurge that require full sun, but prairies or beaches would be. In addition, areas with ground disturbance are more likely to be invaded, as are areas with corridors for easy seed transportation by humans or animals.

Table 3-1. Plant community groups and examples of NNIP invaders.

Plant Community	Invasive Plants
Aquatic Habitats	Eurasian water milfoil, Purple loosestrife
Open / Wet Habitats	Purple loosestrife, Marsh (swamp) thistle, Reed canary grass Common reed
Open / Dry Habitats and Beach Habitats	Spotted knapweed, Diffuse knapweed, Canada thistle, Bull thistle Smooth brome, Crown vetch, Common tansy, Giant hogweed White sweet clover, Yellow sweet clover, Leafy spurge Hound's tongue, Wild parsnip, Common St. Johnswort Common burdock, Scotch pine
Shaded / Wet Habitats	Glossy buckthorn, Exotic Honeysuckles, Common burdock
Shaded Habitats	Common buckthorn, Glossy buckthorn, Japanese barberry Garlic mustard, Exotic Honeysuckles, Common burdock Scotch pine

Herbicides

The HNF currently only uses herbicides at administrative sites, such as office buildings or at campgrounds to control pests like poison ivy. Under an agreement by the Lake States National Forests, herbicide is not used for forestry practices, such as site preparation prior to tree planting. This agreement was amended recently to allow the use of herbicide to treat non-native invasive plants wherever they occur. The extent to which herbicide is used on private lands within the Forest is not known since this information is not tracked by any entity.

Biological control existing conditions

The biological control agents (Table 1-5) proposed for use against purple loosestrife, leafy spurge, and spotted knapweed all have extensive and successful records of prior use in the United States (Van Driesche et al. 2002). The milfoil weevil, the only proposed biological control agent targeting Eurasian water-milfoil, is native to the United States including Michigan. The three insects proposed for targeting purple loosestrife (Table 1-5) were introduced to North America in 1992. The Michigan Department of Natural Resources (DNR) began releasing the two *Galerucella* beetles in 1995 and reported that the beetles were beginning to reduce purple loosestrife populations by 2001. Flea beetles, of the genus *Aphthona*, including the two proposed biological control agents targeting leafy spurge, have been released in neighboring states. The knapweed root weevil and lesser knapweed flower weevil were introduced into the United States for knapweed control in 1988 and 1991, respectively. The root weevil and flower weevil were both introduced into Minnesota in 1994 and into Indiana in the 1990s (Story 2004). Both weevils have also been approved for release in Wisconsin. Neither weevil has yet been released in Michigan. In general, attack by knapweed insects is restricted to the genus *Centaurea*, and usually to the subgenus *Acrolophus*. There have been no reports of attack on non-target species by any of the insects since their release (Story 2004). No members of the genus *Centaurea* are native to Michigan, and several species are invasive.

3.6.1.2 Native Plant Communities Direct and Indirect Effects

The boundary for the analysis of direct and indirect effects to native plant communities were the proclamation boundaries of the HNF, including National Forest System, only, and the time it takes for the proposed chemicals to degrade. This boundary has been used for a variety of reasons. These include the minimal disturbance expected from manual and mechanical treatments, protections resulting from treatment protocol and design criteria to minimize chemicals from drifting and entering water systems, the limited mobility of the herbicides proposed to be used and the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Alternative 1

Effects to NNIP: Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2), such as T&E and RFSS occurrences, as well as recreation areas, roadsides and gravel pits. This is because the HNF has treated approximately 30-50 acres each year since 2003 (project record 2007) with manual and mechanical methods as part of a variety of projects with existing NEPA decisions. It is likely that this level of treatment would continue. However, under this alternative NNIP would continue to spread. NNIP prevention practices such as equipment cleaning would decrease the spread of NNIP from these sites, but would do nothing to control them. The vast quantities of seed produced by NNIP makes it extremely likely that they would spread to new areas of the Forest. Non-native invasive plant education for the public would continue, and this would have an effect on reducing future infestations. Overall, without treatment actions, these NNIP sites would expand and spread to other areas of the Forest.

Effects to Native Plant Communities: Limited NNIP control activities would likely occur on the HNF, emphasizing invasive plant removal on priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2). Examples would include T&E and RFSS plant occurrences, T&E habitat for wildlife (e.g. piping plover) as well as recreation areas, roadsides and gravel pits. Invasive plants within undeveloped areas would mostly go untreated, except where proposed and authorized as part of other Forest projects with other NEPA decisions or as part of T&E and RFSS plant protection. Responsibility for chemical control of lakes infested with Eurasian water-milfoil would be left to the Michigan DNR, lake associations, counties, or other interested parties. Invasive plant prevention and education would continue as described in the draft Forest Invasive Species Strategy (USDA 2005b). Overall, without adequate treatment methods to control widespread invasive plants, many infestations would go unchecked and diversity of native plants and community composition would decline over time. Recent information from field observations by Forest Service employees indicate that the decreasing water level in Lake Michigan has combined with beach succession, and the presence of NNIP in the expanding shoreline, to a magnitude of invasive plant infestation that is exceeding the capabilities of manual control (J. Ekstrum, personal communication, 2007). NNIP would affect native plant communities through competition, chemical changes in soil, allelopathy, and decreased species diversity. Therefore, failure to control NNIP infestations on the HNF could eventually result in a loss of native vegetation diversity and numbers of individual plants. However, most impacts to native plant communities would occur over a longer term, greater than 5 years, as NNIP continued to spread and infest new locations. The colonization of undisturbed areas by NNIP would become more frequent, an occurrence that would threaten native communities more than the current condition.

Alternative 2

Effects to NNIP: Invasive plant sites are likely to be contained (prevented from spreading) under this alternative. Many of these sites would be completely eradicated, if treated soon. Some NNIP, such as spotted knapweed, may persist for several years despite treatment. The treatment actions in Alternative 2 are expected to result in a substantial reduction of NNIP at the sites because most of these are still small. They are also located in disturbed areas, rather than in sites where abundant native plants are found.

Effects to Native Plant Communities: Overall, the control actions in this alternative, guided by the treatment protocol and design criteria (pp. 11-14) would damage a small number of non-target native plants. If non-target plants are dug up or non-target plants susceptible to herbicide are sprayed, they would be killed. Most NNIP sites are small (less than 0.1 acres); therefore, there are few native plants surrounding the NNIP that could be inadvertently killed. Loss of these few plants would not affect native species abundance, distribution, or population viability on the HNF because within the next growing season the area would repopulate from seed in the soil or vegetatively from surrounding native plants or be replanted to native plant as indicated in the treatment protocols (No. 5, p. 11). Furthermore, although a few native plants may be killed, the overall effect would be to increase the health of the native plant community by removing competing NNIP. The higher threshold acreage of NNIP treatments and the multiple treatment options, which would be allowed under Alternative 2, would increase the ability of the HNF to control existing infestations in native plant populations and decrease the likelihood of spread into areas not yet invaded by NNIP. This would occur as a result of treating NNIP in disturbed areas, thereby decreasing or eliminating a seed source that a vector (e.g. vehicle, bird, wind, water) could transport into undisturbed locations.

Mechanical and Manual Control: Proposed manual and mechanical control methods such as hand-cutting, hand-pulling, or root-stabbing are highly selective, but there is a slight risk of injuring or killing non-target plants. The loss of the occasional non-target plant would not cause a reduction in native plant species because surrounding native vegetation remains unharmed and would repopulate.

Nonselective manual and mechanical control methods such as plowing, disking, or blading would be used for high-density patches of NNIP. Since these are not native plant systems, no native plant communities would be affected. Mowing, generally used for roadsides, would remove flowering heads of NNIP to stop them from spreading but it would not harm native grasses. Other native roadside annual and perennial plants appear to tolerate current mowing practices. The weed torch would be used when native species are dormant or on dense patches of NNIP. The weed torch would directly kill the occasional non-target plant; the remaining community would be undamaged. Effects to native plant communities from manual and mechanical method would be minimal and temporary. However, some native plant communities that are currently infested with NNIP would be restored to a condition with more native plants over time as a result of activities in Alternative 2.

Chemical Control: Herbicides are designed to kill plants; some damage to non-target plants in treated areas would be probable despite cautious planning and implementation. Spray methods for herbicide application carry the greatest risk for affecting non-target plants. The application of the protocol and design criteria (pp. 11-14) would prevent unintended loss of more than a small number of native plants. Loss of a few understory plants will not alter the habitat because the area can repopulate from native seed in the soil or vegetatively from surrounding native plants. The herbicides selected for this project (with the exception of imazapic) do not have residual effects so they would not injure other plants through the soil. Imazapic would be used on dense patches of leafy spurge and according to the protocol (No. 5, p. 11), a native plant community would be re-established after the spurge is removed. Spraying herbicide may directly affect some native understory plants but any effect would be minimal and temporary due to small NNIP sites, judicious application, and appropriate timing.

Hand application of herbicides to cut surfaces, or basal bark of woody plants with a sponge or brush would affect NNIP but not injure adjacent non-target plants. Therefore, native plant communities would remain unharmed by hand application.

Aquatic herbicide use poses the greatest risks to non-target plants, since direct application to target plants is not possible underwater. Herbicide would injure or kill native plants it contacts. If chosen for aquatic application, herbicide would be applied only to Eurasian water-milfoil infested patches, which allows the invasive milfoil to be suppressed or eradicated, followed by reestablishment of native plants. The risk of harming non-target plants would be reduced further by applying herbicide in spring before native plants are as active as Eurasian water milfoil and by choosing a broadleaf-selective herbicide so as not to affect grasses, sedges, lilies and other monocot plants. Furthermore, the risk would be reduced due to characteristics of the proposed aquatic chemicals to lose effectiveness and rapidly degrade so they would not spread to other parts of the lake (Tu et al. 2001,7e.5). Negative effects to native vegetation would be on a small scale (only a few lakes within the HNF are currently infested) and of short duration, and therefore, not likely to result in loss of viability for any native plant species.

Biological Control: The three insects proposed for targeting purple loosestrife selectively feed on the invasive plant and would not harm other organisms (OFAH 2003). Therefore, loosestrife beetles would not cause a decline in native plant populations. Reduction of dense patches of purple loosestrife would result in a higher quality native plant community with greater diversity and numbers of native species.

Flea beetles of the genus *Aphthona* are very host specific and feed only on a narrow range of hosts restricted to the spurge family (TEAM 2003). The only known non-target plants fed upon by the proposed beetles are in the subgenus *Escula* of the genus *Euphorbia,* of which there are no native members in the Upper Peninsula (Voss 1995; Gleason and Cronquist 1991). Therefore, there would be no direct or indirect reduction in native plants with the use of flea beetles. Indirectly, reduction in leafy spurge would return habitat to a natural condition with greater native plant diversity and numbers of plants.

The knapweed root weevil feeding is restricted to the genus *Centaurea*, and usually to the subgenus *Acrolophus*. There have been no reports of attack on non-target species by any of the insects since their release (Story 2004). There are no members of the genus native to Michigan, and several species are invasive. Therefore, release of knapweed weevils would have no direct effect on native plants. Indirectly, reduction in invasive knapweeds would return habitat to a more natural condition, as indicated above.

Unlike the other proposed biological control agents, the milfoil weevil is indigenous to the United States, including Michigan and feeds specifically on water-milfoil plants (*Myriophyllum* spp.). It traditionally fed on the native northern water-milfoil (*Myriophyllum sibiricum*) but began to feed on Eurasian water-milfoil when it became established in this country and prefers the non-native when both are present (Van Driesche et al. 2002). Introduction of this insect to a lake where it previously did not exist naturally may cause a reduction in native milfoil plants if they are present. However, the overall effect would be to reduce the non-native milfoil restoring a higher quality habitat with greater native plant diversity and numbers of plants.

3.6.1.3 Native Plant Communities Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including National Forest System lands and lands in other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary was used because of the minimal disturbance expected from manual and mechanical treatments, project protocol and design criteria (pp. 11-14) that prevent chemicals from entering water systems, the limited mobility of the herbicides proposed to be used, the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1

Under Alternative 1 limited NNIP infestations would be treated. Invasive plants would continue to spread into more areas of the Forest, including less disturbed and high quality ecological habitat. Combined with the failure of other landowners to reduce NNIP, this would result in a decline in ecological function of the natural communities on the HNF.

NNIP: Failure of adjacent landowners to control invasive plants would contribute to an increase in NNIP spread. The spread of NNIP may be affected by activities in the areas of private ownership on the Forest. Population growth is expected to occur in the eastern Upper Peninsula in the future. Mackinac County and Chippewa County are expected to increase by 34.7% and 29.6%, respectively, through 2020 (USDA 2006b, p. 3-363). Human activities, including development, recreation, and roads are present within the Forest boundary and may be expected to continue in the future. Clearing of land for homes and other development and trucking offsite material onto private land within the Forest boundary could result in the spread of existing NNIP, and possibly the transport of new species (Table 3-3). Shoreline areas are highly sought after as sites for vacation homes or resorts and are highly vulnerable to ongoing shoreline development. Development could result in spread or introduction of NNIP into these areas.

Several large highways cross the HNF. U.S. Highway 2, M-28, Interstate 75, and MI 123 are examples of highways that serve as routes NNIP continue to reach the Forest.

Anticipated increases in recreation, such as off-highway vehicles or all-terrain vehicles use (OHV or ATV), pedestrian traffic, and horseback riding (USDA 2006b, pp. 3-372 and 3-374) would increase the changes for NNIP to reach the Forest, as well as contribute to further spread. This would result in additional effects to native plant communities by reducing diversity in existing populations and numbers of individual native plants present.

Water level fluctuations in the Great Lakes increase the area of disturbed shoreline resulting in beach succession and colonizing by NNIP (J. Ekstrum, personal communication, 2007). These infestations reduce the ability of native species to colonize the expanding shoreline and become a source of NNIP seed that can spread into other areas if not treated.

Native Plant Communities: Under Alternative 1, there would be no direct effect to native plant communities to add to past, present or reasonably foreseeable actions on the effects upon native plant communities by Forest Service actions. However, indirectly, implementing Alternative 1 would result in an increase in spread of NNIP as detailed above in the discussion of effects on NNIP. The result would be a reduction in native plant community function and composition through a reduction of species diversity, as well as numbers of individual plants present.

Alternative 2

Table 3-3 lists past, present and reasonably foreseeable actions that help control NNIP as well as some that contribute to their spread. The minimal adverse effects of Alternative 2 on native plant communities are out-weighed by the beneficial effects of reducing invasive plants on the landscape. The beneficial effects would be realized due to the higher treatment acreage possible and the multiple methods of NNIP control available under Alternative 2.

NNIP: The treatment actions in Alternative 2 are expected to result in a substantial reduction of NNIP within treated areas on the Hiawatha and NNIP spread to lands of other ownerships would be reduced. The proposed control methods (manual, mechanical, chemical and biological) complement current and foreseeable efforts of Federal, State, County and other groups to control invasive species (Table 3-3). The benefits would be offset slightly by the failure of landowners to control NNIP and other causes of spread listed in Table 3-3, but this is where education efforts by the Forest Service, Michigan DNR and others would prove beneficial. The overall result would be a reduction in size and number of NNIP sites.

Native Plant Communities: Because the direct and indirect effects from manual, mechanical and biological control actions would be minimal, there would be no measurable incremental effect on native plant communities when combined with the impacts of other past, present and reasonably foreseeable future activities (Table 3-3). Due to the strict treatment protocols and design criteria (pp. 11-14), the effects of chemical control methods would be minimal and temporary and would not contribute measurable adverse incremental effects when combined with the impacts of other past, present and reasonably foreseeable future activities. Implementing the actions described in Alternative 2, combined with those past, present and reasonably foreseeable NNIP control actions in Table 3-3, would result in an improvement in native plant community structure, function and composition by increasing diversity and numbers of individual plants within populations.

3.6.2 Overstory Vegetation

3.6.2.1 Overstory Vegetation Affected Environment

NNIP species can be found in nearly all types of habitats, whether upland or lowland, lakes, open areas or forested stands. Most NNIP discovered so far on the HNF prefer open sites, such as gravel pits, roadsides, ditches, savannas, or unforested wetlands. Some, such as garlic mustard, smooth brome, and common buckthorn, also invade forested stands, particularly productive, moist, northern hardwood stands. Currently, known infestations of these NNIP are still small and few (USDA 2006b, p. 3-66).

Northern hardwood stands on the HNF are often managed for an uneven-aged condition. This means that a given stand will contain trees of all ages and sizes, from seedlings to large mature trees, at all times. Maintaining this condition requires that small amounts of regeneration of tree species must occur at relatively frequent intervals. The relatively shade-tolerant species that characterize this forest type are able to regenerate under partial shade.

Other northern hardwood stands are managed for an even-aged condition. This means that a given stand will consist of trees that are nearly all approximately the same age and size. Nearly all regeneration occurs over one relatively short period in the life of the stand.

Garlic mustard poses a particular threat to northern hardwood stands. Major tree species in the northern hardwood forest type, including at least sugar maple, red maple, and white ash, form mutualistic relationships with native mycorrhizal fungi. When attached to tree roots, these fungi help the trees to absorb nutrients from the soil. Chemicals released by garlic mustard have been shown to disrupt the establishment of these root-fungi relationships, inhibiting growth of tree seedlings and reducing seedlings' ability to survive (Stinson et. al. 2006). This disruption has implications for the future of an infested stand. Today's tree seedlings are the future canopy trees.

Non-native honeysuckles may also pose a threat to forested stands. These shrubs are able to grow in shaded environments, as under a forest canopy. A study in Ohio, in hardwood stands that included many tree species that are also common on the HNF, showed that tree growth rates declined after Amur honeysuckle invaded the understory (Hartman and McCarthy, 2007). While this study only documented the effects and did not investigate the cause, a likely possibility is that non-native honeysuckles may out-compete the native tree species for soil nutrients.

3.6.2.2 Overstory Vegetation Direct and Indirect Effects

The boundary for the analysis of direct and indirect effects to overstory vegetation will be the acres actually planned for treatment each year, as any effects would be confined to these acres.

Alternative 1: Under this alternative, an average of about 30-50 acres of NNIP per year would likely be treated, but only by manual and mechanical methods. The treatments would be implemented under other NEPA decisions not associated with this EA. Manual and mechanical methods have been shown to be ineffective to eradicate established infestations of many NNIP, including garlic mustard, buckthorn, and smooth brome. Non-native honeysuckles would be likely to resprout from the rootstocks of cut shrubs. These NNIP, which have demonstrated the ability to spread into forested stands, would continue to spread, displacing native understory plants. Garlic mustard would have the potential to interfere chemically with regeneration of tree species. Non-native honeysuckles, buckthorn and smooth brome would have the potential to interfere with regeneration of tree species by competing with seedlings for light, water and nutrients.

Effects to the trees in an uneven-aged northern hardwood stand might not be obvious to the casual observer for a long time because the stand would still have several size classes of trees for several years. However, if garlic mustard plants became sufficiently numerous, they could cause chemical interference with the ability of northern hardwood tree seedlings to form mutualistic connections with native mycorrhizal fungi. As trees now in the smallest size classes grew larger, they would not be replaced by new seedlings. Continued failure to recruit new seedlings into an uneven-aged stand would eventually result in a lack of one to several of the smaller size classes. As trees already present in these stands gradually grew through the larger, older size classes and died, this lack of recruitment could result in a stand that contained fewer and fewer trees of any size, at least of the tree species most characteristic of the northern hardwood forest type.

Effects to the trees in an even-aged northern hardwood stand would not be obvious until the stand reached maturity and attempts were made to regenerate it. Regeneration efforts would be likely to fail due to the inability of tree seedlings to establish mutualistic connections with native mycorrhizal fungi, caused by chemical interference produced by garlic mustard.

