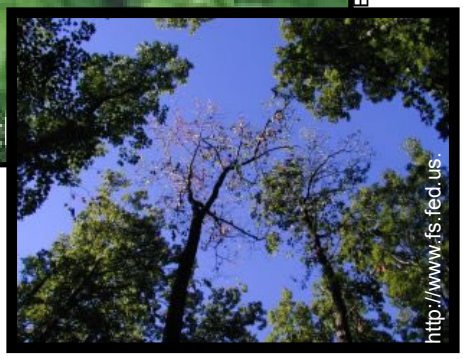
Wisconsin's Forestry

Best Management Practices

For Invasive Species

A Field Manual
For
Foresters, Landowners, and Loggers



Betty Czarapata

TABLE OF CONTENTS

Acknowledgements

This effort was supported by many affected stakeholders who understood the importance of and the need for forestry Best Management Practices for invasive species. We especially want to thank the Advisory Committee and Technical Team members and their organizations for dedicating their time, energy and resources to developing this manual and the BMPs within. Their commitment and support for the future of Wisconsin's forests is evident through their many months of hard work and their continued leadership and advocacy.

Funding for the development of the BMPs was generously provided by the US Forest Service, Northeastern Area State and Private Forestry.

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Preface

In 2002, the Wisconsin Council on Forestry—comprising representatives of private and public forestry professionals, timber and forest product industries, conservation organizations, forestry schools and other interested groups—was created by state statute to advise the Governor, Legislature, the Department of Natural Resources and other State agencies on issues affecting forests in the state. In 2004, the Council sponsored the Governor's Conference on Forestry. The 64 participants who attended these discussions, again, representing a range of interested groups, concluded that "*invasive exotic* [non-native] *species may present the greatest threat to the long-term health and sustainability of Wisconsin's forests*" and reached "*a clear consensus on the need for voluntary forestry/invasive best management practices and a commitment to a partnership-based process for creating them*." In response, the Council created the Forest Invasives Leadership Team to help guide these efforts.

WISCONSIN COUNCIL ON FORESTRY

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February 3, 2009

Dear Forestry Practitioner:

On behalf of the Wisconsin Council on Forestry, I encourage you to consider how our Wisconsin Forestry Community can work together to address the threat of invasive species in Wisconsin's forests. Your work as a forestry practitioner can be a key part of addressing this challenge.

The Best Management Practices (BMPs) identified in this manual are our best attempt to identify effective and realistic practices that we can integrate into routine forestry activities to limit the impact of invasive species. By taking reasonable precautions today, we can help protect the productivity of Wisconsin's forests and our forest economy for the future.

A 14-member Council on Forestry Advisory Committee and support staff from Wisconsin DNR Division of Forestry worked from January 2006 until February 2009 to develop this manual and these practices. We have learned in that time that determining appropriate action in response to the large number of current and potential invasive species that threaten our forests involves complex decisions that are context dependant. For that reason we stress that practitioners applying BMPs need to be allowed a great deal of latitude to select strategies and responses appropriate for their circumstances.

Unlike *Wisconsin's Forestry Best Management Practices for Water Quality*, which prescribes a fairly uniform and measurable set of statewide practices, *Wisconsin's Forestry Best Management Practices for Invasive Species* recognizes a wide range of possible response options to any invasive species situation. Response options will need to recognize the degree of threat posed by an invasive species, the objectives of the landowner, the resources available for additional management activities, and the costs that will be borne by forest practitioners of adopting Best Management Practices.

The Advisory Committee stresses the fact that the primary costs of adopting *Wisconsin's Forestry Best Management Practices for Invasive Species* will be borne by landowners and loggers and forest practitioners who make their living in the forest. We encourage 3rd party auditors or others who may look to adopt or reference these voluntary practices to recognize the need for setting reasonable expectations and realistic goals for practitioners. It is our hope that everyone involved in forestry from foresters, landowners, loggers, and purchasers of raw products, will help share the responsibility to protect our forests from invasive species and ensure the jobs and benefits of our forests remain as strong tomorrow as they are today.

Sincerely,

Frederic Souba, Jr.
Chair, Wisconsin Council on Forestry

Purpose and Scope Statements

Purpose Statement

Forest invasive species can pose a threat to forest ecosystems and forest productivity. Foresters, landowners, and loggers can play important roles in slowing the spread of invasive species. This manual describes practices to aid in those roles. The goal is to provide practices that reduce the impact of invasive species.

Scope Statement

The Best Management Practice (BMP) statements in this manual are intended to apply to forest stewardship activities. The use of this manual is voluntary and non-regulatory and is intended to help foresters, landowners, and loggers make the most efficient use of limited resources to combat invasive species.

How will this be implemented?
The BMPs in this document cover a wide variety of situations. Practitioners who develop management plans, prescriptions, and timber sale documents (including contract language) are encouraged to identify specific BMPs within this manual that address their circumstance. Some landowners or managers will have more resources than others; landowner goals and objectives will vary; therefore the scale and intensity of implementation for each BMP may vary with individual situations.

Who is this for?
Foresters, landowners, and loggers can play important roles in slowing the spread of invasive species, and they may all play different roles in different circumstances. Practitioners should also clarify who has the primary responsibility to implement BMPs.

To what extent should this be implemented?
Initially, we expect these BMPs to apply to a short list of priority invasive species in forested landscapes. As awareness grows, the understanding of invasive species will increase along with the capacity of forest practitioners to address these concerns.

When will it be implemented?
Effective implementation of BMPs will be a process of continuous learning. Over time, training programs for foresters, landowners, and loggers will be necessary to ensure a successful BMP effort.

Which species are covered by this manual?

A priority list of invasive plants in forested landscapes:

	Common Name	Scientific Name	Habitat
1.	garlic mustard	*Alliaria petiolata*	forest
2.	Japanese barberry	*Berberis thunbergii*	forest
3.	thistles—musk, bull, European marsh, Canada	*Carduus nutans, Cirsium arvense, C. palustre, C. vulgare*	open, wetland
4.	oriental bittersweet	*Celastrus orbiculatus*	forest
5.	spotted knapweed	*Centurea biebersteinii*	open
6.	crown vetch	*Coronilla varia*	open
7.	Russian and autumn olive	*Elaeagnus angustifolia, E. umbellata*	forest, open
8.	leafy spurge	*Euphorbia esula*	open
9.	dames rocket	*Hesperis matronalis*	forest
10.	Japanese honeysuckle	*Lonicera japonica*	forest, open
11.	bush honeysuckles—Morrow's, Tartarian, bella	*Lonicera morrowii, L. tatarica, L. x bella*	forest, open
12.	bird's foot trefoil	*Lotus corniculatus*	open
13.	wild parsnip	*Pastinaca sativa*	open
14.	reed canary grass	*Phalaris arundinacea*	forest, open, wetland
15.	Japanese knotweed	*Polygonum cuspidatum*	forest, open, wetland
16.	buckthorns—common and glossy	*Rhamnus cathartica, R. frangula*	forest, open, wetland
17.	black locust	*Robinia pseudoacacia*	forest, open
18.	multiflora rose	*Rosa multiflora*	forest
19.	common tansy	*Tanacetum vulgare*	open
20.	Japanese hedgeparsley	*Torilis japonica*	forest

Footnote: This list may be updated as new invasive species appear in Wisconsin. For factsheets on these species with information on identification and general control methods see Appendix G at http://council.wisconsinforestry.org/. For a more complete working list of terrestrial invasive plant species found in forested landscapes in Wisconsin see Appendix I at http://council.wisconsinforestry.org/.

A priority list of invasive insects in forested landscapes:

	Common Name	Scientific Name
1.	hemlock woolly adelgid	*Adelges tsugae*
2.	emerald ash borer	*Agrilus planipennis*
3.	Asian longhorned beetle	*Anoplophora glabripennis*
4.	European gypsy moth	*Lymantria dispar*
5.	sirex woodwasp	*Sirex noctilio*
6.	conifer bark beetles	Various species

Footnote: This list may be updated as new invasive species appear in Wisconsin. For factsheets on these species with information on identification and general control methods see Appendix G at http://council.wisconsinforestry.org/.

A priority list of invasive diseases in forested landscapes:

	Common Name	Scientific Name
1.	oak wilt	*Ceratocystis fagacearum* (pathogen)
2.	white pine blister rust	*Cronartium ribicola* (pathogen)
3.	annosum root rot	*Heterobasicion annosum* (pathogen)
4.	beech bark disease	*Cryptococcus fagisuga*, *Neonectria ditissima* (syn. *Nectria galligena*) and *Neonectria faginata* (syn. *Nectria coccinea* var. *faginata*) (scale and pathogen)
5.	butternut canker	*Sirococcus clavigignenti-juglandacearum* (pathogen)

Footnote: This list may be updated as new invasive species appear in Wisconsin. For factsheets on these species with information on identification and general control methods see Appendix G at http://council.wisconsinforestry.org/.

Beyond the Scope Statement

There are additional needs in invasive species management that are beyond the scope of this manual. These needs are being addressed by complementary efforts that focus on additional vectors and broader scales which are not fully covered in this manual. These include additional Wisconsin Council on Forestry efforts to develop BMPs for invasive species that address recreation, transportation and utility rights-of-way and urban forestry; regulatory programs at regional or national scales including quarantine and port-of-entry regulations that address movement of invasive species and infested material into and within the US; and federal agency actions to strengthen inspection and management.

Chapter 1: Introduction

What are invasive species?

Non-native plants, animals, and microorganisms found outside of their natural range can become invasive. While many of these are harmless because they do not reproduce or spread in their new surroundings, other non-native species are considered invasive if they can cause harm to the economy, ecology or human health of the new environment. These species thrive in new areas because they establish relatively quickly, tolerate a wide range of conditions, are easily dispersed, and are no longer limited by the diseases, predators, and parasites that kept their populations in check in their native range.

Some non-native species have been introduced intentionally for a variety of reasons, including for food (e.g., agriculture crops and livestock), erosion control (e.g., reed canary grass), gardening (e.g., Japanese barberry, purple loosestrife), shade trees (e.g., Norway maple), sport fishing (e.g., earthworms, carp, brown trout, rainbow trout, salmon), and game animals (e.g., ring-necked pheasant). Increases in international trade are resulting in an increasing rate of unintentional introductions of invasive species to forests in eastern North America. These include the hemlock woolly adelgid, an Asian scale insect, which has spread from Virginia to Maine and Georgia during the last 50 years, and beech bark disease, now spreading through the Upper and Lower Peninsulas of Michigan, which occurs when either of two species of fungi infest American beech following the invasion by an Asian scale insect.

