Pennsylvania Invasive Species Management Plan 2025

Developed by the Pennsylvania Governor’s Invasive Species Council, May 2009; Revised 2017, 2025

This comprehensive invasive species management plan for Pennsylvania was prepared for submission to Governor Josh Shapiro on behalf of the Pennsylvania Governor's Invasive Species Council.

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1. Executive Summary

Pennsylvania's diverse geography is home to thousands of species. Unfortunately, not all of these organisms are beneficial. Pennsylvania's natural resources and economy are threatened by unwanted invaders in the Commonwealth – nonnative invasive species.

An invasive species is defined by the 2016 Presidential Executive Order 13751 as, "with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health". A non-native organism is "any organism that occurs outside of its natural range." From autumn olive (*Elaeagnus umbellata*) to zebra mussels (*Dreissena polymorpha*), and emerald ash borer (*Agrilus planipennis*) to feral swine (*Sus scrofa*), invasive species are constantly making their way into Pennsylvania. Often, they are unintentionally introduced by people when they hide in firewood, attach to boats and other gear, or conceal themselves in merchandise. Regardless of the means of their introduction, they have the potential for significant negative impacts for Pennsylvania's current and future generations in several ways:

1. They outcompete and decrease diversity of our native plants, insects, and wildlife.
2. They decrease agricultural crop yields and increase the cost of cultivation.
3. They damage critical infrastructure like roads, bridges, storm water management systems, and riparian buffers.
4. They impact human health directly by vectoring diseases such as the West Nile Virus, or indirectly by increasing the incidence of Lyme disease.

The value of Pennsylvania's natural and economic resources, and the need to protect the health of Commonwealth citizens, demands an effective response to these impacts. Such a response requires cross jurisdictional cooperation to include multiple state agencies and nongovernment organizations. To meet this need, Governor Edward Rendell created the Pennsylvania Governor's Invasive Species Council (PA EO 2004-1) in 2006, heretofore known as the PGISC, composed of seven state agencies and 14 nongovernment organizations (see appendix for more information). The executive order established a mandate for PGISC to develop a state invasive species management plan to be updated every five years. This dynamic document identifies goals and actions critical to protecting our state's resources, both now and into the future. It provides a framework for a comprehensive plan focusing on all key areas: Prevention, Eradication and Containment, and Long-term Management.

The purpose of this plan is threefold:

1) to outline the components of invasive species management needed to protect the Commonwealth, most notably the need for sustainable funding from the state Legislature
2) to provide recommendations to improve interagency cooperation and collaboration with stakeholders
3) to make policy and procedural/program recommendations that address current shortcomings of invasive species management in Pennsylvania

The 24 recommendations made throughout this plan are provided here for easy reference.

2. Recommendations

1. Establish and maintain a statewide Partnerships for Regional Invasive Species Management (PRISM) program across all regions of Pennsylvania.

Action:

The PGISC and partners will work to develop a funding mechanism to support a statewide PRISM program administered by the Pennsylvania Department of Agriculture. A PRISM program would provide the structure and mechanism to complete recommendations and actions identified in this plan.

2. Develop policies and resources to improve prevention of invasive species introductions and monitor invasion pathways.

Actions:

The PGISC should make recommendations to jurisdictional agencies to develop certification programs to prevent the movement of invasive species and certify products free of invasive species (for example, weed-free certifications for mulch, gravel, fill and feed). Additionally, plants used in landscaping, which were previously climate limited, may become invasive due to an expanded potential range associated with global climate change should be considered for regulatory listing.

Jurisdictional agencies and partners should institute procedures to prevent the spread of invasive species by outdoor recreationists, particularly for geographic areas around known infestations and pathways with prevention opportunities. For example, jurisdictional agencies should mandate inspections for watercraft via additional boat launch steward programs and install boot cleaning stations at trailheads of state and local parks.

3. Improve public outreach and education for prevention of high-risk invasive species threats.

Actions:

Jurisdictional agencies and PRISMs should conduct public outreach and education on invasive species risks and pathways for spread through effective communications and educational events.

Jurisdictional agencies and PRISMs should increase resources available to educate the public and assist with prevention efforts, particularly to interrupt known pathways and stop the spread at recreation access points (for example, trailheads, boat launches, parks, or rights-of-way) and around known high priority infestations.

4. Conduct Horizon Scanning to identify invasive species with a high risk of introduction to Pennsylvania.

Actions:

Jurisdictional agencies, PRISMs, and partners should evaluate invasive species that are not currently present in Pennsylvania to identify those that are of high risk of introduction and the potential for range expansion due to climate change. Identified species should be proactively added to appropriate banned or prohibited regulatory lists and inform the PGISC.

For high-risk species that do not align with any agency's jurisdictional authority, like jumping worms for example, the PGISC should recommend an agency to take on this role.

5. Conduct full risk assessments for identified high-risk invasive species.

Actions:

Jurisdictional agencies should lead efforts with the PGISC, PRISMs, and partners to conduct risk assessments, identify high-risk invasive species and regularly update early detection species lists based on assessments.

Agencies should inform the PGISC of completed risk assessments and species lists, and the PGISC will publish these assessments on their website.

The PGISC should work with agencies to ensure risk assessment processes are standardized.

6. Conduct pathway analyses and implement surveillance for identified high-risk invasive species.

Actions:

Jurisdictional agencies, PGISC, PRISMs, and partners should conduct pathway analyses for species on considered to be priorities for early detection due to a high risk for invasiveness.

Agencies should increase staff, funding, and collaborations to improve surveillance of invasion pathways.

7. Increase surveying and reporting for new invasive species.

Actions:

Jurisdictional agencies and PRISMs should prioritize surveillance efforts for species identified by horizon scanning and risk analyses and high-risk pathways for early detection.

Jurisdictional agencies and PRISM should report early detection sightings to the public online statewide database Pennsylvania iMapInvasives, unless other species-specific reporting tools exist such as the

Penn State Extension reporting tool for spotted lanternfly or agency protocols dictate other reporting mechanisms.

8. Improve invasive species reporting and ensure communication about priority invasive species among jurisdictional agencies, PGISC and partners.

Actions:

Agencies, PRISMs and partners should support the centralized database, Pennsylvania iMapInvasives, and encourage reporting of occurrences of invasive species.

Agencies, PRISMs and partners should improve communication particularly about high priority reports of invasive species to ensure rapid response and management.

9. **Effectively communicate information about new and emerging invasive species and rapid response efforts that have been implemented.**

Actions:

The PGISC should create a communications plan and mechanisms (e.g., letters of understanding) to ensure stakeholders (e.g., agencies, organizations, PGISC members, and PRISMs) are informed of reports of early detection species and rapid response actions. The communications plan should encourage information sharing with partners and stakeholders and establishing effective communications among agencies and partners to improve response. The plan should include points of contact in each agency who are responsible for sharing information. A communications plan should parallel communications mechanisms outlined in the Rapid Response Plan and Procedures for Responding to Aquatic Invasive Species in Pennsylvania (2022).

10. Develop a state rapid response plan for terrestrial invasive species to respond to high priority invasive species infestations in a timely manner to eradicate them at the early stage of establishment.

Actions:

In coordination with the PGISC, the Pennsylvania Department of Conservation and Natural Resources and the Pennsylvania Game Commission should develop a rapid response plan for terrestrial invasive organisms, including terrestrial plants. The plan should include strategies for rapid response on both public lands and private properties, early detection priorities, survey methods, identification information, specimen documentation, and reporting mechanisms. The plan should create a rapid response template that can be utilized for any given invasive terrestrial species, as a response is needed. The plan should include actions that anticipate the impacts of climate change in facilitating species spread.

11. Establish reserve funds that can be utilized to rapidly respond to new invasive species introductions.

Actions:

Agencies should establish their own reserve fund to implement rapid response procedures to new invasive species threats under their jurisdiction.

12. Establish or improve organizational systems, such as incident command systems, that are implemented for responding to new invasive species introductions.

Actions:

Agencies and partners should establish or improve organizational systems for the implementation of rapid response, such as incident command systems. The organizational systems, such as incident command systems, would define roles for staff members, ensure communication among involved parties, assess plans, manage resources, and develop a systematic implementation for rapid response for a specific event.

Jurisdictional agencies and PRISM should be trained on the implementation of established organizational systems.

13. Increase agency funding, staff, and capacity for early detection and rapid response to emerging invasive species threats.

Actions:

Resources should be provided by the legislature for jurisdictional agencies to increase staff capacity and for funds dedicated to carry out early detection surveillance and rapid response procedures to contain and eradicate emerging invasive species. This should include funds needed for rapid response (e.g., inspections, signage, boat/vehicle/equipment cleaning, etc.).

Agencies should utilize additional staff and funds to engage stakeholders to foster collaborative, broad-reaching early detection and rapid response programs. This can be accomplished by creating community science and volunteer opportunities. Examples of other volunteer monitoring programs include the Alliance for Aquatic Resource Monitoring, the Pennsylvania Outdoor Corps, and the Master Watershed Steward Program.

14. Identify invasive species that warrant rapid response efforts (e.g., containment and eradication) using a standard evaluation process and proactively develop plans to implement rapid response.

Actions:

A standard procedure should be developed to determine containment and eradication zones and procedures, identification of dispersal pathways, and monitoring and evaluating success.

Jurisdictional agencies should proactively evaluate and determine invasive species for which containment and eradication efforts should be completed on both a regional and statewide scale. Species identified for containment should be shared with the PGISC, the Governor's Office, and other relevant partners.

Jurisdictional agencies and PRISM should develop tailored procedures for response to specific invasion scenarios that includes an organizational system for implementation. These procedures should identify the most effective methods for eradication, containment, mitigation, and management.

The PGISC should support efforts to increase additional legal authority for jurisdictional agencies to quickly contain novel infestations.

15. Support research to develop more effective early detection, rapid response and control methods for invasive species.

Actions:

Jurisdictional agencies and partners should offer grants and support research on early detection, rapid response methods and effectiveness. The PGISC should support establishing a fund for research of novel and improved rapid response methodology.

16. Improve coordination between jurisdictional agencies and stakeholders for invasive species containment and eradication efforts.

Actions:

Jurisdictional agencies, partners, and the PGISC should manage and assess the containment and eradication status of invasive species, success and failure, needs, information gaps, and plans for next steps if containment fails. Included in the plans should be identification of the areas of information gaps, further assessment needs and research areas of interest.

17. Improve public awareness and engagement for early detection and rapid response activities.

Actions:

Jurisdictional agencies and partners should conduct outreach and education to create public awareness campaigns (e.g., webinars, presentations, and social media) of containment zones and their role in maintaining them and reporting breaches.

Jurisdictional agencies and PRISM should expand awareness for the public and professionals about early detection priorities, surveillance, best management practices, and reporting through educational outreach opportunities and trainings.

PGISC should promote the use of native species in landscaping by annually celebrating Pennsylvania Native Species Day and hold invasive species buy-back events, like the Pennsylvania Invasive Replace-ive program, to educate the public on the impacts of invasive species.

The PGISC, jurisdictional agencies, and partners should promote existing reporting systems (see page 26) to the public and encourage entering data into iMapInvasives.

18. Increase surveillance to determine locations/regions where rapid response efforts are no longer viable and should transition to long-term management.

Actions:

The PGISC should continue to encourage agencies and the public to enter invasive species observations, both occurrence and absence, as well as biocontrol releases, into iMapInvasives to help track prevalence of different species across different regions of the state.

Non-government organizations (NGOs) should conduct surveys and provide data (including nonoccurrence data) to iMapInvasives to assist the PGISC and agencies with prioritization of long-term management efforts.

19. Support and communicate the need for development of improved ways to measure the long-term economic, ecological, and health impacts of invasive species, and compare those to the costs of management. This should include studies on the values of ecosystem services, and study how to efficiently manage long-term invasive pressure with Integrated Pest Management techniques.

Actions:

The Legislature should provide the PGISC with adequate funds to support studies and analyses of the impacts of various invasive species. Studies should improve techniques to estimate costs, benefits and thresholds of long-term management that include economic considerations, valuation of ecosystem services, and carbon sequestration.