In both even-aged and uneven-aged hardwood stands, non-native honeysuckles buckthorn and smooth brome would have the potential to out-grow tree seedlings for the seedlings' first few years, and could therefore compete more successfully for light, water and nutrients. Non-native honeysuckles have been shown to reduce growth rates even in medium-sized to large trees, possibly by competing more successfully for soil nutrients.

The available treatments under this alternative would include only manual and mechanical methods. None would be expected to have any effect on overstory vegetation.

Alternative 2: Under this alternative, an average of approximately 40-70 acres of NNIP would be treated each year with a potential for up to 200 acres each year if funding were available. The range of treatment methods allowed (manual, mechanical, chemical and biological), and the higher maximum treatment acreage would increase the likelihood that an effective treatment method would be available to use against the target NNIP.

Under this alternative, there would be a better opportunity to control NNIP such as garlic mustard, non-native honeysuckles, buckthorn and smooth brome that are able to spread into forested stands. These NNIP would be less likely to displace native understory species in forested stands. All of these NNIP would be less likely to become so numerous that they could reduce regeneration success for seedlings in northern hardwood stands. It would be less likely that non-native honeysuckles could become sufficiently well-established as to impact the growth rates of medium-sized to large trees.

Potential negative effects to overstory vegetation were considered when the additional treatment methods allowed by this alternative were selected, and the only treatment considered that would have had negative effects to overstory vegetation (i.e. prescribed fire) was not included in this alternative. See section 2.1.1 Alternatives Considered but Eliminated from Detailed Study. Of the treatments available under this alternative, none are expected to have any effect on overstory vegetation. Some of the herbicides available for chemical treatments could harm tree species if they were applied by aerial or broadcast spraying, but the treatment protocols in Section 1.3.2, No. 8 provide measures that will prevent herbicides from being applied to non-target vegetation, including trees. None of the insects available for biological control feed on tree species.

3.6.2.3 Overstory Vegetation Cumulative Effects

The boundary for analysis of cumulative effects for the overstory vegetation was determined to be the HNF boundary, including both National Forest System lands and lands in other ownerships, because the degree of success on the treated acres will contribute to controlling of NNIP on all acres within the Forest boundary.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Under this alternative, manual and mechanical methods would likely remain the only means available to treat NNIP. These methods have been shown to be ineffective against established populations of NNIP such as garlic mustard, non-native honeysuckles, buckthorn, and smooth brome, which are able to spread into forested stands. Existing infestations of these NNIP would continue to spread. Existing unchecked garlic mustard infestations would increase in both size and number, and could eventually become a serious problem affecting tree seedling regeneration in northern hardwood stands; existing infestations of non-native honeysuckle, buckthorn and smooth brome would also have the potential to interfere with tree seedling regeneration, though through different means. In addition, non-native honeysuckles could reduce overstory tree growth rates. As other reasonably foreseeable actions occurred, including both recreational use by the public and management activities (Table 3-3), seeds from these unchecked NNIP infestations could be spread to additional locations both on and off the HNF.

Near ownership boundaries there would be little chance that existing NNIP infestations on National Forest System lands could be controlled before they spread to adjacent lands in other ownerships. There would also be little chance of stopping infestations that spread to National Forest System lands from adjacent lands. With only relatively ineffective control methods available, the cumulative effects of this alternative would be that such NNIP infestations, especially of garlic mustard, would bring to an increasing area the problems described above in the discussion of direct and indirect effects.

Alternative 2: Under this alternative, more acres would be treated annually and a much greater range of treatment methods would be available to control NNIP infestations. Some of these additional treatments, such as chemical control, would be more effective than manual or mechanical methods against NNIP, such as garlic mustard, non-native honeysuckles, buckthorn and smooth brome, that are able to spread into forested stands. The result would be an increased likelihood that such infestations could be controlled. Because the infestations could be better controlled, they would be less likely to spread. Garlic mustard populations would be less likely to become so numerous that they could affect tree seedling regeneration. With fewer uncontrolled NNIP infestations on the HNF, there would be fewer sources of seed to be spread by reasonably foreseeable actions, such as recreational use by the public and management activities (Table 3-3), to other areas both on and off the HNF.

Near ownership boundaries there would be an increased likelihood that existing NNIP infestations on National Forest System lands could be controlled before they spread to adjacent lands in other ownerships. There would also be an increased likelihood of stopping infestations that spread to National Forest System lands from adjacent lands. With more effective treatment methods available, the cumulative effects of this alternative would consist of increased control of such infestations, especially of garlic mustard, and would decrease the area affected by the problems described above in the discussion of direct and indirect effects.

3.6.3 Wildlife

3.6.3.1 Wildlife Affected Environment

The HNF is home to a wide variety of animals occupying a range of habitats. People are interested in the Forest's wildlife for a number of reasons, including bird watching, wildlife viewing, hunting and trapping opportunities, unique research activities, and for their inherent ecological value as a component of the Forest's biological diversity.

There are several factors responsible for the diversity of animal species on the Forest. Vegetation and associated structural elements are the dynamic base that constitutes wildlife habitat. The HNF is located in an area of vegetation transition between the boreal forests to the north and the mixed hardwoods forests to the south. Consequently, species representing each zone are present on the Forest. The proximity of the Great Lakes affects temperature and moisture regimes, resulting in more influences on the local animal communities.

Within these animal communities, some species, such as ruffed grouse, hermit thrush, and beaver are common. Other species, such as Blanding's turtle, northern goshawk, black-backed woodpecker and Hine's emerald dragonfly are relatively rare or exist on the edge of their more southerly or northerly ranges. Species that are listed as federal threatened or endangered (T&E) and Regional Forester sensitive species (RFSS) have special protections in the 2006 Forest Plan that help to ensure their viability (USDA 2006a, p. 2-17). These species, which are also collectively called threatened, endangered and sensitive

(TES) species, will be covered in Section 3.6.4. The biological evaluation for this EA contains a detailed analysis of TES (USDA 2007a).

Many birds, including migratory songbirds, waterbirds and raptors, breed on the HNF. Common browsing mammals include white-tailed deer, snowshoe hare, and porcupine. Other mammals include short-tailed shrew, red squirrel, least weasel, and northern flying squirrel. Common reptile and amphibian species include redback salamander, eastern garter snake, and painted turtle.

Uplands on the HNF that support early successional species of vegetation provide habitat for wildlife such as deer, grouse, and snowshoe hare. However, the extent of habitats dominated by early successional vegetation is decreasing as the forest matures. Middle successional and late successional forest cover is expanding and provides habitat for species such as woodpeckers, broad-winged hawk, and marten. Wildlife such as beaver, mink, otter, and muskrat frequent the edge of lakes, streams, and swamps. Lake and stream edges also provide food and cover for a wide variety of songbirds, predators, waterfowl, shorebirds, and amphibians. The inland lakes and streams of the HNF provide a variety of fish including walleye, perch, trout, bass, northern pike, brook trout, rainbow trout, brown trout, and panfish.

Much of the wildlife habitat on the Forest has been altered and is in what many believe to be a “recovery” phase. Some of the primary historical factors affecting wildlife habitat were anthropogenic in nature, including widespread deforestation and slash fires of the late 1800s and early 1900s (USDA 2006c, p. 3-6, Frelich 2002, pp. 4-7). Large areas of mature forests (or old growth), with complex structure and large patch size, dominated the area before Euro-American settlement (Frelich 2002, p. 3). Under this scenario, sensitive wildlife species, which used late seral forest types, likely prospered. Other factors affecting wildlife habitat resulted from natural processes. Certain locations on the Forest experienced frequent local disturbances (Frelich 2002, pp. 33-34), such as wildfire, which likely perpetuated open-land species, such as sharp-tailed grouse. Due to fire suppression activities currently employed on the HNF, fire was more influential in the past at shaping wildlife habitat.

Non-native invasive plants (NNIP) are factor in wildlife habitat on the Forest. Occurrences of NNIP have been observed in various wildlife habitats, from mesic uplands and dry pine oak savannas to shrub wetlands and inland lakes. However, most NNIP documented to date on the HNF occur in open sites, such as gravel pits, ditches, forest openings, and roadsides (USDA 2006c, p. 3-66). The documented infestations represent only a small portion of the nearly 900,000 acres under Forest Service stewardship. Consequently, few species of wildlife have been observed to be adversely affected by NNIP. Great Lakes shoreline and dune habitats are the exceptions. Piping plover habitat has infestations of several invasive plants. Recent information from field observations by USFS employees indicate that the decreasing water level in Lake Michigan has resulted in an expanding shoreline and spreading NNIP to a level that is exceeding the capabilities of manual control of invasive plants in piping plover habitat (J. Ekstrum, personal communication, 2007). Two insects, Lake Huron locust and northern blue butterfly, the latter of which is dependent upon a host plant, dwarf bilberry, have documented infestations in occupied or suitable habitat. Control activities, including pulling and cutting of NNIP have occurred historically in these areas. Currently, known infestations of NNIP are still few.

3.6.3.2 Wildlife Direct and Indirect Effects

The boundary for the analysis of direct and indirect effects to wildlife were defined as the proclamation boundaries of the HNF, including National Forest System lands, and the time it takes for the proposed chemicals to degrade. This boundary has been selected for a variety of reasons. These include the minimal disturbance expected from manual and mechanical treatments, protections resulting from project protocol and design criteria to prevent chemicals from drifting and entering water systems, the limited mobility of the herbicides proposed to be used and the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

When assessing potential impacts to wildlife, the Forest Service focuses on selected wildlife species called Management Indicator Species (MIS). Four species are presently recognized for the HNF, including two birds (ruffed grouse, sharp-tailed grouse), a mammal (American marten), and a fish (brook trout). Table A-8 lists the habitat requirements of each MIS on the HNF, and how each MIS, and the suites of associated species, would be affected by the alternatives.

Alternative 1: Some NNIP sites would be allowed to persist or increase in size. This could reduce available habitat and decrease forage, escape cover, and prey for some species. For species with small home ranges, such as insects, and species with specialized habitats, such as piping plover, higher levels of NNIP infestations could result in decreased fitness of individuals, greater mortality and fewer animals in the population. However, we know of no animal, or MIS, currently being measurably affected by NNIP infestations. On the HNF, infestations would continue to encompass a small percentage of the available habitat for the vast majority of wildlife on the Forest. Thus, for most species there would be alternate habitat to utilize should a location be infested with NNIP. This situation would also be applicable to all of the MIS, including American marten, ruffed grouse, and sharp-tailed grouse, as well as associated species (examples of species are listed in Table A-8). NNIP are present in habitat for the three terrestrial species. However, the level of infestation is low compared to available habitat. There are no NNIP known to occur in brook trout habitat. No measurable effects to MIS would occur over the foreseeable future (approximately 5 years).

Species with certain specialized habitats, including piping plover, northern blue butterfly and Lake Huron locust would be more vulnerable to NNIP infestation and spread. However, due to Forest Plan management direction (USDA 2006a, pp. 2-19, 2-20) NNIP control would likely occur in habitat used by these and similar species. The Forest would likely continue to annually remove approximately 30-50 acres of NNIP through manual and mechanical means only, using individual project decisions not associated with this EA. Due to Forest Plan management direction, a high priority would be placed on eradicating infestations with potential to adversely affect federal threatened and endangered (T&E) species and Regional Forester sensitive species (RFSS) should such circumstances develop on the Forest (USDA 2006a, pp 2-17 – 2-21). However, recent information from field observations by USFS employees indicate that the decreasing water level in Lake Michigan has combined with the presence of NNIP in the expanding shoreline to create a magnitude of invasive plant infestation that is exceeding the capabilities of manual control in piping plover habitat (J. Ekstrum, personal communication, 2007).

Thus, failure to implement a NNIP program that incorporates other methods of control, such as chemical and biological techniques, would allow the infestations and resulting habitat degradation to accelerate in the future for some animals. Aggressive NNIP species tend to replace native plants upon which wildlife depend for food and cover. For example, white sweet clover can invade sparsely vegetated shoreline habitat preferred by piping plover (K. Piehler, personal observation). Purple loosestrife can replace mixed stands of native wetland plants with dense stands of nearly impenetrable vegetation that are poorly suited as sources of food, cover, or nesting sites for much native wetland wildlife such as ducks, geese, rails, bitterns, muskrats, frogs, toads, and turtles (Minnesota DNR 1992, p. 8). Some butterfly species are reported to lay eggs on garlic mustard instead of normal native plant hosts, but unlike the native hosts the garlic mustard does not support complete development of the butterflies (Nuzzo 2000, p. 4). American robins are reported to experience greater nest predation when nesting on exotic buckthorn and honeysuckle shrubs than when nesting on native shrubs and trees (Schmidt and Whelan 1999). Eurasian water-milfoil is of lower value as a food source for waterfowl than the native aquatic plants it displaces, supports an inferior diversity and abundance of aquatic invertebrates that are fed upon by fish, and can deplete dissolved oxygen levels in aquatic ecosystems. The results from these example occurrences would be decreased fitness of individual animals, lower rates of reproduction, and for some species, decreases in population.

However, overall, under Alternative 1, it is anticipated the spread of NNIP into wildlife habitats would be patchy over the 5-year period of this EA, and have minimal or no measurable effects on most wildlife and all of the MIS. Species listed as RFSS and T&E will be discussed in a forthcoming section (3.6.4).

Alternative 2: The subsections below separately address the potential impacts from mechanical, manual, chemical, and biological control components of the proposed HNF NNIP Control Project.

Mechanical/manual Control: Many of the proposed mechanical and manual treatments (Table 1-3) have the potential to disturb wildlife, including the MIS. Digging up or cutting down shrubs could remove or disturb bird nests or animal burrows. Noise from brush saws, mowers, or other mechanical equipment could disturb wildlife. Brief periods of noise could startle some wildlife species, forcing them to temporarily evacuate areas where work is in progress, but are expected to be of minimal impact because all treatments would be temporary, localized and of short duration. Less mobile wildlife could be physically injured or killed by people or equipment during treatments. Nonselective mechanical control methods such as mowing, plowing, or disking would be limited to non-forested already-disturbed sites such as gravel pits, but could still alter the character of wildlife habitat in these areas.

Many of the design criteria outlined in Sections 1.3.2 and 1.3.3 would help to ensure protection of wildlife. To protect nesting birds, a design criterion specifies that thickets of invasive shrubs such as exotic honeysuckle and Japanese barberry would only be treated after August 1. Individual shrubs may be treated at any time if an inspection shows no nesting bird on or below the shrub. Known nests or dens of TES species would be protected from any disturbance during the nesting season. Prior to any treatments, actions covered by this EA would be reviewed by wildlife biologists. Treatments would be designed to minimize effects to associated resources, and pre-project surveys would be conducted when needed. Activities would be performed carefully to avoid physical injury to less mobile wildlife and to nests and burrows. When work is conducted in areas containing nests or burrows of rare or sensitive wildlife, those locations would be flagged or marked. Wildlife biologist review would be required for certain habitat and species. Thus, when the treatment protocol and design criteria are considered there would be a small risk to individuals and no risk to populations from these methods.

Chemical Control: Wildlife, including MIS, could be dermally (absorbed through the skin) exposed to herbicides by direct contact with herbicide spray streams or with recently treated foliage. Wildlife could be orally exposed to herbicides by ingesting treated foliage or insects or other prey in sprayed areas or drinking water from aquatically treated sites. Fish likewise can be exposed to herbicides in waters treated directly with herbicides and can be exposed if herbicides are used in adjacent wetlands or transported into waterways by surface runoff. Design criteria No. 11 (p. 13) would provide protection for this group of species through the minimum 100-foot buffer around all wet areas. Inside this buffer area, as well as the wet areas, only herbicides with label-approved aquatic use could be applied. This would minimize risk to wildlife. Hand application of herbicides to stumps or cut surfaces (cut and stump treatment) or basal bark (basal bark treatment) on woody plants has less potential than spraying for herbicide runoff or drift and therefore would be utilized wherever possible in areas known to contain rare or sensitive wildlife.

Herbicide toxicity data are presented in Tables A-5 through A-7 in Appendix A for aquatic, avian, and terrestrial invertebrate species, as well as mammalian species. The data suggest that the herbicides proposed for use in terrestrial and wetland settings are generally safe to mammals, birds, and other wildlife if used in accordance with the manufacturer label. None of the proposed herbicides are cholinesterase inhibitors, such as organophosphate or carbamate insecticides (or chemically related to such insecticides) that are highly toxic to wildlife, especially insects and other invertebrates. None of the proposed herbicides are chemically related to the chlorinated hydrocarbon insecticides such as DDT that are highly persistent in the environment and known for causing eggshell thinning of raptors (birds of prey) such as bald eagles, peregrine falcon and northern goshawk.

A LD_{50} (Lethal $Dose_{50}$) represents the dose (amount supplied orally) to a test animal species in a controlled laboratory experiment that causes 50 percent mortality. An LC_{50} (Lethal $Concentration_{50}$) represents the concentration causing 50 percent mortality when a test animal species is externally exposed to the chemical (e.g., chemical concentration in a medium such as water) in a controlled laboratory experiment. For purposes of comparison against the mammalian toxicity metrics in Table A-5, the oral LD_{50} for rats exposed in their diet to table salt (sodium chloride) is reported at 3,000 milligrams per kilogram (mg/kg) body weight (Mallinckrodt Baker Inc. 2004). The oral LD_{50} for salt is somewhat higher (safer) than the oral rat LD_{50} values for most formulations of glyphosate and clopyralid, but not substantially greater (safer) than those for many of the other herbicide formulations. Table salt, a common substance with which everyone is familiar and which is generally regarded as safe except at very high concentrations, is often is used as a point of comparison for understanding toxicity data for pesticides. For purposes of comparing the toxicities cited in Table A-6, the reported 48-hour LC_{50} for *Daphnia pulex* (water-flea) exposed to table salt is 1,470 milligrams per liter (mg/L) (Salt Institute 2004); this comparison value of table salt is actually lower (less safe) than the corresponding values for most herbicide formulations reported in the table. Values for many of the formulations do not greatly differ from this value.

Some forms of the herbicides specified are more toxic to fish and other aquatic life than others (Table A-6). Particularly noteworthy in Table A-6 are the extremely low LC_{50} values for aquatic species exposed to the Roundup formulation of glyphosate. Glyphosate is essentially non-toxic to fish as a trimethylsulfonium salt. However, certain product formulations utilizing glyphosate, such as Roundup®, is modified with tallow amine, a surfactant, that results in greater toxicity. For this reason, the Roundup formulation is not labeled for use in aquatic areas and would not be used in wetlands or riparian areas on the HNF (treatment protocol No. 8, p. 12). Instead, the Rodeo formulation would be used when the treatment benefits of glyphosate are needed in aquatic or wetland settings. The aquatic species LC_{50} values for Rodeo are substantially safer, and the Rodeo formulation is labeled for use in aquatic areas. Only herbicide formulations registered for aquatic use would be applied in aquatic settings or wetlands. Design criteria No. 11 (p. 13), which establishes the minimum 100-foot buffer around all wet areas, inside of which only herbicides with label-approved aquatic use could be applied, is an additional protection for wetland habitat and wildlife.

The potential toxicological effects of herbicides on amphibians are being debated. Declines in the populations of amphibian species have been documented (DAPTF 2003). One of the suspected causes of the widespread amphibian population declines is increased use of pesticides, including but not limited to herbicides (Bury et al. 2004). Other suspected causes of amphibian decline include physical disturbance of wetlands; impacts to wetlands and other habitats from timber harvest and forest management, introduction of non-native predators such as sportfish and bullfrogs, acid precipitation, increased ultraviolet radiation, and diseases resulting from decreased immune system function (Bury et al. 2004). As mentioned above, project protocol and design criteria (pp. 11-14), especially those pertaining to buffers around wetlands (protocol No 8, design criteria Nos. 10 and 11) address risks to wetland species from use of herbicides.