Invasive species are now widespread across an increasing number of acres in the United States, posing threats to habitats and economies in areas as diverse as agriculture, forestry, livestock, fisheries, and recreation. Invasive species have spread to a wide range of ecosystems and now rank just behind habitat loss as the leading cause of rare species declines (Wilcove et al. 1998). Local, state, tribal, and national governments; public agencies; non-profit organizations; private corporations; and individual landowners have begun to recognize the invasive species threat and are taking steps to address the problem.

One of the most difficult aspects of managing invasive species is that they are usually widespread before they are recognized as harmful. Some species, like small insects or fungi, are so inconspicuous that populations go unnoticed for many years after introduction. Others species are non-invasive at first, but become invasive later due to adaptation, because wildlife begin to spread them (e.g., multiflora rose), or because population sizes reach the point where exponential growth allows them to increase rapidly.

The figure below illustrates this problem using a hypothetical population with a growth rate of 1.5x each generation. For the first 30 generations population growth is barely detectable; this is called the lag phase. After that, the species reaches a population threshold that allows for a rapid increase in the next ten generations – the exponential growth phase. Often a species is not recognized as invasive until it reaches the exponential phase, but by this point control is very difficult and eradication usually impossible. Gaining an advantage in controlling such species

may require taking action during the lag phase, rather than assuming that these species will not become invasive in the future. Recognizing invasive characteristics and taking action early in the invasion process will make control efforts more effective and less costly.

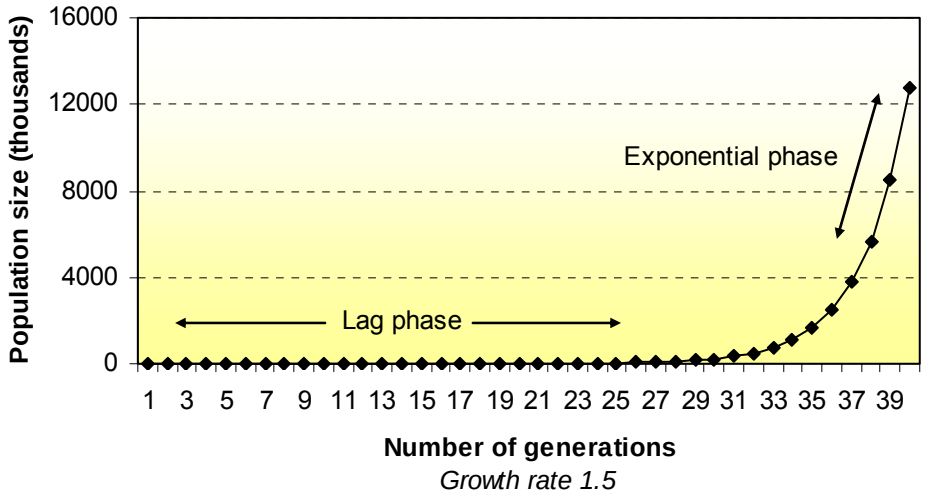


Figure 1. Population growth curve, illustrating the lag and exponential phases for a hypothetical population with a growth rate of 1.5x each generation. Population growth rates vary by species. A species with a growth rate higher than 1.5x (e.g., musk thistle, at 2.2x (Shea and Kelly 2004)) would have a shorter lag phase, and one with a lower growth rate (e.g., spotted knapweed, at 1.17x (Emery and Gross 2005)) would have a longer lag phase.

What impact have invasive species had on forestry?

Invasive insects and diseases have had a significant, negative impact on several commercially important tree species resulting in widespread mortality in some and a reduction in growth in others. Examples include the American chestnut (*Castanea dentata*), once one of the most abundant tree species in eastern U.S. hardwood forests and one of high economic importance. In the late 1800s, chestnut blight (a fungus) was accidentally introduced on nursery stock from Asia, and within 40 years, few chestnut trees remained. Although chestnut trees re-sprouted, the blight continues to attack the sprouts, preventing the tree from regaining its former status.

American elm (*Ulmus americana*) was once a major component of hardwood forests across the eastern half of the United States and a popular street tree in the eastern U.S. until the 1930s when an Asian fungus was introduced on European logs. The disease was spread by two beetle species, one European and one native, and by 1980 had killed the majority of elm trees.

Typical tree-lined street before Dutch elm disease (Green Bay, WI). Photo: WDNR

Gypsy moth (*Lymantria dispar*), originally from Europe, Asia, and North Africa, was accidentally released in Massachusetts in 1867 in a failed attempt to raise a hardy silkworm. The larvae now defoliate approximately one million acres of oak and aspen forest annually from Maine to Virginia, and west to Wisconsin. While gypsy moth has not caused significant mortality, it is an additional stressor that slows growth and often contributes to mortality in trees that have been weakened by previous defoliation, or other stressors such as drought.

Defoliation by gypsy moth. Photo by Mark Robinson

Invasive shrubs are among the most common invasive species in the Midwest. European buckthorns (*Rhamnus spp.*) spread aggressively once they are introduced and have been shown to alter soil ecology, making control and restoration of infested sites difficult (Heneghan et al. 2006). They form dense thickets that negatively impact the establishment of tree seedlings and make accessing infested sites difficult (Frappier et al. 2003, 2004). Non-native honeysuckles (*Lonicera spp.*) also spread rapidly and grow in dense thickets. Honeysuckle infestation reduces species richness and density in forest herbaceous communities and negatively impacts tree seedling establishment (Woods 1993, Hutchinson and Vankat 1997, Collier et al. 2002).

Other invasive species that attack trees include fungal diseases of white pine and butternut and an insect that periodically defoliates tamarack. These pests are among many that are now present in Lake States forests, and more are arriving.

Impacts on tree regeneration, growth, and longevity

Note the lack of tree seedlings and saplings in this garlic mustard-infested forest. Photo by J. Cardina

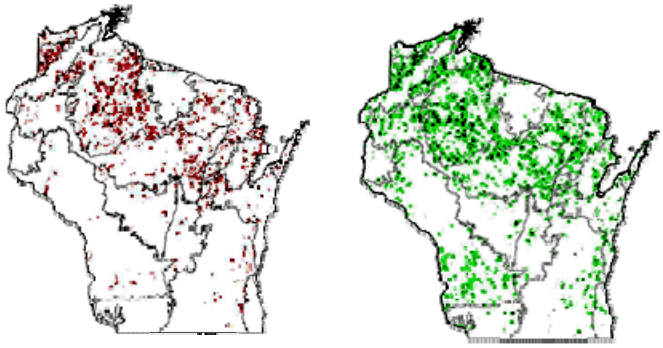
Some invasive species may impact forestry directly by reducing tree regeneration, growth, and longevity. For example, researchers have documented a reduction in the abundance, density, and richness of tree seedlings in areas infested with non-native honeysuckles (Gorchov and Trissell 2003, Collier et al. 2002, Hutchinson and Vankat 1997, Woods 1993). The invasive plant garlic mustard (*Alliaria petiolata*) appears to suppress tree regeneration by disrupting

beneficial associations between tree seedling roots and fungi (mycorrhizal associations), which may help explain its ability to invade undisturbed sites (Stinson et al. 2006). There is also evidence that other invasive species such as common buckthorn (*Rhamnus cathartica*) and non-native earthworms alter the chemistry of forest soils and consequently impact tree regeneration and growth (Bohlen et al. 2004, Heneghan et al. 2004, 2006).

Invasive vines such as Oriental bittersweet (*Celastrus orbiculatus*) can reduce the growth and longevity of desirable trees by shading the canopy, girdling branches and stems, and toppling them with their weight.

Invasive species may alter forest stewardship

Depending on the invasive species present, its abundance, site conditions, and other factors, a landowner's forest stewardship objectives may be affected. For example, emerald ash borer (EAB), an Asian wood-boring beetle that attacks ash trees, was found in Michigan in 2002. By fall 2008, it was found in 10 additional states, including Wisconsin. (For an up-to-date map showing EAB distribution go to www.emeraldashborer.info and click on 'Where is EAB'.) The borer has had a significant impact, causing mortality and the need for removal of non-infected ash to aid in slowing the spread. The borer is expected to spread throughout forested lands in Wisconsin, threatening all ash species. Consequently, forest composition objectives that include ash species are being revised. This is an extreme example of how the arrival of an invasive species can alter management plans.



(Left) **Black ash distribution and** (Right) **white and green ash distribution in WI based on 1996 Forest Inventory Analysis data.**
http://dnr.wi.gov/forestry/fh/ash/eab-impact.htm

Forestry practices can influence the spread of invasive species

Forest stewardship activities can create site conditions suitable for many opportunistic invasive species. These conditions can occur through site disturbance that exposes soil and creates a seedbed for invasive plants, or by releasing invasive species that are already present. Forest stewardship activities may also increase the likelihood of invasive propagules being accidentally introduced to a site.

Propagule (prŏp′ ə gyool) = Any reproductive structure or part of an organism that can grow independently of its parent source. In plants, this may be a fruit, seed, bud, tuber, root, stem with rooting structures, or shoot. In forest insects, this may be an egg, larva, pupa or adult. In forest diseases, this may be a spore, mycelial fragment (similar to roots), or a fruiting body.

What can foresters, landowners, and loggers do about invasive species?

- **Prevention–**An awareness of invasive species and an understanding of their mode of invasion are important aspects of planning.

- **Early Detection and Rapid Response–**Detecting new populations early and responding rapidly increases the likelihood of successful control while keeping costs down.

- **Control**–In many cases an invasive species may be too widespread and abundant to eradicate. In those cases, it may be cost-effective to slow the spread of the species through integrated control and management planning.

- **Monitoring**–The periodic inspection of target areas–travel corridors, access points, post-activity areas, areas with previously treated infestations–can lead to earlier detection and more successful treatment in the long run.

- **Restoration**–Invasive species are more likely to colonize sites that have been disturbed. The earlier a land manager can return the land to desirable vegetation, or find ways to minimize site disturbance, the less vulnerable a site will be to invasion.

How to use this Manual

This Manual provides Best Management Practices (BMPs) to aid in the management and control of invasive plants, insects, and diseases in Wisconsin forests. In addition to the specific BMPs, the document contains information to help the user work through a process of assessing the threats posed by invasive species, in order to plan and implement a management strategy.