20. Conduct outreach and education on the need and benefit of long-term management of invasive species.

Actions:

Jurisdictional agencies and PRISM should conduct public outreach and education on long-term management of invasive species through effective communications and educational events. These efforts should include curriculum that covers:

1) The value of native ecosystems for wildlife, timber regeneration, and carbon sequestration.
2) Identification of invasive species and their impacts.
3) Regional priorities for eradication, containment, and long-term control opportunities for regional PRISMs.

Jurisdictional agencies and PRISM should increase resources available to educate the public and assist them with prevention efforts particularly for known pathways and recreation access points (e.g., trailheads, boat launches, parks, or rights-of-way) and around known high priority infestations.

21. Increase staff capacity and funding dedicated to long-term management of invasive species in Pennsylvania.

Actions:

The Legislature should provide agencies with staff capacity and funds needed to support long term management of existing infestations, such as Japanese barberry, hydrilla, spotted lanternfly, and spongy moth and reduce the long-term impacts of these species.

NGOs should have staff capacity dedicated to the long-term management of invasive species infestations.

The Legislature should provide funding for grants (some of which should be non-restricted) to help landowners and organizations to manage the ecological and economic impacts of established invasive species.

Agencies should recruit partners and volunteers to help manage established invasive species.

22. Improve coordination and funding for biological control of invasive species across the Northeastern US.

Actions:

The Legislature should provide consistent funding to state agencies to support biological controls for invasive species in their jurisdiction. Funding should be used by agencies to provide grants to researchers, supporting the study of novel biological controls; as well as to improve rearing and distribution efforts of approved biological controls.

State agencies should maintain data on historic releases and distribution of all biological control agents within their jurisdiction.

State agencies should improve collaboration with external partners (e.g., USDA APHIS PPQ, USFWS, and USDA Forest Service) and other states on biological controls across all taxa by creating a Northeastern US Regional invasive species biocontrol workgroup.

23. Apply ecological restoration at sites with well-managed or eradicated invasive species to improve biological diversity, natural processes, and habitats.

Actions:

Jurisdictional agencies and PRISM should identify restoration targets (e.g., prioritized habitats or high biodiversity sites), including suggested areas for restoration targets by regions or habitat type. Restoration and monitoring plans should integrate ecological principles and climate change planning.

Jurisdictional agencies and PRISM should develop informational resources for land managers about ecological restoration and invasive species management techniques that incorporate climate change.

Agencies should implement ecological restoration on public lands and seek additional funding to expand related efforts.

The PGISC should foster partnerships, including PRISMS, to implement ecological restoration. The PGISC should support development and sustainability of PRISMs including requesting state funding specifically for long term management and restoration.

24. Develop outreach programs to assist private landowners with restoration.

Actions:

Jurisdictional agencies and PRISM should provide grants to landowners to restore private lands using ecological principles.

3. 2025 Update Notes

This update improves upon the 2017 Pennsylvania Invasive Species Management Plan in the following ways:

- It has been reorganized to follow general invasive species management guidance, including sections for Prevention, Eradication and Containment, and Long-term Management.
- Within each of these sections, key recommendations and specific actions are provided to help steer future efforts to improve invasive species management in Pennsylvania.
- A new section has been added that describes the Partnerships for Regional Invasive Species Management (PRISM) program and recommends it as an essential new program needed in Pennsylvania

Significant shortcomings continue to impede prevention, early detection, rapid response, leadership, and coordination necessary to adequately protect Pennsylvania from invasive species. Jurisdictional agencies and partners are lacking in funding and capacity to adequately address invasive species management. This latest version of the plan addresses these and other important issues and calls on responsible parties to act on potential solutions.

As always, this update reflects the ongoing efforts of the PGISC to protect Pennsylvania's economy, ecology, and the health of its citizens and visitors from the impacts of invasive species.

4. Introduction

4.1 What is an invasive species?

The Pennsylvania Governor's Invasive Species Council (PGISC) adopts the definitions of an *invasive species* and *non-native species* from the 2016 Presidential Executive Order 13751. An invasive species is defined as, "with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health". Furthermore, the term *non-native species* means "…an organism… that occurs outside of its natural range".

The distinction between invasive species and non-native species has important implications for policy and regulations. Invasive species disrupt ecosystems and cause harm to native species leading to a loss of biodiversity. They also cause significant economic damage in agriculture and industry. In comparison, if contained, non-native species can be essential in many ways to society as food sources, pets, horticulture, and many other applications. If they are not contained, non-native species may become invasive if they spread into native ecosystems and cause environmental harm.

The harmful impacts of invasive species can vary in type and magnitude drastically across ecosystems and regions. To highlight this nuanced approach to management of invasive species, "with regard to a particular ecosystem" was added to the invasive species definition within Executive Order 13751.

4.2 Why is managing invasive species important?

The devastatingly negative impacts invasive species have on the environment in turn generate negative impacts on many sectors of the economy. Invasive species are particularly costly to manage for agriculture, forestry, tourism, and recreation industries. Invasive species also affect the infrastructure for transportation and utilities and can negatively affect property values. However, the reasons invasive species are important to manage can be unique and specific to each area as described below.

> **Environment:** Invasive species have profound negative effects on our environment. Invasive species are the second greatest cause of biodiversity loss, behind habitat loss. Biodiversity is critical to maintaining a resilient and healthy environment that provides the foundation for robust economies and vibrant human health. Invasive species are often ecosystem engineers, meaning that they quickly alter ecosystems, disrupting and diminishing many of the natural processes we rely upon. This can include flood and erosion control, pollination, cleaning of the air and water, wildlife nutrition, decomposition and nutrient cycling. Disrupting these and other ecosystem services can have costly and far-reaching effects including reducing our resilience to the harmful effects of climate change. Since climate change can also increase the spread of invasive species, it is important to recognize the interconnectedness of these two threats.

Forestry: Species like spongy moth (*Lymantria dispar*) and emerald ash borer (*Agrilus planipennis*) damage, weaken, and kill valuable hardwood trees like oaks and ashes and are incredibly costly to manage. The Pennsylvania Department of Conservation and Natural Resources spent approximately $5 million in 2021 to suppress spongy moth outbreaks in state parks and forests. Dead ash trees are a significant safety hazard and must be removed at great expense to prevent property damage and human injury. In 2018, the PA emerald ash borer control program costs $100,000 in state funds and $155,000 in federal funds. In addition, there are costs associated with ash trees that fall on and damage utility lines, roads, and hiking trails. Almost 6 million board feet of ash timber (near $1 million in value) were harvested from state forest lands in 2015, three times as much as other years. While this may cause a short-term boom for timber and wood products industries, this resource will not be renewed for future economic benefits. Invasive plants like glossy buckthorn (*Rhamnus frangula*), Japanese honeysuckle (*Lonicera japonica*), and Japanese stiltgrass (*Microstegium vimineum*) negatively impact forest health and regeneration, resulting in additional incurred costs to the timber industry.

Agriculture: Costs for crop losses and for invasive species management add up to a significant price tag. The Pennsylvania Department of Agriculture and the US Department of Agriculture spent approximately $34 million from 2015-2020 to control spotted lanternfly (*Lycorma delicatula*), and $59 million from 1999 to 2009 to eradicate plum pox virus (*Potyvirus spp.*). Invasive insects, like brown marmorated stinkbug (*Halyomorpha halys*) and Japanese beetle (*Popillia japonica*), decrease crop yields and marketability due to feeding damage. In addition to these economic losses, farmers, foresters and agencies must spend millions of dollars every year to keep invasive species in check.

Transportation and Utilities Infrastructure: Roadway and other infrastructure agencies incur significant increased costs for operations because of invasive species management. Zebra and quagga mussels (*Dreissena* bugensis) clog water lines at water treatment and hydroelectric facilities. Although specific figures are not known for Pennsylvania, the Great Lakes Fishery Commission estimates that one power plant can spend up to $1.2 million per year to deal with zebra mussels. Invasive plants such as Japanese knotweed (*Reynoutria japonica*), kudzu (*Pueraria montana*), and mile-a-minute vine (*Persicaria perfoliate*) can rapidly grow through or over paved and gravel roads, rights-of-way, and road signs, degrade roadside embankments, and clog stormwater drainages. The Pennsylvania Department of Transportation spends $500,000 annually to control invasive plants.

Landowners and Recreation: Landowners and the recreation industry also pay for the added expenses from invasive species. In some cases, invasive species decrease property values, reduce the aesthetic qualities of a property, and increase landowner maintenance costs. It costs a homeowner a minimum of $1,000 to remove one tree infected with emerald ash borer. Invasive species impact hunting, fishing, tourism, and other recreation industries by degrading wildlife habitat (e.g., autumn olive (*Elaeagnus umbellata*) and burning bush (*Euonymus alatus*)), making waterways impassible by watercraft (e.g., water chestnut (*Eleocharis dulcis*) and fanwort (*Cabomba caroliniana*)), and causing the loss of aesthetic values (e.g., multiflora rose (*Rosa multiflora*) and roundleaf bittersweet (*Celastrus orbiculatus*)). While a comprehensive analysis of the economic impacts of invasive species in Pennsylvania has not been done, these examples provide some insight of the vast scope of the costs they incur.

Human Health: Invasive species also have negative impacts on human health and create added costs for medical care. They can act as reservoirs or vectors of diseases like West Nile virus. Invasive plants like Japanese barberry (*Berberis thunbergii*) create favorable habitat for ticks and their hosts. Studies have found a higher incidence of Lyme disease-infected ticks in areas with Japanese barberry infestations. Other invasive plants like giant hogweed (*Heracleum mantegazzianum*) and wild parsnip (*Pastinaca sativa*) can cause severe burns and rashes. Studies on the effects of emerald ash borer, which has killed over a hundred million trees across North America, found that human deaths related to cardiovascular and respiratory illnesses rose in places where trees were killed by the pest due to increases in air pollution. In addition, many fatalities have been reported of dead ash trees falling on humans.

Animal Health: Invasive species can have far reaching impact on the health of both domesticated and wild animals. For livestock, invasive plants like poison hemlock (*Conium maculatum*) are toxic to animals if ingested and is difficult to remove because the sap is a skin irritant. The recently introduced invasive Asian Longhorned tick (*Haemaphysalis longicornis*) can vector several pathogens that are lethal to livestock, yet the extent to which this is happening in the US is still being studied. Invasive species can also vector diseases that affect wild animals; the invasive common house mosquito (*Culex pipiens*) vectors West Nile Virus which has been responsible for the decline of many wild bird species. In aquatic systems, species like sea lamprey (*Petromyzon marinus*) have invaded the Lake Erie watershed and are parasites on native fish species. These are such a problem that the Great Lakes Fishery Commission spends $18 million annually on sea lamprey control.

Invasive species are a growing problem. The number of new invasive species introductions is increasing annually due to the expansion of global trade, land use changes and climate change. With the continued growth of global trade and travel, Pennsylvania can expect to see increasing pressure from new invasive species. Climate change will continue to facilitate the spread of invasive species and magnify their negative impacts. As native species are stressed by changing temperatures and weather, they increasingly lose their ability to compete with invasive species. Climate change will also allow some invasive species to survive and thrive in our climate that were not previously able to. There is also growing concern that climate change will impact the efficacy of herbicide and biological controls.

For all these reasons, invasive species require dedicated resources and management to prevent and mitigate their effects in Pennsylvania. This management plan provides a framework to address and improve efforts to meet the ever-increasing threat of invasive species to our Commonwealth.

4.3 How invasive species get to Pennsylvania: Introduction pathways

Introductions of invasive species mainly occur through either intentional or unplanned human-mediated pathways. In an increasingly connected world, invasive species transport is facilitated by travel or commerce vectors. Additionally, invasive species may also spread through natural means via corridors connecting waterways and land or along human-created passages. Invasive species are introduced to Pennsylvania through all the pathway categories for the introduction of alien species delineated by the Convention on Biological Diversity (Document UNEP/CBD/SBSTTA/18/9/Add.1. 26 June 2014). The definitions for the pathways of introduction and an example of invasive species in Pennsylvania that spread through each pathway are presented here.