There is contradictory information in the available literature regarding toxicity to aquatic organisms from adjuvants (i.e. additives such as surfactants and dyes) included in glyphosate formulations (Relyea 2005, Thompson et al. 2006, Wojtaszek 2004, Howe 2004, Langeland 2006). Based on a review of this information, it has been determined the listed herbicides can be used safely on the Forest by incorporating buffers around wetland areas (project design criteria No. 11, p. 13). Design criteria address this risk by specifying varying widths of buffer strips (i.e. untreated land or vegetation), inside which only formulations of herbicides approved for aquatic use (example: Rodeo®) could be employed. The specified buffers are based on guidance included in the Michigan Water Quality Best Management Practices (MDNR 1994) for non-point source pollution. Literature indicates that buffers are effective in reducing herbicides movement from treated sites by decreasing runoff and drift (USDA 2000, 6-9).

<u>*Sensitivity of Animals to Herbicides*</u> - Even for herbicide formulations regarded as toxicologically and environmentally safe, proper application in strict accordance with the manufacturer label is critical to ensure safety to the applicator and the environment. Herbicide solutions would be mixed at appropriate locations to eliminate the potential for spills in naturally vegetated areas. Spray equipment would be inspected prior to each day's use to minimize the potential for leaks or misdirection of spray streams. Adjuvants would only be used as specified by herbicide label direction. When work is conducted in areas containing rare or sensitive wildlife, locations of nests or other immobile wildlife features would be marked whenever possible. Operators would be trained to recognize the protected animals (see Biological Evaluation and design criteria). Not only is it important to ensure that label application rates are not exceeded, but application must take place using properly maintained equipment and under proper weather conditions. All spraying would be conducted on calm days when no rain is predicted within the manufacturer's recommended period of time. Use of improperly maintained equipment can result in leaks and localized high concentrations of chemicals, and application in the wind can result in spray drifts that contact non-target areas (USEPA 1999, 2-3). When herbicides are applied prior to heavy rainfall, they can be carried in runoff to non-target areas. As a protection measure, upland buffers would be established around wet areas where only those products labeled for aquatic use could be used. Buffers are based on recommendations included in the Michigan Water Quality Best Management Practices (BMPs) (MDNR 1994). The minimum buffer width would be 100 feet. Herbicides would only be applied by persons possessing a pesticide applicator's license or (for unrestricted over-the-counter herbicides) under the supervision of a licensed applicator. Herbicide application would follow the directions provided by the product labels. For that reason, the average application rate results displayed in Table A-7 (Appendix A) provide the more accurate estimation of toxicity to animals should they be in contact with the herbicide. Highest rates of application (based on label direction) are unlikely to be used, particularly because the application methods would focus on the target plants only, not the target area. Spot application, rather than broadcast applications would be the normal course of operation when herbicide treatment is determined to be preferable over manual and biological methods (treatment protocol No 8, p. 12). Acute exposure to birds and mammals is unlikely to occur because the application methods would be on a small scale (hand pumps, wand or wick application). No aerial application (plane, helicopter, aerial boom) would be used. Also, since the applications would occur at such a small scale, drift would be minimized, thus reducing herbicide exposure to non-target vegetation and animals (refer to treatment protocol and design criteria, pp. 11-14).

- Chronic exposure would be unlikely for several reasons:
  - Herbicide applications would be expected to be annual at most.
  - In the case of animals eating vegetation, treated vegetation would be dead and would not represent a long-term food source.
  - In the case of animals eating contaminated animals (insects or small mammals), contaminated prey items represent an ephemeral resource due to the infrequency of herbicide application.
  - While some sites would require annual treatment, the treatment method may not be herbicide application each year.

For these reasons, the likelihood of repeated exposure to herbicides for any individual animal is further reduced.

Herbicides would be applied following the manufacturer label instructions and the treatment protocol and design criteria outlined in Sections 1.3.2 and 1.3.3, thereby minimizing the potential for inadvertent exposure of amphibians to spray streams. None of the NNIP control activities proposed as part of Alternative 2 would contribute to the loss or degradation of wetlands or other amphibian habitats or to other activities suspected of contributing to amphibian decline.

Although none of the proposed herbicides are considered to be insecticidal, the toxicity data for terrestrial invertebrates in Table A-6 and ecological risk information in Table A-7 suggest that dicamba could adversely affect honeybees and pollinating insects inadvertently exposed to those herbicides. Glyphosate could adversely affect dragonflies and butterflies, if individuals are directly sprayed. The effects would include injury or death to insects. However, we determined that risks are only to individuals, and the risks are low, considering the design criteria and project protocols in the NNIP project and the low acreage anticipated to be treated relative to the quantity of habitat available.

Biological Control: The act of releasing biological control agents would have little potential for effects to wildlife, including MIS. The insects would be released at only one or a few sites per infested area and would be allowed to spread on their own. To the extent possible, release sites would be chosen at the edges of existing roads in upland habitats, at the upland edge of wetland habitats, or from boats or the shore for milfoil weevils.

As noted for Native Plant Communities (see Section 3.6.1), the proposed agents have been demonstrated through research to adversely affect only the targeted NNIP species and other closely related taxa. Therefore, it is unlikely that native plants upon which wildlife depends for food or cover would be adversely affected. Regionally indigenous wildlife are generally adapted to depend upon regionally indigenous plant species as sources of food and cover. Plants introduced from other parts of the world, while typically beneficial to wildlife in that part of the world, are typically of less value to wildlife in the areas of introduction. For example, purple loosestrife is regarded as being of low value as food and cover for wildlife compared to most wetland plants native to the eastern United States (Minnesota DNR 1992). Introductions of biological control agents targeting purple loosestrife would therefore reduce dominance by purple loosestrife and open infested areas to greater dominance by native plants of greater value as food and cover for wildlife. The discussion in Sections 1.3.1 and 3.6.1 regarding the potential risks of the proposed biological control agents to non-target plant species suggests the agents pose little risk to wildlife habitats. Each of the biological control agents encompassed under this proposal have a record of successful and safe application within Midwestern areas similar to that of the HNF (Van Driesche et al. 2002). Therefore, use of biological controls would not pose substantial detrimental impacts on the species described above. Adverse effects from implementing control methods would be relatively small and temporary for all species in this group.

All NNIP Control Methods - For all treatment methods (mechanical, manual, chemical and biological), human disturbance would be minimal because most applications would not require the use of motorized equipment. There may be some increase in noise and movement from use of equipment such as weed cutters, chainsaws, and back-back spraying units, in wildlife habitats. However, these disturbances are expected to be of minimal impact because all treatments would be temporary, localized and of short duration. Design criteria (pp. 12-14) reduce risks of trampling or flushing to wildlife that exist or nest near the ground or in small trees and shrubs. General design criteria (Nos. 1, 2, 3, and 5, p. 13) and treatment protocol No. 4, p. 11, would provide additional protections for wildlife. The design criteria require that a variety of protections be met, such as designing treatments to ensure RFSS are not harmed, stopping and reviewing treatments if RFSS are observed, and surveying suitable prior to treatment. Thus, the risks of NNIP treatments would be low, and there would be minimal effects on species in this group.

For all treatment methods the low level of vegetation change from NNIP treatments would have no detectable impact on wildlife. There would be a potential for a greater level of activity associated with Alternative 2, than with Alternative 1, but even at the maximum of 200 acres, annually, across the Forest, there would be minimal impacts expected. We anticipate that over the 5-year period of this project, the majority of the treatments would occur in upland, disturbed areas, such as roadsides, gravel pits, temporary roads, and parking areas, rather than in habitats used by the species in this group. Over the period anticipated for control under this EA, there would be potential for restored wildlife habitat. The level of restored habitat over the 5-year period of this EA is expected to be small as control activities slow or stop the spread of NNIP into areas not currently infested. However, over a longer period of NNIP control, the result is expected to be a more diverse vegetative community on the HNF. This condition could theoretically result in more habitat for certain wildlife and ultimately higher levels of productivity and survivability. Alternative 2 would theoretically provide a greater level of benefits than Alternative 1 due to the greater treatment acreage. In addition, the ability to use three treatment methods would enable the NNIP program manager with options, not available under Alternative 1, for decreasing the spread of NNIP and controlling infestations.

Summary – Direct and Indirect Effects – Alternative 2

Considering the proposed manual, mechanical, chemical and biological control activities, treatment protocol and design criteria, direct and indirect effects would be temporary, localized and so small as to not be measurable for wildlife and MIS. Habitat for certain wildlife might increase in quantity and quality over the short term, but would accrue in greater magnitude over a longer period of NNIP control. Alternative 2 would provide a greater level of habitat improvements than Alternative 1 due to the greater treatment acreage, and the ability to use three treatment methods for decreasing the spread of NNIP and controlling infestations.

3.6.3.3 Wildlife Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including National Forest System lands and lands under other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary was used because of the minimal disturbance expected from manual and mechanical treatments, treatment protocol and design criteria (pp. 11-14) that prevent chemicals entering water systems, the limited mobility of the herbicides proposed to be used, the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Because there are only minimal, and in some cases, no direct and indirect effects on wildlife and MIS, there are no cumulative effects. Cumulative effects for RFSS and T&E species will be discussed in Section 3.6.4.

Alternative 2: Direct and indirect effects are minimal under Alternative 2. There would be no measurable effects on most wildlife and MIS to add cumulatively to past present or reasonably foreseeable actions (Table 3-3). Any effects from manual, mechanical, chemical and biological techniques would be small, temporary and very localized. Treatment protocol and design criteria would minimize effects to wildlife and MIS to a minimal level. However, the range of treatment options available under this alternative (manual, mechanical, chemical and biological) and the greater maximum acres of treatment would constitute a more effective strategy to reduce and control the spread of NNIP within the boundaries of the HNF than Alternative 1. Cumulative effects for RFSS and T&E species under Alternative 2 will be discussed in Section 3.6.4.

3.6.4 Threatened, Endangered, and Sensitive Species (TES)

3.6.4.1 Threatened, Endangered, and Sensitive Species Affected Environment

Introduction
A Biological Evaluation (BE) has been prepared for this project that addresses the potential effects of the two alternatives on Regional Forester Sensitive Species (RFSS) and federal Threatened and Endangered Species (T&E)[3] plants and animals known or suspected to occur on the HNF (USDA 2007a). These species are listed in Tables A-9 through A-12.

A BE serves to "review all Forest Service planned, funded, and executed, or permitted programs and activities for possible effects on endangered, threatened, proposed, or sensitive species" (FSM 2672.4). "Endangered", "threatened", and "proposed" refer to those species covered by the Federal Endangered Species Act (16 USC 688 *et seq.*) and designated by the U.S. Fish and Wildlife Service (USFWS). "Sensitive" species include "those plant and animal species identified by a Regional Forester for which population viability is a concern" (FSM 2670.5). The BE evaluated TES plants on general habitat conditions preferred by the species rather than specific known sites. No field surveys were conducted as part of preparing the evaluation. Instead, the BE relies on published species and habitat use information, known site location information maintained by the Forest Service and Michigan Natural Features Inventory, and contact with Forest botanists and biologists. The HNF conducts surveys for rare species in preparation for proposed resource management projects and regularly monitors rare species sites. Forest staff in the areas of botany, wildlife biology, soils, and aquatic biology would review actions covered by this project prior to annual NNIP treatments. Table 3-1 and Table 3-2 present outcome determinations for TES species and groups of species potentially occurring on the HNF.

Plants
Non-native invasive plants are a factor in TES plant management on the Forest. Occurrences of NNIP have been observed across the forest, from aquatic plant habitats to shaded upland locations. However, most NNIP documented to date on the HNF occur in open sites, such as gravel pits, ditches, forest openings, and roadsides (USDA 2006b, p. 3-66). NNIP control has occurred on the HNF in proximity to T&E plants. This has involved mechanical or manual methods. The HNF has reported approximately 30 to 50 acres of NNIP treatments each year since 2003 (project record 2007). In Fiscal Year 2006, 49 acres of NNIP treatments were reported.

To study the effects of this project on plant T&E, species were evaluated individually.

Federal T&E Plants: There are five federally threatened plants known to occur on the HNF. All of these consist of small populations. There are no federal endangered plants on the Forest. There are approximately 21 occurrences of these threatened plants on the HNF (Table A-9). An occurrence is the documented presence of a species at a specific site. Many of these plants have only one or two sites. For example, lakeside daisy (federal threatened) is only known at one site on the HNF. Monitoring and surveying are conducted for T&E plants as part of the Forest's management programs. The surveys have yielded numerous data points that have become part of the HNF information base. There is one likely federal endangered plant, Michigan monkey flower with occurrences close to the Forest boundary and

[3] RFSS and T&E are collectively known as threatened, endangered and sensitive (TES) species.

habitat within the boundary that has not been found on the HNF despite many years of surveys. All five listed plants have NNIP growing within or nearby species element occurrences. (USDA 2005, USFWS 2006).

RFSS Plants: There are considerably more occurrences of RFSS plants than T&E plants on the HNF (Table A-10). This is because there are many more RFSS plants ranked as sensitive but not endangered or threatened for the HNF. As with the T&E, many of the RFSS plants have only one or two sites. Monitoring and surveying are conducted for RFSS plants as part of the Forest's management programs. The surveys have added to the HNF information base. The information indicates that few plant sites that are directly affected by NNIP (USDA 2006b, p. 66). To study the effects of this project on RFSS plants, species were grouped by some very general habitat conditions. While the invasive plants in Tables 1-1 and 1-2 (Section 1.3) have their own habitat requirements, they are aggressive enough to invade over a broad range of habitat conditions. For every habitat favored by RFSS, there are non-native plants that can invade it, so it was useful to discuss NNIP effects to sensitive plants in more general terms of where the NNIP are found (i.e. aquatic, open/wet, open, shade, and shade/wet).

<u>Animals</u>

Non-native invasive plants are factor in wildlife habitat on the Forest. Occurrences of NNIP have been observed in various wildlife habitats, from mesic uplands and dry pine oak savannas to shrub wetlands and inland lakes. However, most NNIP documented on the HNF occur in open sites, such as gravel pits, ditches, forest openings, and roadsides (USDA 2006b, p. 66). The documented infestations represent only a small portion of the nearly 900,000 acres under FS stewardship. Consequently, few species of wildlife have been observed to be affected by NNIP. Great Lakes shoreline and dune habitats are the exceptions. Piping plover habitat has infestations of several invasive plants. Control activities, including pulling and cutting of NNIP have occurred historically in these areas. Known infestations of NNIP are low in number.

Federal T&E Animals: The HNF has five T&E animals (Table A-9). There is no documentation that indicates NNIP are directly impacting any of the species. Habitat for piping plover has occurrences of NNIP, and manual removal of plants has occurred on the Forest in these areas. The population of piping plovers has been on an increasing trend. In 2006, a record eight pairs produced 12 fledglings (Great Lakes Piping Plover Call 2006). However, recent observations by USFS employees indicate the decreasing water level in Lake Michigan has exposed additional shoreline and beach habitat. The presence of NNIP in the expanding shoreline has reach a magnitude that is exceeding the capabilities of manual control in piping plover habitat (J. Ekstrum, personal communication, 2007).

RFSS Animals: The RFSS animals for the HNF are listed in Table A-11. There are NNIP likely to be present in occupied or suitable habitat for many of the species. However, there is no documentation indicating NNIP are affecting any of the species and causing decreased fitness, lower reproductive rates or fewer individuals in a population. However, based on species ecology there are some species likely to be vulnerable to NNIP over time. These would include species with small home ranges that are subject to infestations. Species such as insects would be included in that category. To study the effects of the NNIP Control project on RFSS animals, species were grouped by some general conditions, such as habitat, feeding ecology or classification. When species could not be logically grouped they were analyzed individually. Details of the RFSS analysis is included in the BE (USDA 2007a).

3.6.4.2 Threatened, Endangered, and Sensitive Species Direct and Indirect Effects

The boundary for the analysis of direct and indirect effects to threatened, endangered, and sensitive (TES) species were the proclamation boundaries of the HNF, including National Forest System lands, and the time it takes for the proposed chemicals to degrade. This boundary has been used for a variety of reasons. These include the minimal disturbance expected from manual and mechanical treatments, protections resulting from treatment protocol and design criteria to prevent chemicals from drifting and entering water systems, the limited mobility of the herbicides proposed to be used and the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Alternative 1

Plants

Federal T&E Plants: Implementing Alternative 1, the “No Change” alternative would have no direct effects to T&E plants. There are invasive plants within occurrences of T&E plants. However, we generally categorize these infestations as a low risk due to continuing efforts to manually remove NNIP where they are encroaching on T&E species. The majority of these infestations have a short list of NNIP present and the numbers of individual plants are few. Invasive plants near endangered plant occurrences could be considered an *indirect* risk. The "No Change" alternative would likely result in the HNF using only manual and mechanical methods to treat infestations. Threatened plant sites, are considered "high priority" for NNIP control and some manual pulling has occurred making loss of individuals from invasive competitors an insignificant risk. The HNF would likely continue to annually remove approximately 30-50 acres of invasive weeds through manual and mechanical means, using individual project decisions not associated with this EA. Some NNIP sites would be allowed to persist or increase in size under Alternative 1. We anticipate the spread of NNIP would be patchy over the 5-year period of this EA and have minimal effects on T&E plants. Due to Forest Plan management direction, we anticipate that it is likely a high priority would be placed on eradicating infestations with potential to affect T&E should such a circumstance develop on the Forest. Consequently, over the 5-year period of this EA there would be minimal adverse impact to species in this group from implementing Alternative 1. However, as described in the BE, failure to initiate a program to control NNIP infestations could, over time, result in increased competition experienced by T&E plants on the HNF (USDA 2007a).

RFSS Plants: Implementing Alternative 1 would have no direct effects to RFSS plants. Indirectly, the BE describes how failure to control NNIP infestations could, over time, result in increased competition experienced by RFSS plants. RFSS plant sites are small and few in number (Table A-10) consequently are more susceptible to alteration of those habitats by invasive plant species. Due to the limited treatment acres likely to occur, and the reliance on manual control, more NNIP infestations and increased spread of invasive plants would occur under this Alternative. This would increase the risks to RFSS plants over the long-term (>5 years).

Animals

Federal T&E Animals: Implementing Alternative 1, the “No Change” alternative would have no effects to most T&E animals. For most T&E animal species, no sites of importance have been identified as currently being adversely affected by NNIP infestations. Furthermore, as described in the BE (USDA 2007a), for all but piping plover there are no known sites in imminent danger of future infestations that would result in direct or indirect effects to the species. The HNF would likely continue to remove approximately 30-50 acres of invasive weeds each year through manual and mechanical means, using individual project decisions not associated with this EA. Some NNIP sites would be allowed to persist or increase in size under Alternative 1. We anticipate the spread of NNIP would be patchy over the 5-year period of this EA and have minimal effect on habitat for species in this group, except piping plover. The top carnivore on the list, Canada lynx, has suitable habitat in the tens of thousands of acres and would not be affected by anticipated infestation over the short-term. Bald eagle habitat is also abundant. Kirtland's warblers have special habitat needs that includes dense jack pine, with no effects from NNIP to date. Similarly, Hine's emerald dragonfly has not been affected, and patchy occurrences of NNIP over the next 5 years would result in minimal effects. There are no infestations threatening areas proposed for listing as Hine's emerald dragonfly critical habitat. However, it is possible there are infestations in suitable and occupied Hine's emerald dragonfly habitat and in proposed critical habitat, which are unknown. It is likely there would be a high priority placed on eradicating infestations with potential to affect T&E should that circumstance develop on the Forest. We anticipate that due to Forest Plan direction, Hine's emerald dragonfly sites being threatened by NNIP would be treated, and the threat abated. Implementing Alternative 1 would not change the primary constituent elements of Hine's emerald dragonfly critical habitat: organic soils, hydrology, emergent vegetation; crayfish burrows, prey base, or other physical or biological features. Changes to emergent vegetation would not be anticipated to occur over the 5-year period of the EA, since there are no known infestations, and few are expected. Combined with no known NNIP threats to Hine's emerald dragonfly and Forest Plan direction for protecting breeding habitat for Hine's emerald, we have determined that implementing Alternative 1 would have no effects on the species and proposed critical habitat.