The Manual is structured as in the following example:

→ **BMP Statement: Invasive species BMPs are in bold font and are set off from the body of the document with an arrow. These statements are intended to describe voluntary practices that may reduce the impact of invasive species.**

a. BMP Considerations are listed below the BMP Statement.
b. BMP Considerations were written to give more information about why the BMP is important.
c. BMP Considerations introduce items that could be used to address the BMP; they do not apply to every species or situation, and the user does not necessarily have to follow them to address the BMP (i.e., they are optional).
d. BMP Considerations may include details, suggestions, examples, and issues to consider about invasive species and applying the BMP.

A plant icon is used to identify BMP Statements or Considerations that apply to plants.

An insect icon is used to identify BMP Statements or Considerations that apply to invasive insects.

A microbe icon is used to identify BMP Statements or Considerations that apply to diseases (illustration from forestpathology.org).

If the BMP applies generally to all invasive species covered by this Manual, no icon is used.

Chapter 2: Elements of Invasive Species Management

Invasive species management programs across the country have widely incorporated several common elements (see headings below). These elements serve as the guiding principles of the National Invasive Species Management Plan http://www.invasivespeciesinfo.gov/council/nmp.shtml and form the basis for the USDA-Forest Service Invasive Species Program http://www.fs.fed.us/invasivespecies/.
These elements can help guide or inform landowners and land managers who are concerned about invasive species on their land.

Prevention

An effective, economical, and ecologically sound approach to managing invasive species is to prevent their introduction in the first place. This manual addresses practices that attempt to limit the introduction of invasive species to a site or stand. Other efforts beyond the scope of this manual are aimed at preventing species introduction into the U.S. or the state.

Landowners and land managers have limited resources to manage invasive species. Once a population becomes established, management can be expensive and, in many cases, eradication may be impossible. While it is still necessary to attempt to control the spread of established populations into non-infested areas, resources might be spent more efficiently on proactive management that focuses on prevention and early detection of new invasions.

Elements of invasive species prevention planning can include:

- Education and identification training
- Preventing the introduction of seeds/eggs/organisms into an area
- Early detection and eradication of small populations of invasive species
- Minimizing disturbance of desirable vegetation
- Building and maintaining healthy communities of native species to compete with invasive species
- Periodic inspection of high-risk areas such as access points, transportation corridors and disturbed or bare ground
- Managing stand density and growing conditions in forested stands
- Revegetating disturbed sites with desirable plants; where natives species are lacking
- Periodically evaluating the effectiveness of prevention planning

When planning projects that will disturb vegetation, it would be beneficial for landowners and land managers to consider invasive species management as a part of project decisions. Learn to recognize invasive plants, insects, and symptoms of disease, and consider how to rebuild or maintain healthy plant communities that will effectively compete with invasive species after the disturbance. Identify prevention practices and management needs at the onset of project planning.

Early Detection & Rapid Response

> *Even the best prevention efforts cannot stop all introductions. Early detection of incipient invasions and quick, coordinated responses are needed to eradicate or contain invasive species before they become too widespread and control becomes technically and/or financially impossible. Populations that are not addressed early may require costly ongoing control efforts.*
> -National Invasive Species Management Plan, 2001

It is widely agreed that exclusion is the most effective approach to the problem of invasive species. However, there is a similar consensus that in the current climate of trade and travel, more introductions are inevitable. Because the chances for eradication or control are greatest immediately after introduction, early detection and rapid response will be an important part of managing invasive species (Worall 2002).

Early detection, as applied to invasive species, is a comprehensive, integrated system of active or passive surveillance to find new populations of invasive species as early as possible, when eradication and control are still feasible and less costly. It may be targeted at: a) areas where introductions are likely such as access points and travel corridors, b) areas with high ecological value where impacts are likely to be significant, and c) vulnerable habitats or recently disturbed areas (Worall 2002).

Rapid response is a systematic effort to eradicate, control, or contain invasive species while the infestation is still localized. It may be implemented in response to new introductions or to isolated infestations of a previously established species. Preliminary assessment and subsequent monitoring may be part of the response. It is most effective when based on a plan organized in advance so that the response is rapid and efficient (Worall 2002).

Control

The site level eradication of some invasive populations is an attainable goal especially if new introductions are detected early. However, eradication may not be feasible when populations are large and pervasive. When limited resources or the degree of infestation preclude eradication, a more realistic management goal is to control the unwanted species by reducing their density and abundance to a level which, ideally, does not compromise the integrity of the ecosystem and allows native species to thrive. Control programs are usually ongoing and can include manual, mechanical, chemical, biological, and cultural components. Landowners and land managers should evaluate their site, the life cycle characteristics of the invasive species, and the best available science to determine which control method or combination of methods will be most effective and economical.

Employing a combination of prevention and control measures, e.g. pulling, cutting, targeted pesticide use, biological controls, and native species reintroduction, is an effective way for landowners and land managers to manage invasive species. This approach is often referred to as

integrated pest management (IPM). In the forest context, IPM can be defined as the maintenance of destructive agents (plants, insects, and diseases) at tolerable levels by the planned use of a variety of preventive, suppressive, or regulatory tactics and strategies that are ecologically and economically efficient and socially acceptable.

Where eradication of the invasive species is not realistic, control strategies must strike a balance between ecological impacts of allowing invasive species to spread and the economic realities of control measures. Not all control methods are practical, effective, economically feasible, or environmentally sound for application in forests. In forestry, control programs should be integrated in ways that maximize management objectives, while minimizing negative environmental impacts. Furthermore, control practices continue to develop based on ongoing research. It's recommended that landowners and land managers consult most recent science or contact a public or private forester to determine appropriate control measures.

Slowing the Spread of Invasive Species

Slowing the spread of invasive species, also known as containment, refers to the process or goal of containing an infestation within a defined geographical area. Where eradication is not feasible, containment to a defined area can be very effective at slowing the regional spread of an invasive species. Preventative measures and the early detection of new infestations spreading from a defined containment area are significant components in slowing the spread of invasive species. Steps must be taken to prevent spread and new infestations must be located early so control measures can be implemented quickly. Steps in a containment program may include inventory and prioritization of populations for treatment, restricting activities in certain areas or to certain times of year, minimizing travel through infested areas, inspecting clothing and equipment to minimize species transport, and locating and controlling new infestations promptly.

Reducing Impacts

If eradication, control, and containment methods fail to manage an infestation, the final option is to reduce the impact of invasive species on native species and the ecosystem. At this level the focus shifts from managing invasive species populations, to managing native species. Methods for reducing the impact of well-established and widespread invasive species on native systems can include: focusing control efforts to allow forest regeneration, translocating sensitive species to areas unaffected by the invasion, and manipulation of forest structure and composition, such as planting different species to fill gaps created by ash trees that could potentially be killed by emerald ash borer.

Monitoring

Monitoring is the periodic inspection of post-activity sites to detect new invasions and evaluate the success of pest management plans and control measures. These inspections can be integrated with other forest activities such as reforestation surveys. The early detection of new infestations

will make control measures more effective and may reduce costs. Monitoring will also indicate if control programs are effective.

Monitoring can be an informal process, or it can be highly formal. Most landowners and land managers will not need complex monitoring programs; monitoring should be kept as simple as possible to meet invasive species management objectives. A simple monitoring program will ensure that target areas are monitored, that information is useful, and may keep long-term control costs down by ensuring that new infestations are detected early. Landowners and land managers can simplify monitoring efforts by setting priorities, including identifying specific areas to visit and using a list of prioritized invasive species they are likely to encounter (CNAP 2000). Target areas can include areas that are susceptible to invasion, such as transportation corridors and recently disturbed areas, and/or previous infestations that have undergone control measures. Periodic visits to these areas will allow landowners and land managers to detect new invasions and assess the success of their control efforts.

Restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER 2004). Frequently, the ecosystem that requires restoration has been altered either by natural occurrences like wildfire, floods, or storms, or as the result of human activities, including the intentional or unintentional introduction of invasive species. In the simplest circumstances, restoration can consist of removing or modifying a specific disturbance, thereby allowing ecological processes to recover. In other circumstances, restoration may also require the deliberate reintroduction of native species that have been lost and the elimination or control of harmful, invasive non-native species to the extent possible (Smith 2005). Restoring native plant communities to a site that has been cleared of invasives may reduce the risk of future invasions and in the long run the need for active control.

Chapter 3: Management Planning

Property Planning

Property planning is a conceptual process that can be done for any property. Planning can consist of ideas and approaches that are never committed to paper, or can result in a detailed written document. Written plans are commonly used for larger properties that have more than one stand or management unit. They are required on most public lands and on private properties managed under accreditation or tax law programs (e.g. Sustainable Forestry Initiative, Forest Stewardship Council, or the Managed Forest Law.)

Property planning is a good way to identify long-term goals. It allows landowners to consider their reasons for owning land, the potential of the land to support different forest types and wildlife species, current and potential threats, and options for sustainably managing the property. Written property plans also provide a record of a landowner's wishes. An evaluation of the invasive species threat and the ways to reduce the impact of invasive species are among the important considerations that go into any property planning.

The BMPs and guidance in this section are intended to help foresters, landowners, and loggers consider ways to reduce the likelihood of invasive species introductions, mitigate the effects of invasive species that may arrive despite their best efforts, and manage species that are already present.

→ BMP 3.1: Include a strategy for managing invasive species.

Considerations:

An invasive species strategy includes some or all of the following elements, as appropriate:

a. Preventative measures to limit introductions of invasive species to the property. For examples see the section on Prevention in *Chapter 2: Elements of Invasive Species Management*.

b. Early detection of invasive species populations.

c. An assessment of invasive species threats. The threat assessment considers the impact of invasive species on land management objectives and options for responding to these threats.

d. Goals for controlling invasive species present on the property (e.g. slow spread, reduce abundance, eradicate).

e. Goals for reducing impacts of invasive species present on the property (e.g. reduce abundance of host species [for insects and diseases] or habitat [for plants], increase vegetative diversity, employ forest stewardship techniques that can be successful despite the presence of invasive species).

f. Methods for managing invasive species (e.g. manual, mechanical, chemical, biological, and cultural).

Activity Planning

Once established, many invasive species can increase as a result of even well-intentioned management activities. In many cases, however, skillful execution of routine management activities can help minimize or even reduce the threat of some invasive species. An *activity*, for purposes of this chapter, may include timber harvesting, site preparation, reforestation, prescribed burning, non-commercial practices, or in short – any practice that brings people and equipment into the forest or related habitats.

