New York City Department of Environmental Protection
Bureau of Water Supply

Invasive Species Management Strategy

March 31, 2022

Prepared in accordance with Section 4.8 of the NYSDOH 2017 Filtration Avoidance Determination

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1. Executive Summary

DEP's Invasive Species Program strives to protect water quality, watershed ecosystems and infrastructure from the negative impacts of invasive species through strategic activities to support five goals.

1. Preventing the introduction of new invasive species into the watershed by mitigating the risk associated with known pathways for introduction

Prevention has proven to be a cost-effective first line of defense at the national, state, and regional level and is generally implemented through laws, regulations, and rules targeting activities that would promote the introduction and spread of invasive species via specific pathways. The risk of recreational boating on certain NYC reservoirs, for example, is mitigated by rules that require boats to be steam cleaned prior to use on the reservoir. It is also supported by outreach and education efforts.

2. Detecting new infestations early and responding to them rapidly

Early Detection and Rapid Response (EDRR) is the method by which new infestations of an invasive species to an area are identified, contained, and potentially eradicated quickly to minimize the cost of control and impacts to water quality, the environment, human health, and the economy. EDRR efforts can be implemented at a variety of scales and require regional cooperation to make them most effective. DEP has taken on an important regional rapid response effort for Hydrilla (*Hydrilla verticillata*) in New Croton Reservoir.

3. Control and management to support specific projects

DEP selects invasive species management projects judiciously with attention to available resources. Aside from rapid responses to early detections, other criteria considered are the impacts to water quality, the threat from the invasive species to the successful outcome of other DEP land management projects and whether those management actions threaten to increase the impacts of invasive species to the surrounding area. Additionally, appropriate control strategies must be assessed based on their ability to successfully manage the target species with minimal harm to the natural resources.

4. Mitigate the impacts of any invasive species that cannot be effectively managed

Other methods can be pursued to mitigate impacts in instances where there are no effective tools to eradicate or control an invasive species and it is causing a significant harm. This has been the case with the emerald ash borer (*Agrilus planipennis*), which was first detected in the West of Hudson (WOH) watershed beginning in 2010. DEP is planning to mitigate future impacts from other forest pests and zebra mussels (*Dreissena polymorpha*).

5. Restoring sites to prevent further impacts from invasive species

Restoration activities promote natural succession through the intentional planting or stocking of desired native species. Some of the restoration projects currently underway include a tree planting project at a tornado blowdown site with high invasive plant pressure, planting of native species along stream management projects after treating Japanese knotweed (*Reynoutria japonica*) and the installation of deer fencing in areas undergoing forest management in the Ashokan Reservoir basin.

DEP coordinates among bureaus and directorates and collaborates with partners regionally and statewide to achieve these goals. Many strategies to support these goals are already underway and will be adapted and improved by incorporating lessons learned over the coming years, while others are just coming online and may take some time to fully develop. This document includes strategies that are already being implemented and those that are planned for the next five years to protect water quality, watershed ecosystems and infrastructure from invasive species.

2. Introduction

The New York City Department of Environmental Protection (DEP) strives to prevent and minimize impacts of invasive species on ecosystem functions and the infrastructure that delivers clean, high quality drinking water to over nine million New Yorkers. A species is considered invasive if it is non-native (or alien) to the ecosystem under consideration and its introduction causes or is likely to cause economic or environmental harm or harm to human health.

Concern over the threat invasive species pose to the New York City Water Supply system has been growing since the arrival of the zebra mussel in the Great Lakes in 1988, and has expanded to include many terrestrial and other aquatic species as well. Invasive aquatic plants and animals, like the zebra mussel, can damage or disrupt water supply infrastructure and negatively impact water quality. Terrestrial invasive plants and pests can make the landscape more susceptible to natural disturbances through increased soil erosion and nitrogen loss, as well as decreased overall plant cover, diversity, and forest regeneration. Climate change is expected to increase the distribution and impact of invasive species with extreme weather events and temperature fluctuations favoring species that exhibit characteristics that allow them to succeed following disturbance.

Recognizing these threats and building on the work already completed by DEP, and with stakeholders and regional partnerships, DEP first developed an Invasive Species Management Strategy in 2016 in accordance with Section 4.3 of the New York State Department of Health Revised 2007 Filtration Avoidance Determination (FAD). This document updates that document pursuant to Section 4.8 of the 2017 FAD.

Current Status of Invasive Species

The distribution and abundance of long-established populations of invasive species is variable across the NYC Water Supply watershed with a greater number of invasive species and broader distribution in the East of Hudson (EOH) watershed and fewer species overall in the WOH

watershed. New introductions are more likely to occur in the EOH watershed because of higher population density resulting in a greater number of pathways for introduction as well as the proximity to ports of entry into the United States.

Nutrient-rich EOH reservoirs support abundant aquatic plant growth, including the invasive species Eurasian water milfoil (*Myriophyllum spicatum*), curly-leaf pondweed (*Potamogeton crispus*), and water chestnut (*Trapa natans*). High numbers of deer, a land use history rich with human impacts, and proximity to roads and development EOH contribute to the greater distribution of well-established species like Japanese barberry (*Berberis thunbergii*), Oriental bittersweet (*Celastrus orbiculatus*), and garlic mustard (*Alliaria petiolata*). The hemlock woolly adelgid (*Adelges tsugae*) has impacted the eastern hemlock (*Tsuga canadensis*) in most of the EOH watershed for nearly three decades while the emerald ash borer has spread over the last decade into the region from its epicenter in Ulster County but threatens to nearly eliminate all ash (*Fraxinus*) species. The spotted lanternfly (*Lycorma delicatula*) is just emerging across the region as a novel threat to over 100 tree and herbaceous plant species including agricultural commodities.

The six WOH reservoirs are much less nutrient-rich and tend to only support low numbers of native aquatic plants. These reservoirs are also subject to large fluctuations in water level throughout the growing season which can prevent establishment of many invasive plants. Ongoing agricultural activities or those in the recent past have had a greater impact on the terrestrial invasive species present in the WOH watershed with multiflora rose (*Rosa multiflora*) and Japanese barberry found in abundance in abandoned farm fields. Japanese knotweed has also become widespread WOH as a result of frequent flooding and subsequent work that is done to restore stream bank stability and repair damaged roads. Emerald ash borer is spreading through the WOH watershed rapidly from east to west with satellite populations building in the west and hemlock woolly adelgid is moving through from southeast to northwest at a slow pace. Overall, the WOH of watershed has lower numbers of many of the emerging invasive species that are commonly introduced to areas with greater human populations.

Mission

DEP's Invasive Species Program strives to protect water quality, watershed ecosystems and infrastructure from the negative impacts of invasive species through strategic activities to support five goals. First, preventing the introduction of new invasive species into the watershed by mitigating the risk associated with known pathways for introduction can stop a new invasion before it starts. Secondly, if prevention is not successful, detecting new infestations early and responding to them rapidly is the next best scenario. These two strategic goals have been recognized by the National Invasive Species Council in their 2016 - 2018 Management Plan as the most effective strategies for managing invasive species (United States Department of the Interior, 2016). Where these strategies fall short or established populations already exist, the third goal is to conduct control and management to support specific projects in accordance with

the best management practices (BMP) for each species such as in forest management activities (United States Forest Service, 2013) or wetland mitigation projects (US Army Corps of Engineers, 2005). The fourth goal is to mitigate the impacts of any invasive species that cannot be effectively managed. Lastly, when invasive species control work is not sufficient to maintain native ecosystem functions, restoration of sites that have been degraded may be necessary (United States Department of the Interior, 2016).

Accomplishing these activities requires that efforts be coordinated between DEP bureaus and directorates and is greatly improved by collaborating with partners regionally and statewide. As part of a review of the FAD programs, a 17-member expert panel from the National Academies of Sciences, Engineering, and Medicine (NASEM) produced a report in 2020 that called for the clarification of the role of DEP in responsibility, staffing, and funding commitments in interagency partnerships. The NASEM committee encouraged DEP to review and evaluate the effectiveness of the invasive species partnerships. Additionally, they encouraged forward thinking on how climate change might affect invasive species impacts (National Academies of Sciences, Engineering, and Medicine, 2020).

In order to better understand the priorities and begin to clarify the role DEP should play in invasive species management in our WOH region, DEP and the Catskill Regional Invasive Species Partnership (CRISP) began a concept mapping process in December 2021. Group concept mapping is a structured research methodology that was administered by a third-party contractor to provide unbiased insights into the priorities and perspectives on invasive species management that exist among stakeholders from DEP and other CRISP partners through anonymous responses. During the participant activities which concluded in February 2022, 73 participants submitted 88 statements by completing the prompt, “One specific invasive species priority in the CRISP Region over the next five-years is…” A subset of participants rated the priorities according to importance and feasibility, and then sorted them according to which organization should take the lead in implementation. The full report is included in Appendix A (Dailey, 2022).

Goal

The purpose of this update is to outline the strategies DEP is implementing and has planned for the next five years to protect water quality, watershed ecosystems and infrastructure from invasive species. Many of the strategies outlined in 2016 are still underway and will be adapted and improved by incorporating lessons learned and the stakeholder feedback, while others are still coming online and may take time to fully develop. This document covers work that has been accomplished through the efforts of DEP staff from across the Bureau of Water Supply (BWS) that meet regularly as an Invasive Species Working Group (ISWG) and working with regional and statewide partnerships such as the two Partnerships for Regional Invasive Species Management (PRISMs) that cover the watershed, Lower Hudson PRISM and CRISP.

3. Prevention and Pathway Risk Mitigation

Preventing the introduction of new invasive species to an area by mitigating the risks associated with their known pathways is an important first step to minimizing their impacts on City lands and waters. Pathway risk mitigation has proven to be a cost-effective first line of defense at the national, state, and regional level and is generally implemented through laws, regulations, and rules targeting activities that would promote the introduction and spread of invasive species via specific pathways. The risk of recreational boating on certain NYC reservoirs, for example, is mitigated by rules that require boats to be steam cleaned prior to use on the reservoir. Education and outreach about the effects of certain behaviors is another strategy that is particularly suited to targeting those pathways with an audience that would also be impacted by invasive species, such as recreational boaters who may not be able to continue to enjoy a reservoir once it is invaded by aquatic invasive species.

DEP has taken both approaches to preventing the introduction of new invasive species through high-risk pathways. Federal and state regulations have increasingly been able to provide protection on a number of pathways but where these efforts fall short on targeting some of the greatest risks to the water supply, DEP has implemented internal rules, procedures and practices. DEP also developed a comprehensive communication plan that directs education and outreach efforts to target the highest priority audiences and support national, state and regional education and outreach campaigns such as the *Don't Move Firewood* campaign, *Clean, Drain, and Dry* to stop aquatic hitchhikers, and PlayCleanGo® for recreation users.

Potential Pathways

Pathways are how the introduction or movement of invasive species to a new area is facilitated either intentionally or unintentionally. Firewood is a known source of forest pests and could potentially be a pathway for the very damaging Asian long-horned beetle (*Anoplophora glabripennis*), spreading it from nearby infestations on Long Island or Worcester, Massachusetts into the watershed. Boat trailers are another top concern since aquatic plants can unknowingly be transported long distances within the structure of the trailer. Risk associated with each pathway varies depending on the species carried by the pathway, the frequency with which an introduction might occur, and the distance that a pathway could move a species. They can broadly be categorized into three areas: transportation, living industries, and miscellaneous, which covers natural sources of movement or disturbance as well as anthropogenic processes.

Table 1. Potential pathways of invasive species introduction onto City lands or waters

Transportation	Living Industries	Miscellaneous
Ballast water	Landscaping	Waterfowl
Recreational/fishing boats	Nurseries	Deer
Contractor and DEP boats	Soil and sod	Fire
Boat trailers	Hay and straw	Land clearing/mowing
Fishing equipment	Pet and aquarium trade	Logging
Dredge spoils	Bait/fish stocking	Utility ROW clearing
Cars, buses, and trucks	Aquaculture and seafood	Habitat restoration
Construction equipment	Hunting reserves	Waterways
ATVs	Firewood	Inter-basin transfers
Roadside maintenance		Aqueducts
Hikers/hunters		Wind

Current Pathway Risk Mitigation

Federal and state regulations have been developed to reduce introductions over the years as pathways have been identified as bringing new, costly invasive species into the United States or New York.