Implementing Alternative 1 would likely have effects on piping plover, but not on critical habitat, over the period covered by this EA. While some NNIP sites identified would be allowed to persist or increase in size, it is likely that the Forest would conduct manual removal of NNIP should they threaten a section of shoreline where nesting has occurred, as has been accomplished in the past. There are infestations in and near piping plover nesting sites and piping plover critical habitat. However, these infestations have not reached the level that nesting is precluded. The Forest would likely continue to annually remove approximately 30-50 acres of NNIP, some of which would occur in nesting habitat, as well as critical habitat. It is possible that failure to control the spread of NNIP species into occupied and suitable habitat could eventually result in some degraded habitats that are less favorable to piping plover. Over time, if suitable habitat decreases in quantity or quality, it could affect individual piping plovers on the HNF and lead to lower annual productivity. However, under Alternative 1, it is plausible that the Forest would likely make NNIP treatments in these piping plover areas an annual priority, thereby reducing the risk of decreased productivity.

Vegetation on shoreline habitat might change over time under Alternative 1. We expect the change to be minimal and insignificant within the 1.2-mile section of critical habitat on the HNF under the current program over the 5-year period of the EA. Critical habitat would be likely to be treated under Alternative 1 because it is one of the highest priorities. While decreasing water levels might impact the structural character of critical habitat, implementing the NNIP actions under Alternative 1 would not change physical aspects of beach habitat, slope, length of beach, dune development, distance from tree line or amount of sand and cobble. Long-term (>5years) it is likely NNIP spread would outpace manual and mechanical methods to control infestations.

RFSS Animals: Implementing Alternative 1 would result in no effects to most RFSS animals. The BE (USDA 2007a) describes that for most groups of species, including RFSS raptors, wetland birds, grassland birds, other birds, reptiles, fish, mollusks and dragonflies, the lack of widespread occurrence of NNIP in habitat indicates a low level of risk. It is unlikely over the period of the 5-year period of the project that NNIP would result in decreased survival, lower reproduction and fewer individuals. We anticipate the spread of NNIP into habitats would be patchy over the 5-year period of this EA, and have no effect on habitat for species in these groups. The Forest would likely continue to annually remove approximately 30-50 acres of invasive weeds through manual and mechanical means only, using individual project decisions not associated with this EA. Due to Forest Plan management direction, we anticipate that a high priority would be placed on eradicating infestations with potential to adversely affect RFSS should such circumstances develop on the HNF.

Two insects, Lake Huron locust and northern blue butterfly would be more susceptible to NNIP infestations. The BE describes that for these two species there would likely be some effects, but they would be minimal. Some northern blue butterfly individuals could be affected (less fitness, poor reproduction) if sites where the host plants for this species, dwarf bilberry, are colonized or if infestations spread and are not treated. However, it is likely that NNIP would be treated in dwarf bilberry populations, so the risk is low and the effect would be for individuals and primarily in the long-term (>5 years). Individuals of Lake Huron locust might also be affected with lower levels of fitness and decreased reproduction if the sparsely vegetated areas they prefer become colonized by abundant NNIP. However, it is likely that habitat for this species would be treated, so the risk is low and the effect would be for individuals and primarily in the long-term (>5 years).

<u>Alternative 2</u>:

<u>Plants</u>

Alternative 2 (Proposed Action) is an integrated NNIP management plan with specific treatment protocols and design criteria developed to reduce or eliminate risk to TES plant and animals. The project actions vary by weed species, time of year, and by the restrictions outlined in the design criteria and protocol. The actions would depend on what weed is being treated. All methods have potential to affect sensitive plant species if weeds are present and treated where these plants occur. However, in the presence of a TES plant, actions would be tailored to protect the TES species. The current invasive plant inventory on the Forest is not complete enough to know if there are TES species at any of the NNIP sites; there are some documented. All NNIP sites would be surveyed by a botanist for TES plant species. These Non-target species can easily be avoided making any negative effects discountable.

Manual/mechanical methods: Hand pulling weeds generally has the lowest impact on non-target plants and is effective for small weed populations. Pulling larger plants such as honeysuckle shrubs disturbs the soil, creating a potential seed bed for other weeds. Mowing of some NNIP if timed right, is effective in removing seed heads and weakening the plant's vigor. Mowing could affect TES plants the same way if they are mixed in with the NNIP. The weed torch is non-selective in that it will damage most plants it touches, but with proper control and timing, will avoid non-target organisms. Manual control methods would not have any indirect impact on TES plants.

Chemical Treatment: Herbicide has the potential for contacting and harming non-target organisms if sprayed. The treatment protocol and design criteria (pp 11-14) ensure that TES species would be avoided in all applications. Therefore, there would be little or no direct or indirect effect from chemical treatment. The efficacy of chemical methods allows for more rapid indirect beneficial effects to habitats. This would occur when NNIP are treated and die and are then replaced by native species. This would occur by natural recruitment or by planting.

Biological methods: As described in the BE (USDA 2007a), biological control insects are host-specific and only feed on the target weeds so there will be no *direct* impact. Controlling NNIP would *indirectly* enhance habitat by reducing competition.

Federal T&E Plants: The effects to Federally listed species were analyzed individually. For all 5 (plus one likely to occur) federally listed plants, the BE determined that there would be no *direct* effects from implementing this project. Invasive plants have been manually pulled at some sites with no negative effects. Additional control actions at these sites have the potential to cause harm but project design would minimize effects to where they are extremely unlikely. Manual-only weed control methods would probably continue in close proximity to threatened plants to prevent accidental damage by herbicide, so herbicide would have no effect on federally threatened plants. Biological control insects feed only on target invasive plants and would not harm rare plant and animal species so there would be no effect. Removal of NNIP within known occurrences and threatened plant habitat would decrease competition pressure and provide an indirect benefit.

RFSS Plants: Effects to Regional Forester Sensitive Species (RFSS) plants were analyzed in the BE based on common habitat groups (aquatic, open/wet, open, shade, and shade/wet). Overall, any direct effects from proper implementation of control methods would be relatively small and temporary. The botanist would know where RFSS plants are prior to any treatment and non-target species can easily be avoided. Further, most NNIP infestations are very small and account for only 0.05% of the total Forest acreage making even an inadvertent impact to an RFSS occurrence very low. Indirectly, the removal of NNIP populations would decrease competition and soil chemical changes caused by NNIP. This would improve habitat for RFSS populations.

Aquatic RFSS Plant Habitat

The BE identified a risk of effects to the aquatic habitat group. RFSS plants in aquatic habitat have a risk of direct effect from project actions. This is due to it being almost impossible to be selective in treating NNIP mechanically or chemically in water. However, indirectly there would be a beneficial effect from all methods by the improvement of aquatic ecosystems as NNIP are removed or die from treatment.

*Manual/mechanical methods (**specific to Aquatic habitats**)*: Eurasian water milfoil can be cut and removed manually or by using an aquatic harvester. Manual pulling or cutting would be more selective. A harvester would pull all plants including non-target. Digging or pulling purple loosestrife can be effective and is the preferred control method on small infestations. A botanist would be on site to prevent accidental digging or pulling of RFSS plants near purple loosestrife.

*Chemical Treatment (**specific to Aquatic habitats**):* Chemical application in water would have a direct negative effect if it contacts aquatic RFSS species. There could conceivably be a scenario when Eurasian milfoil invades a lake with an open-water RFSS plant population such as algal pondweed. It may be advantageous to use herbicide on the NNIP before it dominates the lake, but in doing so, some portion of the RFSS population may be killed. There would not be a loss of viability if the sensitive plant had colonies in other parts of the lake to repopulate. Herbicides can be applied to patches of milfoil and only a portion of a lake treated at one time. Chemicals for use in water lose effectiveness and rapidly degrade so they don't spread to other parts of the lake (BE Aquatic plant section – USDA 2007a, pp. 74-77). Timing of application can be in early spring before native plants are as active as the non-native Eurasian water milfoil. Whole lake treatments with herbicide are rare and require a comprehensive Lake Management Plan (MI DEQ 2004, p. 4). There would be a low risk of direct effects to shore/shallow water species if one of the following chemical methods is chosen: 1) a broadleaf-selective herbicide that will not kill grass-like plants on shore (sedges, rushes, irises, cattails); 2) herbicides used on plants near water are wiped on using a saturated glove or sponge wand (very targeted).

*Biological Control (**specific to Aquatic habitats**):* There would be no direct effect from this method. Three species of insect are proposed as predators of purple loosestrife. These insects selectively feed on purple loosestrife and would not harm other organisms. Complete eradication of loosestrife by insects is unlikely. The goal in using this method is to reduce numbers of the target plant to lessen its ability to displace native vegetation This would have an indirect beneficial effect. One insect is proposed to treat Eurasian water milfoil. *Eurhychiopsis lecontei* weevils, native to North America, will feed on the Eurasian milfoil and seem to prefer it to the native species. Biological control poses less risk to aquatic communities than physical or chemical means. Indirectly there would be a beneficial effect from the improvement of invaded aquatic ecosystems.

Open/wet, Open, Shade/wet, and, Shade habitats (The rest of the habitat groups): There would be no direct effects from any of the methods on RFSS plants in the remainder of the habitat groups because the treatment protocol and design criteria (Sections 1.3.2 and 1.3.3) eliminate risk to non-target organisms. Since sites would be surveyed as needed prior to treatment, the botanist would prescribe methods to protect sensitive plants found.

<u>**Animals**</u>

Federal T&E Animals: The effects to Federally listed species were analyzed individually. Pages 41-45 in Section 3.6.3.2, Wildlife Direct and Indirect Effects, address the potential impacts from mechanical, manual, chemical, and biological control components of the proposed HNF NNIP Control Project. The information is also applicable to TES animals.

Considering the low level of NNIP infestations in habitat for these species compared to available habitat, there would be no measurable effects to bald eagle, Canada lynx, and Kirtland's warbler from implementing Alternative 2. There is a slight risk of mortality or injury to adult Hine's emerald dragonfly from direct contact with herbicides. However, the risk is for individuals, not populations, and considered minimal due to treatment protocol and design criteria (Sections 1.3.2 and 1.3.3).

Regarding impacts to Hine's emerald proposed critical habitat, a total of approximately 13,000 acres have been proposed by the USFWS. The likely 10 acres of annual treatment in wetlands across the Forest would represent .08 percent of all areas proposed as critical habitat (assuming all of the wetland treatment occurred in Hine's critical habitat, an unlikely possibility). Thus, implementing Alternative 2 could possibly change a small amount of the vegetation component in proposed Hine's critical habitat. However, the change would improve or enhance habitat, since NNIP would be removed and native plant species would become established on the sites. Changes to emergent vegetation would be small in magnitude over the 5-year period of the EA, since there are no known infestations, and few are expected. Should treatments occur, the most likely scenario is for minimal vegetation to be disturbed. Vegetation that is removed would be rapidly replaced by colonizing species. Implementing Alternative 2 would not change any of the other primary constituent elements (PCEs) of critical habitat: organic soils, hydrology crayfish burrows, prey base, or other physical or biological features.

As detailed in the BE (USDA 2007a), the effects to piping plover from implementing Alternative 2 would be minimal. For piping plover, implementing Alternative 2 would provide beneficial effects. The greater maximum treatment acreage and variety of treatments would provide options for responding to NNIP infestations along the Lake Michigan shoreline. As the water level has decreased, the expanding shoreline and beach succession have resulted in infestations no longer completely treatable with hand pulling and other manual methods. Alternative 2 would provide the options to use herbicide and biological methods to control NNIP and create the sparse shoreline vegetation associated with habitat favored by piping plovers for nesting. A greater area of potential habitat could accommodate more nesting pairs, and increased success rate of nesting attempts. It is unlikely shoreline habitat would be completely void of vegetation after NNIP control treatment because the plants tend to occur in patches and other vegetative species, both native and non-native, are present. Using design criteria for Alternative 2, native and desirable non-native plants could be retained, while NNIP would be removed. Thus, regardless of NNIP treatment employed, a sparsely vegetated habitat would result. Anticipated NNIP control activities outside of beach areas would also benefit the species by slowing or stopping the movement of weeds into piping plover habitat not infested or minimally infested. Long-term NNIP control would sustain habitat for piping plover in the future, increasing or maintaining breeding populations on the HNF. Comparable information is presented in the BO (USFWS 2006, p. 125, Appendix F).

Implementing Alternative 2 would result in enhanced piping plover critical habitat on the HNF. The Recovery Plan for the Great Lakes Piping Plover (USDI 2003) indicates that critical habitat for the species consists of sparsely vegetated sand beaches associated with wide, unforested systems of dunes or inter-dune wetlands. Controlling NNIP under treatment protocol and design criteria of Alternative 2 would help maintain the sparse vegetation component of critical habitat on the HNF. There would be no other effects to critical habitat from implementing the manual/mechanical, herbicide or biological control methods under Alternative 2.

RFSS Animals: Implementing Alternative 2 would result in no effects or minimal effects to RFSS animals. Pages 41-45 in Section 3.6.3.2, Wildlife Direct and Indirect Effects, address the potential impacts from mechanical, manual, chemical, and biological control components of the proposed HNF NNIP Control Project. The information is also applicable to TES animals. The BE describes that for the groups of species, including RFSS raptors, wetland birds, grassland birds, other birds, reptiles, fish, mollusks, dragonflies, and other insects, the activities proposed under Alternative 2 would have minimal effects (USDA 2007a). Treatment protocol and design criteria (Sections 1.3.2 and 1.3.3, pp. 11-14) function to eliminate or reduce risks to minimal levels. The relative low level of NNIP infestations compared to available habitat also functions to minimize risks for certain RFSS.

3.6.4.3 Threatened, Endangered, and Sensitive Species Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including National Forest System lands and lands under other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary was used because of the minimal disturbance expected from manual and mechanical treatments, treatment protocol and design criteria (Sections 1.3.2 and 1.3.3, pp. 11-14) that prevent chemicals from entering water systems, the limited mobility of the herbicides proposed to be used, the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1

Plants

Federal T&E Plants: Because the effects of implementing Alternative 1 on T&E plants are considered to be minimal, they would have little or no incremental effects when combined with the effects of past, present, or reasonably foreseeable future activities in Table 3-3. Table 3-1 (p. 57) shows the determinations made in the BE (USDA 2007a) for listed species. Refer to the BE for detailed information regarding the determinations.

RFSS Plants: Limited NNIP control would take place though other decisions. Under Alternative 1 there would be no direct effects to RFSS plants to add cumulatively to other actions. There would be no widespread efforts to control invasive plants under Alternative 1. Combined with failure of other landowners to control NNIP species on their land, this could indirectly result in increasing regional dominance of NNIP species. Over time this could result in decreased numbers of individuals within RFSS populations. Depending upon the extent of other landowners and managers controlling NNIP in northern Michigan, the invasion and spread of NNIP on HNF lands could be slowed to some degree. Table 3-2 (p. 58) shows the determinations made in the BE (USDA 2007a). Refer to the BE for detailed information regarding the determinations.

Animals

Federal T&E Animals: For bald eagle, Canada lynx, Kirtland's warbler, Hine's emerald dragonfly, piping plover critical habitat and proposed critical habitat for Hine's emerald dragonfly there would be minimal direct and indirect effects. Therefore, there are no cumulative effects. Table 3-1 (p. 57) shows the determinations made in the BE (USDA 2007a). Refer to the BE for detailed information regarding the determinations.

For piping plover there were effects identified. The cumulative effects area for this species are the lands within the proclamation boundary of the HNF, including National Forest System lands and lands under other ownership. This is the area that the USFS monitors and has a level of certainty regarding the movements of this species over the breeding season. Once piping plover nesting activity is initiated in the spring, the adults maintain nesting and foraging areas within the local beach habitat, unless the nest fails. In the event a nests fails, the adults might move many miles from the original nesting location.

Piping plovers may be affected by activities in the areas of private ownership on the Forest. Population growth is expected to occur in the eastern Upper Peninsula in the future. Mackinac County and Chippewa County are expected to increase by 34.7% and 29.6%, respectively, through 2020 (USFS 2006b, p. 3-363). Human activities, including development, recreation, and roads to the shoreline are present and may be expected to continue in these areas. Human disturbance and lack of nest protection measures in piping plover habitat on private lands could have adverse effects to piping plover. Piping plover nests on private land may not be protected unless they are reported. Shoreline areas are highly sought after as sites for vacation homes or resorts and are highly vulnerable to ongoing shoreline development and intensive recreation. Development on private lands would reduce available habitat.

Many of the dune areas within the Forest boundary, however, are protected as "critical dunes" under the Michigan Sand Dunes Protection and Management Program, part of 353 of the Natural Resources and Environmental Protection Act, 1994 PA 451. Part 353 establishes protective standards on dunes considered to be the most sensitive. Such areas are protected from most development, which should provide substantial protection for piping plover habitat.

U.S. Highway 2 runs along much of the piping plover habitat on the Lake Michigan shores. This busy road has several picnic areas and access points along the stretch of Lake Michigan, which increases human access and activity. Impacts from recreational uses include dune erosion and introduction of NNIP. Road maintenance activities, including emergency repairs on eroding shoreline areas, herbicide application, mowing, road salting, shoulder grading, snow removal, and tree removal, may affect piping plover. The Michigan Department of Transportation is trying to stabilize the blowing sand from the dunes, but the movement of sand still occurs. Sand dune stabilization desired for U.S. Highway 2 corridor may affect the dune habitats suitable for piping plovers. Regarding herbicide application, the Forest Service would coordinate with MIDOT annually to determine areas proposed for spraying, acreage and chemicals to be applied. This would provide communication that would help to ensure that only those herbicides with non-toxic or low toxicity to piping plovers and other plants and wildlife are used.

Anticipated increases in OHV use, noise, pedestrian traffic, personal watercraft and other noise-producing activities, possible development of a Great Lakes water-trail, and other activities anticipated along shorelines within the proclamation boundary may increase disturbances to piping plover. This may cause a loss of eggs or individuals, overall reducing nesting success. Increases in shoreline recreation facilities and shoreline residential developments are also likely to increase human disturbance. This could increase the potential for predation and harassment by domestic animals or predators. However, the degree of impact to plovers is difficult to predict. In recent years, piping plover populations have increased along with increased recreation use. While this does not suggest a cause-effect relationship, it is important to note that a potentially complex relationship of factors is involved in the increase in the piping plover population in the Great Lakes area.

Water level fluctuations may affect piping plovers. During periods of high water there is a reduction in the amount of beach habitat available for nesting plovers. Over the past 80 years, maximum Great Lake water levels were in 1973 and 1985; minimum Great Lakes water levels were 1926, 1934 and 1936 (US Army Corp Engineers 2004). Water level fluctuations will continue to occur in the Great Lakes, increasing the potential for destruction of lost piping plover nests during periods of high water. In 2004, water levels rose from the 2003 level in Lake Michigan, causing the loss of some piping plover nesting areas early in the nesting season. During periods of high water, less shoreline habitat would be available as nesting habitat. During periods of low water, beach succession would occur, a condition that would also reduce the amount of nesting habitat available to piping plover.

RFSS Animals: Implementing Alternative 1 would result in no effects or minimal effects to RFSS animals. Therefore, there would be little or no incremental effects when combined with the effects of past, present, or reasonably foreseeable future activities in Table 3-3. Table 3-2 (p. 58) shows the determinations made in the BE (USDA 2007a). Refer to the BE for detailed information regarding the determinations.