Activity planning, in some form, may occur on properties of all sizes and all types of ownerships. Activity plans may be written documents on larger public properties or on properties subject to third-party certification. However, in many cases, activity planning is performed informally by foresters, loggers, and/or landowners and not committed to paper. Recognizing that planning for these activities is accomplished in a variety of ways, the goal of this chapter is to identify a set of steps and considerations that managers and loggers can utilize in their practice to prevent or minimize the threat of invasive species.

Scouting to identify current invasive species infestations or invasions, evaluating the invasive species threat, and understanding and properly applying options for modifying the practice to reduce the impact of invasive species are important components of activity planning.

> Ideally, the primary responsibility for activity planning will be with foresters. Where loggers are working independently with landowners, their responsibility to communicate and plan successful projects should include the considerations outlined in BMPs 3.2-3.5. Forestry and logging professionals should be prepared to recommend additional management practices where needed. Ultimately, it will be the responsibility of landowners to dedicate necessary resources to complete those practices.

→ **BMP 3.2: Prior to implementing management activities, scout for and locate invasive species infestations, consistent with the scale and intensity of operations.**

Considerations:

Knowing which invasive species are present, and their location, is the first piece of information needed to evaluate threats. These are some steps to consider in scouting invasive species:

a. Integrate scouting for invasive species into normal stand inventory and monitoring.

b. The extent and intensity of scouting should be appropriate to the threat posed by invasive species in or likely to be in the area, and by the potential effect of the activities on the spread, release, or control of those species.

c. Scouting can occur both within and around the activity area.

d. Scouting for invasive plants should occur at likely introduction sites such as access points, landings, skid trails, recreational trails and campsites, and other disturbed areas.

e. Scouting for invasive insects and diseases should also occur at high-priority introduction sites such as landings, campsites, new plantings, and stands of dead/dying/stressed trees.

f. Scouting could also include conferring with forest health specialists or other resource managers to identify forest health threats or invasive plant, insect or disease infestations of concern in the area.

→ **BMP 3.3: Consider the need for action based on: 1) the degree of invasiveness; 2) severity of the current infestation; 3) amount of additional habitat or hosts at risk for invasion; 4) potential impacts; and, 5) feasibility of control with available methods and resources.**

Considerations:

A threat assessment is the next planning step after scouting for and locating invasive species, consistent with the scale and intensity of operations. Threats to forests and forestry operations are considered, and options for managing invasive species are identified.

a. Degree of invasiveness
   - Some invasive species are able to invade habitats and hosts rapidly. Species that reproduce frequently and in high numbers, mature quickly, and have multiple ways of dispersing tend to be more invasive. These species often pose a greater immediate threat than those with less invasive tendencies.

b. Severity of the current infestation
   - Areas with severe infestations will have a lower threat level than adjacent areas with little or no infestation. Project plans should minimize movement from infested to non-infested project areas.

c. Amount of additional habitat or hosts at risk

- On properties where an invasive species is present in only part of the area, or its arrival is imminent, the threat level will be higher if there is additional suitable habitat (for plants), or host species (for insects and diseases) that can be invaded.

d. Impacts of invasive species on forest stewardship objectives
   - Some invasive species have relatively low impacts on forests because they cannot tolerate forested conditions (e.g. shade), or the damage they cause is at a low level or temporary/cyclic. It may not be important to manage species such as these. Other species are extremely damaging to forests and can have severe economic and ecological consequences.

e. Feasibility of control
   - Controlling invasive species may be difficult and expensive. Consider control options and costs, as well as consequences and costs of not taking action. For species that do little damage, control may not be warranted. For large existing infestations, the level of effort required may be prohibitive. It is often more feasible to control small or intermediate infestations. For relatively small infestations of extremely damaging species, control is cost-effective in the long-term.

→ **BMP 3.4: Plan management activities to limit the potential for the introduction and spread of invasive species.**

Considerations:

Activity planning may include developing budgets, schedules, or forest stewardship/ silvicultural prescriptions. The planning phase is the time to consider whether special precautions for invasive species are needed and how they will affect the planned activity. The following BMP Considerations are examples of possible ways to address the BMP Statement.

a. Timing
   - Consider the need for invasive species control efforts, and determine whether planned control efforts should occur prior to, after, or concurrent with the activity.
   - If pre-treatment of invasive species is warranted, postpone activity until the infestation can be treated. Effective pre-treatments sometimes need to occur one to two years prior to the activity.
   - Consider practical seasonal timing options that minimize the risk of introducing or moving an invasive species.
   - An option is to choose not to carry out an activity where spread of invasive species is likely to jeopardize long-term productivity.

b. Cleaning
   - Cleaning of clothing, footwear, and equipment may limit the introduction and spread of invasive species; make prior arrangements for any cleaning that may be included with the activity. Consider the risks different types of equipment pose to introducing/spreading invasive species.

c. Boundaries
   - Set up activity boundaries to exclude areas infested with invasive species that could be moved by equipment and forest workers.

d. Scheduling
   - Consider options for the sequence of operations within the activity area and, where feasible, plan to enter areas infested with invasive species last.

e. Ground disturbance
   - Avoiding ground disturbance is one of the best prevention methods, but it is not always possible when carrying out forestry activities. However, one can plan to minimize soil disturbance.
   - Consider the impacts of different types of equipment and, where feasible, plan to use equipment that minimizes soil and vegetation disturbance.
   - Retain native vegetation in and around the activity area to the greatest extent possible.

f. Forest structure
   - Increased sunlight may create favorable conditions for some invasive plants. Forestry activities typically lead to forest canopy manipulation. However, where consistent with project objectives, activities may be planned to allow for the maximum retention of canopy cover and understory structure, in order to suppress or limit the establishment and growth of shade intolerant invasives.
   - Impacts of some forest insects and diseases can be mitigated through silvicultural prescriptions that increase tree vigor or change stand composition. Consider silvicultural treatments when they are known to be an effective strategy against these species.
   - Consider the potential of the activity itself to achieve control of invasive species (e.g. prescribed burning or logging with modifications to remove and treat dense invasive shrub layers). If feasible, incorporate control treatments into the activity plan.

g. Transport
   - Plan for a transportation system in the activity area that limits travel through areas infested with invasive species. Limit the transportation system to the minimum needed to meet project objectives.
   - Consider transport of products away from the activity area and limit the ways that invasive species in the activity area could move off-site. See also *Chapter 9: Transport of Woody Materials.*

→ **BMP 3.5: Plan for post-activity management of highly damaging invasive species.**

Considerations:

After the activity is completed, it may be necessary to monitor for invasive species and follow up with treatments.

a. Plan ahead to obtain resources for:
   - Monitoring the site following a management activity, checking for new infestations of invasive species, or the spread of existing populations.
   - Managing existing populations of invasive species.
   - Reforestation, revegetation, and/or restoration may be necessary depending on site conditions.

Chapter 4: Forest Stewardship

Forest stewardship activities are practices conducted in forests that represent long-term investments to produce a certain kind, or quality, of forest product. Forest stewardship includes timber harvesting and cultural practices.

Timber harvesting refers to the felling, skidding, on-site processing, and loading of raw products onto trucks. Harvesting usually provides an economic return, but is also an important tool foresters use to meet forest stewardship goals and objectives. Limiting the spread of invasive species can be an important consideration in timber harvest areas.

Cultural practices include site preparation, planting, pruning, and tending. These activities often lack an immediate economic return.

Site preparation is the creation of a favorable growing environment for tree seeds or seedlings. It is used to reduce competition from other vegetation. Site preparation can be accomplished by mechanical and/or chemical means and, occasionally, by prescribed burning. Often, an area disturbed for site preparation is conducive to the germination and establishment of invasive plants.

Pruning is the removal of a tree's side branches or multiple leaders. This wounding can attract certain insects, and they may carry diseases to the site.

Tending activities occur during the time period between stand origin and final harvest and may include improvement cutting, thinning, or pre-commercial release. These treatments remove undesirable trees, trees that are too crowded, or trees that have overtopped other, more desirable young trees. Tending activities generally occur as part of a timber harvest, but they can occur at other times as separate activities.

See *Chapter 3: Management Planning* for information on how to develop an Invasive Species Strategy for the site.

Whenever possible, and consistent with project scale and objectives, integrate the management of invasive species into standard silvicultural practices and regular work activities. When workers and equipment are already in the woods, they may have the capability to selectively remove invasive tree and shrub species or infected or susceptible trees.

Prior to activities:

→ **BMP 4.1: Provide training in identification of locally known invasive plants and pests to forest workers.**

→ **BMP 4.2: If pre- or post-activity control treatments are planned, ensure that they are applied within the appropriate time window.**

Considerations:

a. Consider life history of target invasive species in relation to timing of control methods and harvest (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

b. Allow enough time for control prior to activity; this may require a delayed harvest.

c. Allow time and resources for post-activity follow-up control measures, due to persistent seedbank and resprouting.

d. Consider scheduling harvest during time periods when trees are at a low risk of infection by disease and insects following wounding.

e. Consider the importance of timely removal of harvested material.

f. Since landowners and foresters are typically the individuals creating activity plans, they would be responsible for pre- or post-activity invasive species treatments.

→ **BMP 4.3: Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.**

Considerations for soil disturbance:

a. Ground disturbance can uproot existing vegetation and expose soil, creating a seedbed where invasive plants may become established or expand their numbers. This may result in overwhelming competition for native vegetation and desirable trees.

b. Before conducting scarification, roller chopping, tilling, installing plow lines for prescribed burning, or other activities that expose soil, consider the invasive plant species present on the site and the potential for other species to arrive. If there is a seedbank of invasive plants, or if seed-producing individuals are nearby, control measures may be warranted.

c. If soil disturbance is necessary to aid in germination and establishment of some tree seedlings, it should not extend beyond the area where regeneration is desired.

d. Soil disturbance may be used as an invasive species control strategy in infested areas by depleting the seedbank and employing aggressive follow-up control measures.

e. After a soil disturbance activity, encourage prompt regeneration of new trees or other desirable vegetation to rapidly close the time window during which conditions are favorable for invasive plant establishment.

f. Retain native vegetation in and around the activity area to the extent possible.

g. Inspecting areas at highest risk of invasion following soil disturbance activities may help to detect new invasions.

