Multiple Habitats
26. Invasive and Nuisance Pest and Pathogen Removal

DEFINITION

An *invasive* or *nuisance pest* is synonymous with a species that causes harm to humans or the environment (USGS n.d.b). Unlike invasive species, *nonnative species* are organisms that do not occur naturally in an area but do not necessarily cause harm. Nonnative species are typically introduced to areas by humans (NPS 2020). This summary focuses specifically on invasive and nuisance insects and pathogens. *Invasive pathogens* are bacteria, fungi, or viruses that enter habitats to which they are not native and pose disease risks. Invasive pathogens can be particularly devastating if the host species has not been introduced to the particular type of pathogen (USGS n.d.a). Invasive pathogens are a substantial cause of death for tree species in particular (Haight et al. 2011). Invasive insect incursions are typically low-probability but high-consequence events that can cause ecological, economic, and aesthetic devastation (Venette and Hutchinson 2021). Many invasive insects come to the United States after hitchhiking on plant material originating in other countries (Hill et al. 2016). Nuisance species can either be native or nonnative, but always cause ecological or economic harm (Gwise 2021). Both invasive and nuisance insects and pathogens can be extremely destructive and, in most cases, human intervention of some kind is necessary.

TECHNICAL APPROACH

Integrated pest management (IPM) is the primary approach to managing invasive and nuisance pests in environmentally sound ways. IPM focuses on nonchemical treatments first—methods that align with a nature-based approach—but moves to chemical control as a last resort (University of California 2016).

Although invasive threats are unique to each region, some of the top invasive insects in the United States include the Asian citrus psyllid (*Diaphorina citri*), Asian longhorned beetle (*Anoplophora glabripennis*), coconut rhinoceros beetle (*Oryctes rhinoceros*), emerald ash borer (*Agrilus planipennis*), European cherry fruit fly (*Rhagoletis cerasi*), European grapevine moth (*Lobesia botrana*), hemlock woody adelgid (*Adelges tsugae*), imported fire ant (*Solenopsis invicta*), khapra beetle (*Trogoderma granarium*), Mediterranean fruit fly (*Ceratitis capitata*), Mexican fruit fly (*Anastrepha ludens*), Old World bollworm (*Helicoverpa armigera*), oriental fruit fly (*Bactrocera dorsalis*), spongy moth (*Lymantria dispar*), and spotted lanternfly (*Lycorma delicatula*) (USDA n.d.c). Some of the top invasive pathogens include sudden oak death (*Phytophthora ramorum*), laurel wilt (*Raffaelea lauricola*), white pine blister rust (*Cronartium ribicola*), chestnut blight (*Cryphonectria parasitica*), Dutch elm disease (*Ophiostoma spp.*), butternut canker (*Ophiognomonia clavigignenti-juglandacearum*), and white-nose syndrome (*Pseudogymnoascus destructans*) (USFS n.d.a; National Wildlife Health Center 2018).

While nuisance insects are native, they can still cause harm. Some examples include the southern pine beetle (*Dendroctonus frontalis*), mountain pine beetle (*Dendroctonus ponderosae*), western pine beetle (*Dendroctonus brevicomis*), and spruce budworms (*Choristoneura spp.).* Some of the common native nuisance pathogens include armillaria root rot (*Armillaria spp.*), Swiss needle cast (*Phaeocryptopus gaeumannii*), and sycamore anthracnose (*Apiognomonia veneta*) (USFS n.d.b).