<u>Alternative 2</u>

<u>Plants</u>

Federal T&E Plants: Implementing Alternative 2 would result in no effects or minimal effects to T&E plants. Therefore, there would be little or no incremental effects when combined with the effects of past, present, or reasonably foreseeable future activities in Table 3-3. The removal of NNIP from near and within suitable unoccupied plant habitat may improve viability in the long-term due to improved habitat conditions. Effects would be beneficial but only incrementally better than the current situation because NNIP are already controlled at Federal threatened plant sites. Table 3-1 (p. 57) shows the determinations made in the BE (USDA 2007a). Refer to the BE for detailed information regarding the determinations.

RFSS Plants: Implementing Alternative 2 would result in no effects or minimal effects to RFSS plants. Therefore, there would be little or no incremental effects when combined with the effects of past, present, or reasonably foreseeable future activities in Table 3-3. It is anticipated that the proposed control methods described in Alternative 2 could result in a substantial reduction and possible eradication of NNIP species within treated areas. In addition to reduced NNIP on the Forest, this alternative would contribute to existing efforts by adjacent landowner, including State, County, private, and corporate owners. Starting this integrated management program would allow the HNF to work in collaboration with others on infestations that cross ownership boundaries. Table 3-2 (p. 58) shows the determinations made in the BE (USDA 2007a). Refer to the BE for detailed information regarding the determinations.

<u>Animals</u>

Federal T&E Animals: Under Alternative 2, there would be minimal or no measurable effects to bald eagle, Canada lynx, Hine's emerald dragonfly and Kirtland's warbler from implementing Alternative 2. Additionally, there would be benefits for piping plover habitat, and potential enhancement or restoration for Hine's emerald proposed critical habitat and piping plover critical habitat. Therefore, there would be little or no incremental effect when combined with the effects of past, present, or reasonably foreseeable future activities in Table 3-3. Table 3-1 (p. 57) shows the determinations made in the BE (USDA 2007a). Refer to the BE for detailed information regarding the determinations.

RFSS Animals: Implementing Alternative 2 would result in no effects or minimal effects to RFSS animals. Therefore, there would be little or no incremental effect when combined with the effects of past, present, or reasonably foreseeable future activities in Table 3-3. Table 3-2 (p. 58) shows the determinations made in the BE (USDA 2007a). Refer to the BE for detailed information regarding the determinations.

3.6.4.4 Threatened, Endangered, and Sensitive Species Determinations

Tables 3-1 and 3-2 list the determinations of the Biological Evaluation . Separate determinations are provided below for species listed under the Federal Endangered Species Act and for RFSS on the Hiawatha National Forest.

Table 3-1. Federally listed species – Summary of Determinations* of Effects

SPECIES EVALUATED	ALTERNATIVE 1	ALTERNATIVE 2
PLANTS		
Dune thistle (Pitcher's thistle)	NLAA	NLAA
Lakeside daisy	NLAA	NLAA
Dwarf lake iris	NLAA	NLAA
American Hart's tongue fern	NLAA	NLAA
Houghton's goldenrod	NLAA	NLAA
ANIMALS		
Bald eagle	NE	NLAA
Canada lynx	NE	NLAA
Hine's emerald dragonfly	NE	NLAA
Hine's emerald dragonfly critical habitat*	NE	NLAA
Kirtland's warbler	NE	NLAA
Piping plover	NLAA	NLAA
Piping plover critical habitat	NE	NLAA

NE - "No effect"; NLAA - "May affect, not likely to adversely affect"; **LAA** - "May affect, likely to adversely affect"
* - This is proposed critical habitat - the USFWS has not published the final decision on critical habitat as of 3/2007

Table 3-2. Regional Forester Sensitive Species (RFSS) and Likely to occur RFSS (LRFSS) - Determinations of Effects

SPECIES or GROUP EVALUATED	ALTERNATIVE 1	ALTERNATIVE 2
PLANTS		
Aquatic plant habitat	**MINT**	**MINT**
Open/wet habitat	**MINT**	**MINT**
Open/dry & Beach habitat	**MINT**	**MINT**
Shaded/wet habitat	**MINT**	**MINT**
Shaded habitat	**MINT**	**MINT**
ANIMALS		
Mammal		
*Gray wolf**	**NI**	**MINT**
Birds		
Raptors	**NI**	**MINT**
Wetland birds	**NI**	**MINT**
Grassland/Shrub birds	**NI**	**MINT**
Black-backed woodpecker	**NI**	**MINT**
Connecticut warbler	**NI**	**MINT**
*Bald eagle**	**NI**	**MINT**
Reptile		
Blanding's turtle	**NI**	**MINT**
Fish		
Lake Sturgeon	**NI**	**MINT**
Mollusks		
Mollusks	**NI**	**MINT**
Insects		
Lake Huron locust	**MINT**	**MINT**
Northern blue (butterfly)	**MINT**	**MINT**
Dragonflies	**NI**	**MINT**

NI; No Impact; **BI**; Beneficial Impact; **MINT**; May Impact individuals but Not Likely to cause a Trend to federal Listing or loss of viability; **MILT**; "May impact individuals but not likely to cause a trend toward federal listing or loss of viability." * - bald eagle and gray wolf were also evaluated as RFSS due to the likelihood of removal from T&E list

3.7 HERITAGE

3.7.1 Heritage Resources Affected Environment

The HNF contains evidence of human occupation from as early as the end of the last ice age over 8,000 years ago. Today the HNF contains over 1,500 identified cultural resource sites, from a variety of periods and cultural traditions. Pre-historic Native American sites include stone tools, pottery, animal bone, and the remains of fire hearths. Historic Native American sites include villages, trails, and sugar camps. Euro-American historic resource sites include 19th and early 20th century logging, homesteading and recreation sites. The National Historic Preservation Act (NHPA) of 1966 governs how federal agencies identify, evaluate for significance, and manage heritage resources under NEPA.

3.7.2 Heritage Resources Direct and Indirect Effects

The boundaries used for the direct and indirect effects for heritage resources were the proclamation boundaries of the HNF, including National Forest System lands, only. This boundary was used because of the location of heritage resources under the responsibility of the Forest Service are contained therein.

Alternative 1: Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2), including TES plant and piping plover locations, and disturbed areas such as recreation areas, roadsides and gravel pits. This is because the HNF has treated an average of approximately 30-50 acres each year since 2003 as part of a variety of projects with existing NEPA decisions. It is likely that this level of treatment would continue. Some infestations of NNIP would likely go untreated. Although some invasive vegetation can affect heritage sites, especially in non-forested areas, this would be comparable to natural vegetation encroachment. For this reason, there would be no direct or indirect effects to cultural resource sites by implementing Alternative 1.

Alternative 2: Physical control methods that disturb the soil surface, such as hand-pulling or digging, can permanently disturb surface and subsurface archaeological resources occurring on or in the upper 6 to 12 inches of the soil profile. Particularly vulnerable are surface scatters of artifacts from prehistoric and historic periods and remnants of structural foundations. Physical control methods that involve cutting vegetation without disturbing the soil surface, such as mowing, sawing, or use of a weed torch, as well as use of herbicides or biological control agents, would have less potential to disturb cultural resources. However, these projects would also need to be reviewed because they could still cause indirect effects, such as trampling or the displacement or removal of surface artifacts. For this reason, an archaeologist, as indicated in project protocol (No. 4, p. 12), would review all annual treatment proposals. Any needed protection measures would be implemented prior to project approval. Proposed treatments would either be modified or cancelled to exclude any significant or potentially significant heritage resources from areas of potential effects (treatment protocol, No. 4, p. 12). Based on these protection measures, there is minimal risk that implementation of Alternative 2 would result in damage to heritage resources.

3.7.3 Heritage Resources Cumulative Effects

The cumulative effects analysis for heritage resources includes a consideration of all lands within the HNF proclamation boundary under Forest Service ownership that are susceptible to infestation by NNIP. These are the areas under Forest Service responsibility for protection of heritage resources.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Implementing Alternative 1 would not result in any direct or indirect effects to heritage resources on the Forest. Because there would be no direct or indirect effects associated with implementing Alternative 1, there would be no cumulative effects.

Alternative 2: Alternative 2 would not result in any direct and indirect effects. Thus, because there are no direct and indirect effects associated with Alternative 2, there would be no cumulative effects to heritage resources when combined with the effects of past, present, or reasonably foreseeable future activities outlined in Table 3-3.

3.8 HUMAN HEALTH AND SAFETY

3.8.1 Human Health and Safety Affected Environment

The Forest Service implements a Safety and Health Program that is an integral part of the national and international missions of the organization. The Health and Safety Code Handbook (Handbook) is the primary source of standards for safe and healthful workplace conditions and operational procedures and practices in the Forest Service (USDA 1999, pp. O-3, O-5). Direction in the Handbook applies to all Forest Service employees. The Handbook is consistent with the standards and regulations of the Occupational Safety and Health Administration (OSHA).

The Handbook includes safety practices and procedures for manual and mechanical vegetation treatment, such as brushing and piling (USDA 1999b, p. 20-95), and chainsaw operation (USDA 1999b, p. 20-47). It includes safety practices and procedures for herbicide application (USDA 1999b, p. 20-18). For these activities and others associated with treating NNIP on the HNF, personal protective equipment is required of all participants. A Job Hazard Analysis (JHA) is also required. The JHA (Form FS-6700-7) is a systematic process used to identify safety and health hazards in a work project or activity. It is also used to identify and develop actions to reduce those hazards (USDA 1999b, p. O-6).

The Forest Health Protection staff of the USDA Forest Service has the responsibility of managing and coordinating the proper use of pesticides within the National Forest System (NFS). It is also responsible for providing technical advice and support, and for conducting training to maintain technical expertise. In order to achieve this function, the Forest Service maintains a cadre of Pesticide Coordinators and specialists located at Regional Offices and at some Forest Supervisors Offices. Service policy and direction on pesticide use is outlined under the Forest Service Manual Chapter 2150.

The Forest Service is authorized by the Federal Insecticide, Fungicide, and Rodenticide Act and the Cooperative Forestry Assistance Act to use pesticides for multiple-use resource management and maintenance of the quality of the environment as long as the actions comply with the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) regulations. The significance of the three acts is described in the following paragraphs.

- The Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 U.S.C. 136), is the authority for the registration, distribution, sale, shipment, receipt, and use of pesticides. The Forest Service may use only pesticides registered or otherwise permitted in accordance with this act.

- The Cooperative Forestry Assistance Act of 1978 (16 U.S.C. 2101), as amended by the Food, Agriculture, Conservation, and Trade Act of 1990 (7 U.S.C. 1421) is the authority for assisting and advising States and private forest landowners in the use of pesticides and other toxic substances applied to trees and other vegetation and to wood products.
- The provisions of the NEPA (42 U.S.C. 4321) and the CEQ implementing regulations apply to pesticide management (FSM 1950; FSH 1909.15).

Federal law requires that before selling or distributing a pesticide in the United States, a person or company must obtain a registration, or license, from the U. S. Environmental Protection Agency (EPA). Before registering a new pesticide or new use for a registered pesticide, EPA must first ensure that the pesticide (including any adjuvants, surfactants, or other ingredients comprising the product contents), when used according to label directions, can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment. To make such determinations, EPA requires more than 100 different scientific studies and tests from applicants (US EPA 2004). Michigan Department of Agriculture, Pesticide & Plant Pest Management Division, also reviews pesticide labels to ensure that it complies with federal labeling requirements and additional state restrictions of use.

3.8.2 Human Health and Safety Direct and Indirect Effects

The boundaries used for the direct and indirect effect were the proclamation boundaries of the HNF, including National Forest System, and the time it takes for the proposed chemicals to degrade. This boundary has been used for a variety of reasons. These include the minimal disturbance expected from manual/mechanical treatments, protections resulting from treatment protocol and design criteria to prevent chemicals drifting and entering water systems, the limited mobility of the herbicides proposed to be used and the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Alternative 1: Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction in the 2006 Forest Plan dictates (USDA 2006a, Chapter 2), as well as recreation areas, roadsides and gravel pits. This is because the HNF has treated an average of approximately 30-50 acres each year since 2003 with manual and mechanical methods as part of a variety of projects with existing NEPA decisions. It is likely that this level of treatment would continue. Some infestations of NNIP would likely go untreated. However, at this time there are no known sites that pose a risk to human health and safety. Should this occurrence develop on the Forest, a high priority would be placed on correcting the situation. Management direction in the 2006 Forest Plan indicates that safe and healthy vegetation conditions be maintained in developed recreation sites (USDA 2006a, p. 2-7). For these reasons, there would be no direct or indirect effects to human health and safety from implementing Alternative 1.

Alternative 2: Mechanical and manual methods would pose little safety risk to workers or the public provided safety practices routinely observed by the Forest Service or licensed contractors are employed. These safety practices address hazards related to operating mechanical equipment, such as brushsaws, chainsaws and mowers in remote settings. The safety practices also address exposure of workers to natural hazards, such as poison ivy, stinging or biting insects, etc. The public would be excluded from treatment sites while work is in progress. Therefore, effects from this method would be minimal.

Chemical NNIP control methods would be part of an integrated program used with manual/mechanical and biological treatments. Fewer acres would likely be treated with herbicides than would be treated with manual and mechanical control techniques (Table 2-1). Herbicide labeling instructions would be strictly followed and areas treated with herbicides would be closed to the public for the required period following application to prevent contact with recently treated foliage, soil, and water (treatment protocol No. 8, p. 12 and Table A-1). The greatest safety concern therefore involves workers assigned to apply the herbicides.

The mammalian toxicity data presented in Table A-5 suggest that the proposed herbicides are generally safe if properly used in accordance with the label. A LD_{50} (Lethal $Dose_{50}$) represents the dose (amount supplied orally) to a test animal species in a controlled laboratory experiment that causes 50 percent mortality. For purposes of comparison against the mammalian toxicity metrics in Table A-5, the oral LD_{50} for rats exposed in their diet to table salt (sodium chloride) is reported at 3,000 milligrams per kilogram (mg/kg) body weight (BW) (Mallinckrodt Baker Inc. 2004). Table salt, a common substance with which everyone is familiar and which is generally regarded as safe except at very high concentrations, is often is used as a point of comparison for understanding toxicity data for pesticides. The oral LD_{50} for salt is somewhat higher (safer) than the oral rat LD_{50} values for one formulation of glyphosate (glyphosate trimethylsulfonium salt), triclopyr and three of the dicamba formulations. Even so, all are considered safe for humans when applied according to the labels. The other herbicides proposed for use have LD_{50} values greater than 5,000 mg/kg BW, which indicates less oral toxicity to mammals than table salt. Thus, all herbicides have formulations that are safe for use around humans if label directions are followed.

All workers applying pesticides on the HNF under the proposed program, whether Forest Service or contractor personnel, would be licensed or supervised by licensed pesticide applicators. Simple precautions, such as not eating or drinking while working with herbicides, would provide protection for workers against oral exposure (risk indicated by the oral LD_{50} data in Table A-5). Wearing gloves, eye protection, boots, long-sleeved shirts and trousers while working with herbicides and washing hands and clothing after work would provide protection against dermal exposure (risk indicated by the dermal LD_{50}, skin irritation, and skin sensitization data in Table A-5). Label direction for personal protection equipment would always be followed. This type of information is provided in the Health and Safety Code Handbook (USDA 1999, p. 20-18) and would be included in the project JHA.

Human Health and Ecological Risk Assessments have been prepared for the USDA Forest Service applicable to the herbicides proposed for use on the HNF (SERA 2003a (glyphosate), SERA 2003b (triclopyr), SERA 2004a (dicamba), SERA 2004b (clopyralid), and SERA 2004c (imazapic)). In these documents, the process of risk analysis is used to quantitatively evaluate the probability that a given pesticide use might impose harm on humans or other species in the environment. It is the same process used for regulation of food additives, medicine, cosmetics and other chemicals. Each risk assessment used extensive literature searches and unpublished studies submitted to the U.S. EPA to support the herbicide registration. Measures of risk were based on typical Forest Service uses of each herbicide. The proposed rates on the HNF would be at the low end of their estimated range, since no silvicultural use is proposed. For all five herbicides, the Risk Assessments (cited above) showed no indications of risk to the public. The upper ranges of plausible exposures of triclopyr, and dicamba could pose some risk to pesticide applicators. Proposed HNF use would be unlikely to reach these upper ranges of exposure, and protective equipment and safety precautions would further prevent risks from chronic exposure to workers.

Forest Service staff and contractors hired to apply herbicides may be repeatedly exposed to herbicides as the project is implemented. For example, herbicide applicators moving from site to site, repeatedly applying herbicides would be at a greater risk for receiving cumulative herbicide exposures. There may be some increased cumulative risk to workers who apply herbicides or work near applications on a regular basis, or who are exposed repeatedly to herbicides over a long period. Only Forest Service staff and contractors who are licensed pesticide applicators would apply herbicides. All pesticide applicators are trained in safety precautions that protect their health when working with pesticides on a regular basis. However, noting the infrequent nature of herbicide application under this project (15 acres estimated annual treatments in Table 2-1) and the 5-year duration of the project, effects from any repetitive exposure would be minimal because label instructions, Forest Service Handbook (USDA 1999, p. 20-18), and JHA procedures would be followed.

To avoid the risks of exposing the public to herbicides, label direction, and project protocol (No. 8, Section 1.3.2, p. 12) specify that application sites be posted with restricted entry intervals. Trace amounts of herbicides might migrate offsite. However, considering that treatment protocol and design criteria (Sections 1.3.2 and 1.3.3) would be followed, the infrequent nature of this outcome, and the low toxicity to humans of the herbicides selected, this occurrence would not have measurable direct or indirect effects to human health and safety. The large size of the HNF and the infrequent nature of herbicide treatments further limit the likelihood the public would ever be exposed to herbicide treatments.

Thus, considering all of the above information, chemical methods for NNIP control would pose no measurable effect to human health and safety on the HNF.

All of the proposed biological control agents are insects that have been approved for release in the United States by APHIS and have been formerly introduced previously into Michigan or other Midwestern states. None of the information available for review suggests that the insects could be directly harmful to humans (e.g., serving as vectors for human diseases). The specific agents proposed for use on the HNF have a substantial history of use in the United States that suggests any risk to humans is negligible (Van Driesche et al. 2002). Thus, biological methods for NNIP control would pose no measurable effect to human health and safety on the HNF.

3.8.3 Human Health and Safety Cumulative Effects

The boundaries used for the cumulative effects analysis were the proclamation boundaries of the HNF, including National Forest System lands and lands under other ownerships, and the time it takes for the proposed chemicals to degrade. This boundary was used because of the minimal disturbance expected from manual and mechanical treatments, treatment protocol and design criteria (Sections 1.3.2 and 1.3.3, pp. 11-14) that prevent chemicals entering water systems, the limited mobility of the herbicides proposed to be used, the rapid decomposition of the herbicides, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Implementing Alternative 1 would not result in any measurable direct or indirect effects to human health and safety on the Forest. Because there would be no direct or indirect effects associated with implementing Alternative 1, there would be no cumulative effects.

Alternative 2: Manual and mechanical methods and biological control methods described in Alternative 2 would pose no measurable effect on human health or safety. Thus, they would contribute no incremental effects when combined with the effects of other past, present and reasonably foreseeable future activities outlined in Table 3-3. Consequently, these control methods would not contribute to any measurable increase in cumulative effects to human health or safety among either workers or the public.

Chemical methods for NNIP control would pose minimal direct and indirect effects to human health and safety on the HNF. This is a result of the herbicides selected for use, and the treatment protocol and design criteria (pp. 11-14). Herbicides are used by some members of the public, such as landowners within and adjacent to the boundaries of the HNF, particularly private home users, and other public agencies, such as MI Department of Transportation. Under Alternative 2, protocol and design criteria serve to minimize effects to workers and the public.

Overall, chemical (herbicide) control of NNIP would contribute no measurable effects when combined with the effects of other past, present and reasonably foreseeable future activities outlined in Table 3-3. Consequently, this control method would not contribute to any measurable increase in cumulative effects to human health or safety among either workers or the public.