Considerations for canopy manipulation:

h. Achieving forest stewardship objectives often requires opening the canopy; however, many invasive plants are stimulated when additional light becomes available. Maintaining shade may keep these species from expanding to a point where they out-compete native trees and other vegetation.

i. Consider conducting control treatments in advance of opening the canopy to reduce the impacts of invasive plant species that are present on-site or that hold potential for invasion.

j. To limit loss of site productivity due to invasive plants, consider alternatives to complete and rapid canopy opening such as selection harvests spread over several years (resulting in more gradual canopy opening). Consider deferring canopy opening altogether in a heavily infested or vulnerable area.

k. Canopy opening, sometimes combined with soil disturbance, may be used as an invasive species control strategy in infested areas by depleting the seedbank and employing aggressive follow-up control measures.

l. After a canopy-opening activity, encourage prompt regeneration of new trees or other desirable vegetation to rapidly close the time window during which conditions are favorable for invasive plant establishment.

m. Note that some tree foliage diseases are exacerbated by heavy canopy cover, such as anthracnose.

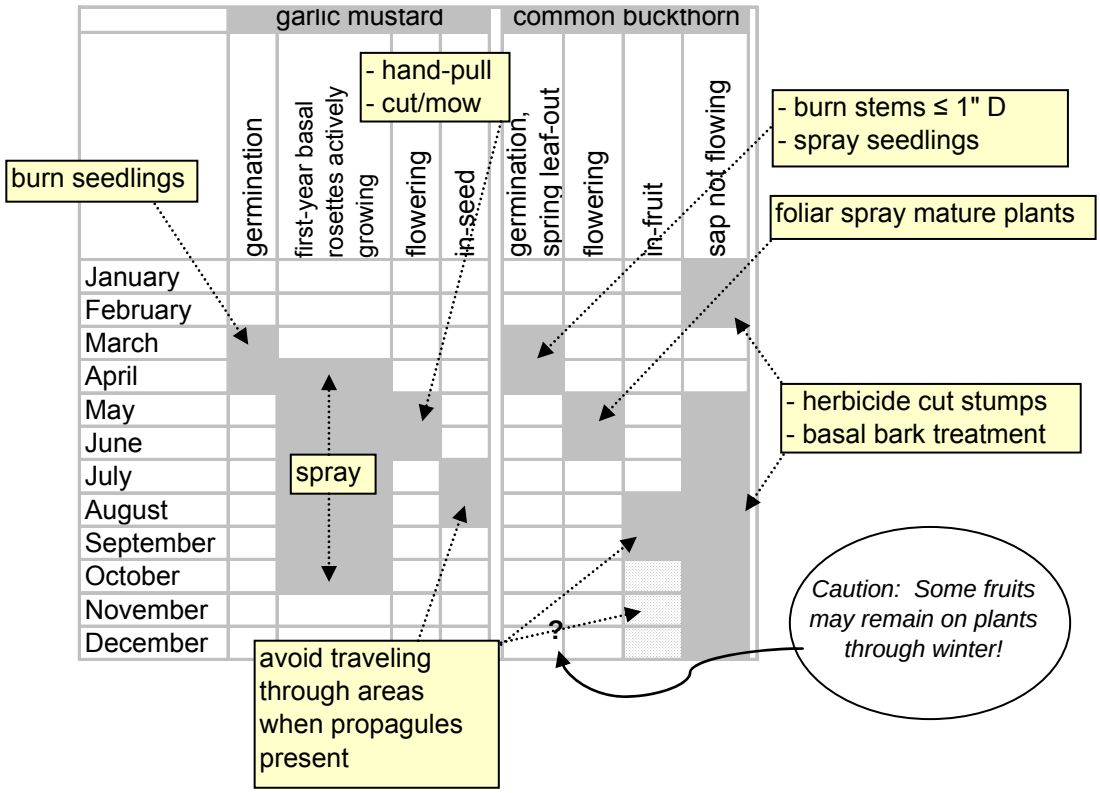


Figure 2: Identifying time windows for invasives species management. The goal of this chart is to present basic planning concepts. For more detailed information on species-specific control, see Appendix G at http://council.wisconsinforestry.org/.

During activities:

Close coordination between landowners, foresters, and loggers will be especially important in effectively and reasonably applying BMPs 4.5 and 4.6. The Considerations listed in these BMPs are a menu of possible choices. Practitioners may select one or more practices as based on these Considerations in planning an activity.

Equipment cleaning

Invasive species can spread by equipment used in forestry activities and by forest workers. Within the context of this chapter, *equipment* refers to off-road, rubber-tired and tracked equipment, including logging skidders, forwarders and processors, as well as dozers, graders, and other construction equipment. Plant propagules and fungal spores in soil or mud can be transported on equipment, as can insects in all life stages. Invasive species can also be moved by boots, clothing, tools, and on the undercarriages of vehicles.

→ **BMP 4.4: Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.**

> **Propagule** (prŏp′ ə gyool) = Any reproductive structure or part of an organism that can grow independently of its parent source. In plants, this may be a fruit, seed, bud, tuber, root, stem with rooting structures, or shoot. In forest insects, this may be an egg, larva, pupa or adult. In forest diseases, this may be a spore, mycelial fragment (similar to roots), or a fruiting body.

Considerations:

a. Foresters, landowners, and loggers may agree to additional cleaning methods.

b. Preferred locations for cleaning equipment areas are those where:
   - Monitoring can be conducted at a later date, perhaps in conjunction with post-harvest visits. See *Chapter 2: Elements of Invasive Species Management* for guidance on monitoring for invasives.
   - Equipment is unloaded and loaded.
   - Invasives are less likely to spread from cleaned equipment.
   - Invasive species are already established

c. Equipment with the ability to run fans in reverse should use this feature to clean air intakes. Fans and air intakes can harbor plant materials and insects. Reversing the fan direction and blowing loose material out of equipment before leaving a site can reduce the likelihood of moving species to another site. Heat exhausted from the engine when fans are reversed may kill some insects and plant parts.

d. In areas where invasive species are present, it is a good practice to routinely remove soil, seeds, vegetative matter, or other debris from shoes, clothing, and tools.

e. To reduce need for equipment cleaning, carry out work under conditions that minimize the risk of spread, e.g., frozen ground, snow cover, seed/propagule absence, etc. (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

→ **BMP 4.5: Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas, during forest stewardship activities.**

Considerations:

a. To minimize movement of invasive species propagules, consider excluding infested areas from equipment travel corridors.

b. Carry out work under conditions that minimize the risk of spread, e.g., frozen ground, snow cover, seed/propagule absence, etc. (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

c. Clean equipment (see BMP 4.4) when moving from infested areas to non-infested areas to reduce the likelihood of spread.

d. Pre-designate landings to avoid yarding products from infested areas across non-infested areas.

e. Pre-designate skid and haul trails to minimize equipment travel from infested areas to non-infested areas. See also *Chapter 5: Forest Access*.

f. Harvest and skid in non-infested areas first.

g. Consider scheduling harvest during time periods when trees are at a low risk of infection by disease and insects following wounding.

→ **BMP 4.6: Take reasonable steps to avoid traveling through or working in small, isolated, populations of invasives during forest stewardship activities.**

Considerations:

a. Avoidance is an effective way of slowing the spread of invasive species from isolated satellite populations.

b. Areas of avoidance should generally be designated prior to the activity.

c. To minimize movement of invasive species propagules, consider excluding infested areas from equipment travel corridors.

d. Clean equipment when moving from infested areas to non-infested areas to reduce the likelihood of spread. See also BMP 4.4 and *Chapter 5: Forest Access*.

e. Removal of affected trees is prescribed for some pest issues.

Chapter 5: Forest Access

Forest access roads occupy a relatively narrow strip of land, often composing a network of passageways that provide access into remote reaches of forested landscapes. Many different types of forest access roads exist, though commonly the majority of roads fall within three categories. They include temporary roads, permanent seasonal roads, and permanent all-season forest roads. Skid trails and landings will also be considered in this chapter.

Temporary roads are designed and constructed for short-term use. Often a temporary road is needed for direct timber harvest access, wildland firefighting, or a specific project. Temporary roads are commonly closed, gated, or bermed after use and artificially or naturally revegetated.

Permanent seasonal roads, also known as permanent secondary roads, are maintained as part of a permanent road system, but are typically narrower and are built to lower engineering standards. Secondary roads may also be restricted to use only when the ground is frozen or firm to prevent rutting or damage to the road base.

Permanent all-season forest roads, also known as permanent primary roads, are the most improved and are constructed and maintained for year-round use. They are vital avenues of a forest transportation system and are often graveled and routinely repaired.

Skid trails are another type of forest access important to consider with invasive species planning. Skid trails provide forestry equipment quick access to felled timber for the immediate aim of transporting logs to a landing.

Landings are where products are sorted and loaded onto trucks; they may be permanent or temporary. Even the short-term use of skid trails and landings by forestry equipment removes vegetation and presents invasive species with the opportunity to colonize areas of bare soil.

Forest stewardship activities rely on the construction and maintenance of roads, skid trails, and landings to provide access to management areas. These access points may facilitate the spread of invasive species by altering habitat conditions, stressing or removing native species, and allowing easier movement of animals and humans into the forest. The Best Management Practices in this chapter refer to existing or new, private or public, forest access roads, skid trails, and landings constructed for the purpose of forest stewardship.

→ **BMP 5.1: To the extent practical, use existing roads, skid trails, and landings to reduce disturbance.**

Considerations:

a. Treatment of existing infestations on roads, skid trails, and landings may help prevent further spread.

b. Consider future uses of the road system, particularly if invasives are present.

c. Coordinate development of accesses with adjacent landowners when possible.

→ **BMP 5.2: Avoid constructing new roads, skid trails, and landings in areas infested with invasive species where possible.**

Considerations:

a. Survey potential routes for invasives during the growing season.

b. Limit the number, width, and length of roads, skid trails, and landings to help minimize soil disturbance and to limit the risk of unintentionally transporting invasives into non-infested areas.

c. Use existing infrastructure that is free of invasive species when possible.

→ **BMP 5.3 Avoid spreading seeds and other propagules from infested to non-infested areas during road maintenance, reconstruction, new construction, and closure.**

Note: BMP 4.4: Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.

Propagule (prŏp′ ə gyool) = Any reproductive structure or part of an organism that can grow independently of its parent source. In plants, this may be a fruit, seed, bud, tuber, root, stem with rooting structures, or shoot. In forest insects, this may be an egg, larva, pupa or adult. In forest diseases, this may be a spore, mycelial fragment (similar to roots), or a fruiting body.