The steps for combating invasive and nuisance pests and pathogens are as follows:

1. **Prevention:** With any invasive or nuisance species, the most cost-effective approach is always to prevent their spread; both pests and pathogens can be challenging to control once established (McLaughlin and Dearden 2019). Prevention includes any activity that prevents a pest from becoming established. These methods may include removing pests' food, water, or shelter sources or blocking their access (University of California 2016).
2. **Early detection:** Early detection and rapid response is a method that involves coordinated efforts to eradicate invasions before they can spread (USDA n.d.b). There are new detection methods currently available that scientists can use to detect nonnative insects before they become invasive (McLaughlin and Dearden 2019). Early detection can be achieved through coordinated monitoring, surveying, and reporting efforts. Rapid response involves species-specific actions aimed at eradicating early invasions. Quarantining is a method that is often implemented in the rapid response phase. It can be crucial to quarantine a newly invaded area by aiming to close off potential pathways of further spread (DOI 2016).
3. **Eradication:**
    - **Cultural controls:** *Cultural controls* include any activity that discourages pest invasion. Activities include good sanitation and gear cleaning, safely removing infested material, and using pest-resistant plants in farms, homes, parks, and other outdoor spaces (University of California 2016). Cultural controls also include any method implemented to change human behavior to increase awareness of invasive species (USDA n.d.b).
    - **Physical or mechanical controls:** *Physical or mechanical controls* include directly removing pests from plants or using barriers (Figure 1, University of California 2016). Another manual control strategy is removing host trees that are already severely affected (USDA 2021).
    - **Biological controls:** *Biological control* is a method in which beneficial organisms or natural predators are used to manage pests (University of California 2016). It is essential to ensure that, when using biological control methods, only native predators be involved (USDA n.d.b).
    - **Chemical controls:** While chemical controls are not recommended because of their negative effects on the rest of the ecosystem, they are sometimes necessary, and there are ways to make chemical use more environmentally friendly (Figure 2). Pesticides can be very effective in reducing invasive insect invasions, but it is crucial to ensure their use is absolutely necessary and, when possible, avoid the use of broad-spectrum pesticides (University of California 2016).

Figure 26.1 Hanging a spruce budworm trap in Alaska

Photo courtesy USDA Forest Service, Alaska Region

4. **Monitoring**: Monitoring invasive and nuisance species invasions is crucial to long-term management. Monitoring aids in future pest and pathogen management decisions and allows for further learning about site-specific management needs. It also helps reduce project costs by increasing knowledge about the successes and failures of past management (Flint 2012).

Figure 26.2 Verbenone pouches to protect whitebark pines from mountain pine beetles

Note: Verbonene is a synthetic pheromone that indicates to the beetles that the tree is already at capacity and there is not enough food for additional beetles.

Photo courtesy USDA Forest Service, Region 6

OPERATIONS AND MAINTENANCE

The process of detection and prevention will need to continue over time to prevent reintroductions or reinvasions of nuisance or invasive pests and pathogens. In some cases, long-term management will be required to contain and prevent spread.

FACTORS INFLUENCING SITE SUITABILITY

- ✓ **Terrestrial habitat:** Studies show that terrestrial systems are the most economically impacted by invasive and nuisance species, specifically because of crop and timber yields that rely on healthy systems (Crystal-Ornelas et al. 2021).
- ✓ **Sites with new establishment:** The International Union for Conservation of Nature recommends prioritizing sites with newly established invasive or nuisance insects and pathogens when working toward eradication (IUCN 2000).

- ✓ **Sensitive sites:** Management is often focused on sites that are particularly vulnerable to invasive species, such as protected areas (McGeoch et al. 2016).
- ✓ **High likelihood of invasion:** Managers can use maps to estimate pathways and potential invasion threats for particular species and, with that information, can try to prevent invasion (McGeoch et al. 2016).
- ✓ **Destructive invasive or nuisance species:** Many prioritization methods focus on the potential negative impacts of the invasion, typically focusing on the traits that most adversely affect the economy, society, ecosystem, or native species (McGeoch et al. 2016).
- ✗ **Lack of resources:** If the agency does not have the time or resources to conduct invasive or nuisance species management at a site, even if all the other site priorities are met, management cannot be implemented (McGeoch et al. 2016).