Examples of federal regulations that target invasive species pathways include:

- The US Coast Guard's regulation, Ballast Water Management for Nonindigenous Species in Waters of the United States, targets the introduction of aquatic invasive species that could be carried into US waters through the shipping industry's ballast water.
- The Plant Protection Act allows the US Department of Agriculture Animal Plant Health Inspection Service (USDA APHIS) to regulate the movement of approximately 100 listed weeds including many invasive species.
- The Lacey Act grants the US Department of the Interior the ability to prohibit the importation or transportation of injurious wildlife that threaten humans or natural resources.
- The Plant Quarantine Act provides the USDA APHIS with the authority to regulate interstate movement of plants that are known to carry harmful pests including invasive insects or diseases.

Examples of New York State regulations that target invasive species pathways include:

- New York Environmental Conservation Law Article 11 Fish and Wildlife, Title 5 Fish and Wildlife Management 11-0507 prohibits the intentional liberation of zebra mussels into any waters of the state and 11-0509 prohibits the planting, transport, transplanting or trafficking of water chestnut.

- Title 6 of the Department of Environmental Conservation (DEC) Codes, Rules, and Regulations
    - Part 180.12 prohibits the hunting or trapping of Eurasian boar since hunters are a known pathway for transporting boar to new locations.
    - Part 192.5 prohibits movement of untreated firewood more than 50 linear miles to prevent the spread of forest pests.
    - Part 575 prohibits and regulates the sale, propagation, and importation of listed species that have been ranked highly for invasiveness.
    - Part 576 establishes reasonable precautions to prevent the spread of aquatic invasive species on watercraft into public waters.

<u>New York City Department of Environmental Protection</u>

While these and other similar regulations help to reduce the spread of many species, there are still gaps that leave City lands and waters vulnerable to invasion, particularly by species that may be common in nearby areas. The primary pathways that have been recognized as needing to be addressed by internal rules, procedures and practices include bait, fishing equipment, recreational and fishing boats, contractor and DEP boats and their trailers, logging, and construction equipment. They are currently managed through the following rules, strategies, plans, practices, policies and specifications.

DEP Rules for the Recreational Use of City Property

The NYC Rules for the Recreational Use of City Property (updated 6/30/2019) is Chapter 16 of Title 15 of Rules of the City of New York and govern the recreational use of all New York City Water Supply lands, lakes, and reservoirs. These rules apply to everyone who legally accesses these lands.

- §16-07 (f) Bait and Bait Disposal allows live aquatic bait, which may include, but is not limited to, alewives, shiners, leeches, and crawfish, to be used for fishing unless it has been taken from waters infested with zebra and/or quagga mussels, or other invasive species. Neither bait nor the water from aquatic bait containers shall be disposed of on City Property. DEP, at its sole discretion, may prohibit the use of specified bait.
- §16-07 (g) (1) Fishing Equipment provides DEP the right to prohibit or require cleaning of certain waders from use in the watershed due to the potential threat of invasive species being transferred from waders into the NYC water supply.
- §16-10.1(i) Boat Tag requires all anglers' boats used on City Property to be registered and steam cleaned by DEP, when available, as listed on the DEP website, and stored on-site in Boat Storage Areas designated by DEP due to the threat of Water Supply contamination by organisms such as zebra mussel larvae that may be introduced to City waters by boats previously used in contaminated waters.
- §16-10.2 (b) and (5) Recreational Boat Tags, governing the Recreational Boating Program, requires that all boats used in Recreational Boating Areas shall be registered

and steam cleaned by DEP's designees, as listed on DEP's website due to the threat of Water Supply contamination by organisms such as zebra mussel larvae that may be introduced to City waters by boats previously used in contaminated waters.

Zebra Mussel Prevention Strategy

Since 1993, DEP has been implementing a strategy to prevent the introduction of zebra mussels through steam cleaning of contractor and DEP vessels and equipment that enter or move between reservoirs through operating procedures that have been established to prevent the inadvertent introduction or spread of zebra mussels or other small-bodied organisms:

- Small Boat Program Guide - Section 5 – Environmental, Health and Safety
  5.2 Equipment Steam Cleaning and Inspection is an internal procedure for steam cleaning and inspection of equipment that is used in the water by Bureau of Water Supply personnel and contractor vessels under 16 feet in length.
    - All water is drained from the vessels and their components including bilge water offsite
    - All parts of the vessel and equipment are visually inspected for adult mussels
    - If any suspect organisms are discovered they are collected, identified by trained staff, and verified by the DEP Fisheries Biologist
    - If there are confirmed zebra or other invasive mussels attached to the vessel it will be quarantined for a minimum of two weeks
    - All vessels will be steam cleaned inside and out with high pressure steam spray
    - Steam cleaning must be done with a minimum of 160° F, 700 psi and 2 gallons per minute.
    - Interior areas that cannot be steam cleaned can be treated with 5% chlorine solution for at least 48 hours
    - Bureau of Water Supply vessels must be steam cleaned each day before a vessel is deployed all year around.
    - If visiting multiple reservoirs, the vessel must start at the most upstream reservoir in a given watershed (Figure 1.1)
    - If moving from one watershed system to another, that vessel must be steam cleaned again.
    - If moving to an upstream reservoir, a vessel must be steam cleaned again
    - A specification is included in all contracts that requires contractor vessels 16 feet and longer and/or equipment to come into contact with the reservoirs to be steam cleaned by the contractor under DEP supervision. The specification prohibits all ballast exchanges in the reservoirs and details protocol for inspection and steam cleaning. Procedures and quarantine times for cases where organisms are found attached to any vessel or piece of equipment are also specified.

Table 2. NYC DEP Equipment Steam Cleaning Table - This table is from the DEP Small Boat Program Guide and indicates when boats must be steam cleaned between waterbodies.

Equipment Steam Cleaning Table

In this table, **Y** (yes) denotes **steam cleaning is required** or **N** (no) **is not required** when moving equipment from a specific body of water to another **on the same day.**

Taking out from here… / ON SAME DAY then putting in here	Cannonsville	Neversink	Pepacton	Rondout	Ashokan	Esopus Creek	Schoharie	Amawalk	Bog Brook	Boyds Corner	Cross River	Croton Falls	Diverting	East Branch	Kensico	Kirk Lake	Lake Gilead	Lake Gleneida	Middle Branch	Muscoot	New Croton	Titicus	West Branch
	Delaware				Catskill			Croton Watershed System															
Cannonsville	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Neversink	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pepacton	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rondout	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ashokan	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Esopus Creek	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Schoharie	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Amawalk[4]	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bog Brook	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	N	N	Y	Y
Boyds Corner	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N
Cross River	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
Croton Falls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y
Diverting	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y
East Branch	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	N	N	Y	Y
Kensico	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
Kirk Lake	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	Y	Y
Lake Gilead	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	Y	Y	N	N	Y	Y
Lake Gleneida	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N	N	Y	N	N	Y	N
Middle Branch	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	N	N	N	Y	Y
Muscoot	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
New Croton	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Titicus	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y
West Branch	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N	Y	N	N	Y	N

[4] Note: Any boat retrieved from Amawalk must be steam cleaned immediately thereafter because of the known presence of zebra mussel veligers in this reservoir. If a boat is used on Amawalk with a bilge that cannot be completely drained or a trailer constructed of rectangular tubes that cannot be completely drained, procedures outlined in 6.10.a must be followed. (R-4 13-NOV-18)

Gear Decontamination Policy for Didymo

In response to the discovery in 2009 of the diatom, Didymo (*Didymosphenia geminata*) in the Esopus Creek, DEP instituted a set of protocols to decontaminate field equipment to help prevent staff from spreading Didymo to other areas of the watershed during field work. The protocol requires sampling from upstream to downstream, inspection of equipment for Didymo, and

provides several methods to decontaminate equipment after field work including bleach, salt solution, freezing or submersion in hot water (>45°C).

Conservation Practices and Process for DEP Forest Management Projects

This internal guidance document includes a section that covers strategies to prevent the spread of existing terrestrial invasive plants throughout active forest management project sites and to stop the spread of seeds and other propagules from moving onto City lands on logging equipment.

- 4.7.3 Invasive Plant Best Management Practices specifies that:
    - Control of invasives in the log landing zone will be prioritized, as applicable to prevent their spread throughout the site
    - Existing roads, skid trails, and landings are used as much as possible to reduce soil disturbance which could promote invasive plant establishment
    - New roads, skid trails and landings are avoided in concentrated areas of invasive plants, if possible, to minimize soil disturbance and limit the unintentional transport of invasives into non-infested areas
    - Non-infested areas are harvested before infested areas to reduce the spread of invasive plants, if possible
    - Prior to moving equipment onto and off of a project area, soil, debris and vegetation and seeds will be broom-swept and/or scraped off from exterior surfaces of equipment, to the extent possible, to minimize the transport of invasive materials

Land Use Permits

DEP issues Land Use Permits to applicants that require access to City lands for a variety of purposes. Land Use Permit applications are reviewed for potential actions that may cause the introduction and spread of invasive species into the reservoirs or onto City lands. Any permitted activity that involves access to water requires the same steam cleaning protocols outlined in the Small Boat Program document (Appendix B) or the contractor specification. Other permit conditions requiring actions to be taken to prevent the introduction or spread of invasive species and/or site restoration are added as needed by the particulars of the use.

Invasive Species Communication Plan

Laws, regulations, rules, procedures, and practices often fall short on addressing the local spread of invasive species by routine activities. Spread prevention education and outreach can provide insight to specific audiences who may not realize that they are spreading invasive species and that these species might negatively affect their future activities.

DEP developed an internal document to generate targeted and consistent messaging to internal and external audiences to support existing national, state, and regional campaigns with messages relating to invasive species management (Appendix C). These messages are intended to increase capacity, efficiency and support for invasive species spread prevention among other management efforts. The plan targets internal audiences, such as DEP units that engage in land management and mowing, providing training on some invasive species spread prevention techniques addressing the *Don't Spread Invasive Species* message as part of the implementation of this plan.

External audiences identified in the plan include loggers, construction contractors, design consultants, landscape architects, anglers, hunters, boaters, hikers, officials, policy makers, planning boards, planning professionals, and streamside landowners all of whom may spread invasive species within the watershed through their regular activities. To date the following elements of the plan have been implemented to reach external audiences: webpages on invasive species prevention techniques for hikers, hunters, anglers, and boaters on the DEP website; messaging through the DEP's Recreation Newsletter; distribution of print materials through booths at farmers' markets and fairs to address aquatic invasive species spread by boats and fishing equipment; signs at boating areas regarding bait and fishing equipment; and a boot brush station and signage at a popular trailhead.

Planned Pathway Risk Mitigation Strategies

Identify Gaps and Improve Messaging

The ISWG will continue to review programs and policies for their efficacy at preventing introductions through the various pathways and identify gaps in prevention. By bringing forward concerns from throughout BWS, ISWG members provide many perspectives on this issue and are exposed to a breadth of potential pathways.

One such pathway that has been brought up through the ISWG is soil disturbance from land clearing activities associated with construction projects, some Land Use Permit activities, stream management projects, farming practices, and other work on infrastructure. Members of the ISWG are working with Bureau of Engineering Design and Construction to develop contract specifications to help address the establishment of invasive species that have been brought in on equipment, since disturbed soil provides an optimal environment for them to become established. DEP is considering cleaning and site maintenance requirements to ensure that equipment is cleaned properly and to guide treatment should invasive plants become established for all relevant contracts.

The Watershed Protection Programs Outreach Committee will assist with the development and adoption of spread prevention messages for audiences such as hunters, anglers, and boaters. The response will be assessed by using surveys, observation at outreach events, and interviews with user groups. Messaging will be adapted to achieve the desired behavior change. Additionally, messaging will be coordinated with the statewide invasive species outreach, and broader

programs such as the North American Invasive Species Management Association's PlayCleanGo® campaign.

Partnership Efforts

The New York State Invasive Species Advisory Committee (ISAC), Lower Hudson PRISM and CRISP have been working toward developing consistent invasive species messages and promoting specific themes statewide during the annual Invasive Species Awareness Week, in addition to other programming throughout the year. DEP continues to support the annual statewide and regional outreach themes that help to amplify the efforts for all participating groups and prevent duplication of efforts.

4. Early Detection and Rapid Response

EDRR is the method by which new infestations of an invasive species to an area are identified, contained and ideally eradicated quickly to minimize the costs of control and impacts to the environment, human health and the economy. EDRR efforts can be implemented at a variety of scales and require regional cooperation to make them most effective.