Considerations:

a. For new road, trail or landing construction, survey potential routes for invasives during the growing season.

b. Treat infestations on roads, skid trails, and landings before activities begin.

c. In areas where infestations are present, consider road closures, either permanent (bearing in mind that the use of existing infrastructure is encouraged) or temporary (to avoid activities when propagules are present or to allow for pre-activity control measures).

d. Limit the spread of existing populations by performing road maintenance from non-infested to infested areas.

e. Carry out activities under conditions that minimize the risk of spread, e.g., frozen ground, snow cover, seed/propagule absence, etc. (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

f. Clean equipment after operations in infested areas.

g. Run equipment air intake fans in reverse when moving from infested to non-infested areas.

h. Check non-infested areas for new invasions where road work has taken place 1-2 years after the activity.

i. For road, trail or landing closures, erect a barrier such as a gate, berm, or boulders; and post "Closed" signs stating the length of time and/or reason for closure, and invite acceptable uses, to encourage compliance.

→ **BMP 5.4: Where site conditions permit, allow natural revegetation of the roads, skid trails, and landings to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation.**

Note:	BMP 6.2: Revegetate or reforest as quickly as feasible after site disturbance. BMP 6.3: When consistent with site conditions and goals, allow natural revegetation of the ground layer to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation.

Considerations:

a. Revegetate roads that will not receive continued motorized use, i.e., temporary roads, skid trails, and landings.

b. In areas where invasive species are known to be in the seed bank, it may be necessary to treat invasives before revegetating.

c. A non-persistent cover crop, such as annual rye or oats, can be used to temporarily and rapidly stabilize the soil, discourage the establishment of invasive species, and allow native species to re-colonize. In some situations, annual crops may not be competitive with invasives and more persistent non-invasive plant materials would be preferred.

d. Do not plant invasive species. (See Table 1).

e. Use weed-free, locally appropriate seed mixes where available. (A list of nurseries that carry native plant material is available on the DNR's website http://dnr.wi.gov/org/land/er/plants/nurseries.htm).

f. Fertilizer should not be used when revegetating with native plant species. Native plants do not need additional nutrients; the fertilizer may encourage the growth of invasives and other weed species.

g. Use weed-free mulch where available. Be aware "Marsh hay" may contain reed canary grass, for example.

h. Monitor newly revegetated areas for highly damaging invasive species and treat as necessary.

Table 1: Do not use these species for roadside plantings. Many previously recommended species are now presenting invasive problems. For species recommended for revegetation see Appendix H at http://council.wisconsinforestry.org/.

Common Name	**Latin Name**
creeping bent grass	*Agrostis palustris*
smooth brome grass	*Bromus inermis*
crown vetch	*Coronilla varia*
quack grass	*Elytrigia repens*
tall fescue	*Festuca arundinacea*
flat pea	*Lathyrus sylvestris*
Chinese lespedeza	*Lespedeza cuneata*
bird's foot trefoil	*Lotus corniculatus*
big leaf lupine	*Lupinus polyphyllus*
reed canary grass	*Phalaris arundinacea*

→ **BMP 5.5: Ensure, to the extent practical, that fill and gravel are free of invasive species and their propagules.**

Considerations:

a. Keep stockpiled material free of invasive species.

b. Avoid infested source material, or treat it to remove invasive species prior to use.

Chapter 6: Reforestation and Revegetation

Reforestation is the reestablishment of forest cover either naturally (e.g., natural seeding, coppice, root suckers) or artificially (e.g., direct seeding or planting).

Invasive species can interfere with reforestation efforts by limiting regeneration success through direct competition for resources or by altering ecological interactions. For example, garlic mustard has been found to release a chemical that attacks a fungus on which tree roots depend for nutrient uptake (Stinson et al. 2006).

The use of accepted methods for successfully establishing the desired vegetation is important for quick forest establishment and not inadvertently encouraging invasives. Wisconsin Management Guidelines (PUB-FR-226 2003), which can be found at http://www.dnr.state.wi.us/forestry/publications/Guidelines/toc.htm, discusses methods for reforestation in Chapter 15 including: planting, seedling care and handling, root pruning and culling, machine and hand planting, transporting, seedling storage, direct seeding, and reforestation aids.

Revegetation is the reestablishment and development of vegetation. The purpose of revegetation is to provide ground cover with desirable species, as quickly as possible, in the hopes of discouraging establishment by invasive species.

Revegetation can be temporary or permanent depending on site conditions and goals. Temporary revegetation with a short-lived cover crop may be the goal when it's thought that native vegetation will recapture an area in a relatively short time. Permanent revegetation with native species may be the goal when little or no desirable vegetation is nearby to colonize the disturbed ground. Of course, temporary and permanent cover can be used in conjunction with each other. Often times a short-lived cover crop like annual rye is planted to quickly occupy disturbed ground and act as a nurse crop while a permanent cover is establishing.

→ BMP 6.1: Limit the introduction and spread of invasives during reforestation or revegetation site preparation activities.

Site preparation methods should be determined by site conditions, silvicultural requirements of the target tree species, and site preparation objectives (WDNR 2003). Site preparation can be accomplished by mechanical methods, chemical methods and/or prescribed burning. Often these methods are used in conjunction to control competing vegetation. Mechanical site preparation can include scarification, roller chopping, disking, tilling, and raking.

Most site preparation methods involve disturbing the soil bed by removing existing vegetation and exposing soil to create a favorable growing environment for trees or other

desirable vegetation. It is important to keep in mind that site preparation methods will create conditions favorable to invasive plants as well. New invasive species may become

> **Note:** BMP 4.4: Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.

established and existing populations may expand.

Considerations:

a. In areas where invasive species are known to be present, including in the seed bank, it may be necessary to treat invasives as part of the site preparation process. Keep in mind it is almost always easier to treat invasives before an area is planted to its desired vegetation.

b. Time site preparation activities to avoid spreading invasive seeds and other propagules. (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

c. While ground disturbance is necessary to aid in germination and establishment of desirable vegetation, it should not extend beyond the area where reforestation or revegetation is desired.

d. Consider targeted approaches (patch or row scarification) if broadcast mechanical site preparation is likely to spread infestations or initiate infestations (WDNR 2003).

e. Spot application of herbicides may reduce the impact to non-target plants.

f. Avoid damaging branches, stems, or roots of any standing trees during mechanical site preparation.

g. Retain native vegetation in and around the activity area to the extent possible (Clark 2003).

→ **BMP 6.2: Revegetate or reforest as quickly as feasible after site disturbance. (See also BMP 5.4)**

Considerations:

a. The time window from the end of logging to site preparation to reforestation or revegetation has the highest likelihood of invasive species colonizing disturbed soil (Clark 2003).

b. Getting planted materials into the ground before invasives are established gives them the best chance for survival.

c. Keep in mind that thorough site preparation should not be sacrificed to plant quickly. Sites that are not properly prepped for planting will more likely have problems with competing vegetation and thus not be as successful.

→ **BMP 6.3: When consistent with site conditions and goals, allow natural revegetation of the ground layer to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation. (See also BMP 5.4)**

Natural revegetation is most likely to occur when a site is free of invasive species and is surrounded by native plants ready to occupy bare soil. Natural revegetation is not likely to occur in areas with continued disturbance, during drought conditions, or when desirable native vegetation is not present. Nor is it likely to be successful in a timely manner on dry sites due to lack of moisture and limited seed set.

Considerations:

a. A non-persistent cover crop, such as annual rye or oats, can be used to temporarily and rapidly stabilize the soil, discourage the establishment of invasive species, and allow native species to re-colonize. In some situations, annual crops may not be competitive with invasives and more persistent non-invasive plant materials would be preferred.

b. In areas where invasive species are known to be in the seed bank, it may be necessary to treat invasives before revegetating.

c. Use weed-free, locally appropriate seed mixes where available. (A list of nurseries that carry native plants and seeds is available on the WI DNR's website http://dnr.wi.gov/org/land/er/plants/nurseries.htm.)

d. Fertilizer should not be used when revegetating with native plant species. Native plants do not need additional nutrients; the fertilizer may encourage the growth of invasives and other weed species.

e. Use weed-free mulch where available. Be aware "Marsh hay" may contain reed canary grass, for example.

f. Monitor newly revegetated areas for highly damaging invasive species and treat as necessary.

→ **BMP 6.4: Select plant materials that are site appropriate to favor establishment and vigor.**

Considerations for reforestation:

a. Healthy trees endure infestation and infection better than stressed trees.

b. Use plant materials from local sources of known, regional adaptation. (Plant materials may be available from other areas of a species' geographic range with greater growth potential and similar adaptation.)

c. Use native or non-invasive non-natives.

d. Plant a diversity of tree species where possible (WDNR 2003).

e. Examine stock before planting—be sure it is not diseased or infested with insects. (Note: It is not common for stock to be diseased. However, a disease like gall rust could easily be identified, and those plants could be culled.)

f. Recognize that non-native earthworms and invasive plant propagules may inhabit containerized stock.

Considerations for revegetation:

g. Use weed-free, locally appropriate seed mixes where available. (A list of nurseries that carry native plants and seeds is available on the WI DNR's website http://dnr.wi.gov/org/land/er/plants/nurseries.htm.)

h. Use locally sourced seed if available, because it will be best adapted to the local environmental conditions.

i. Select plant materials that would be competitive with invasive species should they occur.

→ **BMP 6.5: Plan for post-planting management of invasive species (See also BMP 3.5).**

Considerations:

a. After reforestation or revegetation activity, monitor for and treat new or expanded invasive plant infestations (WDNR 2003).

b. Where feasible or practical, manage existing populations of invasive insects and diseases (See Appendix G at http://council.wisconsinforestry.org/.)

c. Consider the following actions if you have a heavy infestation of invasive species: plant tree species that can be broadcast sprayed with herbicides to kill competing vegetation, including invasive plants, without killing the tree; plant species (e.g. oaks) that can tolerate prescribed burning to control competing vegetation; plant trees that are already large enough to overtop and out-compete invasive plants.

Chapter 7: Wildlife Habitat Management

Many working forests throughout Wisconsin are also managed for wildlife habitat. In addition to providing important food and shelter for our State's wildlife, this habitat also provides valued opportunities for humans, including wildlife viewing and hunting.

This chapter addresses forest stewardship practices that are undertaken to enhance wildlife habitat within forests that are also being managed for timber production. Guidelines in this chapter are similar to those found elsewhere in the document, but are assembled here to provide a condensed set of BMPs that apply to the activities of land managers whose objective is wildlife management.