Intentional release in nature: Species *are planted or released intentionally for purposes such as biological control, hunting or fishing, habitat/environmental goals, or cultural/medicinal or other reasons.* Crown vetch (*Coronilla varia*) was planted intentionally for erosion control, especially at road construction sites. Since then, it has spread on its own outside of original plantings throughout Pennsylvania's agricultural fields and in disturbed habitats. Growing in dense monocultures, crown vetch may competitively exclude native plants contributing to their decline and disrupting the ecosystem.

Escape from confinement: Species that are intentionally contained in a confined environment can unintentionally escape. Feral swine (*Sus scrofa*) have escaped from captivity on farms or hunting preserves and have established free-roaming feral populations. These wild populations are destructive to wetlands and other natural habitats, carry diseases that can infect domestic pigs, and damage crops.

Transport as contaminants: Species are unintentionally transported as a contaminant along with animals, plants, consumer goods, or other materials. The hemlock woolly adelgid (*Adelges tsugae*) was likely introduced to Pennsylvania on the nursery stock of trees transported from Asia. This invasive insect subsequently established on native eastern hemlocks (*Tsuga canadensis*) in our state's forests. The resulting widespread tree death is severely damaging streamside forests that shade the cold-water streams, which native brook trout (*Salvelinus fontinalis*) require.

Transport as stowaways: Species are unintentionally transported as stowaways in equipment, vehicles, ballast water, boats, or recreation gear. Now decimating ash trees in Pennsylvania, the emerald ash borer beetle (*Agrilus planipennis*) is believed to have arrived in the U.S. in wood packing materials. The damage to ash trees is a costly loss to the timber industry, threatens the persistence of the rare pumpkin ash (*Fraxinus profunda*) and other ash trees, and kills street trees across the Commonwealth.

Spread via human-made corridors: Species can spread along human-made corridors, such as roads, trails, canals, tunnels, and railroads. Japanese stiltgrass (*Microstegium vimineum*) spreads on its own along roadways and trails, increasing its distribution along these disturbance corridors. From there, it easily invades forest understories where it can crowd out other plants and reduce biodiversity.

Spread unaided via natural corridors: Species can expand their distributions through dispersal along naturally connected habitats, such as waterways and connected suitable habitats. The aquatic plant, hydrilla (*Hydrilla verticillata*), may establish through vegetative means in new locations when fragments float downstream to a connected waterbody, or by hitchhiking on boats and trailers when unsuspecting recreationists travel to lakes and rivers across the Commonwealth. The dense growth of hydrilla creates unsuitable habitat for aquatic organisms and inhibits boating and fishing.

4.4 Ongoing Invasive Species Management in Pennsylvania

Currently in Pennsylvania, management of invasive species often falls to individual jurisdictional agencies, non-governmental organizations, or landowners. Examples of jurisdictional agencies include the Pennsylvania Fish and Boat Commission's charge to manage aquatic invasives; the Department of Conservation and Natural Resources' authority over forest pests and diseases; and the Department of Agriculture's responsibility for agricultural pests (for a full list of jurisdictional authorities, see Appendix). Other state and federal agencies are responsible for inspecting domestic and international agricultural commodities, consumer goods, and other imported goods. For example, the U.S. Department of Agriculture Animal and Plant Health Inspection Service enforces the Plant Protection Act (7 U.S.C. 7701) to prohibit or restrict the importation, exportation, and interstate movement of plants, plant products, biological control organisms, noxious weeds, and plant pests. Private conservation and agricultural organizations, such as Western Pennsylvania Conservancy and Pennsylvania Landscape and Nursery Association, also share in the effort of restricting and managing invasive species. Educational institutions in the state, such as Penn State University and Temple University, help research invasives, while local groups such as Allegheny Plateau Invasive Plant Management Area, educate citizens and organize control efforts.

Overarching all these groups, the Pennsylvania Governor's Invasive Species Council (PGISC) recognizes invasive species threats and forms a united response between agencies and organizations. The mission of the council is to "minimize the harmful ecological, economic and human and animal health impacts of invasive species through the prevention and management of their introduction, expansion and dispersal into, within and from Pennsylvania" (Executive order 2017-17). The PGISC is made up of seven state agencies and fourteen non-governmental organizations (for a full list of PGISC members and responsibilities, see Appendix), which meet quarterly in meetings open to the public to highlight recent invasive species discoveries and management initiatives, develop invasive species action plans, advise the Governor on invasive species policy development, and coordinate interagency responses to invasive species threats. The PGISC seeks to identify invasive species of concern that could potentially threaten the Commonwealth's resources, and to improve public outreach and education on these species.

Despite PGISC's ongoing efforts, as well as those of many agencies, groups, and individuals, management of invasive species continue to present a significant challenge across the Commonwealth. Pennsylvania is a large state, with diverse stakeholders, landowners, natural ecosystems, and economic activities. Hundreds of invasive species are already present in the state, impacting agriculture, human and animal health, timber, rare native species, waterbodies, recreation, and industry. Meanwhile, there are many known potential invaders that have not yet entered the state but might easily be introduced from surrounding regions (e.g., Asian longhorned beetle (*Anoplophora glabripennis*)).

Pennsylvania's current approach to invasive species has critical gaps in jurisdictional responsibility, responses, staffing, and funding resources.

Attempting to control the impacts of established invasive species and minimize the introduction of new species is a major effort that cannot be handled by the individual responses of citizens, organizations, or government agencies. Instead, all must work together to share knowledge, prioritize threats, adopt effective policies, and muster sufficient resources to meet the challenge. A statewide plan is required to meld the efforts of these groups into a cohesive strategy that will effectively protect Pennsylvania.

5. Pennsylvania Invasive Species Management Plan

5.1 Introduction

Invasive species management plans describe the tools, techniques, policies, and actions needed to prevent and control invasive species, and restore ecosystems that have been adversely affected by them. Invasive species management plans are vitally important to minimize the chances that new invaders will become established and cause harm, and to control established invasives to minimize the harm they cause.

Comprehensive invasive species management plans have four essential features. First, they are science-based and data-driven to ensure management decisions are based on accurate and reliable information. Second, they outline regular field survey procedures to detect new species introductions and monitor changes in the distribution of established populations. Third, they prescribe strong education and outreach programs that engage the public in awareness, detection, and control of invasive species. Lastly, they are updated regularly using an iterative, adaptive management process to account for newly acquired information, unexpected events, and uncertainties. An effective framework to organize the essential features of an invasive species management plan consists of four components that correspond to the stages of the non-native species invasions (Figure 1). **Prevention** focuses on identifying and addressing invasive species before they are introduced. **Eradication** focuses on detecting invasive species early after introduction and mounting a rapid response to eliminate the population. **Containment** focuses on limiting the geographic spread of invasive species that have established by controlling their dispersal to other locations. If enacted quickly, these two components can be effective in removing invasive species that have been introduced through early detection and rapid response (EDRR) programs. **Long-term management** seeks to reduce the densities of well-established invasive species to limit their negative impacts. Of these four components, prevention is by far the most important and least costly component of invasive species management that can have the biggest and most positive impact for the Commonwealth. Unfortunately, invasive species are often introduced and established before they are discovered. Therefore, this plan places special emphasis on eradication, containment, and long-term management.

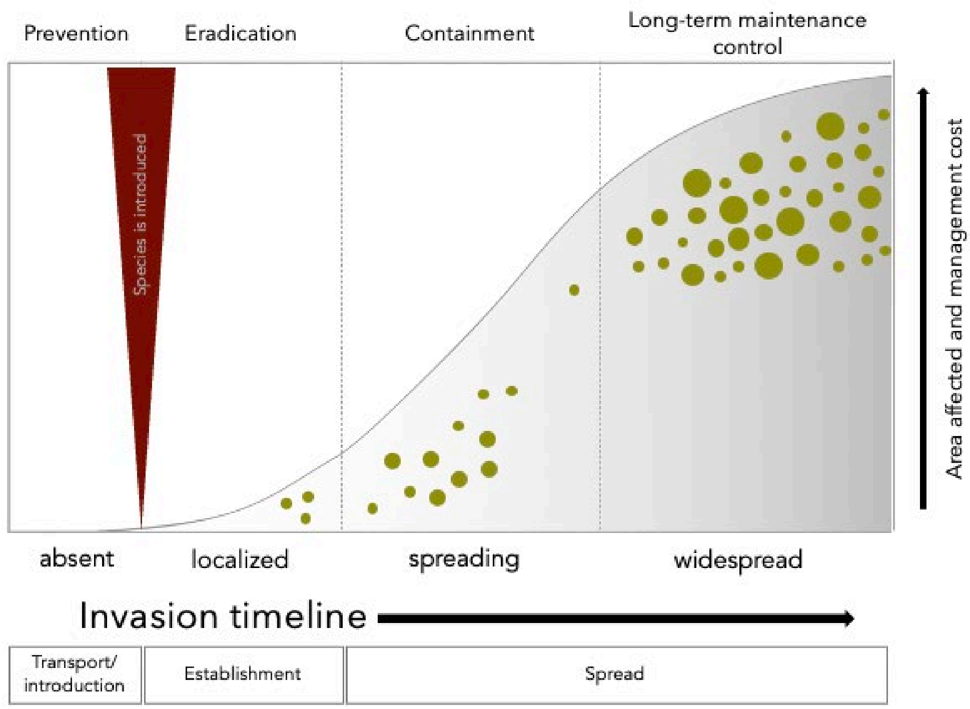

Figure 1: Generalized invasion curve showing management options appropriate to each stage of a species invasion. Figure credit: Adapted from Invasive Plants and Animals Policy Framework/State of Victoria, Department of Primary Industries, 2010

While it is convenient to organize a management plan into discrete sections that correspond to stages of invasion, for any given species, the extent of the invasion and size of its population may require application of several strategies concurrently (Figure 2). For example, before the species is introduced to Pennsylvania, prevention is the only strategy needed. Following introduction, eradication and containment (EDRR) should be used. However, as the species spreads, smaller satellite populations may be amenable to eradication, whereas the eradication of larger populations may not be a feasible option and long-term management is needed. Above all, clear definitions for all end goals and actions are imperative for guiding the management of an invasive species.

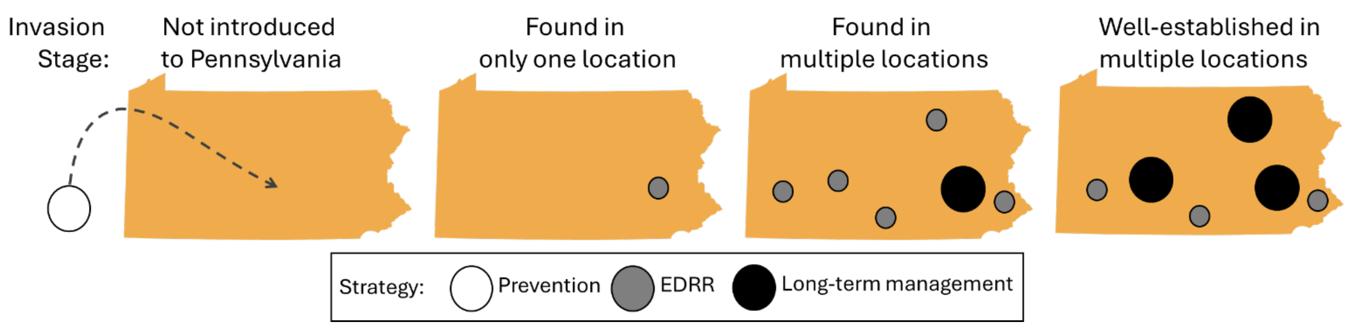

Figure 2: Management strategies (shading of circles) appropriate for invasion stage. For species not yet introduced to Pennsylvania, Prevention is the appropriate strategy. Once the species has been introduced, if the population is small enough, eradication and containment may be achieved through an early detection rapid response (EDRR) program. Once the population grows beyond the capacity of EDRR, then long-term management is necessary. Importantly, different strategies may be needed for different populations of a single invasive species depending on the extent of the invasion, as illustrated in this figure.