The ISWG developed an EDRR Plan in 2011 and updated it in 2022 (Appendix D). The plan contains a broad strategic roadmap and a specific work plan to guide discussion of invasive species policy issues, allocation of budgetary and staff resources, and decisions regarding appropriate actions necessary to achieve DEP goals with respect to monitoring, surveying and responding to invasive species threats. The plan calls for a focus on City-owned lands and reservoirs with active engagement in Lower Hudson PRISM's and CRISP's EDRR efforts. The plan also specifies that implementation takes an adaptive management approach with regular evaluation and revision.

Current Early Detection and Rapid Response Strategies

The plan includes specific tasks that support the following objectives:
1. Ensure new invasive species are identified and their risks assessed promptly

- Formal risk assessments were developed by the ISWG for over 50 species and are to be updated with new species and information every five years. The risk assessment process incorporated the New York State Invasiveness Ranking forms as well as a DEP-specific rapid assessment that accounts for potential impacts to water quality, water supply infrastructure, watershed ecosystem function, or employee health and safety. The risk assessments were used to generate a priority list of species to focus EDRR and other efforts.

- A comprehensive survey of aquatic invasive species in all five terminal reservoirs (Rondout, Ashokan, West Branch, New Croton, and Kensico) was completed for DEP by staff from the State University of New York at Oneonta's Biological Field Station in

2016. They used traditional survey techniques and piloted the use of environmental DNA (eDNA) to survey for traces of organisms in water samples collected in the reservoirs and analyzed in a laboratory. The results of the pilot indicated that traditional survey techniques are still superior to eDNA but noted that changes in technology in the next decade may make eDNA a feasible option. In 2018 and 2019, DEP worked with the Catskill Center and Dr. Michael Tessler of the American Museum of Natural History to survey for aquatic invasive plants using eDNA. Once again, DEP determined that due to technological limitations traditional survey methods were still more reliable, but DEP will continue to monitor this rapidly improving technology.

- Early detection visual snorkel surveys are conducted annually by DEP's Invasive Species Biologist and Aquatic Ecologist at recreational boat launches to find any inadvertent introductions that may result from the expansion of recreational boating opportunities. The only species of concern detected has been the rusty crayfish (*Orconectes rusticus*), which is very widespread and was likely introduced through bait many years ago.

2. Ensure early reporting of new invasive species occurrences/infestation both internally within DEP and externally with watershed partners

- DEP holds trainings to teach field staff identification skills for priority early detection species. Trainings have been offered to staff from BWS's Source Water Operations and Water Quality and Innovation directorates and Bureau of Police and Security. Staff are directed to make a report of any suspect organisms to DEP's Invasive Species Biologist for verification.

- Recreation users are encouraged to report suspicious species through informational pages on the website, signage posted around reservoirs, and other activities outlined in the Invasive Species Communications Plan.

3. Define decision making responsibilities and response protocols

- DEP has established a rapid response protocol that is appropriate for a subset of highly impactful invasive species. This is less useful when the response is within a regional framework or a more limited response to a small infestation of a species that is less harmful. A more iterative approach is needed to make the rapid response protocol more functional given real-world constraints and variability. This will be incorporated into a protocol update in 2022.

4. Establish and maintain capacity to act

- DEP maintains capacity to address smaller scale responses with staff, summer field interns, and an increasing number of in-house pesticide applicators on staff.

- DEP will seek to establish a two-tiered approach to funding rapid responses with standing procurement agreements for smaller-scale responses for both terrestrial and aquatic invasive species and project-specific contracting for larger scale responses as needed.

5. Incorporate adaptive management in plan implementation.

- The EDRR plan is a fluid document that can reflect changes in priorities through evaluation of each response and DEP will continue to update it periodically.

Evaluating several rapid response projects in which DEP has been involved has been instrumental to supplement the Invasive Species Management Strategy and to update the EDRR Plan to reflect the real-life hurdles to a rapid response.

Giant hogweed (*Heracleum mantegazzianum***)** – NYSDEC has a statewide initiative to eradicate this species and is the lead in this effort. DEP works with NYSDEC and other partners to survey for new plants found on or adjacent to City lands so that they can be managed immediately. All known populations on City lands have been eradicated as of 2021 and DEP is working with Lower Hudson PRISM to regularly monitor the sites for an additional three years to ensure the seedbank is completely exhausted in these areas.

Silver vine (*Actinidia polygama*) – Lower Hudson PRISM and DEP are working to manage an infestation that crosses over from City lands to private lands since it was detected in 2015. This is only the second known infestation of this species in the state. This population is nearly eradicated with fewer than ten stems detected in 2021. Management will continue until all stems are eradicated.

Hydrilla – DEP and NYSDEC have been working closely together to respond to an infestation that stretches from the New Croton Reservoir to the Hudson River in a multifaceted resource-intensive effort since 2014.

Hydrilla was first found in the Croton River downstream from the New Croton Reservoir in 2013 and in the reservoir in 2014. Upon discovery, DEP and SUNY Oneonta conducted a reservoir-wide survey in 2014 and found Hydrilla in four locations. The highest density was measured around the boat launch, suggesting it as the point of introduction. Hydrilla

is a prolific aquatic invasive species that reproduces and spreads from plant fragments, underground tubers and turions. It can negatively impact the reservoir, water supply infrastructure, and the downstream ecologies of the Croton and Hudson Rivers. Water quality impacts include increased total organic carbon in the reservoir with the potential of increased disinfection by-products, and changes in water chemistry (DO, pH) that may degrade habitat quality for aquatic plants, fish and macroinvertebrates. DEP began actively monitoring and managing Hydrilla to reduce impacts and spread to other waterbodies and anticipates spending nearly $4.5 million on these efforts by the end of 2023.

In 2014, DEP began hand pulling Hydrilla at the boat launch with limited success and in 2015 and 2016 deployed benthic barriers to the boat launch area. Benthic barriers smother and suppress growth but do not eradicate Hydrilla and are only feasible in small areas. DEP formed a subcommittee of the ISWG to study management options in 2015 that recommended the use of the aquatic herbicide fluridone and chelated copper to manage Hydrilla in the reservoir. DEP then funded the Water Research Foundation to form an expert panel with representatives from academia, government, utilities, consulting and industry to explore BMPs to control Hydrilla in drinking water sources and examine DEP's management plan for efficacy and impact on water quality. The panel endorsed DEP's management plan (Wright et al. 2018).

In 2018, 2019, and 2020, DEP piloted fluridone treatment in select 17-acre areas of the reservoir to study the efficacy of treating Hydrilla with fluridone, assess fluridone's behavior in the reservoir (i.e., migration out of treatment areas), and to test its use in varying reservoir conditions. Given the success of the pilot treatments, DEP conducted the first year of a reservoir-wide eradication project in 2021. Two hundred and fifty acres of Hydrilla beds were treated throughout the reservoir between June and September using Sonar® H4C and SonarONE®. Results from the first year of full treatment were encouraging. Most Hydrilla beds had stressed plants exhibiting chlorosis, loss of biomass, fewer leaves and stunted growth. The post-treatment Hydrilla survey showed more beds with below-nuisance level densities than nuisance level densities for the first time since surveys began in 2016. Tuber surveys showed tuber densities to be significantly reduced from 2020. Treatment will continue through 2023 and likely for several years after that until Hydrilla is undetectable in the reservoir.

The Hydrilla management contract includes Hydrilla surveys in all the other EOH reservoirs. Surveys in 2021 in Boyd Corners, West Branch, Muscoot and Kensico Reservoirs were all negative for Hydrilla. Those reservoirs will be surveyed annually, and the remaining EOH reservoirs will be surveyed once through 2023.

Planned Early Detection and Rapid Response Projects

Early detection survey work in both aquatic and terrestrial ecosystems will continue and expand as new threats are identified. Aquatic surveys targeting Hydrilla in all EOH Reservoirs are scheduled to be completed in 2023 and will be critical to responding rapidly if it should be detected in a new reservoir. Additionally, terrestrial plant survey efforts will be coordinated with

the Lower Hudson PRISM and CRISP. DEP has participated in the Lower Hudson PRISM Blockbuster Survey Program for several years and will continue to use this program to survey in the EOH watershed. In 2020, DEP began to participate in a statewide response for the spotted lanternfly that is being led by NYS Department of Agriculture and Markets (NYSDAM) and will continue to conduct surveys and trapping on City lands for this species as part of that effort.

Coordinating a regional response effort across agencies and jurisdictions has proven to be challenging in the past. Depending on the taxa, there may be collaboration with several different agencies and stakeholders. Response efforts will be guided, going forward, when possible, by the NYSDEC's DLF-16-1 Rapid Response for Invasive Species: Framework for Response (Framework), which was drafted in 2016 and promotes a collaborative approach among agencies and PRISMs. It is designed to be adapted for any number of response scenarios and draws from experience gained over the last decade by New York State Department of Environmental Conservation (NYSDEC) and their partners.

5. Control and Management

DEP invests a great deal of consideration in the selection of invasive species control and management projects in the NYC water supply reservoirs and on City lands. Every infestation of every species cannot and should not be controlled over the 2,000 square mile watershed, so projects must be selected judiciously with attention to available resources. Aside from rapid responses to early detections, other criteria considered are the impacts to water quality, the threat from the invasive species to the successful outcome of other DEP projects and whether those projects threaten to increase the impacts of invasive species to the surrounding area. Additionally, appropriate control strategies must be assessed based on their ability to successfully manage the target species.

Control Strategies

Control projects are implemented using methods that have the least non-target species impacts, are most appropriate for the species and site conditions, are based on the latest scientific research and BMPs and have a high likelihood of achieving the desired outcome. The following control strategies have been either implemented or considered for use in controlling invasive species:

Manual and Mechanical Control

Manual and mechanical control are strategies that involve using hands, hand tools or mechanized equipment to pull, dig, mulch, cut, mow, destroy or otherwise remove invasive species. This method works well over small areas and is preferable to other control strategies in sensitive environments where water quality or non-target impacts from chemical control are considered unacceptable. These strategies can generally be implemented without obtaining permits or going through other approval processes. These strategies are currently being considered

or implemented along streams, wetlands, in and around reservoirs, and for some lower abundance invasive species.

Chemical Control

Chemical control strategies involve the use of approved pesticides for the control of invasive plants and insects in accordance with their labels and any special recommendations approved by New York State with Section 2 (ee) of the Federal Insecticide, Fungicide, and Rodenticide Act. All pesticide applications on City lands are done by certified applicators who carry the proper licensing in the correct category for the work that they are conducting. DEP staff, contractors and subcontractors are all subject to the same review process when planning and implementing any type of chemical control project.

DEP's ecotoxicologist must review any chemical control project and issue an internal permit with the total amount of active ingredients to be used, formulation and other relevant information. Certain conditions for application can be placed on the applicator as well. Preference is given to the use of products with fewest known environmental impacts and lowest toxicity. A majority of projects over recent years have used the active ingredient glyphosate, due to its efficacy and low toxicity, particularly in water.

Application technique varies based on the species and habitat being treated, with foliar application being the most common method in terrestrial systems. Stem injection for Japanese knotweed control and basal bark or hack-and-squirt application for Japanese angelica tree (*Aralia elata*) and tree of heaven *(Ailanthus altissima)* control have also been used. Cut stump treatment has also been used for multiflora rose and Japanese barberry. Foliar application is generally favored because it requires the least amount of time and active ingredient, making it cost-effective and reducing the total amount of product applied to the site. Stem injection, basal bark application, hack-and-squirt, and cut stump treatments are less likely to have immediate non-target impacts but may require a greater total amount of chemical and persist longer in the soil.

Herbicides for the control of aquatic invasive plants are considered only when they are critical to a special project such as in the rapid response effort for Hydrilla or if the operations of the water supply were threatened.

Biological Control

Classical biological control is the use of co-evolved predator or herbivorous organisms for long-term control of an invasive plant or insect. Biological control agents that have received federal approval and are available for sale have minimal environmental impacts when compared to other control methods. The risk of non-target effects such as trophic disturbance, competition, or other

abiotic and biotic factors that could harm native species and disturb ecological communities is lessened via an extensive screening protocol enforced by the federal government through USDA APHIS. Potential control agents are tested with no-choice feeding experiments to see if they will feed on closely related native and economically valuable species present in the release region to ensure the control agent will not harm non-target species. Additionally, NYSDEC has a system of approval and licensing for the release of agents that have received a federal Finding of No Significant Impact within the state.