Forest stewardship that incorporates wildlife objectives may employ the following practices, depending on the wildlife species desired:

- Creating and maintaining wildlife openings.
- Planting tree species that enhance wildlife habitat for food, forage, nesting sites, cover.
- Selective removal of trees that are less valuable for the desired wildlife species, while retaining tree species or growth forms that benefit them.
- Retaining snag and den trees and live trees that may become future snags or den trees.
- Creating patches of early-successional forest (e.g., aspen, paper birch) through even-aged management.
- Manipulating stand structure during timber harvest (e.g., creating forest gaps in northern hardwoods for gap-associated songbirds, reducing density in oak forests to favor savanna associates).

The many different kinds of wildlife found in Wisconsin use a variety of habitats, including small isolated openings, large unbroken patches of forest, dense conifer thickets, savanna-like oak stands of low tree density, and homogeneous habitats (e.g., plantations) that contain a high amount of edge. Some of these habitats are inherently more susceptible to invasive species than others, particularly where forest edge habitat is extensive, and where intensive maintenance activities are required. Sunny forest edges favor germination of invasive plants, providing a pathway for them to spread to the interior of a stand. Intensive maintenance activities, such as mowing wildlife openings, present another potential risk for invasive species to be introduced on machinery.

If forest stands are small and isolated, if management practices promote extensive habitat edge, or if intensive management is required to maintain habitat, a land manager must carefully consider the risks of invasive species along with the benefits to wildlife, and develop long-term management strategies accordingly.

See *Chapter 3: Management Planning* for information on how to develop an Invasive Species Strategy for the site. Whenever possible, and consistent with project scale and objectives, integrate the management of invasive species into standard wildlife habitat management practices.

Note: It is not within the purview of this manual to address the recreational aspects of forest wildlife habitat management *vis-à-vis* invasive species.

→ **BMP 7.1: Provide training in identification of locally known invasive plants and pests to land managers whose objective is wildlife management.**

→ **BMP 7.2: Select non-invasive species for seed mixes and plant materials used in wildlife habitat projects. (See also *Chapter 6: Reforestation and Revegetation*.)**

Considerations specific to wildlife management:

a. Select native plant species whenever possible for habitat plantings.

b. Be a cautious consumer of new non-native species, whose invasive potential is currently unknown. For example, some non-native oak and hickory species are promoted for mast, but native genotypes may reduce the risk of introducing a potentially invasive new species.

c. Do not plant invasive species. Be aware of invasive species that were promoted historically for wildlife habitat projects; examples include: autumn olive and non-native bush honeysuckles.

> **Good Practice:** When working in areas where invasive species are present, habitat managers should routinely remove soil, seeds, vegetative matter, or other debris from shoes, clothing, and tools.

→**BMP 7.3: If invasive tree or brush removal is planned, ensure that it is applied within the appropriate time window such that introduction and spread of invasive species is limited.**

Considerations:

a. For removal of invasive trees, shrubs, and herbs, consider life history of target species in relation to timing of control methods and harvest (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

b. Allow time and resources for post-activity follow-up control measures, due to persistent seedbank and resprouting.

→**BMP 7.4: If desirable (i.e. native or non-invasive) tree or brush removal is planned as part of habitat enhancement, ensure that it is applied within the appropriate time window such that introduction and spread of invasive species is limited.**

Considerations:

a. Schedule harvest during time periods when trees are at a low risk of infection by disease and insects following wounding. (See Appendix G at http://council.wisconsinforestry.org/.)

> **Forest Access:** Trails and roads may be created through forested habitats for the benefits of land managers or recreational users. These access points may facilitate the spread of invasive species by altering habitat conditions, stressing or removing native species, and allowing easier movement of animals and humans into the forest. See *Chapter 5: Forest Access* for pertinent BMPs and considerations.

Equipment cleaning

Invasive species can spread by equipment used in wildlife habitat management activities. Within the context of this chapter, *equipment* refers to off-road, rubber-tired and tracked equipment, such as tractors used for wildlife opening maintenance**.** Plant propagules and fungal spores in soil or mud can be transported on equipment, as can insects in all life stages. Invasive species can also be moved by boots, clothing, tools, and on the undercarriages of vehicles.

→ **BMP 7.5: Prior to moving equipment onto and off of a management unit, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.**

> **Propagule** (prŏp′ ə gyool) = Any reproductive structure or part of an organism that can grow independently of its parent source. In plants, this may be a fruit, seed, bud, tuber, root, stem with rooting structures, or shoot. In forest insects, this may be an egg, larva, pupa or adult. In forest diseases, this may be a spore, mycelial fragment (similar to roots), or a fruiting body.

Considerations:

a. Foresters, landowners, and loggers may agree to additional cleaning methods.

b. Preferred locations for cleaning equipment area are those where:
   - Monitoring can be conducted at a later date, perhaps in conjunction with post-harvest visits. See *Chapter 2: Elements of Invasive Species Management* for guidance on monitoring for invasives.
   - Equipment is unloaded and loaded.
   - Invasives are less likely to spread from cleaned equipment.
   - Invasive species are already established.

c. Equipment with the ability to run fans in reverse should use this feature to clean air intakes. Fans and air intakes can harbor plant materials and insects. Reversing the fan direction and blowing loose material out of equipment before leaving a site can reduce the likelihood of moving species to another site. Heat exhausted from the engine when fans are reversed may kill some insects and plant parts.

d. In areas where invasive species are present, it is a good practice to routinely remove soil, seeds, vegetative matter, or other debris from shoes, clothing, and tools.

e. To reduce need for equipment cleaning, carry out work under conditions that minimize the risk of spread, e.g., frozen ground, snow cover, seed/propagule absence, etc. (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

→ **BMP 7.6: Take steps to minimize the movement of invasive plants, insects, and diseases to non-infested areas during habitat maintenance activities.**

Considerations:

a. To minimize movement of invasive species propagules, consider excluding infested areas from maintenance equipment travel corridors.

b. Carry out work under conditions that minimize the risk of spread, e.g., frozen ground, snow cover, seed/propagule absence, etc. (See Figure 2 in Chapter 4 and Appendix G at http://council.wisconsinforestry.org/.)

c. Clean equipment (See BMP 7.5) when moving from infested areas to non-infested areas to reduce the likelihood of spread.

Prescribed Fire: Prescribed fire is utilized in wildlife habitat management for a number of reasons: for invasive species control, site preparation for planting or seeding, land conversion to a historical fire regime, site maintenance (e.g., prairie grass burns) and for site composition management (e.g., limiting succession of oak woodland to maple/basswood). See *Chapter 8: Fire Management* for pertinent BMPs and considerations.

→ **BMP 7.7: Consider the likely response of invasive species or target species when prescribing activities that result in soil disturbance or increased sunlight.**

Considerations for soil disturbance:

a. Ground disturbance can uproot existing vegetation and expose soil, creating a seedbed where invasive plants may become established or expand their numbers. This may result in overwhelming competition for native vegetation and desirable trees.

b. Before conducting tilling, installing plow lines for prescribed burning, or other activities that expose soil, consider the invasive plant species present on the site and the potential for other species to arrive. If there is a seedbank of invasive plants, or if seed-producing individuals are nearby, control measures may be warranted.

c. Soil disturbance may be used as an invasive species control strategy in infested areas by depleting the seedbank and employing aggressive follow-up control measures.

d. After a soil disturbance activity, encourage prompt regeneration of new trees or other desirable vegetation to rapidly close the time window during which conditions are favorable for invasive plant establishment.

e. Retain native vegetation in and around the activity area to the extent possible (Clark 2003).

f. After a soil-disturbing activity, monitor the area and treat new invasive plant infestations.

Considerations for canopy manipulation:

Achieving forest wildlife habitat management objectives often requires opening the canopy. Some common timber harvest techniques that promote canopy opening include clearcuts, shelterwood cuts, patch cuts for wildlife openings, and increasing habitat edge. Many invasive plants, however, are stimulated when additional light becomes available and may gain pathways to forest interiors via establishment in openings or along edges.

g. Consider conducting control treatments in advance of opening the canopy to reduce the impacts of invasive plant species that are present on-site or that hold potential for invasion.

h. Consider deferring canopy openings altogether in a heavily infested or vulnerable area.

i. Opening the canopy, sometimes combined with soil disturbance, may be used as an invasive species control strategy in infested areas by depleting the seedbank and employing aggressive follow-up control measures.

j. After a canopy-opening activity, encourage prompt regeneration of new trees or other desirable vegetation to rapidly close the time window during which conditions are favorable for invasive plant establishment.

k. Note that some tree foliage diseases are exacerbated by heavy canopy cover, such as anthracnose.

Chapter 8: Fire Management

Due to the nature of wildfire, it is recognized that restricting the spread of invasive species may not always be possible. Life safety, property, and resources shall remain the priorities (in that order) for wildfire suppression.

However, the management of invasive species should be integrated into standard prescribed fire practices whenever consistent with project scale and objectives.

Prescribed fire is utilized in forestry practices for a number of reasons: invasive species control, site preparation for tree planting or direct seeding, land conversion to a historical fire regime, site composition management (e.g. under burning in oak stands to set back red maple growth), and reducing fuel accumulations to prevent wildfires. Prescribed fire can be an effective and less costly management tool.

When utilizing prescribed fire for forest stewardship practices, consider the use of the Fire Effects Information System website (http://www.fs.fed.us/database/feis/). This website offers information regarding how various animal and plant species, including invasive plants, react to fire. It also contains information regarding what intensity of fire is best for the management of these species.

Another website that may be useful in deciding whether prescribed fire is a viable management technique is The Nature Conservancy's Global Invasive Species Team website (http://tncweeds.ucdavis.edu/esadocs.html). The website features Invasive Plant Species Summaries which give information regarding the management of various invasive species.

Always rely on trained personnel to plan and implement prescribed burns. Before conducting prescribed burns, obtain a burning permit from the Wisconsin Department of Natural Resources (DNR) or your local municipal or township authorities.