5.2 PRISM: The vision for future invasive species management in Pennsylvania

Pennsylvania is at a crossroads in invasive species management. While there has been progress, invasive species management continues to be an unrelenting challenge that will only intensify in the future. If the state continues on the current management trajectory, it is unlikely to keep pace with the challenges invasive species present and negative environmental, economic and health impacts will increase. One of the main obstacles to effectively managing invasive species in the Commonwealth using the current strategies lies in the absence of coordinated management from the state to regional and local levels. Therefore, PGISC recommends the establishment of a Partners for Regional Invasive Species Management program (PRISM). See Figure 3 for a comparison of key differences between current strategies and the proposed PRISM program. Such programs have been developed elsewhere and serve to successfully fill gaps in communication, resource allocation and effort coordination from state to regional and local levels. Here we outline the components of a PRISM program in Pennsylvania and highlight priorities for funding.

A regional approach to invasive species that relies on partnerships of natural resource managers including NGOs, universities, state and federal agencies, and other government entities (e.g., county conservation districts) is anticipated to be a successful model for managing invasive species. Six PRISMS will cover the regions of Pennsylvania: northeast, north central, northwest, southwest, south central, and southeast. Each PRISM's region is a focal, geographic area for invasive species management.

A PRISM would be comprised of partners within the region whose knowledge will anchor the partnership's efforts in the current management needs for the area. Expertise relevant to the region and its highest priority invasive species threats, early detection species, key stakeholders, and vectors for transmission will be valuable for effective control of invasive species. As suggested by PGISC, the structure for PRISM would include the partner members, a steering committee, a staff coordinator, supporting staff members, and volunteers. The staff would be embedded within a partner organization. Funding provided by the state budget is necessary for a sustained PRISM program in order to systematically address invasive species management. Additional funding would be sought by the partnerships for projects within the region and research to inform invasive species management.

The tasks of PRISM are anticipated to be wide-ranging and will include facilitating early detection of novel invasive species, coordinating invasive species control efforts and monitoring, implementing strategies to prevent invasive species threats, restoring habitats impacted by invasive species, and educating stakeholders about invasive species topics. The PRISMs will coordinate with state and regional invasive species initiatives and research on topics related to management, early detection, and the impacts of climate change. The intention is to share information among PRISMS about invasive species occurrences and management to synergize efforts and maximize resources. PRISM partners will work together on shared goals under the umbrella of the partnership.

Many recommendations and actions in this plan are integrated with a functioning PRISM program. Without it we anticipate that the needed recommendations will not be enacted, and the prescribed actions will not occur to meet the most urgent needs for invasive species management.

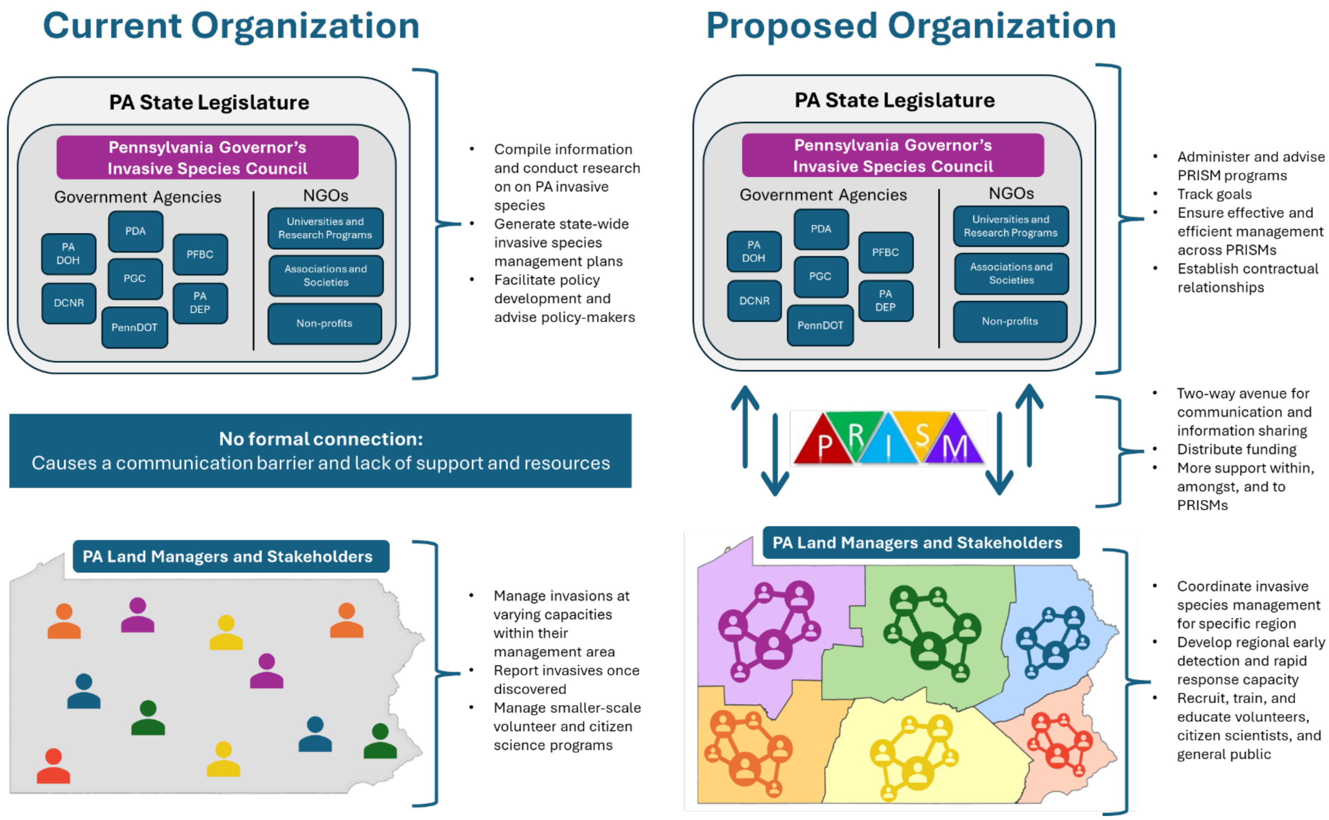

Figure 3. A comparison between the structure of current of invasive species management in Pennsylvania and the proposed Partnerships for Regional Invasive Species Management (PRISM) program.

Priorities and funding

A robust PRISM program with funding is needed for effective improvements to invasive species management. The level of invasive species management and restoration efforts would be increased many-fold through the adoption of PRISMs. Projects would be prioritized within PRISM regions and completed by participating collaborators. Moreover, sustained funding would facilitate management of invasive species and increase ecological restoration. Currently, invasive species management funding is largely limited to select programs on public lands and the funds are often limited in the scope of how they can be applied. Support from other sources of funds, that expand the types of lands and waters where restoration projects occur, could go far to reduce invasive species and improve ecological restoration on public and private lands and waters. As of the time this writing, funding for the program has not been acquired to support a statewide program for PRISMs.

Recommendation

1. Establish and maintain a statewide Partnerships for Regional Invasive Species Management (PRISM) program across all regions of Pennsylvania.

Action:

The Council and partners will work to develop a funding mechanism to support a statewide PRISM program administered by the Pennsylvania Department of Agriculture. A PRISM program would provide the structure and mechanism to complete recommendations and actions identified in this plan.

5.3 Prevention

Prevention of colonization by invasive species is not only the most successful management option, but also by far the most cost-effective way to minimize their associated risks and impacts. Globally, prevention programs are underfunded; we spend on average 25 times less on prevention than management. However, the return on investment for prevention is 1:100 whereas the return on investment for management is only 1:1-5*, indicating a strong need to invest in prevention measures. Successful prevention requires three things:

1) *Horizon scans* that systematically identify species that pose potential threats before they are introduced to an ecosystem
2) *Risk assessments* that prioritize species that pose the greatest threat and sites at greatest risk of being impacted by introduction
3) *Pathway analyses* that forecast routes of dispersal and modes of introduction

Recommendations

2. Develop policies and resources to improve prevention of invasive species introductions and monitor invasion pathways.

Actions:

The PGISC should make recommendations to jurisdictional agencies to develop certification programs to prevent the movement of invasive species and certify products free of invasive species (for example, weed-free certifications for mulch, gravel, fill and feed). Additionally, plants used in landscaping previously limited by climate may become invasive due to an expanded potential range associated with global climate change and should therefore be considered for regulatory listing.

Jurisdictional agencies and partners should institute procedures to prevent the spread of invasive species by outdoor recreationists, particularly for geographic areas around known infestations and pathways with prevention opportunities. For example, jurisdictional agencies should mandate inspections for watercraft via additional boat launch steward programs and install boot cleaning stations at trailheads of state and local parks.

* Cardinale, B. J., and J. D. Murdoch. 2025. Conservation Biology, 2nd edition. Oxford University Press.

3. Improve public outreach and education for prevention of high-risk invasive species threats.

Actions:

Jurisdictional agencies, Penn State Extension, PA Sea Grant, and PRISMs should conduct public outreach and education on invasive species risks and pathways for spread through effective communications and educational events.

Jurisdictional agencies, Penn State Extension, PA Sea Grant, and PRISMs should increase resources available to educate the public and assist with prevention efforts, particularly to interrupt known pathways and stop the spread at recreation access points (for example, trailheads, boat launches, parks, or rights-of-way) and around known high priority infestations.

5.3.1 Horizon Scanning

Horizon scanning is a systematic process of identifying potential future threats by gathering, evaluating, and prioritizing information on species before they are accidentally or intentionally introduced to an ecosystem. The information gathered from a horizon scan can come from a variety of sources, including literature reviews, analysis of species present at the beginning and end of trade or transportation routes, surveys of expert invasion biologists, and analyses of species distribution models. Regardless of how potential threats are identified, best management practices require that horizon scans be performed on a regular basis, approximately every five years, so that potential threats can be identified and assessed before they materialize. To our knowledge no systematic horizon scan for Pennsylvania has been conducted.

Recommendation

4. Conduct Horizon Scanning to identify invasive species with a high risk of introduction to Pennsylvania.

Actions:

Jurisdictional agencies, PRISMs, and partners should evaluate invasive species that are not currently present in Pennsylvania to identify those that are of high risk of introduction and the potential for range expansion due to climate change. Identified species should be proactively added to appropriate banned or prohibited regulatory lists and inform the PGISC.

For high-risk species that do not align with any agency's jurisdictional authority, like jumping worms for example, the PGISC should recommend an agency to take on this role.

5.3.2 Risk Assessment

In conjunction with horizon scanning, *risk assessment* is also used to prioritize the use of limited resources towards those species that pose the greatest risk. Analysis of risk considers two things: 1) the probability or likelihood that a potential threat will occur (e.g., introduction, establishment, and spread of species) and 2) the consequences or impact if the threat does occur. These two components of risk can be visualized by creating a 'risk matrix' that organizes species according to the probability they will be introduced, become established, and spread versus their predicted impact (Figure 3). Species that have low probabilities of becoming established may not be high priorities for management, even if their impacts are potentially large (Fig. 3, yellow, orange). Similarly, species with high probabilities of establishment may not be a priority for management if their impacts are predicted to be negligible (Fig. 3, green). Instead, limited time, funding, and personnel should be spent on managing species that have high probabilities of establishment as well as severe impacts if established (Fig. 4, red).