DEP views biological control as a tool to be used in tandem with other strategies as part of an integrated pest management program to suppress invasive species broadly over the region or to be released on a particular site in an inundative application to temporarily decrease a population. DEP will only implement biological control use if the appropriate permitting has been obtained and a careful review of the potential non-target impacts has been completed. City lands are an ideal place for university and government institutions to assist in the research to determine best methods for establishment of several biological control insects.

Currently, ten biological control agents for five invasive species have been approved for release in New York State and are commercially available according to the New York Invasive Species Research Institute. *Rhinoncomimus latipes*, a weevil that targets mile-a-minute vine (*Persicaria perfoliata*) and *Galerucella calmariensis* and *pusilla,* which target purple loosestrife (*Lythrum salicaria*) have been released in a number of locations in the watershed and have been proven to establish and effectively control these species. *Leucopis argenticollis, Leucopis piniperda* and *Laricobius nigrinus,* which target hemlock woolly adelgid, and *Spathius agrili, Tetrastichus plannipennisi,* and *Oobius agrili*, which target emerald ash borer have all been released on City lands. Research is ongoing to determine if these species have successfully established and their

efficacy in controlling pest populations is still being evaluated. DEP plans to participate in additional releases of these species in the coming years.

Current Control Project Selection Priorities

Forest Management Projects

As part of the process outlined in the DEP Forest Management Conservation Practices, potential impacts from invasive species on the success of forest regeneration and the potential for spread outside the project area are assessed for each forest management project (FMP). DEP will control invasive species prior to the start of many FMPs to minimize impacts once the canopy is opened and light levels and soil disturbance are increased.

With the expansion of DEP Forestry Program staff in 2017 and the subsequent increase in forest management activity, invasive species control needs exceeded existing contracted capacity. An in-house treatment program was determined to be an efficient and effective tool to meet the increased need and provide stability in treatment capacity. One Forestry Program staff member received the training and obtained necessary pesticide applicator certification in 2019 and plans are in place to increase this capacity to additional staff in 2022. The option to have Forestry Program staff treat invasive species has improved the ability to administer treatments at times that are both compatible with project schedules and timed according to the life cycles of target species. The in-house treatment program has also increased the ability to rapidly address emerging invasive species populations and engage in control of species considered a high priority by the Lower Hudson PRISM.

Since the beginning of the in-house treatment program in 2019, EOH Forestry Program staff has engaged in control efforts to reduce vegetative competition from invasive plants and encourage the growth of native forest species. The program has treated invasive plants on seven FMPs and five additional sites throughout the EOH watershed, and one WOH FMP. In total, 111 acres have been surveyed, monitored, and treated in 2019, 2020, and 2021. Work on FMP sites focused on the removal of common invasive species that out-compete native trees including Japanese barberry, winged euonymus *(Euonymus alatus)*, Japanese angelica tree, and mile-a-minute vine. A focus on controlling tree of heaven beyond FMP sites has emerged in conjunction with statewide efforts to reduce habitat for the spotted lanternfly. Additional work to control the high priority species, amur corktree *(Phellodendron amurense)*, has occurred in conjunction with tree of heaven reduction efforts. The ability to monitor and quickly re-treat sites from year to year has proven to be a valuable component of the in-house program. Other species that have been managed through contractors and in-house work in the past include porcelain berry, Japanese knotweed, common buckthorn, wisteria (*Wisteria* spp.) and Oriental bittersweet.

The Forestry Program will continue invasive species control efforts based on protecting native forest ecosystems in the NYC watersheds. In 2022, additional foresters will become certified to apply pesticides, expanding in-house capacity to stem the spread of invasive species in both watersheds. The in-house invasive species control program will continue to address populations that threaten FMP sites, work to eradicate high priority species, and collaborate with the DEP invasive species program on EDRR efforts.

Wetland Mitigation Projects

There are currently six wetland mitigation sites built on City lands to offset wetlands impacts from DEP-sponsored construction and other projects. Wetland permit conditions that require mitigation often have performance standards that cap the percent cover of invasive species and require a certain percentage of native planting survival. Invasive species management is required

when the cap is exceeded to bring the site into compliance and to facilitate the growth of native plant species.

Purple loosestrife was manually removed from one wetland mitigation site from 2013 to 2017 in the Ashokan Basin to maintain compliance with percent cover requirements in a United States Army Corps of Engineers' permit. Additionally, chemical control has been used at several mitigation sites EOH to control phragmites and manual control has been employed for mile-a-minute vine control. It is anticipated that future wetland mitigation projects will require invasive species management.

Stream Restoration Projects

Invasive species can threaten the success of stream restoration projects by spreading rapidly in the project area ultimately decreasing stream bank stability. Native vegetation has more complex root structures that enhance bank stability better than invasive species. Preemptively controlling invasive plants to allow native vegetation to establish is an important component of stream restoration work. Both chemical and mechanical control strategies have been employed. Japanese knotweed, mugwort (*Artemisia vulgaris*), Japanese barberry, and multiflora rose have been treated. These projects have been managed by the Soil and Water Conservation Districts working with DEP in all WOH basins and are ongoing.

Other Special Projects

Infrastructure, small dam removal, and other large construction projects on City lands often include site restoration with native species. Permits often require restoration and include performance standards based on percent coverage by invasive species and survival of restoration plantings. Invasive plants can interfere with tree planting projects by outcompeting native plantings, and with stormwater retention structures or roadside sightlines by rapidly becoming overgrown. By controlling invasive plants early in these construction projects there is a greater chance of native vegetation becoming established and suppressing the harmful impacts of invasive species.

Japanese barberry, Japanese angelica tree, Japanese knotweed, Oriental bittersweet, Japanese stiltgrass (*Microstegium vimineum*) and garlic mustard have been controlled through chemical and manual strategies to support infrastructure projects on City lands. Several planned projects will include more invasive species control work over the coming years.

Project Monitoring

Once a control project is complete, the site is monitored through formal surveys and informal observation. Requests for follow-up treatment come to DEP's Invasive Species Biologist from DEP field staff. The current process is mainly focused on identifying areas where recolonization by the invasive species is becoming problematic and monitoring has not addressed overall project outcomes on other aspects of the ecosystem.

The measure of an invasive species control project is how effective it is in reducing the presence of the invasive species, as well as measuring the recovery of the native plant community and fish and wildlife habitat. A project monitoring framework had been under development at DEP with collaboration and input from partners across the state, however a pilot version of a data collection tool will be in the testing phase through the New York State iMapInvasives database in 2022 with additional guidance anticipated from the New York State Invasive Species Research Institute in 2023. DEP will adopt the statewide monitoring protocol and is participating in the field trials. The purpose of this data framework and statewide collaboration is to have a consistent and efficient method to assess which control strategies have proven effective at any given site in support of adaptive management, whereby strategies can be adjusted for greater success.

Planned Project Selection Prioritization Strategies

Beyond the current priority control and management projects that are being implemented to support the success of DEP initiatives, there are other land management objectives that could be met through invasive species control work. New York State has also been working on an invasive species control project prioritization protocol that incorporates several existing resources that can rank invasive species impacts, conservation values of the site of the proposed project, and the likelihood of success of a project. DEP is working with PRISMs and other partners across the state to better consider additional types of control projects that can provide meaningful outcomes and provide the best use of available resources.

6. Mitigation of Impacts

In some instances where there are no effective tools to eradicate or control an invasive species and it is causing a significant harm, other methods may be pursued to mitigate impacts. This has been the case with the emerald ash borer, which was first detected in the WOH watershed beginning in 2010, and again with the zebra mussel after adults were detected in Amawalk Reservoir in 2021. Impacts from the hemlock woolly adelgid, which has been in the EOH watershed since the 1990s, are being observed throughout the watershed and spotted lanternfly will likely require some mitigation activities in the near future.

Current Mitigation Activities

Since 2002, all attempts have failed to eradicate emerald ash borer, an invasive wood-boring beetle. Emerald ash borer has been in the watershed since 2010, is rapidly and completely killing all species of ash and disperses up to three miles in a single year. There is typically near 100% mortality in an area within five years of infestation, making it possible to protect only small numbers of trees through chemical insecticide control. DEP initially worked with NYSDEC and the United States Forest Service to implement a plan to slow ash mortality through strategic tree girdling and removal efforts. This effort was discontinued in 2013 due to loss of funding and extensive spread. Since then, the activities surrounding this pest have switched over to mitigation activities.

The major impacts anticipated from the loss of infested ash on City lands include development of hazard trees along roadways and the creation of gaps in the forest canopy. Once ash trees are infested, they quickly dry out and become brittle and dangerous due to the potential for falling limbs. This poses a hazard to the motoring public, recreation users, and loggers removing the trees. Removing ash trees before they become a hazard is also important because dead ash does not retain any timber value so any work that is done once trees die would have a high cost associated with it as opposed to a traditional forestry project which can recover the cost of removal through the sale of timber.

To date, DEP has removed a significant number of potential hazard ash trees from City lands, working in concert with the NYS Department of Transportation, county public works, and others. Several hundred acres of ash dominated forest have been significantly thinned through forestry projects to promote regeneration. Additionally, DEP has supported a project called Monitoring and Managing Ash (MaMA) that was developed to find “lingering ash” or ash trees with some natural resistance to the emerald ash borer that can be used in a selective breeding process to develop resistant trees to restore ash to the landscape. There are five MaMA monitoring plots on City lands, and they will be searched for lingering ash as the trees succumb to the emerald ash borer. Surrounding areas are then searched for “lingering ash” or the ash trees that have maintained a nearly full canopy when nearly all other ash in the area are dead.

Planned Mitigation Strategies

Lake Mahopac is a popular public lake located in the Town of Carmel in Putnam County. It is within the EOH watershed, but not owned or controlled by the City. Zebra mussels were first reported in Lake Mahopac, a notable fishing destination, in 2015 and infested boats were the likely vector for their introduction. In 2018, veligers were detected by DEP scientists throughout the outlet, downstream in the Muscoot River, and in Amawalk Reservoir following select high water events. After several years of monitoring, adult mussels were detected in 2021 within the reservoir on settling plates and various substrates along the shoreline.

In response to the detection of zebra mussels in Amawalk Reservoir, DEP is pursuing the necessary updates to water supply infrastructure to avoid fouling of intake structures and pipes. Over the next several years, new systems will be installed that will allow DEP to safely treat and remove attached mussels from clogged pipes to manage this negative impact. Additionally, DEP staff will continue to promote prevention measures for recreation users and staff to minimize the chances for any further movement of zebra mussels into other reservoirs and monitor their abundance and spread downstream.

Hemlock woolly adelgid is another forest pest that has had a significant impact on the landscape through decline and mortality of the eastern hemlock. DEP is concerned with protecting hemlock trees in parts of the watershed that are not yet impacted but many areas of the watershed have longstanding infestations and are transitioning into other forest types. As this problem becomes more widespread, mitigation tools to preserve the ecosystem functions that hemlocks once provided for water quality may be necessary. This is an active area of research and a strategy that is currently being explored.

The spotted lanternfly poses a large threat to agriculture and forests due to its swarming behavior and feeding habits and it is rapidly expanding its range around the watershed. When this leaf hopper eats, it excretes a very sugary honeydew which promotes the growth of sooty molds. These molds make crops unusable and can damage or even kill trees in the forest. This insect is also prone to gathering on structures, leaving a sticky and moldy mess behind. As populations continue to grow in the area, mitigation measures such as power washing, trapping, egg mass removal, or pesticide application may be needed to reduce the impacts of the spotted lanternfly on forests and to maintain water supply facilities.

7. Restoration

Site restoration should be conducted following invasive species management, where needed and feasible, to prevent or reduce the risk of recolonization or spread of invasive species and increase the likelihood of establishing a native functional ecosystem. Invasive plant species tend to readily disperse and colonize sites and are fast-growing, especially in high light environments. Re-introducing native plant species is a tool to prevent recolonization of invasive plant species by reducing the amount of light, space, and other resources that invasive plant species need to establish and grow. In areas where the seedbank is dominated by invasive species or if surrounding areas are heavily invaded, native seed, plants or other inputs may be required. Without the addition of native plant material, monocultures of invasive species may replace the community controlled through invasive species management. Although some invasive plants are not thought to differ from native plant communities in their water quality ecosystem services, monocultures of any species make a given site vulnerable to disturbance (e.g., flood, wind, pests, extreme weather). With the overarching goal of establishing a diverse community of species,

restoring native species is an insurance strategy to protect against the loss of vegetation on a site from future disturbances.