Pre-fire, Pre-incident Training:

→ **BMP 8.1: Incorporate invasive species awareness, identification, and prevention education into fire training (e.g. fire effects and prescribed fire training).**

Prescribed Fire:

→ **BMP 8.2: Avoid placing fire breaks in infestations of invasive species.**

Considerations:

a. Preplanning:
   - Conduct a property survey for invasive plant species in and outside of the burn unit near the planned fire break.
   - Incorporate invasive species information into pre prescribed burn briefings.
   - Before moving equipment from the maintenance building/garage to the burn site remove invasive species and their propagules.

b. Location:
   - Fire break construction (by mowing, plowing, or hand line) can spread invasives.
   - Locate fire breaks to limit the potential to spread invasive species.
   - If invasive species are present that are damaged or killed by fire, incorporate the area of infestation into the burn unit when feasible.
   - If invasive species are present that are promoted by fire, exclude the area of infestation from the burn unit when feasible.

c. Fire break type:
   - Utilize existing natural and man-made breaks (lakes, streams, roads, trails, etc.) when possible.
   - If invasive species are present consider utilizing a fire break type that restricts the spread of the infestation (i.e. mowed vs. mineral soil).

d. Construction
   - Time the mowing of fire breaks to avoid the spread of invasive species. For example, mow before plants have seed heads.
   - Construct firebreaks only deep enough and wide enough to control the spread of the fire (WDNR 2003).

→ **BMP 8.3: Incorporate invasive species considerations into the planning of prescribed burns. (See also *Chapter 3: Management Planning*).**

Considerations:

a. If an invasive species is present that is sensitive to fire, consider timing and conditions of the fire to maximize control. For example, burning buckthorn in early spring when plant

carbohydrate stores are at their lowest may kill buckthorn seedlings and saplings or reduce resprouting vigor in older plants.

b. If an invasive species is present that is promoted by fire, consider a different management technique or plan follow up invasive control measures. For example, burns may stimulate the germination of buckthorn seeds. Follow up treatments (e.g. herbicide) should then be used to kill the established seedlings. Planning for this response and follow up can be used as a technique for depleting the seedbank of invasive plant seeds.

c. See Appendix A for an overview of control methods and Appendix G at http://council.wisconsinforestry.org/ for a list of highly invasive plant species.

→ **BMP 8.4: Avoid spreading invasive seeds and other propagules from infested to non-infested areas during prescribed fire activities.**

Note:	BMP 4.4: Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.

Considerations:

a. Do not move equipment from a burn unit that has invasive species to an area that is free of invasive species unless the equipment has been cleaned.

b. A thorough cleaning of equipment at the end of the burn day will minimize spread.

c. Maintain an invasive-free equipment staging area and cleaning area, for example, by cleaning equipment on a non-porous surface like blacktop or on a filter pad to collect debris removed from vehicles.

d. To prevent the spread of aquatic invasives, avoid moving water from one waterbody to another. For example, any equipment that draws water from one waterbody should not be drained into another waterbody. As part of general maintenance, equipment, such as portable pumps and hoses, should be flushed and run with clean water between uses. Also, waterbodies with particularly virulent diseases (e.g. Viral Hemorrhagic Septicemia) should be excluded from use during fire operations.

e. Post-burn, monitor activity areas, staging areas, access routes, and equipment cleaning areas for new infestations (WDNR 2003).

→ **BMP 8.5: Following a prescribed burn, rehabilitate soil disturbance related to burn activities, especially bladed or plowed firelines, where invasive species establishment is likely.**

Note: BMP 6.2: Revegetate or reforest as quickly as feasible after site disturbance.

BMP 6.3: When consistent with site conditions and goals, allow natural revegetation of the ground layer to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation.

Considerations:

a. Revegetate firelines in areas that are most likely to be colonized by invasive species (e.g. areas that are near existing populations of invasive species).

b. Limit soil disturbance during break rehabilitation.

c. Rehabilitation of firelines can prevent the use of fireline corridors as illegal motorized vehicle travelways. Place sufficient sod, downed trees, root wads, and boulders to block access by motorized vehicles and to slow the flow of water, both of which may carry seeds of invasive plants.

Wildfire Suppression:

→ **BMP 8.6: When possible, avoid infestations when constructing fire breaks.**

There are two methods to attacking a wildfire: direct attack and indirect attack. In the **direct attack** method firefighters build a fire break directly along the edge of the wildfire. It is understood that direct attack prevents the decision of where to place the fire line in conjunction with areas that have, or do not have, invasive species present. In the **indirect attack** method firefighters build a fire break at a safe distance away from the fire and burn the area between the fire break and the fire to remove fuel.

Considerations for Indirect attack:

a. Location:
   - Fire break construction (by mowing, plowing, or hand line) can spread invasives.
   - Locate fire breaks to limit the potential to spread invasive species.
   - If invasive species are present that are damaged or killed by fire, incorporate the area of infestation into the burn unit when feasible.
   - If invasive species are present that are promoted by fire, exclude the area of infestation from the burn unit when feasible.

b. Fire break type:
   - Utilize existing natural and man-made fire breaks (lakes, streams, roads, trails, etc.) when possible.

c. Construction:
   - Construct firebreaks only deep enough and wide enough to control the spread of the fire (WDNR 2003).

→ **BMP 8.7: Avoid spreading invasive seeds and other propagules from infested to non-infested areas during fire fighting activities.**

> **Note:** BMP 4.4: Prior to moving equipment onto and off of an activity area, scrape or brush soil and debris from exterior surfaces, to the extent practical, to minimize the risk of transporting propagules.

Considerations:

a. When feasible, do not move equipment from a burn unit that has invasive species to an area that is free of invasive species unless the equipment has been cleaned.

b. A thorough cleaning of equipment at the end of the burn day will minimize spread.

c. Maintain an invasive-free equipment staging area and cleaning area, for example, by cleaning equipment on a non-porous surface like blacktop or on a filter pad to collect debris removed from vehicles.

d. To prevent the spread of aquatic invasives, avoid moving water from one waterbody to another. For example, any equipment that draws water from one waterbody should not be drained into another waterbody. As part of general maintenance, equipment, such as portable pumps and hoses, should be flushed and run with clean water between uses. Also consider excluding waterbodies with particularly virulent diseases (e.g. Viral Hemorrhagic Septicemia) from use during fire operations.

e. Post-burn, monitor activity areas, staging areas, access routes, and equipment cleaning areas for new infestations (WDNR 2003).

→ **BMP 8.8: Following a wildfire, rehabilitate soil disturbance related to suppression activities, especially bladed or plowed firelines, where invasive species establishment is likely.**

Note: BMP 6.2: Revegetate or reforest as quickly as feasible after site disturbance.

BMP 6.3: When consistent with site conditions and goals, allow natural revegetation of the ground layer to occur. If seeding or planting is necessary to minimize the threat of highly damaging invasive species from spreading, use native seed or non-invasive cover crops for revegetation.

Considerations:

a. Invasive species that establish a seed source in firelines can spread into adjacent areas (Merriam et al. 2006).

b. Revegetate firelines in areas that are most likely to be colonized by invasive species (i.e. areas that are near existing populations of invasive species).

c. Rehabilitation of firelines can prevent the use of fireline corridors as illegal motorized vehicle travelways. Place sufficient sod, downed trees, root wads, and boulders to block access by motorized vehicles and to slow the flow of water, both of which may carry seeds of invasive plants.

d. Limit soil disturbance during break rehabilitation.

The Wisconsin Department of Natural Resources, Division of Forestry does not have specific statutory authority to rehabilitate private lands where they have disturbed soils as a result of their suppression actions. Moreover there is a constitutional prohibition on works of internal improvement that effectively prevents fire rehabilitation on private lands (Article VIII, Section 10, Wisconsin Constitution).

Chapter 9: Transport of Woody Material

Long-range Transport

Movement of invasive species occurs naturally in a wide variety of ways. Some species of plants, insects, and fungi have very small reproductive propagules that can be moved long distances by wind without the influence of human activity. There are however, some invasive species that do not move long distances on their own including Emerald Ash Borer, Sirex wood wasp, Asian Long horned beetle, and oriental bittersweet.

Regulatory Considerations

Be aware of all state and federal quarantine rules related to transportation of regulated articles out of a quarantined area.

It is a violation of state and federal laws to transport designated regulated articles outside of a quarantined area. USDA Animal Plant Health Inspection Service (APHIS) and the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) are responsible for designating the quarantined area and determining what materials will be regulated. Movement of regulated articles may be allowed under certain circumstances; details of exceptions are provided in a compliance agreement, which is issued by USDA APHIS.

→ **BMP 9.1: Prior to trucking, implement mitigation strategies to reduce the risk of transporting highly damaging invasive insect and disease species when present, to the extent practical.**

Considerations:

a. This BMP does not include invasive plant species.

b. Practical mitigation strategies to minimize the risk of transporting highly damaging invasive species should be discussed during the planning process and considered for inclusion in the management plans, prescriptions, timber sale prospecti, and contract language.

c. Mitigation activities should focus on site- and threat-specific activities that reduce the risk of transporting invasive species.

d. Examples of mitigation strategies are listed in Table 2. Strategies for a particular invasive species may be appropriate for application on a broad-scale, for a specific site only or not at all.

e. Effectively reducing the risk of transporting invasive species requires the cooperation of foresters, landowners, loggers, and purchasers of raw products.

f. Mitigation strategies begin in the planning phases and include numerous steps: scouting (BMP 3.2), planning of invasive species management strategies (BMP 3.4), training in identification of invasive species (BMP 4.1), and timing of control treatments (BMP 4.2).

Table 2: Examples of invasive forest insects and diseases and possible mitigation strategies to minimize the risk of long-range transportation.

Invasive Species	Possible Mitigation Strategies
Conifer bark beetles (*Ips* spp.)	If harvesting conifers during April-September, transport conifer logs away from the residual conifer stand within four weeks of harvest to avoid the build-up of bark beetle populations in the freshly cut log and reinfestation of the residual stand.
Annosum root rot (*Heterobasidion annosum)*	If working in a stand of conifers known to be infected with Annosum root rot, leave infested material on the site to limit the movement of disease. This material is typically dying or in a state of decline.
Oak wilt (*Ceratocystis fagacearum)*	Oak trees that have been killed from oak wilt will produce an infectious spore stage the spring or summer of the year following death. This "infectious material" can be the source of a new introduction of oak wilt. *Oak that is killed by oak wilt and may still produce the infectious spore stage should not be transported into counties where oak wilt has not been confirmed.* *If transporting oak that could produce a spore stage (infectious material), consider either utilizing (removing bark and jacket wood) from infected trees before spores can be formed (spring of year following death) or leaving recently-killed trees on site.* Oak trees killed from oak wilt that have loose or sloughing bark are not infectious and do not require any special treatment.