3.9 SOCIO-ECONOMIC

3.9.1 Socio-economic Affected Environment

Natural resources have been a mainstay of life in Michigan for centuries. Indigenous people utilized forest plants and animals extensively; their cultures adapted to use forest resources over hundreds of generations. Cultivated crops, use of fire as a management tool and subsistence hunting were part of their society. By the time European explorers arrived in the early 1600s, about 15,000 indigenous people lived in Michigan. Fur traders and missionaries, mostly from France, were among the first European immigrants. After the United States gained independence, the Northwest Territory, of which Michigan was a part, began to develop. The first lumber from Michigan's pineries was shipped to eastern markets in 1836. In the 1840s, copper and iron ore were discovered in the U.P. The infrastructure and workers that were needed to extract these resources followed. By the beginning of the 20th century, natural resources conservation became an important social movement. The HNF was established in 1931 when the federal government began purchasing mostly cutover lands. The name of the Marquette National Forest was later dropped when it was consolidated with the HNF. Forest resources benefit both local residents and visitors through a wide range of consumptive and non-consumptive uses and values. The solitude provided in the forest environment provides forest visitors a chance to unwind from busy lives and reconnect with nature. The forest environment attracts many non-resident visitors, who provide an important stimulus to the local economy and thus affect the quality of life for residents dependent on tourism activities for income. Many residents rely on the harvesting and/or processing of forest resources as a source of income to support their families. The timber industry and related traditions are an important element of the local lifestyle for some families (USDA 2006b, p. 3-261).

Since achieving statehood in 1837, Michigan's population has steadily increased from just over 200,000 people in 1840 to almost 10 million in 2000. Population growth surged after World War II with an increase of over 1 million people each decade from 1950 to 1970. By 1980, growth had slowed and by 1990, it had almost stopped. The 2000 census indicated a reversal of that trend with documented growth of over 640,000 people statewide.

In the U.P., Chippewa (29.6%) and Mackinac (34.7%) counties are expected to experience significant growth. Luce (-2.8%) and Marquette (-3.6%) counties are expected to experience a slight decrease in population. All other counties are expected to experience relatively low levels of growth ranging from 1.7 percent to 2.9 percent. On average, the population is projected to grow by 7.7 percent compared to the estimated growth for the State of 6.8 percent (USDA 2006b, p. 3-262). About 429,900 U.S. residents live within 60 miles or one hour from the Forest. About 1,468,100 U.S. citizens live within 120 miles or two hours. About 75,000 Canadians also live in close proximity to the Forest (USDA 2006b, p. 3-262).

3.9.2 Socio-economic Direct and Indirect Effects

The boundaries used for the direct and indirect effects for socio-economic resources were the proclamation boundaries of the HNF, including National Forest System lands, only. This boundary was used because of the minimal disturbance expected from manual and mechanical treatments, the treatment protocol limiting effects, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Alternative 1: Limited NNIP control activities would likely occur on the HNF, emphasizing priority sites as management direction contained in the 2006 Forest Plan (USDA 2006a, Chapter 2), as well as recreation areas, roadsides and gravel pits. This is because treatment acreage would likely be limited to historic levels of an annual average of 30-50 acres using manual and mechanical methods. Some infestations of NNIP would likely go untreated. Some NNIP can affect locations on the HNF for native vegetation and products that can be gathered or areas where wildlife or fish might be harvested, or other locations for revenue generation, such as recreation sites. However, the magnitude of NNIP occurrences is too small to cause an effect over the period of this project. Similarly, NNIP infestations on the HNF, in the foreseeable future would have no effect on social conditions, local or regional employment, or revenue generated. For these reasons, there would be no direct or indirect effects to socio-economic resources from implementing Alternative 1.

Alternative 2: Because of the limited size of the proposed control activities, this alternative would result in no measurable effect on local or regional social conditions such as increased traffic, overcrowding, school size, or crime rates. Similarly, the control methods would have no substantial direct or indirect effects on local or regional infrastructure requirements. Opportunities for local contract NNIP treatments would be created, although this would present only a minor increase in employment or revenue generation. Treatment protocol and design criteria (Sections 1.3.2 and 1.3.3, pp. 11-14) would ensure resource protection and minimize effects to local residents and visitors. For these reasons, there would be no measurable effects to socio-economic resources from implementing Alternative 2.

Environmental Justice
Executive Order 12898, titled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, mandates that federal agencies take the appropriate steps to identify, address, and mitigate all disproportionately high and adverse impacts of federally funded projects on the health and socioeconomic condition of minority and low-income populations. Ethnic minorities are defined as African Americans, American Indian and Alaska Native, Asian, Hispanic or Latino, and Native Hawaiian and other Pacific Islanders. Low income persons are defined as people with incomes below the federal poverty level.

Alternative 2 (Proposed Action) and Alternative 1 (No Change) described in this EA are limited to Forest Service managed lands. There would be no measurable effects from these activities, such that there would be minimal, limited short-term effects on residents bordering the Forest Service lands. The treatment protocols and design criteria outlined in Sections 1.3.2 and 1.3.3 (pp. 11-14), including short-term closures during herbicide applications, would ensure that the proposed activities would have no effects on the health of minorities or low-income individuals.

3.9.3 Socio-economic Cumulative Effects

The boundaries used for cumulative effects for socio-economic resources were the proclamation boundaries of the HNF, including National Forest System lands. This boundary was used because of the minimal disturbance expected from manual and mechanical treatments, the project protocol limiting effects, and our inability to foresee or control activities that occur outside the proclamation boundaries.

Past, present, and reasonably foreseeable future actions considered in this analysis may be found in Table 3-3.

Alternative 1: Implementing Alternative 1 would not result in any direct or indirect effects to socio-economic resources on the Forest. Because there would be no direct or indirect effects associated with implementing Alternative 1, there would be no cumulative effects.

Alternative 2: Because of the limited size of the proposed manual/mechanical, chemical, and biological control activities, there would be little or no appreciable change or increase in employment, revenue, or social conditions resulting from implementing Alternative 2. As the socio-economic direct and indirect effects would be negligible, they would contribute little or no incremental effects when combined with the impacts of other past, present and reasonably foreseeable future activities outlined in Table 3-3.

3.10 MONITORING

Treatment data resulting from NNIP control on the HNF would be added to the applicable vegetation management database. Monitoring of herbicide use would be completed annually and on a daily basis during periods of herbicide application. Records would include information on the date of application, type of herbicide, total amount of the herbicide used, method of application, species treated, and location of treatment. This information would be consolidated in the annual Forest Service Pesticide Use Report.

The Forest Service would monitor treated areas to ensure that control measures and site protection measures meet objectives. Appropriate monitoring techniques, or other evaluations would be used, as appropriate (FSH 2109.14).

Monitoring and evaluation is required under the 2006 Forest Plan (USDA 2006d). Monitoring and evaluation determines how well the Forest Plan is working. It is designed to answer the following questions:

- Did we do what we said we were going to do? This question addresses how well the Forest Plan direction is being implemented. Collected information is compared to objectives, standards, guidelines and management area direction.
- Did it work how we said it would? This question addresses whether the application of standards and guidelines is achieving objectives; and whether objectives are achieving goals (USDA 2006d, p. 4-1).

There is a specific monitoring item for non-native invasive species that asks the question: "How effective is the Forest at treating and controlling the spread of NNIS?" This information is to be reported at minimum once every 5 years (USDA 2006d, p. 4-6).

Table 3-3. List of principal past, present, and reasonably foreseeable actions considered in Chapter 3 cumulative effects analysis.

Resource	Principal Past, Present, and Reasonably Foreseeable Actions Relative to the Respective Resource
Land use, recreation, and aesthetics	• Other federal/non-federal related Non-Native Invasive Plant (NNIP) control activities (Seney NWR) • Other federal/non-federal development and recreational activities
Climate and Air	• Forest Service and private vehicular emissions • Emissions from power plants • Herbicide emissions from other Forest Service and private control activities
Hydrology and Water Quality	• Non point source agricultural chemical runoff from private lands • Agricultural and other physical activities on private lands and in campgrounds and developed areas of HNF contributing to sedimentation
Soils and Geology	• Other activities contributing to point source and non-point source discharges of contaminants such as mercury
Biological resources	• Forest Service, private, commercial and recreational activities such as vehicles which carry and spread infestations of NNIPs. NNIPs can also be spread by other non-human activities (wind, birds, wildlife) • Non-federal physical weed control activities such as mowing • Herbicide applications to control weeds by private entities bordering or near the HNF • Limited past use of herbicides by the Forest Service to control NNIPs (recreation sites and campground) • Use of physical methods by the Forest Service to control NNIPs • Use of biological agents by the Forest Service to control NNIPs • Timber harvesting and other forest management activities that can result in loss of species and habitat (on HNF and private land) • Fragmentation, parcelization, and development of private land • Management activities, including recovery and natural forest aging, which is designed to protect species, particularly threatened and endangered species • Additional future projects designed to control the spread of NNIPs • Management practices which allow natural successional changes in vegetation on HNF and private lands • Transport of soil, mulch, gravel and other materials from off-Forest sites • Water level decreases in Lake Michigan – increase area for NNIP colonization
Human health and safety	• Traffic accidents, drownings, worker place and hand tool accidents • Forest Service sponsored herbicide applications within HNF • Public and private herbicide applications • Forest Service, contractor, and private pesticide spraying activities that might expose individuals to pesticide residues
Heritage resources	• Other federal/non-federal related NNIP control activities • Federal/non-federal land use and development activities • Management activities designed to protect heritage resources
Socio-economics	• Future federal NNIP control activities on the HNF • Other local and regional, federal/non-federal business and development activities, particularly those that that stimulate jobs or economic growth

APPENDIX A – TABLES

Table A-1. General guidelines for reentry into areas treated with herbicides proposed for non-native invasive plant (NNIP) control on the Hiawatha National Forest

Herbicide	Non-Worker Protection Standard Uses	Restricted Entry Interval (REI) (under Worker Protection Standard, 40 CFR part 170)
Glyphosate	Keep people and pets off treated areas until spray solution has dried.	12 hours
Triclopyr	Not stated on label	48 hours
Clopyralid	Not stated on label	12 hours
Imazapic	Not stated on label (Cadre)	12 hours
Dicamba	Not Stated on label (Banvel)	24 hours

Table A-2. Volatility (atmospheric) of herbicides proposed for non-native invasive plant (NNIP) control on the Hiawatha National Forest

Herbicide	**Volatility Characteristics**
Glyphosate	Does not readily volatilize (Tu *et al.* 2001).
Imazapic	Does not volatilize readily (Tu *et al.* 2004).
Triclopyr	Ester formulations can be volatile, and care should be taken during application. Salt formulation is much less volatile than the ester formulation (Tu *et al.* 2003).
Clopyralid	Does not volatilize readily (Tu *et al.* 2001).
Dicamba	Reported to be relatively volatile. It can evaporate from leaf surfaces, and may evaporate from the soil (SERA 2004a).

Table A-3. Mobility and persistence of herbicides proposed for non-native invasive plant (NNIP) control on the Hiawatha National Forest

Herbicide	Characteristics		
	Mechanisms of degradation	**Half-life in soil**	**Mobility**
Glyphosate	Degradation is primarily due to soil microbes	Average of 47 days	Glyphosate has an extremely high ability to bind to soil particles, preventing it from being mobile in the environment
Imazapic	Degradation is primarily due to soil microbes	Ranges from 31 to 233 days depending upon soil characteristics/ environmental conditions	Imazapic is moderately persistent in soil, but has only limited mobility.
Triclopyr	Triclopyr is rapidly degraded to triclopyr acid by photolysis, microbes in the soil, and hydrolysis.	30 days	Ester formulation binds readily with the soil, giving it low mobility. The salt formulation binds only weakly in soil, giving it higher mobility. However, both formulations are rapidly degraded to triclopyr acid, which has an intermediate adsorption capacity, thus limiting mobility.
Clopyralid	Clopyralid is degraded by soil microbes.	40 days	Does not bind strongly to soils. During the first few weeks, there is a strong potential for leaching and possible contamination of groundwater, but adsorption may increase over time.
Dicamba	Rapid metabolism by soil microbes (slower in anaerobic soil conditions), slow photodegradation (WSSA 2006)	<14 days under conditions amenable to rapid metabolism (WSSA 2006)	Low to medium leaching potential (mobile in soil but degrades rapidly) (WSSA 2006)

Note: Data is from Tu *et al.* 2001, unless otherwise noted.

Table A-4. Herbicide solubility, half-life, and aquatic toxicity data of herbicides proposed for non-native invasive plant (NNIP) control on the Hiawatha National Forest

Herbicide	Solubility	Half-life	Aquatic Toxicity and Bioaccumulation
Glyphosate	Rapidly dissipated through adsorption to suspended and bottom sediments	12 days to 10 weeks	Technical grade is moderately toxic to fish. A formulation is registered for aquatic use (i.e. Rodeo) that is practically non-toxic to fish, aquatic invertebrates, and amphibians (Tu *et al*. 2001). Does not bioaccumulate in fish (SERA 2003a).
Imazapic	Soluble, but not degraded, in water. Rapidly photodegraded (half-life 1-2 days) by sunlight in aqueous solution	Ranges from 31 to 233 days depending upon soil characteristics/ environmental conditions	Imazapic is of low toxicity to birds and mammals, and does not bioaccumulate in animals, as it is rapidly excreted in urine and feces. Non-toxic to a wide range of non-target organisms, including mammals, birds, fish, aquatic invertebrates, and insects (Tu *et al*. 2004).
Triclopyr	Salt formulation is water-soluble. The ester formulation is insoluble in water	Salt formulation can degrade in sunlight with a half-life of several hours. The ester formulation takes longer to degrade (Tu *et al*. 2003).	Ester formulation is extremely toxic to fish and aquatic invertebrates. Acid and salt formulation is lightly toxic to fish and aquatic invertebrates. The hydrophobic nature of the ester formulation allows it to be readily absorbed through fish tissues where it is converted to triclopyr acid which can be accumulated to a toxic level. However, most authors have concluded that if applied properly, triclopyr would not be found in concentrations adequate to harm aquatic organisms (Tu *et al.* 2003).
Clopyralid	Highly soluble in water and will not bind with particles in water column	8 to 40 days	Low toxicity to aquatic animals (Tu *et al.* 2001). No evidence of bioaccumulation in fish tissues (SERA 2004b).
Dicamba	Highly water soluble (WSSA 2006)	Low to medium leaching potential, but degrades rapidly. Low potential for runoff due to rapid degradation (WSSA 2006)	Relatively low toxicity to fish and aquatic invertebrates (Daphnia 48-hr. TL_{50} of 110 mg/L, bluegill sunfish and rainbow trout 96-hr. TL_{50} of 135 mg/L). No information on bioaccumulation (WSSA 2006).

Table A-5. Mammalian toxicity data for herbicides proposed for non-native invasive plant control

Herbicide	Acute Toxicity						Chronic Toxicity		
(Technical product unless specific formulation noted)	Oral LD_{50} (rat)	Dermal LD_{50} (rabbit)	4-Hour Inhalation LC_{50} (rat)	Skin Irritation (rabbit)	Skin Sensitization (guinea pig)	Eye Irritation (rabbit)	24-Month Dietary NOEL (mouse)	24-Month Dietary NOEL (rat)	12-Month Dietary NOEL (dog)
	mg/kg BW		mg/L				mg/kg BW/day		
Glyphosate									
Glyphosate acid	5600	>5000	NA	None	No	Slight	4500	400	500
Glyphosate isopropylamine salt	>5000	>5000	NA	None	No	Slight	Chronic toxicity data available only for technical glyphosate acid		
Glyphosate trime-thylsulfonium salt	748	>2000	>5.18 (unspec.)	Mild	Mild	Mild			
ROUNDUP	>5000	>5000	3.2	None	No	Moderate			
RODEO	>5000	>5000	1.3	None	No	None			
Imazapic									
Imazipic acid	>5000	>5000	NA	None	No	Slight	Long-term dietary administration produced no adverse effects in mice and rats.		
Imazipic ammonium salt	>5000	>5000	2.4	None	No	None	Chronic toxicity data available only for technical imazipic acid		
PLATEAU	>5000	>5000	2.4	None	No	None			
CADRE	>5000	>5000 (rat)	2.4	None	No	None			
Triclopyr									
Triclopyr acid	713	>2000	NA	None	Positive	Mild	5.3 (22mo)	3	NA
GARLON 3A	2574	>5000	>2.6 (unspec.)	NA	NA	Severe	Chronic toxicity data available only for technical triclopyr acid		
GARLON 4	1581	>2000	>5.2 (unspec.)	Moderate	Positive	Slight			
Clopyralid									
Clopyralid acid	>5000	>2000	>1.3 (unspec.)	V. Slight	No	Severe	500 (18mo) (mouse)	50 (rat)	100 (dog)
STINGER	>5000	NA	NA	NA	NA	NA	Chronic toxicity data available only for technical clopyralid acid		
Dicamba									
Dicamba acid	1707	>2000	9.6	Slight	Possible	Extreme	115 (18mo)	125	60
BANVEL	2629	>2000	>5.4	Moderate	No	Extreme	Chronic toxicity data available only for technical dicamba acid		
BANVEL 720	2500	NA	NA	NA	NA	NA			
BANVEL SGF	6764	>20000	>20.23	Slight	N/A	Minimal			
WEEDMASTER Dicamba+2,4-D	>5000	>20000	>20.3	Minimal	N/A	Minimal			

Source: Herbicide Handbook (WSSA 2006), Greenbook (2006); NA = Not Available e

Table A-6. Toxicity data for other types of wildlife for herbicides potentially used as part of proposed action

Herbicide Formulation (Technical product unless specific formulation noted)	Avian Receptors				Terrestrial Invertebrates		Aquatic Receptors		
	Bobwhite Quail		Mallard Duck		Earth-worm	Honeybee	Daphnia	Bluegill	Rainbow Trout
	Oral LD_{50}	8-day dietary LC_{50}	Oral LD_{50}	8-day dietary LC_{50}	LC_{50}	Topical LD_{50}	48-hour LC_{50}	96-hour LC_{50}	96-hour LC_{50}
	mg/kg BW	ppm (in food)	mg/kg BW	ppm (in food)	ppm (in soil)	ug/bee	Mg/L (in water)		
Glyphosate									
Glyphosate acid	>4640	>4640		4640		>100	780	120	86
Glyphosate trimethylsulfo-nium salt		>5000	950	>5000		>62.1	71	3500	1800
ROUNDUP					>5000	>100	5.3	5.8	8.2
RODEO							930	>1000	>1000
Imazapic									
Imazapic Acid	>2150	>5000	>2150	>5000				100	32
Triclopyr									
Triclopyr acid		2934	1698	>5620		>100	133	148	117
Triclopyr butoxyethyl ester		5401		>5401		>100	1.7	0.36	0.65
Triclopyr triethylamine salt		>10000	3176	>10000		>100	775	891	613
Clopyralid									
Clopyralid acid		>4640	1465	>4640	1000	>0.1	232	125	104
Dicamba									
Dicamba acid	216	>10000	1373	>10000			110 (TL_{50})	135 (TL_{50})	135 (TL_{50})
BANVEL		>4640	>2510	>4640			1600	>1000	1000
BANVEL SGF		>10000	>4640	>10000			38.1	706	558
WEEDMASTER Dicamba+2,4-D		>4640	>4640	>4640			>1800	>1000	>1000

LD_{50} = Lethal Dose 50; LC_{50} = Lethal Concentration 50; TL_{50} = Threshold Level 50. Data is from 2006 PNW Weed Management - Weed Science Society of America (WSSA 2006) and associated product Material Safety Data Sheets (MSDS); Tu et al. (2001); Tu et al. (2003); Tu et al. (2004); Cornell (1993); Cornell (2006).