Installing and maintaining native plant communities is expensive, so DEP will prioritize which invasive species mitigation sites to actively restore vs. passively wait for native species propagules to colonize. When a diverse native seedbank is present, the best strategy may be to not actively restore the site and allow for natural recovery. Mitigation sites will be prioritized based on the position of the site within the watershed, light availability and canopy cover, and proximity to invasive species vs. native species propagules. For example, all else being equal, it is usually more critical for sites near reservoirs and tributaries to have a stable plant community with mature canopy cover than most upland sites. This protects shorelines from erosion, disrupts and slows surface flow to reduce turbidity and nutrient runoff, and shades the water to decrease temperatures. Ecologically sensitive areas may also rank highly for prioritizing restoration when reintroducing native plant material is predicted to create conditions conducive to resisting invasive species and the ecosystem effects are thought to create favorable conditions for the sensitive area (e.g., shade). Especially in high light environments, it may not make sense to manage invasive species without a plan for restoring native plant species. Long-term restoration objectives, such as diverse species assemblages, mixed-age forests, or native pollinator habitat, will be considered when invasive species removal projects are initially conceived to decide whether native plant re-introduction is needed.

After invasive species management projects are completed, strategies to restore a relatively invasion-resilient plant community include:

1. Reintroduce native species within the same growing season or the next growing season to pre-empt space and resources. For large invasive species mitigation sites, phase mitigation with native species reintroduction.
2. Use native species that are relatively fast growing and whose functional traits and phenology are similar to the invasive species that are in close proximity to attempt to increase the probability that the native species will be able to compete by pre-empting resources. Select a range of native species that fill multiple functional trait niches to pre-empt space and resources from invasive species propagules.
3. Depending on site characteristics, soil amendments can break the feedback cycle of invasive species soil legacy effects:
    - Amend soil with carbon to reduce nutrient availability in productive, mesic sites. Sulfur can be added to reduce pH.
    - For allelopathic invasive species, activated charcoal can be applied to absorb allelopathic chemicals. Native plants can be introduced in life stages that are less susceptible to allelopathy.

- Inoculate the site with a native microbial community using slurries of native soil or commercially available mycorrhizae to take advantage of priority effects.

4. Fencing, to protect native plants in the new plant community across a range of different life forms (i.e., shrubs, herbaceous), is the most efficacious deer deterrent for invasion-resistance.
5. For each site, budget contingency funds for follow-up treatment of satellite invasive species populations, re-planting native species, and maintaining herbivory control to protect the investment in the initial invasive species mitigation treatments and native plant restoration.
6. A site monitoring plan with benchmarks that would trigger adaptive management decisions.

In the coming years some of these strategies to restore relatively invasion-resilient native plant communities at invasive species mitigation project sites will be used, for example the ongoing management of a tornado blowdown adjacent to the Kensico Reservoir. Similar to the approach taken by other watersheds that are managed by multiple programs, DEP will design an approach to target resources to sites that are predicted to have the greatest marginal benefit to water quality protection.

8. Intra-Agency Collaboration

Assessment and mitigation of the potential and realized impacts of invasive species on the NYC Water Supply cuts across many groups and disciplines in DEP. A multi-group, interdisciplinary approach to invasive species is necessary to address the problem comprehensively. As the threat of invasive species on the water supply infrastructure and lands became more widely appreciated, DEP's response became more organized, cohesive and collaborative. DEP created an Invasive Species Biologist position, formalized an Invasive Species, Aquatic Ecology and Restoration Programs, allocated funds for program operations, and constituted an interdisciplinary ISWG and a Mollusk Monitoring Group (MMG).

Invasive Species Biologist

The position of landscape ecologist was formally changed in 2008 to Invasive Species Biologist and tasked with developing the Invasive Species Program and forming the Invasive Species Working Group. In 2007, DEP completed a white paper entitled *Invasive Species and the New York City Water Supply: Recommendations for Management* that summarized the literature to date on potential impacts of invasive species on water supplies, watersheds, reservoirs and water supply infrastructure, and recommended ten steps that DEP should take to manage invasive species in the watershed (DEP, 2007). The white paper was the impetus for formalizing the

Invasive Species Biologist position, development of the Invasive Species Program and the formation of the ISWG. Since 2008, DEP has had a biologist dedicated to invasive species prevention and control and added an Aquatic Ecologist in 2018 and Restoration Ecologist in 2019 that also support invasive species programming.

Invasive Species Working Group

For years, many groups within DEP worked independently on the issue and there was a need for a unified approach for effectively addressing invasive species. Acting on one of the white paper recommendations, BWS formed the ISWG in 2008 comprised of members from three BWS Directorates - Watershed Protection Programs, Water Quality and Innovation, Source Water Operations - and DEP's Bureau of Police and Security. The purpose of the Working Group is to act as a coordinating body, meeting semi-annually to develop recommendations to BWS management and staff on an overarching invasive species plan and related policy issues, and to act as an advisory body on the prevention and management of new and emerging invasive species that may impact the water supply. Subcommittees are formed to work on specific tasks and issues to guide management and policy decisions with the goal of providing guidance on monitoring, preventing and responding to invasive species in the NYC water supply watershed.

Mollusk Monitoring Group

DEP has closely monitored for zebra mussels since they invaded regional waters in the early 1990s. Due to the potential for significant operational and ecological impacts to the NYC water supply should zebra mussels become established, DEP formed a separate working group in 2019, the MMG, led by the Aquatic Ecologist. The MMG meets on a quarterly basis to discuss and coordinate sampling needs and schedules, the status of operational controls, and the general sharing of sampling results and any other pertinent topics to ensure DEP's needs are being met. The MMG is composed of staff from several Directorates within the Bureau of Water Supply (BWS) such as Source Water Operations, Watershed Protection Programs, and Water Quality and Innovation.

Other Collaborative Efforts

In addition to the intra-agency work of the ISWG and MMG, the Invasive Species Biologist works with other bureaus and groups to reduce the introduction and spread of invasive species on City lands and in the watershed. Collaboration is typically through the development of guidelines to reduce the likelihood of introduction and spread by developing BMPs for internal procedures, environmental reviews of projects sponsored by DEP to upgrade or maintain infrastructure and manage lands, and reviews of other types of projects proposed in the watershed. These projects are reviewed through the State Environmental Quality Review Act (SEQRA) and the City Environmental Quality Review (CEQR).

Many groups within DEP are responsible for activities that have the potential to introduce or spread invasive species on City lands. BMPs have been developed through the ISWG and other ad-hoc committees to reduce the potential for introduction and spread of invasive species by normal job tasks including prevention of aquatic invasive species introductions by DEP and contractor vessels, spread of invasive species on maintenance and construction equipment, site restoration plans requiring the use of locally sourced native plants and post-project management plans to help prevent the re-infestation by invasive species. Proposed DEP construction projects are reviewed through collaboration between the Bureau of Water Supply, Bureau of Engineering Design and Construction and Bureau of Environmental Planning and Analysis.

DEP reviews proposed construction project designs, site restoration plans and invasive species management plans in the watershed through SEQRA for the potential of those projects to create conditions that promote the introduction and spread of invasive species. DEP recommends steps and design alterations that can be taken by the applicant to help reduce the likelihood of introducing and spreading invasive species during and after project construction.

9. Partnerships

By collaborating with other agencies and organizations working on invasive species management, DEP addresses emerging invasive species issues with greater efficiency. This was highlighted in the 2020 NASEM report and moving forward DEP will continue to strengthen partnerships and clarify roles. Partnerships allow for the sharing of knowledge and resources and have been identified by the National Invasive Species Council and others as critical to invasive species management at a regional scale. In 2005, the New York State Invasive Species Task Force recommended the formation of eight Partnerships for Regional Invasive Species Management to coordinate partner efforts, recruit and train citizen volunteers, identify and deliver education and outreach, establish early detection monitoring networks and implement direct eradication and control efforts. DEP has been an active member in the two PRISMs that cover the geographic extent of the NYC watershed, the Lower Hudson PRISM and CRISP, since their formation.

Beyond these regional partnerships, statewide collaboration is important to furthering policy changes and fostering dialogue on larger invasive species initiatives. As a result of the Invasive Species Task Force's findings, a New York Invasive Species Council and an Invasive Species Advisory Committee were established to assess the scope of all potential impacts caused by invasive species in the state and to identify and coordinate actions to prevent, control, and manage invasive species. DEP has been a member of the Advisory Committee since 2008. NYSDEC, NYSDAM, USDA, The Nature Conservancy, and Cornell University have also partnered directly with DEP on several targeted invasive species projects.

Current Partnerships

Catskill Regional Invasive Species Partnership

CRISP's mission is to promote education, prevention, early detection, and control of invasive species to limit their impact on the ecosystems and economies of the Catskills. DEP was a founding partner and holds a seat on the steering committee. DEP has been involved in CRISP partnership including:

- Asian Long-horned Beetle Campground Surveys – DEP staff and interns worked with CRISP to survey approximately 20 private campgrounds for the Asian long horned beetle and distribute outreach materials on preventing the spread of forest pests in firewood in 2009 and 2013.
- Eradication of pale swallowwort (*Cynanchum louiseae*) – DEP and The Nature Conservancy worked with CRISP on eradicating pale swallowwort from a site next to the Pepacton Reservoir for five years as part of the NYSDEC Eradication Grant Program.
- Boat Stewardship – DEP staff and interns developed a program to educate recreational boaters at the Pepacton Reservoir on the importance of invasive species spread prevention techniques with CRISP in 2013-2014.
- Ashokan Rail Trail Invasive Species Management – DEP worked with the Catskill Center and CRISP to survey the Ashokan Rail Trail, get stakeholder feedback, and plan and execute volunteer removal projects in 2020 – 2022.
- Strategic Planning Collaboration – DEP worked with the Catskill Center and CRISP to carry out a strategic planning exercise using the groupwisdom™ Group Concept Mapping platform to solicit feedback on future initiatives from CRISP partners and stakeholders in 2022 to determine priorities for the next five years.
    - In the sorting exercise, participants identified CRISP and NYSDEC as the lead for the majority of highly rated statements, reinforcing the need for a top-down regional and statewide approach to invasive species management.
    - Out of the 88 statements, 20 activities were perceived to be best served with DEP as the lead.
    - The top 10 ranked statements from the DEP leadership subset are shown in the table below with priority rank based on the combined importance and feasibility means as rated by DEP in the first column and all CRISP partners in the second. These statements tended to include work in riparian areas and to address pathways of aquatic invasive species introductions.

Table 3. Top Ten Priorities for DEP Leadership by CRISP Partner's Sorting – Rank here indicates placement in the list of 88 statements based on the calculated mean of importance and feasibility rating.

Rank as rated by:		Invasive Species Management Statement
DEP	**CRISP**	
14	26	Manage riparian zone invasive species and restore these areas with native riparian plant communities
24	48	Assess threats to riparian forest overstory that maintain channel morphology and the presence of likely replacement species
31	44	Mount a coordinated spotted lanternfly rapid response
34	41	Explore feasibility of standalone solar powered boat washing facilities for anglers and boaters at high traffic waterways
37	47	Support riparian restoration programs through invasive plant suppression (knotweed)
44	60	Assess impacts of beech leaf disease (*Litylenchus crenatae mccannii*) and support identifying strategies to mitigate the impacts in the Catskills and potential loss of beech (*Fagus*)
46	57	Create an eDNA program for the Catskills to regularly survey throughout the region for invasive fish and aquatic plants as the technology matures
50	80	Eradicate the Hydrilla in New Croton Reservoir
52	49	Improve invasive species prevention infrastructure and inspection steward staffing and capacity at public boat launches
54	40	Engage watercraft stewards in aquatic invasive species management

Lower Hudson Partnership for Regional Invasive Species Management

Lower Hudson PRISM strives to protect the rich biodiversity of the Hudson Valley by identifying conservation areas, likely areas of introduction and methods of early detection and response. DEP has been highly involved and has been a frequent member of the rotating steering committee. Partnership projects with the Lower Hudson PRISM include:

- Blockbuster Survey – DEP has participated in surveying 5 km squares as part of an effort to establish baseline presence and absence data for select invasive species across the entire region by surveying City lands that fall within assigned squares in 2015 and 2016.
- Giant Hogweed Eradication – DEP partners with NYSDEC and Lower Hudson PRISM to identify and remove giant hogweed in the EOH watershed and has successfully eradicated all giant hogweed plants on City lands. DEP conducts survey work while Lower Hudson PRISM staff properly control the plant as needed annually.