TOOLS, TRAINING, AND RESOURCES FOR PLANNING AND IMPLEMENTATION

Name and Link	Resource Type	Year	Authors/ Authoring Organization	Geography	Description	Resource Includes: Design/Construction Guidance?	Site Selection?	Monitoring Guidance?	Example Projects?
US Department of the Interior (DOI) Training Related to Invasive Species Management	Document	2021	DOI	National	This resource provides information on training opportunities within the DOI to inform invasive species management.	✓	✓	✓	—
National Plant Diagnostic Network	Website	2002	National Plant Diagnostic Network	National	This website provides information for each state's plant diagnostics lab(s), which aim to support the health and productivity of plants affected by pests and pathogens.	✓	—	✓	—
A National Road Map for Integrated Pest Management	Document	2018	US Department of Agriculture (USDA)	National	This document provides information on IPM principles and focal landscapes for different federal agencies.	✓	—	✓	—

Name and Link	Resource Type	Year	Authors/ Authoring Organization	Geography	Description	Resource Includes: Design/Construction Guidance?	Site Selection?	Monitoring Guidance?	Example Projects?
US DOI Funding Guide for Invasive Species Management	Document	2022	DOI	National	This funding guide gives information on funding sources through the DOI for invasive species projects.	✓	—	—	—
Safeguarding America's Lands and Waters From Invasive Species	Guidebook	2016	DOI	National	This resource provides information on implementing a national framework for early detection and rapid response.	✓	✓	✓	✓
EDDMapS	Website	2005	University of Georgia	National	This website allows people to report invasive species, monitor current distribution, learn about management methods, and get species information.	✓	✓	✓	✓
Assessing and Managing Invasive Species within Protected Areas	Guidebook	2009	The Nature Conservancy	National	This guide provides information on managing invasive species for biodiversity within protected areas. This guide is meant for practitioners.	✓	✓	✓	✓
Invasive Species: Alaska	Website		Safeguarding America's Lands and Waters from of Fish and Game	Alaska	This website provides information on invasive species within Alaska and how to manage, prevent, and report them.	✓	—	✓	✓
Invasive Species Strategic Plan 2021-2025	Report	2021	DOI	National	This document provides information on DOI's plans for invasive species management throughout the different bureaus and agencies.	✓	✓	✓	✓
Invasive Species List	Website	2022	USDA National Invasive Species Information Center	National	This website provides a list of registered invasive species within each state and the regulations accompanying them.	✓	✓	—	—

Name and Link	Resource Type	Year	Authors/ Authoring Organization	Geography	Description	Resource Includes: Design/Construction Guidance?	Site Selection?	Monitoring Guidance?	Example Projects?
Cohesive Approach for Invasive Species Management in the Northeastern U.S.	Guidebook	2007	USDA Forest Service (USFS)	Northeastern United States (20 states bounded by Minnesota, Maine, West Virginia, and Missouri)	This guide is meant to help facilitate collaboration, create management plans, and conduct targeted actions plan for invasive species in the northeastern United States.	✓	—	✓	✓
A Land Manager's Guide to Best Management Practices (BMPs) to Prevent the Introduction and Spread of Invasive Species	Guidebook	2011	The University of Georgia Center for Invasive Species and Ecosystem Health	National	This document provides best management practices for land managers to prevent the introduction and spread of invasive species.	✓	✓	✓	✓

LIKELY BENEFITS AND OUTCOMES

Primary objectives for each strategy are highlighted.

Climate Threat Reduction

- **Carbon storage and sequestration:** Invasive species that target trees can lead to the release of carbon dioxide. Therefore, managing for these invasive and nuisance insects and pathogens can reduce the release of carbon and increase carbon sequestration (Fei et al. 2019).

Social and Economic

- **Agriculture and timber yields:** Invasive insects and pathogens can lead to mass mortality of crop and timber yields, so management is essential for the preservation of these industries (Huber et al. 2002).

- **Cultural values:** Invasive insects and pathogens can have aesthetic effects on different ecosystems. Management of these pests can preserve the aesthetic values of land and waterscapes (Raffa et al. 2023).
- **Food security:** Because of invasive and nuisance insects and pathogens' effect on crops, it is crucial to manage these invasive species to ensure food security within the United States. It is estimated that invasive insects and pathogens cause $40 billion in crop damage annually (USDA 2023).
- **Jobs:** While limited personnel is an often-reported challenge of managing invasive and nuisance insects and pathogens, this also means there are potential job opportunities in this sector (Beaury et al. 2020).