Table A-7. U.S. Forest Service Ecological Risk Assessment Information for herbicides proposed for Non-Native Invasive Plant Control on Hiawatha National Forest

Risk Assessment Application Rate	**Terrestrial Mammals**	**Birds**	**Insects**	**Fish & Other Aquatic Receptors**
		Glyphosate (Source: SERA 2003a; Tu et al. 2001)		
2 lb a.e./acre (average rate) 7 lb a.e./acre (maximum rate)	Effects resulting from average application rate are minimal. Some risk exists for large mammals consuming foliage for an extended period of time in areas treated with maximum application rate.	Effects resulting from average application rate are minimal. Some risk exists for small birds consuming insects for an extended period of time from areas treated with maximum application rate.	Effects resulting from average application rate are minimal. Some risk from maximum application rate to bees exposed to direct spray.	Effects resulting from average application rate are minimal. Some risks exists to fish near areas treated with maximum application rate using some of the more toxic formulations not labeled for use in aquatic settings.
		Imazipic (Source: SERA 2004c, Tu et al. 2004)		
0.100 lb a.e. /acre (average rate) 0.1875 lb/acre (maximum rate)	No substantial risk to small mammals at maximum rates. Some risk exists for large mammals, if consumed over long period (i.e. 2 years).	No substantial risk at maximum rates.	No substantial risk at maximum rates. Non-toxic to bees	No substantial risk at maximum rates. However, limited toxicological data available. Potential for risk to aquatic plants from maximum rates is borderline.
		Triclopyr (Source: SERA 2003b, Tu et al. 2003)		
1 lb a.e./acre (average rate) 10 lb a.e./acre (maximum rate)	No substantial risk at average rate. Some risk for mammals exposed via direct spray or consuming sprayed vegetation when applied at maximum rate.	No substantial risk at average rate. Some risk for large bird exposed via direct spray or consuming sprayed vegetation when applied at maximum rate.	No substantial risk to terrestrial vertebrates and invertebrates from salt and ester formulations. Risk to aquatic invertebrates when if exposed to the butoxyethyl ester (BEE) formulation.	No substantial risk when triethylamine (TEA) salt formulations are applied at average rate. Some risk to aquatic species when butoxyethyl ester (BEE) formulations are applied at average rate. Substantial risk when BEE formulations applied at maximum rate.

Risk Assessment Application Rate	Terrestrial Mammals	Birds	Insects	Fish & Other Aquatic Receptors
Clopyralid (Source: SERA 2004b, Tu et al. 2001)				
0.1 lb a.e./acre (typical rate) 1.0 lb a.e./acre (maximum rate)	Reported to be relatively non-toxic, with little potential for adverse effects.	Reported to be relatively non-toxic, with little potential for adverse effects.	Reported to be relatively non-toxic to bees, with little potential for adverse effects. Low toxicity to soil invertebrates and microbes.	Reported to be relatively non-toxic, with little potential for adverse effects.
Dicamba (as Vanquish, the diglycolamine salt of dicamba) (Source: SERA 2004a, Cornell 1993)				
2 lb a.i./acre (foliar application) 1.5 lb a.i./acre (cut surface application) (VANQUISH)	No plausible and substantial hazard under normal conditions of Forest Service use.	No plausible and substantial hazard under normal conditions of Forest Service use.	Reported to be non-toxic to bees.	No plausible and substantial hazard under normal conditions of Forest Service use.

Table A-8. Summary of potential impacts to management indicator species (MIS) for alternatives associated with controlling non-native invasive plant species on the Hiawatha National Forest.

Species	Description	Alternative 1	Alternative 2
American Marten	**Mammal** **Habitats:** Late-successional of northern hardwoods and conifer dominated forests **Associated Species:** Pileated woodpecker, northern goshawk, eastern chipmunk, woodland jumping mouse, gray wolf, black-throated blue warbler	No measurable direct and indirect effects over period of NNIP EA. No evidence habitat suitability is being affected by NNIP. Current level of manual and mechanical control would likely continue with minimal restored or enhanced habitat.	Minimal direct/indirect effects. The proposed herbicides are of low mammalian toxicity. Could result in enhanced habitat over the long term by reducing colonization and spread of NNIP in forested areas.
Sharp-tailed Grouse	**Gallinaceous bird** **Habitats**: Open land and early-successional stages of jack pine **Associated Species**: Short-eared owl, black-backed woodpecker, eastern bluebird, Kirtland's warbler, meadow jumping mouse	No measurable effects over period of NNIP EA. No evidence habitat suitability is being affected by NNIP. Current manual and mechanical control effort would likely continue with minimal restored or enhanced habitat. RFSS status would makes leks a priority area should infestations present a risk to the species. Spread of NNIP species, over a long period of time (>5 years), could possibly indirectly lead to adverse effects on the sharptail by reducing openland quality habitat.	Minimal direct/indirect effects. The proposed herbicides are of low avian toxicity. Human disturbance would be minimal. Controlling some of the NNIP, such as spotted knapweed, in openlands over the long-term (>5years) could restore or enhance habitat.
Ruffed Grouse	**Gamebird** **Habitats:** Early-successional of aspen **Associated Species:** Golden-winged warbler, white-tailed deer, snowshoe hare, American woodcock, indigo bunting	No measurable effects over period of NNIP EA. No evidence habitat suitability is being affected by NNIP. Current manual and mechanical control effort would likely continue with minimal restored or enhanced habitat.	Minimal direct/indirect effects. The proposed herbicides are of low avian toxicity. Controlling some of the NNIP, such as garlic mustard, in forest understory over a long period could result in restored and/or enhanced habitat.
Brook Trout	**Gamefish** **Habitats:** Clear, cold-water streams and rivers **Associated Species:** Mottled sculpin, blacknose dace, longnose dace, brook stickleback	No measurable effects over period of NNIP EA. No evidence current NNIP are affecting brook trout habitat. Minimal effects on species through continued manual/mechanical control.	Minimal direct/indirect effects. Current NNIP are not affecting brook trout habitat. The proposed herbicides are primarily of low fish toxicity. All waterways are protected with a minimum 100-foot buffer where only herbicides approved for aquatic areas can be used.

Table A-9. Endangered and threatened species considered during analysis for non-native invasive plant (NNIP) EA on the Hiawatha National Forest (see BA/BE for more information).

Federally Listed Species - *Endangered (E) Threatened (T)*			
Common Name	Scientific Name	Habitat	# EOs
Plants			
American hart's tongue fern	*Phillitis (Asplenium) scolopendrium v. americanum*	shade - alvar/rock, mesic forest	6
Pitcher's thistle	*Cirsium pitcheri*	open - dune	2
Lakeside daisy	*Hymenoxys herbacea*	open / wet - interdunal wetlands, alvar	1
Dwarf lake iris	*Iris lacustris*	open - dune, beach	3
Houghton's goldenrod	*Solidago houghtonii*	open - dune, beach, interdunal wetland	9
Michigan Monkey-flower - "likely"	*Mimulus glabratus var. michiganensis*	shaded / wet - springs, seeps in cedar swamps	0
Animals			
Kirtland's warbler	*Dendroica kirtlandii*	small size, densely stocked jack pine	
Piping plover	*Charadrius melodus*	Great Lakes shoreline, beach	
Hine's emerald dragonfly	*Somatochlora hineana*	marsh, fen, sedge meadow w/calcareous substrate	
Bald eagle	*Haliaeetus leucocephalus*	lakes, rivers, shorelines and riparian edge,	
Canada lynx	*Lynx canadensis*	mosaic of forested uplands and lowlands, young forest	

Table A-10. Regional Forester Sensitive Species (plants) considered during analysis for non-native invasive plant (NNIP) EA on the Hiawatha National Forest (see BA/BE for more information).

Regional Forester Sensitive Species** (RFSS) - **Plants			
Common Name	Scientific Name	Habitat	# EOs
Vascular Plants-RFSS			
Climbing fumitory	*Adlumia fungosa*	shade - mesic forest, calcareous	1
Round-leaved orchis	*Amerorchis rotundifolia*	shade - old cedar swamp	2
Lake cress	*Amoracia lacustris*	aquatic - spring fed	1
Walking fern	*Asplenium rhizophyllum*	shade - mesic forest, rock	13
Green spleenwort	*Asplenium trichomanes ramosum*	shade - mixed forest, rock	13
Canadian milk-vetch	*Astragalus canadensis*	open - beach	4
Cooper's milk-vetch	*Astragalus neglectus*	open - beach	1
American sloughgrass	*Beckmannia syzigachne*	open - marsh	
Prairie moonwort	*Botrychium campestre*	open - dune, prairie w/ limestone	2
Michigan moonwort	*Botrychium michiganense (hesperium)*	open & shade - mesic field, forested dune	2
Goblin moonwort	*Botrychium mormo*	shade - mesic forest	2
Blunt-lobed grapefern	*Botrychium oneidense*	shade - mesic to dry mesic forest	
Pale moonwort	*Botrychium pallidum*	open - meadow, field, dune	3
Ternate grape fern	*Botrychium rugulosum*	open - pine barrens	
Spathulate moonwort	*Botrychium spathulatum*	open - dune	5
Autumnal water-starwort	*Callitriche hermaphroditica*	aquatic	1
Calypso orchid	*Calypso bulbosa*	shade/wet conifer swamp	13
Beauty sedge	*Carex concinna*	shade - boreal forest, limestn	2
Hudson Bay sedge	*Carex heleonastes*	shade - wet forest, bog/fen, muskeg	1
New England sedge	*Carex novae-angliae*	shade - mesic to dry mesic forest	2
Richardson sedge	*Carex richardsonii*	open - beach, alvar	
Bulrush sedge	*Carex scirpoidea*	open wet - beach, alvar	
Wiegand's sedge	*Carex wiegandii*	open wet - bog, poor fen	15
Douglas's Hawthorn	*Crataegus douglasii*	shade - forested dunes, barrens	1
Slender cliff brake fern	*Cryptogramma stelleri*	shade - mesic forest calcareous rock	
Northern wild comfrey	*Cynoglossum virginianum* var. *boreale*	shade - mesic to dry mesic mixed forest	16
Ram's head lady slipper	*Cypripedium arietinum*	shade/wet - conifer swamp	4
Laurentian bladder fern	*Cystopteris laurentiana*	shade - forest with calcareous rock	2
English sundew	*Drosera anglica*	open - interdunal wetland, bog/fen	1
Spreading wood fern	*Dryopteris expansa*	shade - mesic forest	4
Male fern	*Dryopteris filix-mas*	shade - mesic forest	1
Flattened spike-rush	*Eleocharis compressa*	open wet - beach, marsh, shore, calcareous	1
Blue wild-rye	*Elymus glaucus*	open - beach, forest edges	1
Black crowberry	*Empetrum nigrum*	open - Lake Superior beach	<10
Hyssop-leaved fleabane	*Erigeron hyssopifolius*	open wet - beach, marly pools	4
Northern three-lobed bedstraw	*Galium brevipes*	shade - interdunal conifer forest	2
Northern wild licorice	*Galium kamtschaticum*	shade - mesic forest, seeps	2
Limestone oak fern	*Gymnocarpium robertianum*	shade - calcareous conifer swamp	2
Downy sunflower	*Helianthus mollis*	open - barrens, prairie	1
Fir clubmoss	*Huperzia selago*	open wet - alvar, interdunal wetlands	6
Butternut	*Juglans cinerea*	shade - mesic forest	19
Moor rush	*Juncus stygius*	open wet - bog, poor fen	1
Vasey's rush	Juncus vaseyi	open wet - interdunal wetland	1
Dune grass	*Leymus mollis*	open - dune, beach	1
Auricled twayblade	*Listera auriculata*	shade - shrub, streambank, sand	1
American shoregrass	*Littorella uniflora*	aquatic - sandy edge of lake	2

Regional Forester Sensitive Species *(RFSS)* **- *Plants***			
Common Name	Scientific Name	Habitat	# EOs
Small flowered wood rush	*Luzula parviflora*	shade - mesic forest openings	
Northern prostrate club moss	*Lycopodiella margueritae*	open wet - wet meadow, marsh	
White adder's mouth	*Malaxis brachypoda*	shade - conifer swamp	9
Mat muhly	*Muhlenbergia richardsonis*	open wet - bog, wet meadow	
Alternate-flowered water milfoil	*Myriophyllum alterniflorum*	aquatic - soft water lakes, streams	
Woodland cudweed	*Omalotheca (Gnaphalium) sylvatica*	shade - mesic forest edges, sand	4
Plains Ragwort	*Packera (Senecio) indecora*	open & shade - swamp, bog, beach	1
Sweet-coltsfoot	*Petasites sagittatus*	open wet - fen, bog, wet meadow	4
Butterwort	*Pinguicula vulgaris*	open wet - moist cliff, fen, bog	2+
Canada rice-grass	*Piptatherum (Oryzopsis) canadense*	open - barrens, edge of dry pine forest	12
Algal pondweed	*Potamogeton confervoides*	aquatic - acid bog lakes	
Pine drops	*Pterospora andromeda*	shade - dry mesic to mesic forest	4
Lapland buttercup	*Ranunculus lapponicus*	shade - conifer swamp	3
Dwarf raspberry	*Rubus acaulis*	open wet - fen, bog, edge of swamp	1
Satiny willow	*Salix pellita*	open wet - beach of lake or stream, marsh	1
Torrey's bulrush	*Schoenoplectus (Scirpus) torreyi*	open wet - marsh, beach, wet meadow	1
Prairie dropseed	*Sporobolus heterolepis*	open - prairie, barrens, alvar	1
Long-stalked stitchwort	*Stellaria longipes*	open - dune, beach	1
Lake Huron tansy	*Tanacetum bipinnatum ssp. huronense*	open - Great Lakes beaches	1
Veiny meadow rue	*Thalictrum venulosum* v. *confine*	open - beach, edge of thicket, rocky	
Dwarf bilberry	*Vaccinium cespitosum*	open - barrens, sandy, edge of forest	5
Non-Vascular Plants			
Eastern candlewax lichen	*Ahtiana aurescens*	shade - on trees conifer swamp	
Small firedot lichen	*Caloplaca parvula*	shade - on ash, maple swamp	
liverwort	*Frullania selwyniana*	shade - on trees cedar swamp	
Porthole lichen	*Menegazzia terebrata*	shade - on trees or rock	
Spongy gourd moss	*Pohlia lescuriana*	shade - pond edges, stream banks	
Dotted line lichen	*Ramalina farinacea*	shade - on trees, mesic forest	
Schistostega moss	*Schistostega pennata*	shade - mesic forest, tip-ups, crevices	
Foam lichen	*Sterocaulon condensatum*	open - on sandy soil, fields, openings	
Little Georgia moss	*Tetradontium brownianum*	shade -	

Table A-11. Regional Forester Sensitive Species (animals) considered during analysis for non-native invasive plant (NNIP) EA on the Hiawatha National Forest (see BA/BE for more information).

Regional Forester Sensitive Species** (RFSS) - **Animals		
Common Name	Scientific Name	Habitat
BIRDS		
Northern goshawk	*Accipiter gentilis*	woodlands
Short-eared owl	*Asio flammeus*	grassland/marsh
Le Conte’s sparrow	*Ammodramus leconteii*	grassland/sedge meadow
Red-shouldered hawk	*Buteo lineatus*	woodlands
Black tern	*Chlidonias niger*	lakes/ponds
Yellow rail	*Coturnicops noveboracensis*	marsh
Trumpeter swan	*Cygnus buccinator*	lakes/ponds
Prairie warbler	*Dendroica discolor*	shrub/dune
American peregrine falcon	*Falco peregrinus*	cliffs/shore
Common loon	*Gavia immer*	lakes/ponds
Migrant loggerhead shrike	*Lanius ludovicianus migrans*	grassland/shrub
Black-crowned night heron	*Nycticorax nycticorax*	marsh
Connecticut warbler	*Oporornis agilis*	woodlands
Black-backed woodpecker	*Picoides arcticus*	jack pine/conifer woodlands
Caspian tern	*Sterna caspia*	beach/dunes/shore
Common tern	*Sterna hirundo*	beach/dunes/shore
Sharp-tailed grouse	*Tympanuchus phasianellus*	grassland/pine barrens
Bald eagle	*Haliaeetus leucocephalus*	lakes, rivers, shorelines and riparian edge,
MAMMAL		
*Gray wolf**	*Canis lupus*	mosaic of forested uplands and lowlands, young forest
REPTILES		
Blanding’s turtle	*Emydoidea blandingii*	marsh/streams
FISH		
Lake Sturgeon	*Acipenser fulvescens*	lakes/streams
MOLLUSKS		
Land snail	*Catinella exile*	cobble beach
Land snail	*Euconulus alderi*	tamarack/white cedar
Eastern flat-whorl	*Planogyra asteriscus*	tamarack/white cedar
Land snail	*Vallonia gracilicosta albula*	other
Delicate Vertigo	*Vertigo bollesiana*	carbonate cliffs
Six Whorl Vertigo	*Vertigo morsei*	calcareous wetland
Mystery vertigo	*Vertigo paradoxa*	carbonate cliffs
INSECTS		
Green-faced clubtail	*Hylogomphus viridifrons*	rocky rivers/streams
Northern blue butterfly	*Lycaeides idas nabokovi*	grassland/pine barrens
Warpaint emerald dragonfly	*Somatochlora incurvata*	bog/fen
Lake Huron locust	*Trimerotropis huroniana*	beach/dunes
Ebony Boghaunter	*Williamsonia fletcheri*	bog/fen
Ringed Boghaunter	*Williamsonia linteri*	bog/fen

* - bald eagle and gray wolf were also analyzed as RFSS due to the potential for removal from T&E list

Table A-12. Regional Forester Sensitive Species "Likely to Occur" considered during analysis for non-native invasive plant (NNIP) EA on the Hiawatha National Forest.

"Likely to Occur[1]" Regional Forester Sensitive Species **No Element Occurrences on forest**		
Common Name	Scientific Name	Habitat
Vascular Plants		
Screwstem	*Bartonia paniculata*	open wet - meadow, bog, fen
Northern reed-grass	*Calamograstis lacustris*	open - beach, cliffs
Large tooth-wort	*Cardamine maxima*	shade - rich mesic forest
Walking sedge	*Carex assiniboinensis*	shade - mesic hardwood forest
Schweinitz's sedge	*Carex schweinitzii*	shade wet - swamp, streambank
Many-headed sedge	*Carex sychnocephala*	open wet - shore, wet meadow
Hill's thistle	*Cirsium hillii*	open - barrens, alvar, calcareous soil
Purple clematis	*Clematis occidentalis*	shade - part open, rocky woods
Rock witlow-grass	*Draba arabisans*	open - beach, bedrock, alvar
Slender spike-rush	*Eleocharis nitida*	open wet - fen, interdunal wetland, pond edge
Mountain fir clubmoss	*Huperzia appalachiana*	open wet - moist cliff, acidic rock
Farwell's water milfoil	*Myriophyllum farwellii*	aquatic - muck bottom lake
Yellow pond lily	*Nuphar pumila*	aquatic -
Hill's pondweed	*Potamogeton hillii*	aquatic - calcareous lake pond
Little shinleaf	*Pyrola minor*	shade - mesic forest
Awlwort	*Subularia aquatica*	aquatic - sand/gravel bottom lakes
Non-Vascular Plants		
Lichen	*Cladonia wainoi*	open - rock
Forked liverwort	*Metzgeria furcata*	shade - on bark of trees
Felt lichen	*Peltigera venosa*	shade - on moist rock
Yellow speckleberry Lichen	*Pseudocyphellaria crocata*	shade - on moist rock in forest
Methuselah's beard lichen	*Usnea longissima*	shade - on trees, humid forest

APPENDIX B – LIST OF CONTRIBUTORS TO PROJECT ANALYSIS

Anne Davy, USDA Forest Service, NEPA Coordinator, Hiawatha National Forest

Chuck Bassett, USDA Forest Service, Fisheries Biologist, Hiawatha National Forest

Deborah LeBlanc, USDA Forest Service, Botanist, Hiawatha National Forest

Donna Iraneta, USDA Forest Service, Database Analyst, Hiawatha National Forest

James Gries, USDA Forest Service, Soil Scientist. Hiawatha National Forest

Jean Perkins, USDA Forest Service, Silviculturist, Hiawatha National Forest

Jessica Stuntebeck, USDA Forest Service, Geologist, Hiawatha National Forest

John Frazen, USDA Forest Service, Archeologist, Hiawatha National Forest

Kirk Piehler, USDA Forest Service, Wildlife Biologist, Hiawatha National Forest

Louise Congdon, USDA Forest Service, Forester, Hiawatha National Forest

Marjory Brzeskiewicz, Contract Botanist

Mike Lanasa, USDA Forest Service, Ecosystem Team Leader. Hiawatha National Forest

APPENDIX C – REFERENCES

Buckley, D. S., T. R. Crow, E. A. Nauertz, and K. E. Schultz. 2003. Influence of skid trails and haul roads on understory plant richness and composition in managed forest landscapes in Upper Michigan, USA. p. 518 Forest Ecology and Management 175: 509-520.