- Silver vine Eradication – DEP and Lower Hudson PRISM staff have been working together to eradicate the second known population of silver vine in the state from City lands and the neighboring private lands since 2017.
- Invasive *Viburnum* Control – Lower Hudson PRISM and the Friends of the Old Croton Aqueduct are working with DEP through a land use permit to control invasive *viburnum* species in the land along the Old Croton Aqueduct trail west of the New Croton Reservoir dam since 2020. This is a multi-landowner control project with Westchester County Parks, Recreation and Conservation and other private landowners to reduce the spread of these emerging invasive species along the trail.

New York State Invasive Species Advisory Committee

The ISAC is a statutory body created in 2008 by Title 17, Section 9 of the Environmental Conservation Law (ECL) to provide information, advice, and guidance to the Invasive Species Council, which is comprised of nine state agencies that play a role in managing invasive species, including providing assistance with the development of invasive species regulations. Up to 25 members from stakeholder organizations described or specified in the law constitute the Committee, including DEP which represents all New York water utilities and chaired the committee from 2015 to 2017. To date, the accomplishments of the ISAC include:

- Prohibited and Regulated Species – ISAC worked with NYSDEC to develop the 6 NYCRR Part 575 Prohibited and Regulated Invasive Species regulations.
- Aquatic Invasive Species Spread Prevention – ISAC supported the formation of the part 6NYCRR 576 Aquatic Invasive Species Spread Prevention regulations.
- Invasive Species Awareness Week – ISAC sponsored a statewide education and outreach initiative which included the declaration of a formal Invasive Species Awareness Week to concentrate and cross-promote events for a single week to broadly raise awareness of the issue.

New York State Department of Environment Conservation

The NYSDEC takes on the leadership in management actions for certain invasive species that are deemed to be a high-level threat. DEP has partnered with NYSDEC to support two such efforts. In 2011, DEP supported the NYSDEC Slow Ash Mortality project to create trap trees to slow the westward expansion of emerald ash borer in the Catskills, and in 2014, DEP and NYSDEC began working jointly on a response to Hydrilla in the New Croton Reservoir and the Croton River.

Additionally, in 2020 the northern snakehead (*Channa argus*), a predatory fish native to Asia, was observed downstream of the water supply in the Delaware River at Callicoon and in 2021, in Bashakill Marsh near Wurtsboro. They are likely introduced when aquarium owners discard them into local waterways, or in some cases release them from fish markets. Northern

snakehead has the potential to outcompete native species for food sources and could reduce or even eliminate native fish populations and alter aquatic communities. This could have financial impacts related to ecological and recreational damages. Although this species prefers to live in stagnant shallow ponds or swamps, it can inhabit canals, reservoirs, lakes, and rivers. Thus far, the northern snakehead has not been observed within New York City's water supply watershed. However, the DEP will coordinate with NYS DEC, continue to monitor for them, and will work closely with the NYS DEC should northern snakehead be found within the watershed.

New York State Department of Agriculture and Markets

The New York State Department of Agriculture and Markets is the lead agency for the response to the spotted lanternfly in New York State. Since 2020, DEP has been participating in the response through involvement in a biweekly or monthly Multi-Agency Coordination, conducting surveys on City lands, and trapping for the spotted lanternfly. DEP will continue to support the response and will continue to coordinate with the NYSDAM.

United States Department of Agriculture

Recently, the federal domestic quarantines that regulate the handling of emerald ash borer host material have ceased, and USDA APHIS Plant Protection Quarantine (PPQ) has shifted its focus toward establishing biological control agents – namely *Tetrastichus planipennisi*, *Spathius galinae* and *Oobius agrili* (parasitoids that prey solely on emerald ash borer). In 2020, DEP enlisted as a cooperator with hundreds of others across 372 counties in 30 states. Being a cooperator involves surveying for suitable sites, conducting parasitoid releases and monitoring success over the next several years with the goal of developing a widely dispersed parasitoid population to come into equilibrium with emerald ash borer populations and save future generations of ash species. Ultimately, the goal for DEP is to provide the opportunity for ash to become established again in the watershed forests of the future.

The Nature Conservancy

DEP has been working with the Nature Conservancy to assess the impacts of deer and invasive species on forest regeneration in the Ashokan watershed. The Nature Conservancy designed a study to look at plant regeneration inside and outside of deer exclusion fencing in 2014 and has been working with DEP to collect deer impact data on the area through a statewide initiative Assessing Vegetation Impacts from Deer (AVID) since 2019. Preliminary results indicate some variation of deer impacts across the basin and further study is needed to better address the relationships.

Cornell University

DEP is working with the Cornell University's New York State Hemlock Initiative to support the conservation of eastern hemlock in the watershed. Cornell is evaluating the use of several biological control organisms on City lands to determine if any of these species will be able to

establish and become a viable management tool for hemlock woolly adelgid. This work is being supported through the New York City Town+Gown program, an open platform research program that uses service (experiential) learning and faculty-directed research to facilitate partnerships between academics and practitioners on applied built environment research projects through the collaborative inquiry model of systemic action research.

The Lake Mahopac Park District

The Lake Mahopac Park District (LMPD) has aided DEP in better understanding the risk zebra mussels pose to the NYC water supply system. In 2018, 2019, and 2021 the LMPD has provided the DEP with access to a boat and pilot to sample the lake for veligers and in return DEP shares the results of its study.

United States Geological Survey

In 2009 and 2010, researchers from the United States Geological Survey collected periphyton samples in the Esopus Creek both up and downstream of the Portal in Shandaken to survey fro Didymo. Didymo was found at several locations, but its presence did not strongly affect the periphyton, macroinvertebrate and fish communities.

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Appendix A
Stakeholder Input Report on Invasive Species Priorities

STAKEHOLDER INPUT REPORT ON INVASIVE SPECIES PRIORITIES

Prepared for
The Catskill Regional Invasive Species Partnership (CRISP)
and
The New York City Department of Environmental Protection (DEP)

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March 15, 2022

Executive Summary

The Catskill Regional Invasive Species Partnership (CRISP) and the New York City Department of Environmental Protection (DEP) collaborated on a project between December 2021 and March 2022 to gather stakeholder input on invasive species priorities. A concept mapping process was utilized, which is a structured research methodology that generates insights into the perspectives and priorities that exist among stakeholders. The process provided insights into the makeup of the stakeholder group, the invasive species topics they see as priorities, how the priorities compare in terms of importance and feasibility, and who the participants feel should take the lead on implementing each priority.

The 73 participants self-categorized by role, employer / affiliation, the primary habitat they work in, and engagement with invasive species work in the region. They identified 88 priorities by completing the prompt, “One specific invasive species priority in the CRISP Region over the next five-years is…” Twenty-nine priorities were rated above average in importance and feasibility and are listed in the Results section of the report. The participants then sorted all of the statements into groups and an analysis revealed four clusters, including NYC DEP, NYS DEC, CRISP, and a collaborative cluster. The results discussed in the report and the data included in the Appendices can be used as a consensus-driven pipeline of prioritized projects for each organization and their collaborators.

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Background

In the fall of 2021, the Catskill Regional Invasive Species Partnership (CRISP) and the New York City Department of Environmental Protection (DEP) sought to understand stakeholder perspectives on invasive species management priorities in their region. A grant from the DEP was awarded to employ a concept mapping methodology.

Concept mapping enables participants to participate in a convenient, confidential, structured, and timebound process (Trochim, 1989b). It has been used in many fields to assist with group decision making and was recently employed by the New York Invasive Species Research Institute for a similar purpose with their New York State stakeholders. To facilitate the process, a software license was purchased for access to a platform designed for participant input and analysis (Concept Systems, 2022).

The concept mapping process involves significant planning, including the development of a focus prompt, demographic questions, rating criteria, and for this project, an alternate sorting methodology. The process then includes several stakeholder activities, including demographic questions, idea generation, rating, and sorting.

Schedule

The CRISP-DEP process followed the schedule below in Table 1. Multiple extensions were offered to participants, initially to complete the ratings and then an additional period at the end for all activities.

Table 1. Schedule

Activity	**Start**	**End**
Discussions	May 26	November 16, 2021
Planning	November 16	December 2, 2021
Participant Activities		
Idea Generation	December 3	December 31, 2021
Importance Rating	January 10	January 28, 2022
Feasibility Rating	January 19	January 28, 2022
Sorting	February 1	February 7, 2022
Extension	February 9	February 12, 2002
Analysis & reporting	February 14	March 7, 2022

Activities and Participation

Participation was open to all CRISP and DEP stakeholders, and invitations were sent by email to a CRISP Mailchimp list with 143 addresses, a CRISP listserv with 287 addresses, and individual invitations. There was some overlap between the two CRISP lists, and recipients were encouraged to forward the invitation to those who may not have received it. Examples of the emailed invitations are in Appendix A.

The first activity of brainstorming generated 161 ideas by stakeholders completing the prompt, “One specific invasive species priority in the CRISP Region over the next five-years is…” These ideas were submitted through 84 contributions, from a likely smaller number of participants who returned more than once. We do not know the exact number of participants because submitting ideas in this activity was done anonymously.

The 161 ideas were reduced and synthesized to eliminate redundancies and combine similar ideas, resulting in a list of 88 priorities. The people involved in this process were the project owners, John Thompson of CRISP, Meredith Taylor of DEP, and the consultant, Bryan Dailey.

Redundancy in a statement set can be considered as an indication that the ideas represent the breadth of a topic. The full list of statements is included in Appendix B. Some common themes included early detection, rapid response, education, and outreach. There were also several specific species that were submitted multiple times, including beech leaf, jumping worms, spotted lantern fly, and woolly adelgid.

Subsequent activities required registration, and 73 stakeholders responded to participant questions, importance rating, feasibility rating, and sorting. Participant questions were asked to provide a better understanding of the stakeholders as a group and to allow the results to be segmented according to sub-groups.

There were surprisingly 8 participants who completed the questions but did not participate in the rating or sorting activity. Their responses were included in the participant descriptions below in order to provide the most complete description possible of the stakeholder group, although it means that these descriptions may not strictly describe the slightly smaller group of participants who provided input in the activities.

The four participant questions asked for primary role, primary employer/affiliation, primary habitat in which they work, and involvement with CRISP and/or invasive species management in the region. It was hoped that the menu of responses would describe the participants, but due to the variety of potential stakeholders who were expected to participate, an “Other” response was included for the first three questions with an open text field.

The possible responses to primary role included Landowner, Land manager, Researcher, Educator, Contractor (landscaper/forester), Volunteer, and Other. The

most common responses were Land managers (37%) and Researchers (19.2%). The “Other” option was selected surprisingly often (20.5%) and was most often an administrator or manager type of role. The breakdown is shown in the figure below.