Risk assessment protocols can be structured in multiple ways depending on the context and objectives. Some are qualitative, such as those that rely on expert opinions that are solicited using questionnaires that ask experts to identify threats and score potential impacts and probabilities of introduction, establishment, and spread. Other methods are more quantitative, such as trait-based risk assessments that use measurable life history traits and other biological characteristics, like genetic or morphological

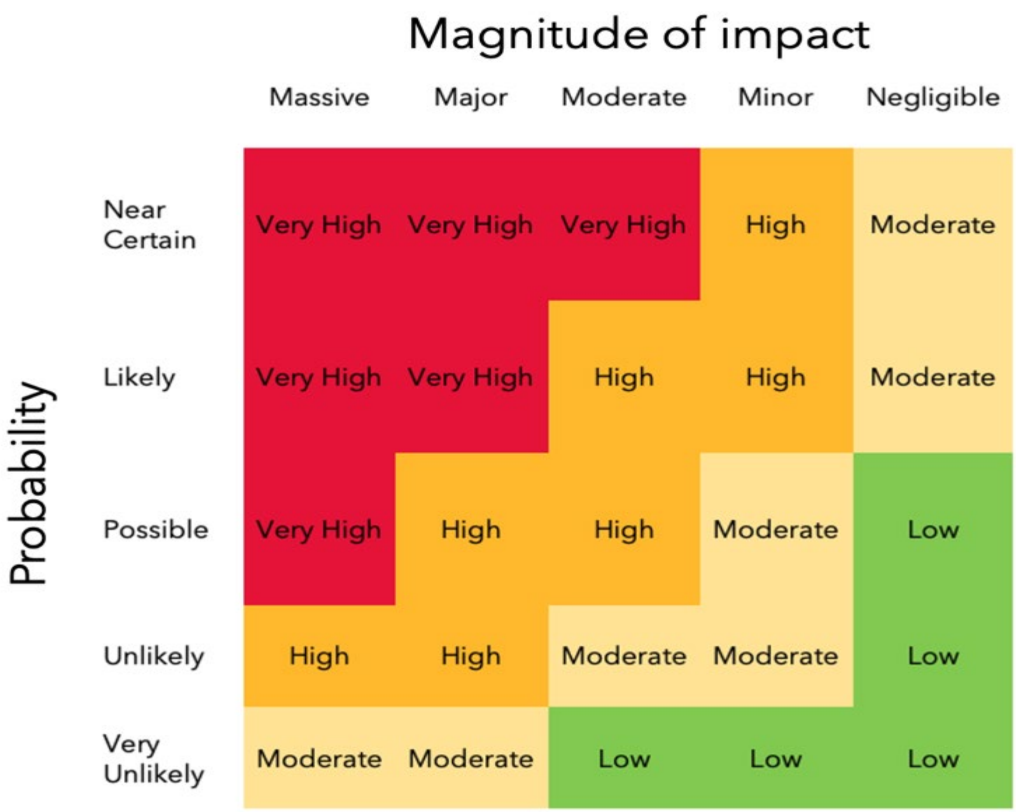

Figure 4. Invasive species risk matrix showing the probability that a species will be introduced and the predicted impact (risk) of that species. Cell entries give estimates of risk from low risk (green) to moderate risk (yellow) to high risk (orange, red). These are organized according to how likely an invasive species is to be introduced, become established, and spread, and their potential impact. Figure credit: Lieurance D, Culley T, Brand M, Canavan S, Daehler C, Evans C, Keller R (2024) Preventing the next plant invasion: Opportunities and challenges. Council for Agricultural Science and Technology (CAST). Issue Paper 73. CAST, Ames, Iowa.

characteristics, of invasive species to try to predict their introduction, establishment, and spread. The example of a completed risk assessment for wavyleaf basket grass (*Oplismenus hirtellus*) is applicable for the concepts for other assessments.

Recommendation

5. Conduct full risk assessments for high-risk invasive species identified from horizon scans.

Actions:

Jurisdictional agencies should lead efforts with the PGISC, PRISMs, and partners to conduct risk assessments, identify high-risk invasive species and regularly update early detection species lists based on assessments.

Agencies should inform the PGISC of completed risk assessments and species lists, and the PGISC will publish these assessments on their website.

The PGISC should work with agencies to ensure risk assessment processes are standardized.

5.3.3 Pathway Analyses

Pathway analyses are the final component of prevention. Pathways are the means and routes by which invasive species spread from one location to another (see Section 4.3). A pathway analysis is a summary of the pathways of spread for high-risk species identified in horizon scanning and risk assessment analyses, which can be used to identify pathways that represent the greatest risk of introduction, and thus, in greatest need of management action (Figure 5). Pathways are often weighted by factors that represent the probabilities of introduction, such as the number of hikers who might be transporting seeds on their shoes, fishing pressure on a lake that might influence chances of deliberate release, volume of traffic, etc. Weighted pathways are then used to identify routes that represent the greatest risk of introduction so that steps can be taken to manage those risks.

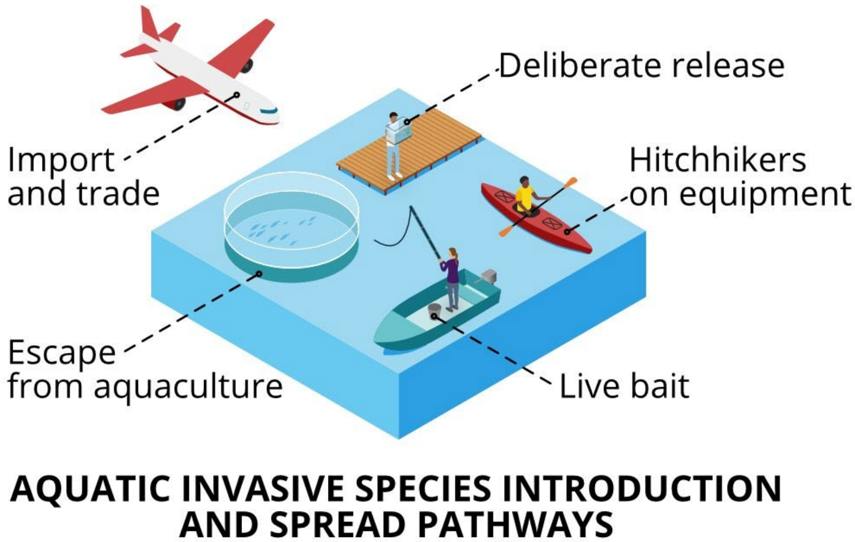

Figure 5. Hypothetical pathways of introduction and spread for an aquatic invasive species, yet keep in mind that pathways exist for all invasive species regardless of whether they are aquatic or terrestrial. A pathway analysis summarizes these means of spread to identify areas of risk that must be controlled. Source: www.gov.uk

Recommendation

6. Conduct pathway analyses and implement surveillance for identified high-risk invasive species.

Actions:

Jurisdictional agencies, PGISC, PRISMs, and partners should conduct pathway analyses for species on considered to be priorities for early detection due to a high risk for invasiveness.

Agencies should increase staff, funding, and collaborations to improve surveillance of invasion pathways.

5.4 Eradication and containment through early detection and rapid response

If an invasive species is introduced to the Commonwealth, the next best option is to detect it as early as possible and rapidly respond by either eradicating the species before it spreads or containing the infestation to prevent establishment or further spread. Rapid response to eradicate or contain a population is the next best option if prevention is unsuccessful. Complete remediation and restoration of an invaded habitat is achievable when management actions are implemented early, before irreversible environmental and economic impacts take hold.

5.4.1 Early Detection

5.4.1.1 Identifying emerging threats

Successful early detection begins with the ability to identify which invasive species pose a threat and where they are most likely to spread. Species prioritized through horizon scanning, risk assessment, and pathway analyses are used to create a watchlist for surveillance and monitoring for early detection. These priorities should be communicated to the agencies and organizations involved in monitoring, identification, reporting, and control so they can be incorporated into existing surveillance programs. Guidance should specify recommended survey methods, identification criteria, specimen documentation, reporting procedures, and subsequent management steps.

Novel invasive threats are not always known or identified in advance. For this reason, successful early detection also relies on the efforts of knowledgeable community members and natural resource professionals to identify emerging infestations that are unknown or unfamiliar.

5.4.1.2 Surveillance

Proactive surveillance for emerging threats in areas that have a high risk of introductions, and that target priority invasive species, is needed for early detection of new invasions. Targeted surveys to actively find new or spreading infestations require resources. Currently, ongoing surveillance is mainly focused on agricultural and forest pests. For example, the Pennsylvania Department of Agriculture's programs include surveillance for pathogens, nematodes, mollusks and insects in agricultural food production, forests, and plant nurseries. The Department of Conservation and Natural Resources runs similar programs for forest pathogens and pests. Expansion of surveillance and monitoring to include a wider variety of organisms would increase biosecurity within the Commonwealth across multiple sectors and ecosystems. New programs could prioritize additional, high-risk organisms, provide staff capacity in jurisdictional agencies, and include initiatives with partners and community scientists to expand the reach of early detection monitoring. For instance, a framework for surveillance could include a network of monitors from agency and partner organizations and the integration of emerging technology to surveil areas with increased risk of novel invasive species.

Recommendation

7. Increase surveying and reporting for new invasive species.

Actions:

Jurisdictional agencies and PRISMs should prioritize surveillance efforts for species identified by horizon scanning and risk analyses and high-risk pathways for early detection.

Jurisdictional agencies and PRISM should report early detection sightings to the public online statewide database Pennsylvania iMapInvasives, unless other species-specific reporting tools exist such as the

Penn State Extension reporting tool for spotted lanternfly or agency protocols dictate other reporting mechanisms.

5.4.1.3 Reporting

When a novel invasive species is detected in Pennsylvania, it is essential that the finding be reported, and the information communicated to the appropriate authority to initiate a rapid response process. Information about the occurrence ideally would be reported to a centralized database, such as Pennsylvania iMapInvasives, which shares the report with jurisdictional agencies (noted below). Reporting invasive species findings to a centralized database consolidates information and may be accessed by jurisdictional agencies and partners to share data and standardize findings.

A report of an early detection species should contain information about the location including GPS coordinates, extent of infestation, and high-quality photographs or a collected specimen to confirm the sighting. Once the information is received by Pennsylvania iMapInvasives, it will be quickly communicated to invasive species coordinators at the appropriate jurisdictional agency and other relevant partners. The parties receiving the information may then begin the next steps for response.

- **Pennsylvania iMapInvasives**
    - Public report form and online database for all invasive species
    - Communicates reported occurrences to jurisdictional agencies
    - Email alert capability which allows custom notifications about submissions of recently reported invasive species

Jurisdictional agencies provide mechanisms such as email, online reporting portals, and phone hotlines for directly reporting invasive species under their responsibility. In Pennsylvania, there are a variety of ways to report early detection of concerning invasive species:

- **Pennsylvania Department of Agriculture**
    - Email badbug@pa.gov to report insect invasive species
    - Spotted Lanternfly reporting webpage and hotline 1-888-4BAD-FLY (1-888-422-3359)
    - PA noxious weed reporting hotline (insect invasive species, terrestrial or aquatic noxious weeds) 1-833-INVASIV and email RA-plant@pa.gov

- **Pennsylvania Game Commission** Wildlife disease reporting webpage

- **Pennsylvania Fish and Boat Commission**
    - Aquatic invasive species reporting form (for other aquatic organisms)

- **Pennsylvania Sea Grant**
    - Mobile app for aquatic invasive species

While there are multiple ways to report invasive species, timely response requires effective communication and collaboration between the receiving entity and jurisdictional agencies or partners. Agencies often prioritize reports of certain taxonomic groups but may lack the capacity to document species considered a lower priority. Underreporting or not reporting lower priority organisms is a significant gap that needs to be addressed to improve capacity for early detection and rapid response.

Recommendation

8. Improve invasive species reporting and ensure communication about priority invasive species among jurisdictional agencies, PGISC and partners.

Actions:

Agencies, PRISMs and partners should support the centralized database, Pennsylvania iMapInvasives, and encourage reporting of occurrences of invasive species.

Agencies, PRISMs and partners should improve communication particularly about reports of high priority invasive species to ensure rapid response and management.

Examples of invasive species education and outreach products to spread awareness

- "Seeing The Unseen: Aquatic Invaders & What's at Stake" documentary film produced by the Western Pennsylvania Conservancy in partnership with Great Lakes Media & Film
- Short videos produced by the Pennsylvania Fish and Boat Commission:
  -Getting to Know Invasive Mystery Snails
  -Getting to Know Invasive Rusty Crayfish
  -Getting to Know Invasive Hydrilla
  -Getting to Know Invasive Curly Pondweed
  -Getting to Know Invasive Red-eared Sliders
  -Clean Your Gear to Prevent the Spread of Aquatic Invasive Species
- Pennsylvania's Field Guide to Aquatic Invasive Species produced by Pennsylvania Sea Grant
- Mid-Atlantic Field Guide to Aquatic Invasive Species produced by Pennsylvania Sea Grant
- Series of Rapid Response Case Studies developed by the PGISC Aquatic Invasive Species Rapid Response Committee
  -Water Lettuce and Water Hyacinth
  -Invasive Carp
  -European Water Chestnut

5.4.1.4 Awareness

Expanded outreach to the public is needed to generate awareness of species targeted for early detection responses and reporting. Similarly, providing clear guidance on what to look for and how to report occurrences can broaden participation and strengthen surveillance. Effective communication about early detection invasive species should aim to engage a would ideally wide audience and emphasize the importance of reporting occurrences of high priority invasive species.