Bury, R. B., P. S. Corn, C. K. Dodd, Jr., R. W. McDiarmid, and N. J. Scott. 2004. Amphibians. In: LaRoe, E. T., G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac (eds.). Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. U.S. Department of the Interior, National Biological Service. Posted at http://biology.usgs.gov/s+t/noframe/d053.htm.

Cornell University. 1993. Pesticide Information Notebook. Extoxnet Extension Toxicology Network. Second Edition. Pesticide Information Profile: Dicamba. Available: http://pmep.cce.cornell.edu/profiles/extoxnet. Accessed: 2/2007.

Cornell University. 2006. Pesticide Information Notebook. Extoxnet Extension Toxicology Network. Second Edition. Available: http://pmep.cce.cornell.edu/profiles/extoxnet

DAPTF (Decline in Amphibian Populations Task Force). 2003. About Amphibian Declines. Posted at http://www.open.ac.uk/daptf/declines/dec1O.htm.

Ekstrum, J. 2007. U.S. Forest Service. Wildlife Biologist. Personal communication (email) with K. Piehler 2/7/2007.

Elliot, J. A., A. J. Cessna, K. B. Best, W. Nicholaichuk, and L. C. Tollefson. 1998. Leaching and preferential flow of clopyralid under irrigation: field observations and simulation modeling. Journal of Environmental Quality. Vol. 27. pp. 124-131.

Executive Order 13112. 1999. Invasive Species. Federal Register. Vol. 64. No. 25. February 8, 1999. Posted at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=1999_register&docid=99-3184-filed.pdf

Extoxnet 1993. Dicanmba. Extension Toxicology Network. A Pesticide Information Project of Cooperative Extension Offices of Cornell University, Michigan State University, Oregon State University, and University of California at Davis. 6 pp. Available at: http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/dicamba-ext.html

Fischer, D. 2006. Applying Herbicides Effectively and Accurately. Notes from presentation by David Fischer, University of Wisconsin, Madison, WI at the Midwest Invasive Plant Symposium, December 13-14, 2006, Milwaukee, WI.

Frelich, L. E. 2002. Forest Dynamics and Disturbance Regimes – Studies from temperate evergreen-deciduous forests. Cambridge University Press. 266 pp.

Great Lakes Piping Plover Call. 2006. Breeding summary for piping plover for 2006 nesting season. August 31, 2006. 2 pp.

Gleason, H. A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada, second edition. The New York Botanical Garden, New York.

Greenbook. 2006. Information regarding pesticide product labels, supplemental labels, and material safety data sheets (MSDS). Available: http://www.greenbook.net/Library/showDetails.asp?ProductID=45476&WebSiteID=0

Gries, J. USDA Forest Service, Personal observation. Soil Scientist, Escanaba, MI

Hager, A., C. Sprague, and M. McGlamery. 1999. Factors affecting herbicide persistence. Chapter 20 in 2000 Illinois Agricultural Pest Management Handbook. College of Agricultural, Consumer and Environmental Sciences, University of Illinois at Urbana-Champaign. Kevin Steffey, Handbook Coordinator. Available at http://www.ag.uiuc.edu/~vista/abstracts/aiapm2k.html.

Hartman, K.M. and B. C. McCarthy. 2007. A dendro-ecological study of forest overstorey productivity following the invasion of the non-indigenous shrub Lonicera maackii. Applied Vegetation Science 10: 3-14, 2007.

Howe, C. M., Berrill, M., Pauli, B. D., Helbing, C. C., Werry, K., and N. Veldhoen. 2004. Toxicity of glyphosate-based pesticides to four North American frog species. Environmental Toxicology and Chemistry, Vol. 23, No. 8. pp. 1928-1938.

Jerome, D., 2006. Landforms of the Upper Peninsula, Michigan (Draft). February 2006. USDA, Natural Resources Conservation Service. 56 pp.

Kansas State University, Research & Extension. 2001. Horticulture 2001 Newsletter, No. 27, July 3, 2001Herbicide Drift. http://www.oznet.ksu.edu/dp_hfrr/hnewslet/2001/welcome.htm.

Landis, D. 2004. Michigan State University. Professor, Insect Ecology, Biological Control. Letter to Ottawa National Forest concerning proposed invasive plant control project. 1/28/04.

Langeland, K. A. 2006. Safe use of glyphosate-containing products in aquatic and upland areas. University of Florida. IFAS Extension. SS-AGR-104. 4 pp.

LeBlanc, D. 2007. U.S. Forest Service Botanist. Personal Communication with K. Piehler, April 2007.

Mallinckrodt Baker, Inc. 2004. Material Safety Data Sheet (MSDS) for Sodium Chloride, MSDS Number S3338. J. T. Baker Environmental Health & Safety. CAS No. 7647-14-5. Effective Date: January 12, 2004.

MDOT. 2006. Michigan Department of Transportation, personal communication with Marjory Brzeskiewicz regarding roadside maintenance in the U.P. of Michigan, phone conversation December 19, 2006.

McNab, W. H. and P. E. Avers. 1994. Ecological Subregions of the United States: Section Descriptions. Publication WO-WSA-5. United States Department of Agriculture. Available: http://www.fs.fed.us/land/pubs/ecoregions/.

MDEQ. 2002. 2002 Annual Air Quality Report. pp. 1-48. Michigan Department of Environmental Quality. http://www.deq.state.mi.us/documents/deq-aqd-reports-02AQReport.pdf

MDEQ. 2004. Untitled table listing current chemical control options for aquatic plant control in Michigan. 09/04. Michigan Department of Environmental Quality. http://www.deq.state.mi.us/documents/deq-water-illm-plantchemicaltable.pdf

MDEQ 2006. Water Quality And Pollution Control In Michigan: 2004 Sections 303(D) And 305(B) Integrated Report. Michigan Department of Environmental Quality.

MDEQ 2006b. Groundwater mapping project. Last updated March 6, 2006. Available on-line at http://gwmap.rsgis.msu.edu/viewer.htm. Accessed on 11/27/2006

MDNR. 1994. Water Quality Management Practices on Forest Land. Michigan Department of Natural Resources and Michigan Department of Environmental Quality, Lansing, MI. 26 pp.

Michigan Department of Community Health (MDCH) 2004. 2004 Michigan Family Fish Consumption Guide: Important facts to know if you eat Michigan fish. MDCH Environmental and Occupational Epidemiology Division. Downloaded 14 November 2006. Available on-line at http://www.michigan.gov/documents/FishAdvisory03_67354_7.pdf

Midwest Regional Climate Center. 2006. Precipitation, Temperature, and Snowfall Summaries. Queries ran for Station 202626 Escanaba, 205690 Munising, 20724 St. Ignace Mackinac Br, 205816 Newberry State Hospital, 207366 Sault Ste Marie WSO. http://mcc.sws.uiuc.edu/climate_midwest/maps/mi_mapselector.htm. Accessed on August 30, 2006.

Miller, P. and P. Westra 2004a. Herbicide Behavior in Soils. Number 0.562. Colorado State University, Cooperative Extension – Agriculture. August 23, 2004. 3 pp. Available at: http://www.ext.colostate.edu/pubs/crops/00562.html

Miller, P. and P. Westra 2004b. How Formulations. Number 0.558. Colorado State University, Cooperative Extension – Agriculture. August 23, 2004. 3 pp. Available at: http://www.ext.colostate.edu/pubs/crops/00558.html

Miller, P. and P. Westra 2004c. How Surfactants Work. Number 0.564. Colorado State University, Cooperative Extension – Agriculture. August 23, 2004. 3 pp. Available at: http://www.ext.colostate.edu/pubs/crops/00564.html

Minnesota DNR. 1992. A Field Guide to Aquatic Exotic Plants and Animals. Minnesota Department of Natural Resources & Minnesota Sea Grant. Posted at http://www.seagrant.umn.edu/exotics/fieldguide.html.

Nuzzo, V. 2000. Element Stewardship Abstract for Alliaria petiolata (Garlic mustard). The Nature Conservancy. Arlington, Virginia. http://tncweeds.ucdavis.edu/esadocs.html

OFAH. 2003. Purple Loosestrife: What you should know , what you can do (brochure). Ontario Federation of Anglers and Hunters in cooperation with Minnesota DNR, Wisconsin DNR, U.S. Great Lakes Sea Grant Network and others, Peterborough, Ontario Canada.

Piehler, K. USDA Forest Service, Personal observation. Wildlife Biologist, Escanaba, MI

Project record. 2007. Project record for Non-native invasive plant (NNIP) control project. Hiawatha National Forest. Escanaba, MI.

Putnam, M., D. Childs, G. Ruhl, and B.R. Lerner. Unknown date. Diagnosing herbicide injury on garden and landscape plants. Purdue University, Cooperative Extension Service. Posted at www.agcom.purdue.edu/AgCom/Pubs/ID/ID-184.html. Accessed 11/13/2006.

Rees, N. E. and P.C. Quimby, Jr., and B.H. Mullin. 1996. Biological Control of Weeds. In: Rees, N.E., P.C. Quimby, Jr., G.L. Piper, E.M. Coombs, C.E. Turner, N.R. Spencer, and L.V. Knutson (eds). Biological control of weeds in the West. Pgs. 13-15. Western Society of Weed Science, in cooperation with USDA Agricultural Research Service, Montana Department of Agriculture, and Montana State University.

Relyea, R. A. 2005. The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. Ecological Applications, 15(2), 2005, pp. 618-627.

Salt Institute. 2004. What is Salt? Available online: http://www.saltinstitute.org/15.html.

SERA. 2003a. Glyphosate - Human Health and Ecological Risk Assessments Final Report. Syracuse Environmental Research Associates, Inc. Submitted to USDA Forest Service, Forest Health Protection, Arlington, VA. USDA Forest Service Contract No. GS-10F-0082F Task 9 Mar 1.2003. Available online: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2003b. Triclopyr - Human Health and Ecological Risk Assessments Final Report. Syracuse Environmental Research Associates, Inc. Submitted to USDA Forest Service, Forest Health Protection, Arlington, VA. USDA Forest Service Contract No. GS-10F-0082F Task 13, Mar15, 2003. Available online: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2004a. Dicamba - Human Health and Ecological Risk Assessments Final Report. Syracuse Environmental Research Associates, Inc. Submitted to USDA Forest Service, Forest Health Protection, Arlington, VA. USDA Forest Service Contract No. GS-10F-0082F Task 17, Nov 24 2004. Available online: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2004b. Clopyralid - Human Health and Ecological Risk Assessments Final Report. Syracuse Environmental Research Associates, Inc. Submitted to USDA Forest Service, Forest Health Protection, Arlington, VA. USDA Forest Service Contract NoGS-10F-0082F Task 17, Dec. 5, 2004. Available online: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

SERA. 2004c. Imazapic - Human Health and Ecological Risk Assessments Final Report. Syracuse Environmental Research Associates, Inc. Submitted to USDA Forest Service, Forest Health Protection, Arlington, VA. USDA Forest Service Contract No. GS-10F-0082F Task 17, Dec 23, 2004. Available online: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Schmidt, K.A. and C.J. Whelan. 1999. Effects of Exotic Lonicera and Rhamnus on Songbird Nest Predation. Conservation Biology 13(6): 1502-1506. http://www.blackwell-synergy.com/links/doi/10.1046/j.1523-1739.1999.99050.x/abs/

Stinson, K. A., S. A. Campbell, J. R. Powell, B. E. Wolfe, R. M. Callaway, G. C. Thelen, S. G. Hallett, D. Prati, and J. N. Klironomos. 2006. Invasive Plan Suppresses the Growth of Native Tree Seedlings by Disrupting Belowground Mutualisms. In: PLoS Biology, May 2006, Vol. 4, Issue 5, pp. 0727-0731.

Story, J. 2004. in Van Driesche et al. 2002. Biological Control of Invasive Plants in the Eastern United States, Chapter - Spotted Knapweed. USDA Forest Service Publication FHTET-2002-04. Available online: http://www.invasive.org/eastern/biocontrol/

TEAM. 2003. Biological Control of Leafy Spurge. USDA-ARS TEAM Leafy Spurge integrated pest management program, December 2003, (fourth printing). Available online: http://www.team.ars.usda.gov/biocontrolmanual.html

Thompson, D. G., Solomon, K. R., and B. F. Wojtaszek. 2006. Response letter to the editor for Relyea, R. A., The impact of insecticides and herbicides on the biodiversity and productivity of aquatic communities. Ecological Applications, 16(5), 2006, pp. 2022-2027.

Trombulak, Stephen C., and Christopher A. Frissell. 1999. Review of ecological effects of roads on terrestrial and aquatic communities. p 24, Conservation Biology 14(1): 18-30.

Tu, Mandy, C. Hurd, and J.M. Randall. 2001. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas, Clopyralid, Glyphosate - version - 2001. Available online at: http://tncweeds.ucdavis.edu/handbook.html

Tu, Mandy, C. Hurd, and J.M. Randall. 2003. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas, Triclopyr – revised version – December 2003. Available online at: http://tncweeds.ucdavis.edu/handbook.html

Tu, Mandy, C. Hurd, and J.M. Randall. 2004. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas, Imazapic – revised version - January 2004. Available online at: http://tncweeds.ucdavis.edu/handbook.html

U.S. Department of Interior, Fish and Wildlife Service. 1983. Northern States Bald Eagle Recovery Plan. U. S. Fish and Wildlife Service, Twin Cities, MN. 75 pp.

U.S. Department of Interior, Fish and Wildlife Service. 2003. Recovery Plan for the Great Lakes Piping Plover(Charadrius melodus). September 2003. 141 pp.

USDA Forest Service 1999.Dicamba: Herbicide Information Profile. United States Department of Agriculture, Forest Service Pacific Northwest Region. 22 pp. Available online: http://www.fs.fed.us/r6/nr/fid/pubsweb/dicamba_99.pdf

USDA Forest Service 1999b. Forest Service Handbook. Health and Safety Handbook. Amendment No 6709.11-99-1. Effective December 1, 1999. pp. O-3 – O-7.

USDA. 2000. Conservation buffers to reduce pesticide losses. Natural Resources Conservation Service. March 2000. 21 pp.

USDA. 2001. USDA Forest Service Guide to Noxious Weed Prevention Practices. Version 1.0 25 pp. Available on the web at: http://www.fs.fed.us/rangelands/ftp/invasives/documents/GuidetoNoxWeedPrevPractices_07052001.pdf.

USDA. 2001b. FSM 2600 – WILDLIFE, FISH AND RARE PLANT HABITAT MANAGEMENT**.** chapteR 2670 - THREATENED, ENDANGERED, AND SENSITIVE PLANTS AND ANIMALS**.** Supplement No.: 2600-2001-1**.** Effective Date: February 23, 2001

USDA Forest Service. 2004. Dicamba: Human Health and Ecological Risk Assessment, Final Report. Submitted by Syracuse Environmental Research Associates, Inc. 179 pages. Available at: http://www.fs.fed.us/foresthealth/pesticide/risk_assessments/112404_dicamba.pdf

USDA. 2004b. National Strategy and Implementation Plan for Invasive Species Management. U.S. Forest Service. FS-805. October 2004. 18 pp. Available: http://www.fs.fed.us/rangelands/ftp/invasives/documents/Final_National_Strategy_100804.pdf

USDA Forest Service. 2005. Biological Assessment for the Hiawatha National Forest. August 2005. 332 pp.

USDA. Forest Service. 2005b. Invasive Species Strategy (Draft). Hiawatha National Forest. 21 pp.

USDA Forest Service. 2006a. Hiawatha National Forest Land and Resource Management Plan (2006 Forest Plan) Hiawatha National Forest. Escanaba, MI.

USDA Forest Service. 2006b. Hiawatha National Forest Final Environmental Impact Statement, To Accompany the Land and Resource Management Plan, 2006, Hiawatha National Forest. Escanaba, MI.

USDA Forest Service. 2006c. Hiawatha National Forest Monitoring and Evaluation Plan, Chapter 4 in the Land and Resource Management Plan, 2006, Hiawatha National Forest. Escanaba, MI.

USDA Forest Service. 2007a. Hiawatha National Forest Biological Evaluation (Biological Assessment) Appendix to the Environmental Assessment for the NNIP Control Project Environmental Assessment. March 2007. Hiawatha National Forest. Escanaba, MI.

US Environmental Protection Agency (USEPA). 1999. Topical and Chemical Fact Sheets. Spray Drift of Pesticides. December 1999. 5 pp. Available: http://www.epa.gov/pesticides/factsheets/spraydrift.htm#2

US Environmental Protection Agency (USEPA). 2004. Pesticides: Regulating Pesticides. Agency web page. http://www.epa.gov/pesticides/regulating/index.htm#eval

USFWS. 2006. Biological Opinion for the Hiawatha National Forest Land and Resource Management Plan, March 2006. U.S. Department of Interior, Fish and Wildlife Service East Lansing Office, MI.

Van Driesche R., S. Lyon, B. Blossey, M. Hoddle, R. Reardon. 2002. Biological Control of Invasive Plants in the Eastern United States, pp. 79-90, 149-157, 169-180, 181-194. Available at: http://www.invasive.org/eastern/

Van Es, H. M. 1990. Pesticide Management For Water Quality: Principles and Practices. Pesticide Management Education Program, Cornell University. Accessed 14 November 2006. Available at: http://pmep.cce.cornell.edu/facts-slides-self/facts/pestmgt-water-qual-90.html

Voss, E. 1995. Michigan Flora, Part II, Dicots. Cranbrook Institute of Science, Bulletin 59 and University of Michigan Herbarium pp 520-527.

Wilson, L. M. Schwarzlaender, M., Blossey, B. and C. B. Randall. 2005. Biology and Biological Control of Purple Loosestrife. USDA-Forest Service FHTET-2004-12. p. 2. Article available online: http://www.invasive.org/weeds/

Wilson, L. M. and C. B. Randall. 2005. Biology and Biological Control of Knapweed. USDA-Forest Service FHTET-2001-07. 2nd Edition, Chapter 3, Section 1. Article available online: http://www.invasive.org/weeds/knapweed/chapter3.html

Wojtaszek, B. F., Staznik, B., Chartrand, D. T., Stephenson, G. R., and D. G. Thompson. 2004. Effects of Vision herbicide on mortality, avoidance response, and growth of amphibian larvae in two forest wetlands. Environmental Toxicology and Chemistry, Vol. 23, No. 4. pp. 832-842.

WSSA (Weed Science Society of America). 2006. PNW Weed Management Handbook, November 2005. Available online: http://pnwpest.org/pnw/weeds?01W_INTR01.dat