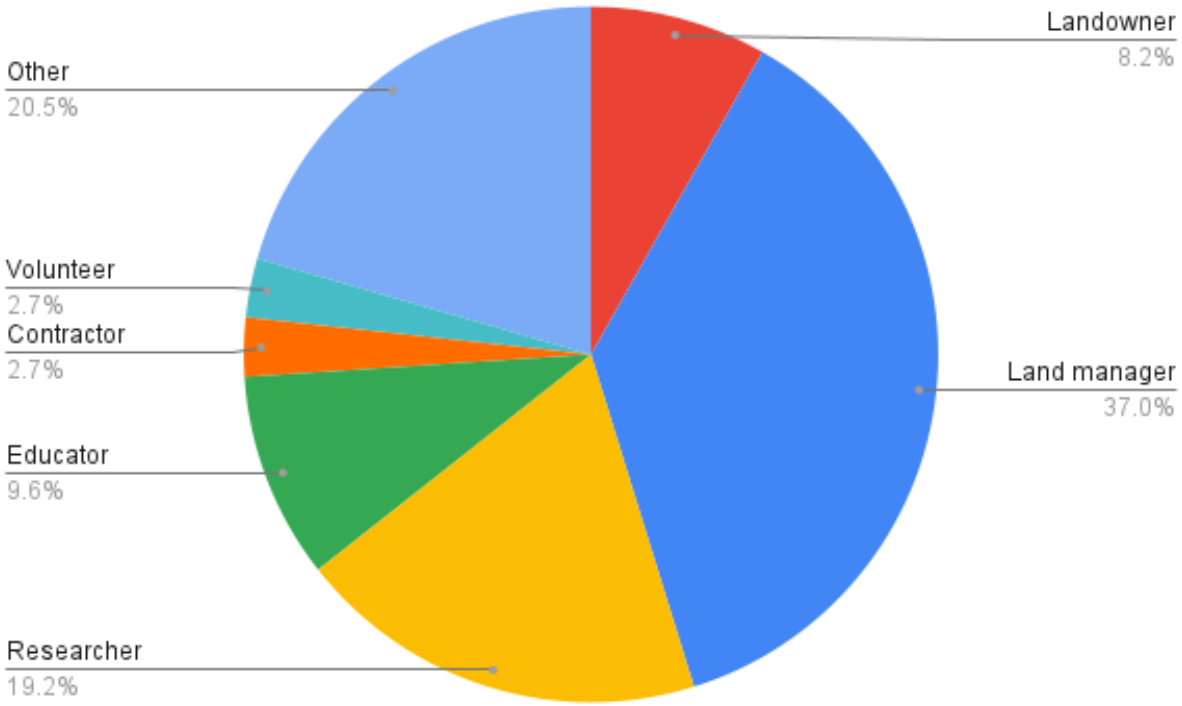


Figure 1. Primary Role

Possible responses to the second question of primary employer or affiliation included NYC DEP, PRISM, Local entity (CCE, SWCD, other municipal office, non-profit), NYS/Federal Agencies, University/College, and Other. The most common responses were NYC DEP (40.9%) and Local Entity (15.5%). Again, the “Other” response was selected frequently, and the most common responses given were retirement and self-employment. The breakdown is shown in the figure below.

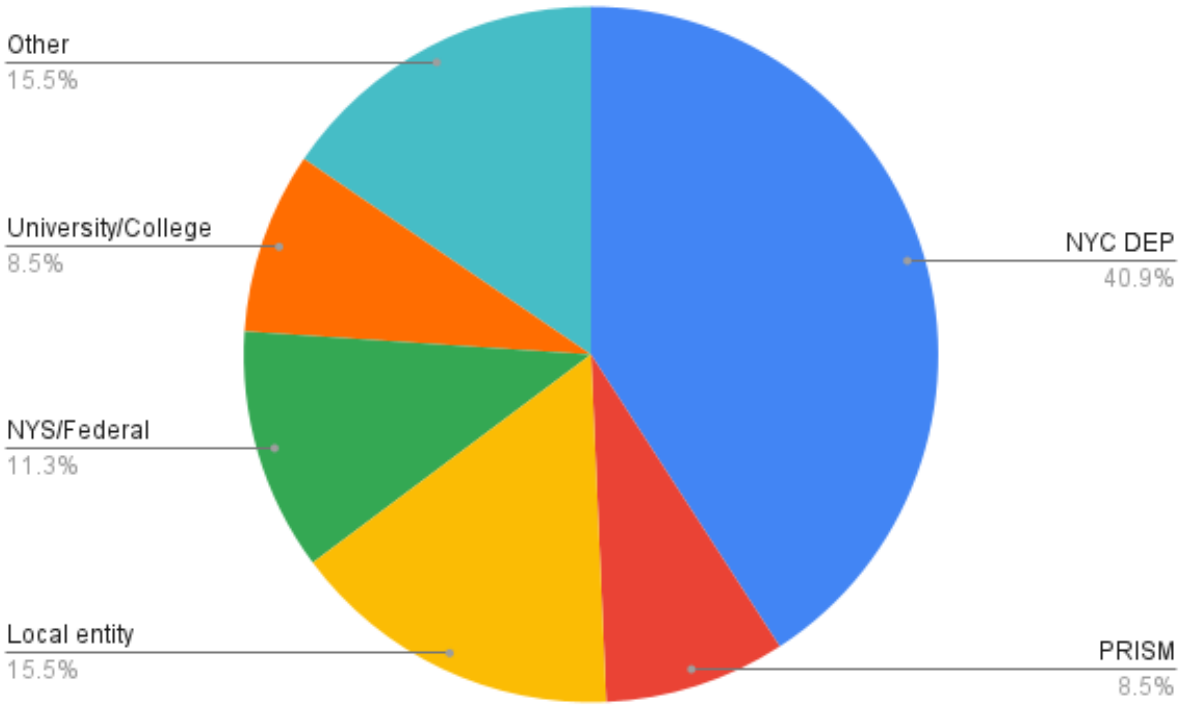


Figure 2. Primary Employer / Affiliation

Possible responses to the third question included Aquatic, Riparian, Wetland, Upland/Terrestrial, and Other. The most common responses were Upland/Terrestrial (50%) and Aquatic (19.4%). The “Other” category included 13.9% of participants and the most common reason was that they wanted to include multiple habitats. The full breakdown is shown in the figure below.

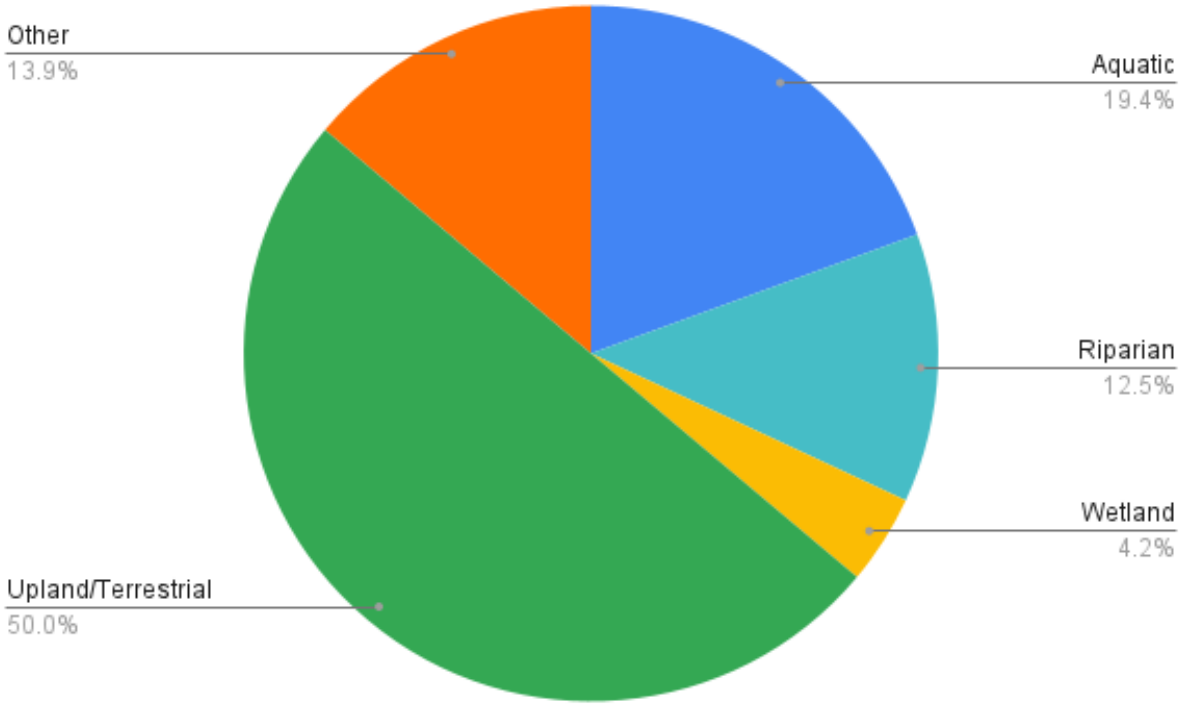


Figure 3. Primary habitat

Responses to the fourth question, of involvement with invasive species work, included Very involved, Somewhat, and Not at all. The most common response was Somewhat (67.1%), followed by Very Involved (19.2%). Participants who were not at all involved was 13.7%. The full breakdown of the results is shown in the figure below.

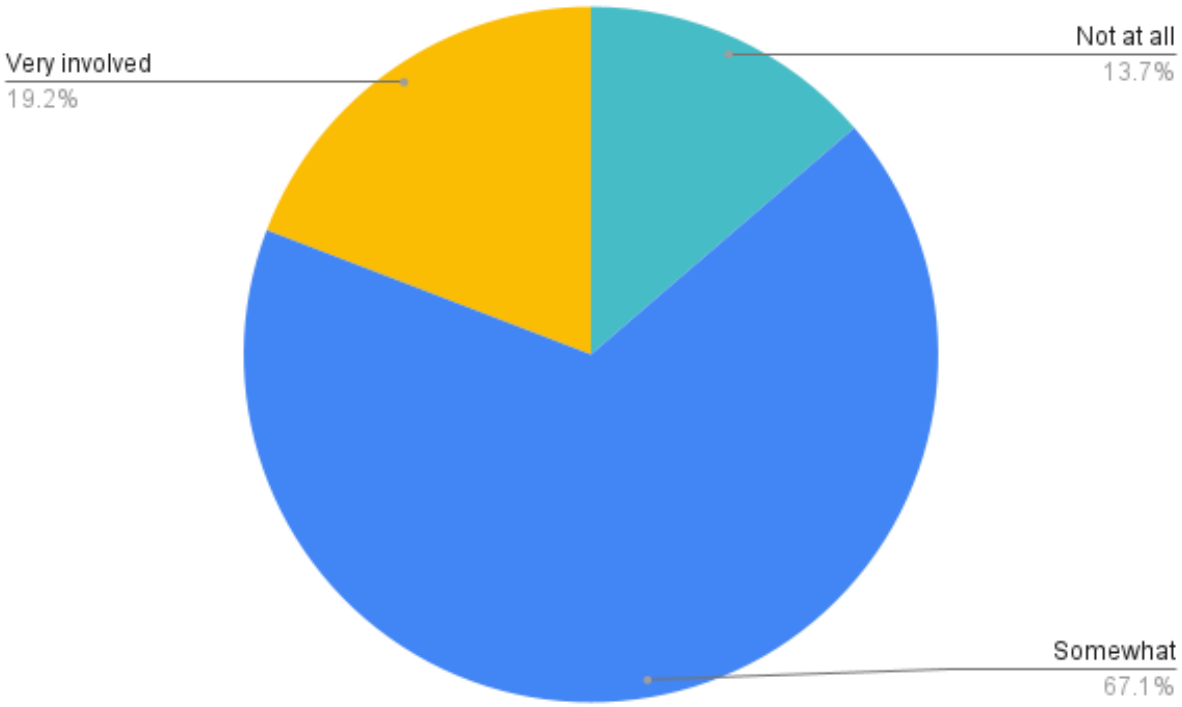


Figure 4. Involvement with CRISP and/or Invasive Species Management in the Region

The two rating activities had solid participation, with 61 participants for the importance rating and 31 participants for the feasibility rating. The concept mapping process would normally schedule the rating activity after the sorting activity. Sorting often has a lower number of participants because it is more complicated and more time intensive than the rating activities. The prioritization was especially important for this project, so those activities were conducted immediately after brainstorming and the sorting activity was conducted afterward.

We also used a somewhat unconventional approach for the sorting activity. CRISP and DEP desired more directed input from stakeholders than might be produced by sorting according to similarity. We therefore requested that participants sort the ideas according to who they thought should take the lead on implementing it. We did not define which organizations or any number of organizations that they should use.

While 25 stakeholders participated in the activity, only 17 followed the instructions and were included in the results. The instructions were included in the invitation and reminder emails, in the activity directions on the software platform, and in an

instructional video produced for the activity. The video is hosted on Youtube at https://www.youtube.com/watch?v=9PH0e0Md1qU and was viewed 42 times before the sorting activity concluded.

Results

Participants were asked to rate the statements according to importance and feasibility, using a Likert scale of 1 to 5, with 1 being least important or feasible and 5 being most important or feasible. The two ratings are illustrated together in the priority matrix below, with importance on the y-axis and feasibility on the x-axis.

The crosshairs represent the average rating for each activity. Statements that were rated above average for importance and feasibility, for example, are in the upper right quadrant in green. Statements in the top left quadrant were rated most important but less feasible, and statements in the lower right quadrant were rated most feasible but less important.