5.4.2 Rapid Response

Once a priority invasive species is detected, a rapid response provides the best opportunity to minimize negative impacts and enables the possibility of eradication. Response may include eliminating the new invasion entirely, isolating the threat, or preventing its spread through containment measures. Most importantly, a concerted response should proceed at a pace that matches the rate of spread of the infestation.

5.4.2.1 Planning

Actions taken under the category of rapid response depend on the resource at stake, authority granted to jurisdictional agencies, and available funding. Specifically addressing aquatic invasive species, the Rapid Response Plan and Procedures for Responding to Aquatic Invasive Species in Pennsylvania (2022) (hereafter referred to as the aquatic invasive rapid response plan) outlines action steps once an threat is verified:

- Risk assessment – Determining whether the report is a credible and a highly invasive threat in a new geographic region
- Site assessment – Assessing the spread and level of invasion
- Evaluating response options – Choosing priority objectives and developing response options
- Implementing a response plan and follow-up activities – Creating a plan for the chosen response action and implementing the needed actions.

A rapid response plan for terrestrial organisms should be developed to apply to organisms which are not addressed in the aquatic plan. It would include similar topics as those in the aquatic invasive rapid response plan. Creating a plan for terrestrial organisms would establish a commitment to rapid response procedures for the entities involved.

5.4.2.2 Culture of action

Reacting to emerging invasive threats requires nimbleness for addressing a novel situation and the resources to follow through with rapid response actions. Actions must be implemented quickly to prevent an invasive species from becoming established and infestations expanding. While the plan outlines actions needed for aquatic invasive species, resources to follow through with next steps are also necessary. The concepts of the aquatic invasive rapid response should be explicitly applied to situations involving terrestrial invasive organisms in a separate plan.

To be successful, there must be a culture of urgent action, adequate staffing capacity, and funding to carry out rapid response. When faced with the challenge of confronting a newly discovered invasive species, agencies and partners may find that resources come up short for mounting a full and rapid response. Current staff levels at jurisdictional agencies are below what is needed to address novel threats and only the most high-level threats receive any follow-up actions. Staff may not have the funding to thoroughly evaluate an emerging threat, develop plans for management, and implement a response. What is needed is an addition of dedicated staff at jurisdictional agencies with the authority and resources to act rapidly upon novel invasive species threats.

Recommendations

9. Effectively communicate information about new and emerging invasive species and rapid response efforts that have been implemented.

Actions:

The PGISC should create a communications plan and establish mechanisms (e.g., letters of understanding) to ensure stakeholders (e.g., agencies, organizations, PGISC members, and PRISMs) are promptly informed of reports of early detection species and rapid response actions. The communications plan should encourage information sharing with partners and stakeholders and establishing effective communications among agencies and partners to improve response. The plan should include points of contact in each agency who are responsible for sharing information. A communications plan should parallel communications mechanisms outlined in the Rapid Response Plan and Procedures for Responding to Aquatic Invasive Species in Pennsylvania (2022).

10. Develop a state rapid response plan for terrestrial invasive species to respond to high priority invasive species infestations in a timely manner to eradicate them at the early stage of establishment.

Actions:

In coordination with the PGISC, the Pennsylvania Department of Conservation and Natural Resources and the Pennsylvania Game Commission should develop a rapid response plan for terrestrial invasive organisms, including terrestrial plants. The plan should include strategies for rapid response on both public lands and private properties, early detection priorities, survey methods, identification information, specimen documentation, and reporting mechanisms. The plan should create a rapid response template that can be utilized for any given invasive terrestrial species, as a response is needed. The plan should include actions that anticipate the impacts of climate change in facilitating species spread.

11. Establish reserve funds that can be utilized to rapidly respond to new invasive species introductions.

Actions:

Agencies should establish their own reserve fund to implement rapid response procedures to new invasive species threats under their jurisdiction.

5.4.2.3 Organized and effective response

An organized response to invasive species should follow a structured and dynamic plan to describe the extent of the infestation, the options for actions, the resources needed, sources of funding, personnel, timing, permitting, outreach needs, partnerships, evaluation steps, and restoration options. The plan should be organized by the appropriate jurisdictional agency. Structured decision-making should be the basis for the rapid response plan to clarify objectives, identify outcomes, weigh tradeoffs, and implement the most appropriate response (Figure 6). Staff should have the ability to act urgently, with authority, and have the flexibility to mount an organized response. Expanded capacity for jurisdictional agencies and dedicated funding for rapid response efforts is greatly needed.

An approach similar to emergency management using an incidence command system (ICS) could be applied to rapid response for invasive species. In ICS, a dynamic management hierarchy and procedures are established to coordinate a novel situation, such as an emerging invasive species threat. An ICS coordinates organizations which may otherwise work together sporadically, manages the resources for the incident, and integrates communications under the directive of an incident commander. An ICS is designed to avoid a lack of accountability, poor communication, and lack of an orderly, systematic planning and implementation process.

Invasive species management through regional groups could also contribute to rapid response efforts and be integrated into ICS or other rapid response plans. Efforts for rapid response and long-term management could be synergized through partnerships. A model for Partnerships for Regional Invasive Species Management (PRISMs) is used in other states, such as New York. PRISMs consist of cooperators (state and regional agencies, non-governmental organizations, and other partners) which have a shared goal of prioritizing and managing invasive species threats in a region. Although PGISC supports the development of a PRISM program to combine the Commonwealth's counties into regional groupings under the mandate to address invasive species and expand current capacity for management, PRISMs are not yet created across the state. With additional support, funding from the state budget could soon make PRISMs a reality. As of this writing, the Legislative Committee of PGISC is seeking support from legislators and the Governor's office to add funding to coordinate invasive species management in the state. If successful, it would be awarded to PGISC to fund for PRISMS.

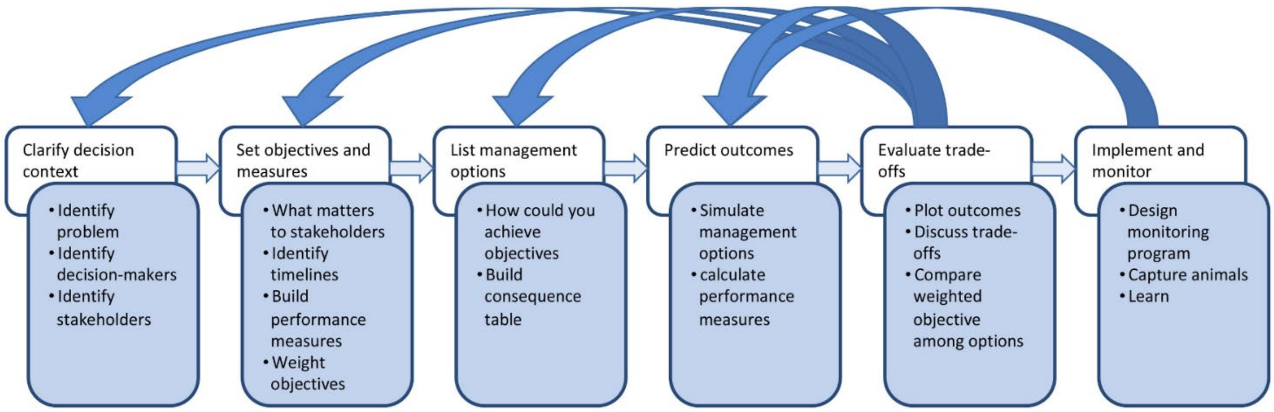

Figure 6. A generalized structure of the decision-making process required to implement an effective rapid response to new invasive species introductions. Adapted from Liu and Cook 2016, The International Society for Plant Pathology.

Recommendation

12. Establish or improve organizational systems, such as incident command systems, that are implemented for responding to new invasive species introductions.

Actions:

Agencies and partners should establish or improve organizational systems for the implementation of rapid response, such as incident command systems. The organizational systems, such as incident command systems, would define roles for staff members, ensure communication among involved parties, assess plans, manage resources, and develop a systematic implementation for rapid response for a specific event.

5.4.3 Eradication

If an invasive species is detected early when the population is small and localized, and the management response is quick enough, it may be possible to eradicate the species' population. Eradication occurs when no individuals capable of reproduction now or in the future remain. Since eradication is incredibly difficult to achieve, "functional" eradication may be a more realistic outcome, where populations are kept below levels that cause appreciable environmental harm. Functional eradication is achieved through a combination of containment and management strategies.

5.4.4 Containment

In many cases, once invasive species managers are alerted to an invasion, the species has already established a reproducing population. In such cases, it is important to enact c*ontainment* measures to prevent the spread of the species to new locations. Often, the same factors that make a species difficult to eradicate also make it difficult to contain. For example, species with high reproductive rates and difficult-to-predict dispersal patterns are difficult to eradicate or contain. For this reason, considering containment as a back-up to eradication may be a strategy with little chance for success.

Instead, it may be more effective to use containment and eradication strategies together when managing an invasive species. If eradication is not possible, containment will continue indefinitely and be a component of a long-term management plan. Regardless of whether the overall goal is eradication or long-term management, successful containment strategies have no endpoint; successful containment results in the species 'being contained' for an infinite time period. Breaches in containment measures are inevitable and should be part of the management strategy. Containment plans must be adaptive and iterative to respond to changing conditions.

It is imperative to identify the spatial scale at which a species disperses to new locations and enact containment strategies at this scale. For many invasive species, their spread to new locations involves a mix of dispersing naturally and dispersing through human assistance (e.g., secondary pathways). Natural dispersal may occur seasonally, such as the dispersal of porcelain berry (*Ampelopsis brevipedunculata*) seeds by birds in autumn or with particular weather conditions like the overland dispersal of invasive crayfish during flooding rain events. Human-assisted dispersal is often unintentional and occurs when species hitchhike on goods or vehicles moved from one location to another, such as the spread of hydrilla (*Hydrilla verticillata*) from one lake to another by boats or trailers. However, human-assisted dispersal can also occur intentionally by the use of unregulated invasive species for horticulture.

Once the spatial scale of a species' dispersal mode(s) is identified, containment plans can be devised. For some species, an effective containment plan may be to delineate a core invaded zone surrounded by a buffer zone within the species' dispersal range where it does not yet occur (Figure 7). While the unoccupied zone surrounding the buffer zone is beyond the expected dispersal distance of the species, long-distance dispersal events to this zone are still possible, especially if the species is spread by humans. Containment of the species may be best achieved by intercepting the species while it is dispersing. Alternatively, for species with cryptic modes of dispersal, containment may be better achieved by controlling propagules that arrive in the buffer or unoccupied zones. Since species may use different modes of dispersal to the buffer versus unoccupied zones, different surveillance methods (e.g., eDNA, regular surveys) may be needed to detect the species in each zone.