Ecological

- **Enhanced biodiversity:** Invasive and nuisance pests and pathogens are one of the leaders in the destruction of biodiversity and can often lead to species extinction (Hanley and Roberts 2019). Removing them thus boosts biodiversity.

BARRIERS AND SOLUTIONS FOR PRACTITIONERS

Common Barriers

Several barriers are common across many of the nature-based solutions strategies; these are described in more detail in Section 1 of the Roadmap. Additional notes about the barriers specific to invasive and nuisance pest and pathogen removal are included here.

- **Expense:** In 2022, DOI allocated $18,525,500 toward invasive species management projects (USDA n.d.a). Though the remediation investment is high, invasive insects annually cost North America an estimated $27.3 billion in goods and services alone (Bradshaw et al. 2016). In 2005, it was estimated that invasive insects and pathogens resulted in an annual loss of $40 billion for crop and forest production in the United States (Paini et al. 2016).
- **Capacity:** Land managers have reported that they cannot effectively manage invasive species due to limited staff and funding (Beaury et al. 2020).
- **Public opinion**
- **Conflict with other land uses**
- **Regulation**
- **Lack of effectiveness data**

Community

- **Increase in trade:** As global trade increases, presence of invasive and nuisance insects and pathogens will also increase, making management even more challenging (Klapwijk et al. 2016).

Ecological

- **Pesticide use:** Chemical methods of removal of invasive species can adversely affect the ecosystem. It is crucial only to implement this method when absolutely necessary and to avoid broad-spectrum pesticides when possible (University of California 2016).
- **Climate change:** Climate change will affect the distribution of both invasive and nuisance insects and pathogens throughout the United States. For species that are cold-limited, they will be able to spread northward as a result of the warming climate (Dukes et al. 2008). The number of invertebrate pests has also risen with rising temperatures, which will likely continue to increase (Hanley and Roberts, 2019). Climate change adds more challenges to invasive species management, so it is important to observe trends and manage them accordingly.
- **Biological control targeting other species:** In some cases, when using biological control methods or natural predators, these species can target species other than the intended one(s), disrupting the ecosystem. It is crucial to do plenty of research prior to implementing biological control methods (USDA n.d.b).

EXAMPLE PROJECTS

Name and Link	Location	Leading Organizations	Techniques Used	Size	Cost	Duration	Project Description	Climate Threats Targeted	Lessons Learned or Adaptive Management
Collins Emerald Ash Borer (EAB) Management and Response Plan	Fort Collins, CO	City of Fort Collins	3-year ash treatment rotation; IPM	67,000+ ash trees	$7 per trunk inch diameter	Ongoing (began in 2021)	This project is the new management plan for the City of Fort Collins' ash trees. They are implementing different techniques to try to limit the spread of the emerald ash borer.	Carbon and biodiversity loss	No
Winning the Dutch Elm Disease Battle: Developing Resistant Elms for Minnesota	Minnesota	University of Minnesota	Propagating disease-resistant American elms	Not provided	$233,924	Ongoing	This project aims to propagate trees that appear to be resistant to Dutch elm disease, an invasive pathogen. These trees will then be brought back into the natural landscape.	Biodiversity loss.	No
Chicago vs. The Asian Longhorned Beetle: A Portrait of Success	Chicago, IL	The City of Chicago, Illinois Department of Agriculture	Public outreach, education and involvement, cut down and replaced trees, chemical treatment, containment or quarantine	Total not provided	$480,000 (from USFS), along with matching donations (Poland et al. 1998)	1999-2004	This project began with the introduction of the Asian longhorned beetle in Chicago. Managers used chemical and mechanical treatments to eradicate the species.	Biodiversity loss	Chicago had information from 2 years of New York City eradication efforts and had success learning from their struggles.

Bolding indicates DOI affiliates.

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