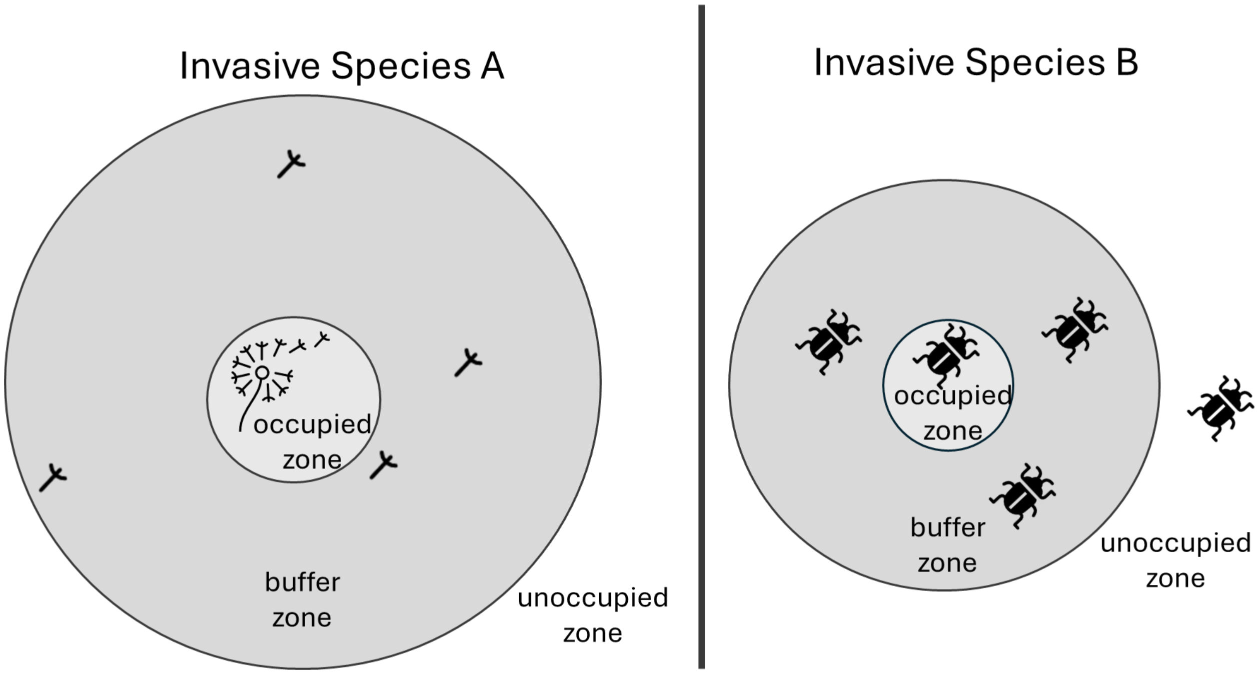

Figure 7: Example containment plans that use buffer zones. The size of the buffer zone surrounding the zone occupied by the invasive species is determined by the maximum likely dispersal distance of the species. In this example, invasive species A has a greater dispersal distance than invasive species B, hence the larger buffer zone. Because the buffer zone is scaled based on the species' dispersal distance, most propagules will likely disperse to the buffer zone and this is where surviellance measures should be focused. However, for species spread by humans (invasive species B in this example), long-distance dispersal events may occur to the unoccupied zone beyond the buffer zone, requiring additional surveillance. Figure modified from Grice et al. 2020, *Australian Journal of Botany*.

The main methods for enacting containment are inspections, quarantine, and barriers to dispersal, each of which are described below.

5.4.4.1 Inspections

Inspections of equipment, goods, vehicles, etc. for invasive species serve to detect invaders that may spread by hitchhiking. For example, the inspection of boats for hitchhikers (e.g., like that of the Pymatuning Boat Launch Steward Program in Crawford County, PA) can identify species that may be removed from an invaded lake and introduced to a new location. Different inspection methods may be needed for different life stages of the species: eggs, seeds, juveniles, adults, etc. Once species are detected, appropriate control methods can be enacted to reduce their spread to new locations. Inspections are successful for many types of invasive species, but not all species can be detected with the available methods.

5.4.4.2 Quarantine

Quarantines involve restricting the movement of goods or other items out of an invaded area and are frequently used to contain the spread of forest pests. For example, the region invaded by the emerald ash borer is under quarantine. There it is prohibited to move wood or nursery stock outside of the area. When followed, quarantines can be effective; however, public awareness and compliance needs to be high if enforcement is not feasible.

5.4.4.3 Chemical and physical barriers to dispersal

For some species, mounting chemical or physical barriers to dispersal can be an effective mechanism for containing species that disperse naturally. Chemical barriers serve to block or kill dispersing individuals. For example, carbon dioxide barriers in rivers can reduce the spread of invasive fish and have the added benefit of not interfering with shipping or river flow. Alternatively, pesticides can also be used as chemical barriers, but may have unintended consequences of harming native species. Like chemical barriers, physical barriers are also used to prevent the movement of invasive species and can be effective in aquatic habitats, such as the electric barriers used to contain Asian carp and prevent their spread into Great Lake watersheds. The effectiveness of physical barriers may vary depending on the species and are often not species-specific. In some cases, these barriers can also impede the movement of native species that may disperse in a similar manner. To minimize the potential non-target impacts of barriers, it is crucial to restrict their use to periods when the invasive species is actively dispersing. Once this period has passed, the barriers should be removed to restore the natural movement of other species.

Recommendations

13. Increase agency staff and capacity for early detection and rapid response to emerging invasive species threats.

Actions:

Resources should be provided for jurisdictional agencies to increase staff capacity and funds dedicated to carry out early detection surveillance and rapid response procedures to contain and eradicate emerging invasive species. This should include funds for the tools and resources needed for rapid response (e.g., inspections, signage, boat/vehicle/equipment cleaning, etc.).

Agencies should utilize additional staff and funds to engage stakeholders to foster collaborative, broad-reaching early detection and rapid response programs. This can be accomplished by creating community science and volunteer opportunities. Examples of other volunteer monitoring programs include the Alliance for Aquatic Resource Monitoring, the Pennsylvania Outdoor Corps, and the Master Watershed Steward Program.

Jurisdictional agencies and PRISM should be trained on the implementation of established organizational systems.

14. Identify invasive species that warrant rapid response efforts (e.g., containment and eradication) using a standard evaluation process and proactively develop plans to implement rapid response.

Actions:

A standard procedure should be developed to determine containment and eradication zones and procedures, identification of dispersal pathways, and monitoring and evaluating success.

Jurisdictional agencies should proactively evaluate and determine invasive species for which containment and eradication efforts should be completed on both a regional and statewide scale. Species identified for containment should be shared with the PGISC, the Governor's Office, and other relevant partners.

Jurisdictional agencies and PRISM should develop tailored procedures for response to specific invasion scenarios that includes an organizational system for implementation. These procedures should identify the most effective methods for eradication, containment, mitigation, and management.

The PGISC should support efforts to increase additional legal authority for jurisdictional agencies to quickly contain novel infestations.

15. Support research to develop more effective early detection, rapid response and control methods for invasive species.

Actions:

Jurisdictional agencies and partners should offer grants and support research on early detection, rapid response methods and effectiveness. The PGISC should support establishing a fund for research of novel and improved rapid response methodology.

16. Improve coordination between jurisdictional agencies and stakeholders for invasive species containment and eradication efforts.

Actions:

Jurisdictional agencies, partners, and the PGISC should manage and assess the containment and eradication status of invasive species, success and failure, needs, information gaps, and plans for next steps if containment fails. Included in the plans should be identification of the areas of information gaps, further assessment needs and research areas of interest.

17. Improve public awareness and engagement for early detection and rapid response activities.

Actions:

Jurisdictional agencies and partners should conduct outreach and education to create public awareness campaigns (e.g., webinars, presentations, and social media) of containment zones and their role in maintaining them and reporting breaches.

Jurisdictional agencies and PRISM should expand awareness for the public and professionals about early detection priorities, surveillance, best management practices, and reporting through educational outreach opportunities and trainings.

PGISC should promote the use of native species in landscaping by annually celebrating Pennsylvania Native Species Day and hold invasive species buy-back events, like the Pennsylvania Invasive Replace-ive program, to educate the public on the impacts of invasive species.

The PGISC, jurisdictional agencies, and partners should promote existing reporting systems (see page 26) to the public and encourage entering data into iMapInvasives.

5.5 Long-term Management and Restoration

Long-term management of invasive species takes place once the invasion moves into the long-term maintenance control portion of the invasion curve. At this stage, the cost and effectiveness of control and restoration efforts must be weighed against the benefits of controlling the impacts of established invasive species. Containment efforts may still continue to prevent the invasive species from moving to new areas, but within the core infested area management is focused in minimizing impacts instead of eradication.

Once a species becomes established, the priorities for long-term management often become less clear and more challenging to define. Strategies shift to containment and targeted management to slow the spread or to suppress infestations. Given extremely limited resources for dealing with invasive species, decisions must be made on where to spend time and money. Managers must answer challenging questions like, should efforts be taken to limit the spread of an established species? Which strategies are effective to decrease the impacts in invaded areas? Which species or taxa should be prioritized for management? How do we protect high priority resources from invasive species? Currently there is no standardized evaluation process that ranks and prioritizes important species, regions, or targeted areas for long-term management, success rates for restoration, or any method to assess the costs associated with invaded ecosystems (e.g., ecosystem services and management costs).

Therefore, most agencies, organizations, and individuals are only conducting long term management efforts in locations where invasive species are affecting their resources or jurisdictional charges (e.g., timber, game or rare native species, agricultural crops). As a result, the goal of long-term management is often to employ control methods that minimize dispersal specifically to protect certain resources.

Long-term management of invasive species is often broken into the following control methods: mechanical, chemical, and biological. It is important to understand the strengths and weaknesses of each method when considering how to prioritize or enact long-term management efforts. As with all invasive species management, education and outreach is a key component of long-term management to ensure the public is aware of ongoing issues related to established invasive species.

5.4.1 Mechanical Control

Mechanical control is any action that physically damages or removes the invasive species. It includes methods such as hand-pulling or picking, trapping, digging, mowing, fire, or browsing. For example, trapping or shooting feral swine; hand-picking spotted lanternfly; mowing Japanese knotweed; using controlled burns to manage Japanese barberry; cutting and chipping trees infested with emerald ash borer; or using goats to browse invasive plants. Mechanical control is generally the simplest form of control to enact, but due to its high labor and equipment costs, mechanical control is often expensive.

Mechanical control is especially useful for removing small infestations or it may be used in combination with other treatment methods for managing large areas of invasive species. For example, removal of infestations of water chestnut (*Trapa natans*) can be very effective eliminating it or suppressing it. By managing water chestnut the spread of this species is slowed. Similarly, mechanical control efforts like hand-pulling or cutting can be useful in smaller areas that are ecologically sensitive. For example, in wild plant sanctuaries, other control methods such as chemicals may have unintended consequences to the rare native plant species that necessitate control of invasive species in the first place. Removing invasive species solely by mechanical methods may not be feasible for large infestations, but in conjunction with other methods, like prescribed fires and chemical control, mechanical methods can be effective.

Perhaps most importantly, minimal training is needed to use certain mechanical control methods and they can be carried out by landowners and volunteers. State agencies and other land managers can increase public awareness about the problems posed by invasive species through volunteer removal programs. Such programs for removing invasive species (i.e., garlic mustard pulls or spotted lanternfly squishing) suppress infestations and also are a means to educate the public about the issue. Additionally, members of the public can suppress invasive species by cutting or digging up problematic plants on their property, which can help stop satellite infestations before they can grow into intractable problems.

5.4.2 Chemical Control

Chemical control is the application of pesticides to control an invasive species. The Environmental Protection Agency defines a pesticide as “any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.” Chemicals can be applied proactively to prevent an infestation, or directly to the invasive species. Examples of chemical control include the application of systemic insecticides to kill hemlock wooly adelgid (*Adelges tsugae*); piscicides to control snakehead fish; preemergent herbicide used to prevent mile-a-minute (*Persicaria perfoliata)* seed germination; or systemic herbicide to kill tree-of-heaven (*Ailanthus altissima*).

Chemical control is often highly targeted to taxa (i.e., mammals, fish, plants, or insects), and can even be targeted to more specific groups of species (i.e., the herbicide triclopyr targets broadleaf plants, but is not effective on grasses). However, pesticides can still have unintended impacts on native species or human health, especially if label requirements are not strictly followed. Future pesticide formulations that are currently being researched, including RNAi chemicals, may have greater selectivity with even fewer side effects.

Chemical control can be used as a spot treatment targeting individual organisms (e.g., tree-of-heaven trap trees for spotted lanternfly), or as large broadcast treatments (e.g., aerially applied spongy moth pesticide treatments). It can be especially effective and efficient, for example, compared with mechanical control on large scales.

Addressing invasive species will, in part, require integrating methods of chemical control. As invasive species management efforts grow, The PGISC, along with partners like Penn State Extension, will also promote systems that advance science, professionalism, and accountability in relation to tools like pesticide.

With more partners—from agencies and landowners to citizen stewards—engaging more actively in management, each shares a responsibility to ensure pesticides are only used legally, appropriately, safely, and in ways that uphold public trust.

Through the PGISC partners can, for example, model safe handling practices, promote integrated pest management, support applicator trainings, host pest-control workshops, create accessible licensure pathways for citizen applicators, fund herbicide efficacy trials, and discourage misuse.

Cultivating professionalism in invasive species management—and chemical control in particular—helps mitigate pesticides' inherent risks while reinforcing the credibility and long-term success of Pennsylvania's invasive species initiatives.

5.4.3 Biological Control

Biological control is the practice of introducing natural enemies, such as predators, parasitoids, pathogens, or herbivores, to manage populations of invasive or pest species, reducing their abundance and impact on ecosystems or agriculture. It can be an extremely cost-effective method for controlling invasive species, as once it is established the biological control operates independently of human labor and resources. Successful examples of invasive species being managed with biological controls in Pennsylvania include spongy moth (biocontrols = *Entomophaga maimaiga*, *Nucleopolyhedrosis virus*), hemlock wooly adelgid (biocontrol = *Laricobius nigrinus*), and mile-a-minute (biocontrol = *Rhinoncomimus latipes*).

Current protocols for developing biological control include extensive testing on native and commercial species to avoid unintended impacts on non-target species and ecosystems. However, historically the release of nonnative species (accidental or purposeful) has shown there is some risk of unintended impacts when a biological control is introduced. Modern research and testing standards from the US Department of Agriculture's Animal and Plant Health Inspection Service, minimize this risk, while verifying that biological controls have at least some assurances of effectiveness. Years or even decades of study must go into this process to make informed and safe decisions, without any guarantee that the effort be successful in the long run. For many species. no suitable biological controls exist. And even when a 'perfect' biological control is found, it often requires years or decades to show any level of control for an invasive pest, and never fully eradicates the target species.

However, biological controls are still a valuable method for dealing with some invasive species, especially ones that have become established and are beyond traditional mechanical or chemical control efforts. With the long lead times and complicated research required, state agencies and educational institutions must do the bulk of the work to investigate and propagate biological controls. However, once these stages are successful, the public can help disseminate biological controls to new areas.

The application of one or a combination of long-term management techniques (commonly called integrated pest management, or IPM) can result in varying levels of success from decreasing populations below detectable levels to no measurable impact. IPM can also result in the reduction of pesticide use. In cases where target species population levels are decreased, efforts to restore habitat to its previous natural state should be undertaken. In cases where little or no decrease of the target invasive species is achieved, adapting management strategies to account for a novel ecosystem composed of both native and invasive species is needed. Management may shift focus to protecting only high value habitats, organisms, or commodities, or completely suspended until new or improved techniques are developed.

5.4.4 Restoration for the present and future

Damage caused by invasive species can include altered habitats, disruptions to ecosystem processes, and reduced biodiversity. Once an invasive species has been controlled in an area, implementing ecological restoration efforts returns vital ecological functions to degraded areas and is an essential component of invasive species management. If an invasive species can be sufficiently suppressed or eradicated, restoration to a pre-invasion condition requires remediating altered conditions (e.g., addressing eroded soils or degraded water quality) and populations of preexisting organisms. Restoring natural habitat conditions will be favorable to the recovery of native species populations, making the area more resilient to the establishment of invasive species. For instance, controlled burns may be used to ensure seed germination of native species and suppress invasive species.

Removing an invasive species may leave open niches which allow for reestablishment of invasive species. Restoration managers should consider how to suppress or remove new invasions of unwanted species. Cultivating habitats for native species and reintroducing them will be part of most ecological restorations. The organisms may need to be planted or stocked, and techniques should be based on best practices to ensure successful reintroduction. More research on techniques for invasive species management and improving ecological restoration will benefit these efforts.

Restoring native species and ecosystem features typically demands a long-term commitment and forward-thinking planning. The reestablishment of ecological processes and native species often requires an extended period to fully recover. During restoration, monitoring for invasive species is often required and managers will need to continue to control invasive organisms. Ideally, ecosystem restoration practices would include planning for a changing climate and include anticipating changes in precipitation, temperatures, and phenology.

Recommendations

18. Increase surveillance to determine locations/regions where rapid response efforts are no longer viable and should transition to long-term management.

Actions:

The PGISC should continue to encourage agencies and the public to enter invasive species observations, both occurrence and absence, as well as biocontrol releases, into iMapInvasives to help track prevalence of different species across different regions of the state.

Non-government organizations (NGOs) should conduct surveys and provide data (including nonoccurrence data) to iMapInvasives to assist the PGISC and agencies with prioritization of long-term management efforts.

19. Support and communicate the need for development of improved ways to measure the long-term economic, ecological, and health impacts of invasive species, and compare those to the costs of management. This should include studies on the values of ecosystem services, and study how to efficiently manage long-term invasive pressure with Integrated Pest Management techniques.

Actions:

The Legislature should provide the PGISC with adequate funds to support studies and analyses of the impacts of various invasive species. Studies should improve techniques to estimate costs, benefits and thresholds of long-term management that include economic considerations, valuation of ecosystem services, and carbon sequestration.

20. Conduct outreach and education on the need and benefit of long-term management of invasive species.

Actions:

Jurisdictional agencies and PRISM should conduct public outreach and education on long-term management of invasive species through effective communications and educational events. These efforts should include curriculum that covers:

1) The value of native ecosystems for wildlife, timber regeneration, and carbon sequestration.
2) Identification of invasive species and their impacts.
3) Regional priorities for eradication, containment, and long-term control opportunities for regional PRISMs.

Jurisdictional agencies and PRISM should increase resources available to educate the public and assist them with prevention efforts particularly for known pathways and recreation access points (e.g., trailheads, boat launches, parks, or rights-of-way) and around known high priority infestations.

21. Increase staff capacity and funding dedicated to long-term management of invasive species in Pennsylvania.

Actions:

The Legislature should provide agencies with staff capacity and funds needed to support long term management of existing infestations, such as Japanese barberry, hydrilla, spotted lanternfly, and spongy moth and reduce the long-term impacts of these species.

NGOs should have staff capacity dedicated to the long-term management of invasive species infestations.

The Legislature should provide funding for grants (some of which should be non-restricted) to help landowners and organizations to manage the ecological and economic impacts of established invasive species.

Agencies should recruit partners and volunteers to help manage established invasive species.

22. Improve coordination and funding for biological control of invasive species across the Northeastern US.

Actions:

The Legislature should provide consistent funding to state agencies to support biological controls for invasive species in their jurisdiction. Funding should be used by agencies to provide grants to researchers, supporting the study of novel biological controls; as well as to improve rearing and distribution efforts of approved biological controls.

State agencies should maintain data on historic releases and distribution of all biological control agents within their jurisdiction.

State agencies should improve collaboration with external partners (e.g., USDA APHIS PPQ, USFWS, and USDA Forest Service) and other states on biological controls across all taxa by creating a Northeastern US Regional invasive species biocontrol workgroup.

23. Apply ecological restoration at sites with well-managed or eradicated invasive species to improve biological diversity, natural processes, and habitats.

Actions:

Jurisdictional agencies and PRISM should identify restoration targets (e.g., prioritized habitats or high biodiversity sites), including suggested areas for restoration targets by regions or habitat type. Restoration and monitoring plans should integrate ecological principles and climate change planning.

Jurisdictional agencies and PRISM should develop informational resources for land managers about ecological restoration and invasive species management techniques that incorporate climate change.

Agencies should implement ecological restoration on public lands and seek additional funding to expand related efforts.

The PGISC should foster partnerships, including PRISMS, to implement ecological restoration. The PGISC should support development and sustainability of PRISMs including requesting state funding specifically for long term management and restoration.

24. Develop outreach programs to assist private landowners with restoration.

Actions:

Jurisdictional agencies and PRISM should provide grants to landowners to restore private lands using ecological principles.

6. Appendix - PGISC Membership/Jurisdictional Authorities

The vast task of preventing and managing invasive species in Pennsylvania is spread across diverse entities – agencies with authority to regulate organisms under their jurisdiction and public land managers and land trusts that control invasive species. The seven agencies on the Governor's Invasive Species Council and their roles are:

Department of Agriculture (PDA)

Mission: Protecting human, animal, environmental, and plant health through regulatory oversight; Promotion of and education about Pennsylvania's agriculture products and sectors; Conserving farmland and natural resources for the prosperity of Pennsylvania.

The Department of Agriculture chairs the Pennsylvania Governor's Invasive Species Council. The 1895 legislation that created the Department of Agriculture transferred to it the three basic functions the state board of Agriculture had previously held: law enforcement, education, and prevention of plant and animal disease. The department provides services to maintain and protect Pennsylvania agriculture through consumer protection and product regulation. This includes detection, identification, and control of destructive plant pests (i.e., diseases, pathogens, insects, and weeds - both native and exotic). Among others, the department administers the state's Noxious Weed Control Law, the Plant Pest Act, the Seed Act, and the Commonwealth's Domestic Animal Law.

Department of Conservation and Natural Resources (DCNR)

Mission: To conserve and sustain Pennsylvania's natural resources for present and future generations' use and enjoyment.

The Department of Conservation and Natural Resources (DCNR) has responsibility for the protection of "all forestland" in the Commonwealth from "fungi, insects, and other enemies". Towards this end, the Bureau of Forestry's Forest Health Division helps to survey, monitor, and manage insects and diseases that threaten trees in the state.

DCNR is the jurisdictional agency for native wild plants which are threatened by the spread of invasive plants. Also, as a major landowner in the Commonwealth with over 2.2 million acres, the impacts of invasive species are a major threat to DCNR lands. To help combat this threat, DCNR maintains an invasive species plan and an informational website for the public on invasive plants.

Department of Environmental Protection (DEP)

Mission: To protect Pennsylvania's air, land, and water from pollution and to provide for the health and safety of its citizens through a cleaner environment.

The Department of Environmental Protection (DEP) is charged with responsibility for development of a balanced ecological system incorporating social, cultural, and economic needs of the Commonwealth through development and protection. It is responsible for the state's land, air, and water management programs, as well as other aspects of environmental protection and the regulation of mining operations.

Department of Transportation (PennDOT)

Mission: Enhance, connect, and add value to our communities by providing a sustainable, equitable transportation system and quality services for all.

The Pennsylvania Department of Transportation is a major partner in the prevention of nonnative invasive species as our highways and byways are a recognized pathway of spread. The Pennsylvania Department of Transportation controls noxious and problematic vegetation on rights-of-way across the Commonwealth and actively supports research on management and control.

Department of Health

Mission: To promote healthy behaviors, prevent injury and disease, and assure the safe delivery of quality health care for all people in Pennsylvania.

The Department of Health has the authority to enforce all statutes pertaining to public health and the rules and regulations passed by Pennsylvania's Advisory Health Board. In addition to enforcing statutes and regulations pertaining to public health matters, the department works to prevent and suppress outbreaks of disease. Using community-based strategies, the Department of Health has successfully reduced the number of serious illnesses, injuries, and deaths due to major health threats, tobacco-related diseases, infectious diseases, and accidental injuries.

Fish and Boat Commission

Mission: To protect, conserve, and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities.

The Fish and Boat Commission is charged with ensuring the protection, propagation, and distribution of game fish, fish bait, baitfish, amphibians, reptiles, and aquatic organisms and managing recreational boating in the Commonwealth.

Game Commission

Mission: Manage and protect wildlife and their habitats while promoting hunting and trapping for current and future generations.

The Game Commission is responsible for enforcing the Commonwealth's game laws relating to the management, protection and preservation of game, birds and fur-bearing animals. The commission regulates the hunting and trapping of game, sets bag limits, operates game farms, and employs game protectors. The commission is authorized to prohibit the introduction, sale, and release of any wildlife species of birds or mammals which are considered harmful to the public or wildlife of Pennsylvania.

Non-governmental Organizations (NGO)

NGOs are key members of the Pennsylvania Governor's Invasive Species Council, providing knowledge, resources and assistance to the state agencies. While NGO membership can be more fluid, key partners include:

Allegheny Plateau Invasive Plant Management Area

County Commissioners Association of Pennsylvania

Penn State University

PennAg Industries Association

Pennsylvania Association of Conservation Districts

Pennsylvania Farm Bureau

Pennsylvania Lake Management Society

Pennsylvania Landscape & Nursery Association

Pennsylvania Sea Grant

Pennsylvania State Association of Township Supervisors

Temple University

Transportation Sector

University of Pennsylvania

Western Pennsylvania Conservancy

For more information on the agencies and NGOs that make up the PGISC, including contact information for their current representative, please visit the Council Membership webpage.