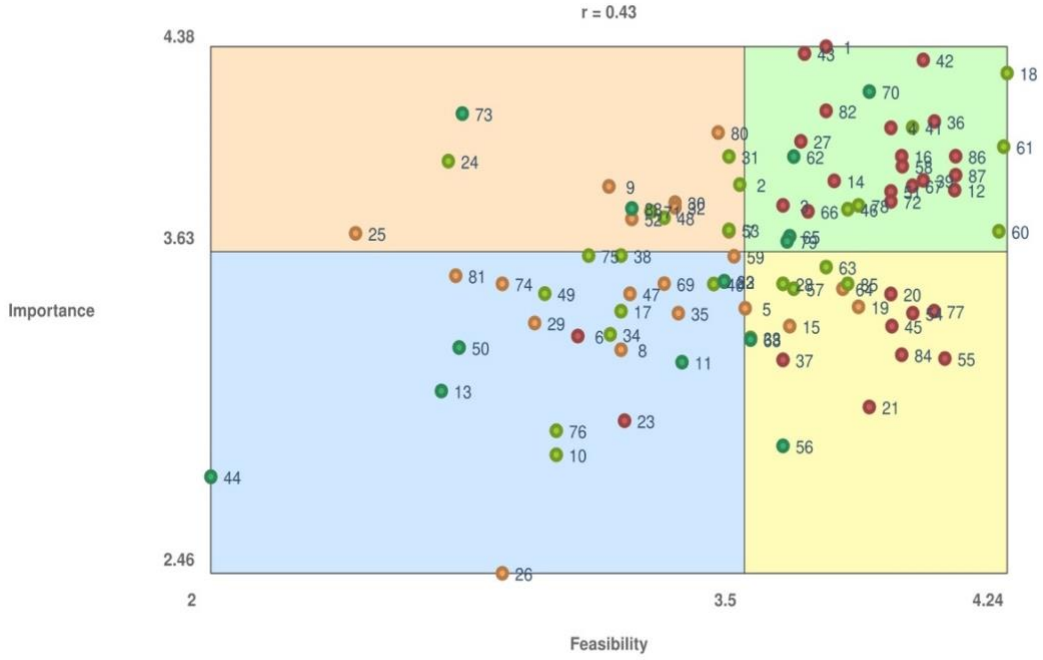


Figure 5. Priority Matrix

Another way to view the most highly rated statements is with a combined average score from the two ratings, which ranged from 8.52 to 4.81. A list of the 29 statements in the

top right quadrant, sorted by combined scores, are listed in the table below. A list of all statements and combined scores is included in Appendix C.

Table 2. Rating Scores, Sorted by Combined Mean

Statement Number	Import-ance	Feas-ibility	Combined	Statement
18	4.29	4.24	8.52	Create a BMP training program for municipal highway departments and landscapers to minimize introduction and spread of invasives
42	4.33	4.00	8.33	Collaborate with neighboring PRISMs to manage species that may be moving in from the border areas
61	4.02	4.23	8.24	Collaborate with the NY Hemlock Initiative on the release of hemlock woolly adelgid biocontrol agents and their efficacy
36	4.11	4.03	8.14	Increase management capacity through training students, citizen scientists, volunteers, landowners, and forest owners
1	4.38	3.73	8.11	Increase capacity to perform early detection and rapid response
70	4.22	3.86	8.08	Assess the success of management projects
86	3.98	4.09	8.07	Create a quick and easy way for landowners/stakeholders to ask questions and get answers and feedback to specific invasive species management topics via the web page
41	4.09	3.97	8.06	Work with DEC Region 3 and 4 permit staff to make sure that invasive species issues (SLF transport quarantines, clean equipment, native plant lists etc.) are flagged in permit reviews.
43	4.36	3.67	8.02	Work with local governments to build invasive species prevention and management into their planning and review processes
87	3.91	4.09	8.00	Finalize an invasive species management and monitoring protocol
4	4.09	3.91	8.00	Prioritize mitigation of threats to Catskills ecosystems and forest ecosystem processes (i.e. forest regeneration)
12	3.86	4.09	7.95	Increase outreach on spread prevention to Catskill recreationists and tourists
16	3.98	3.94	7.92	Investigate and implement the most effective education and outreach strategies
60	3.71	4.21	7.92	Maintain an active list of licensed pesticide applicator businesses with expertise at invasive plant removal for partners
39	3.89	4.00	7.89	Coordinate with local colleges and universities to investigate research needs and facilitate invasive species field learning labs/volunteer days for students in environmental fields
58	3.95	3.94	7.89	Develop/adopt best management practices for spread prevention on construction equipment and fill following the SLELO PRISM model

82	4.15	3.73	7.88	Coordinate activities between partners so there is minimal redundancy in management strategies to maximize the funding available for specific monitoring and research proposals
67	3.88	3.97	7.84	Develop uniform approaches to data collection by field crews
51	3.85	3.91	7.76	Develop the next generation of invasive species professionals through meaningful internships that provide hands on experience in the Catskills
72	3.82	3.91	7.73	Develop a procedure for objectively ranking invasives in order to triage the limited resources
27	4.04	3.66	7.69	Build capacity to perform site restoration at treatment sites and provide resources to partners for restoration
14	3.89	3.79	7.68	Identify and manage Invasive Species Prevention Zones based on low current invasion and critical habitats
78	3.80	3.82	7.62	Manage invasive plants that influence human health such as giant hogweed
62	3.98	3.64	7.62	Focus on early detection of aquatic invasive species
46	3.79	3.79	7.58	Create a strategic plan to deal with future hemlock loss
66	3.78	3.68	7.46	Advocate for prioritizing and funding treatment strategies for known infestations
3	3.80	3.61	7.41	Build Catskills specific citizen science program, adaptable to a wide audience (include college ecology programs), to provide information to volunteers and critical data to researchers, land managers, and agencies
65	3.69	3.63	7.32	Research & compare the range of methods available for reducing invasive annual plants (mile-a-minute, stiltgrass)
79	3.67	3.62	7.29	Collaborate to use plant species and water quality data to identify Invasive Species Prevention Zones

The variance of these ratings can be indicative of consensus. A smaller variance indicates a higher level of agreement. The table below shows the average variance in ratings for importance and feasibility, broken down by first quarter, first half, and second half. There appears to be an increasing level of consensus with the highest rated statements.

Table 3. Rating Variance

Combined Score Rank	Importance Variance	Feasibility Variance
1-22	0.86	0.85
1-44	0.92	0.97
45-88	1.26	1.15

Appendix D shows a priority matrix as above in Figure 5 and Appendix E shows a table of rating scores as in Table 2, but both are limited to data from DEP participants. Of the participants who selected DEP in the participant questions, 24 participated in the importance rating and 13 participated in the feasibility rating.

The final participant activity was to sort the statements. While the concept mapping process would normally have participants sort statements according to similarity, we asked participants to sort them according to which organization they thought should take the lead on implementation.

The first step of the analysis is to use multidimensional scaling to represent the results in a point map, shown in the figure below. Each point in the figure represents an idea, with its corresponding number next to it. The proximity between points represents the frequency with which the ideas were sorted together by all of the participants.

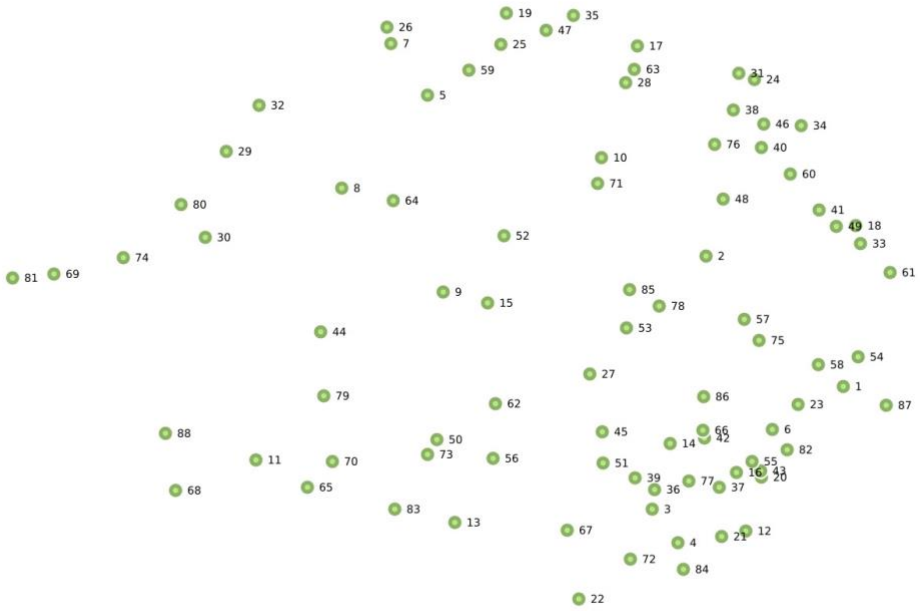


Figure 6. Point Map

Once the point map is created, clusters of points are delineated with hierarchical cluster analysis using Ward's minimum variance method. The final number of clusters is somewhat subjective, as it depends on a best fit with the particular set of ideas being organized. The two sponsors of this project anticipated a small number of clusters, and that did seem to fit well with the results.

The name of each cluster is also somewhat subjective but begins with the names of participants' groups with centroids closest to the centroid of the cluster. Those labels often repeat, and that was the case with the cluster map shown below in Figure 7. It shows four clusters, clockwise from the top left, are NYC DEP, NYS DEC, CRISP, and All.

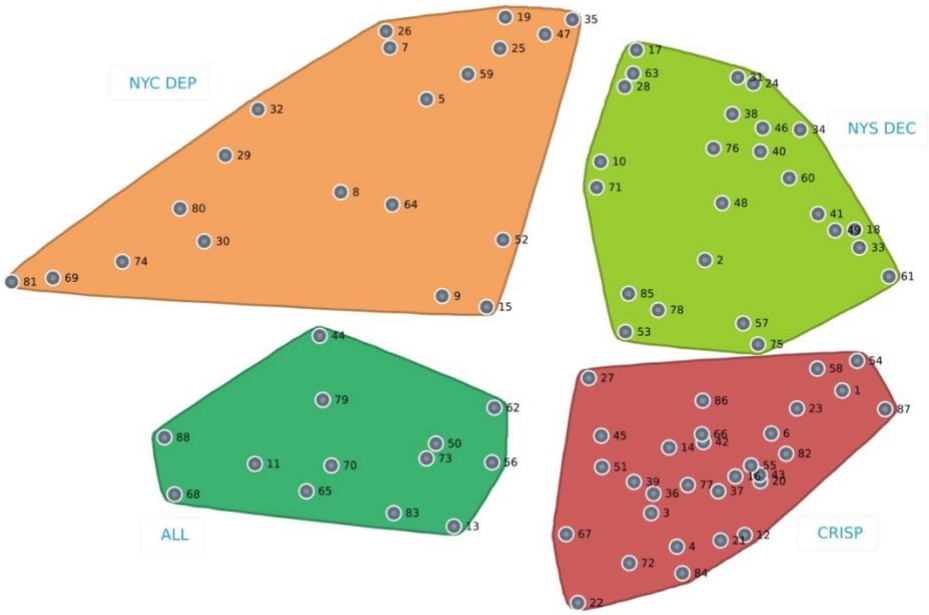


Figure 7. Cluster Map

The sorting seemed to emphasize the collaborative nature of the groups, with the All cluster requiring all organizations to work together on implementation. Some of the other organizations named along with each cluster are listed in the table below. The statements in Appendix F are listed with the cluster into which they were sorted.

Table 4. Lead Organizations and Collaborators

Lead Organization	**Collaborating Organizations**
NYC DEP	Soil & Water Conservation
	SUNY Oneonta
	NYS Dept of Agriculture & Markets
	PRISMS
	Boat Steward Program
	Land Managers
NYS DEC	CRISP

	Catskill Mountainkeeper
	New York State
CRISP	Catskill Center
	CCE
	NY/NJ Trail Conference
ALL	NYISRI
	Catskill Science Collaborative
	iMapInvasives
	Other - local NGOs, govts, academic institutions etc.

Clusters and ratings can also be visualized together, to illustrate the relative importance and feasibility of groups of statements. In the figures below, the cluster map integrates the ratings by adding layers to signify higher average scores. Figure 8 illustrates that the CRISP cluster includes the statements with the highest average importance ratings, followed by the NYS DEC cluster.

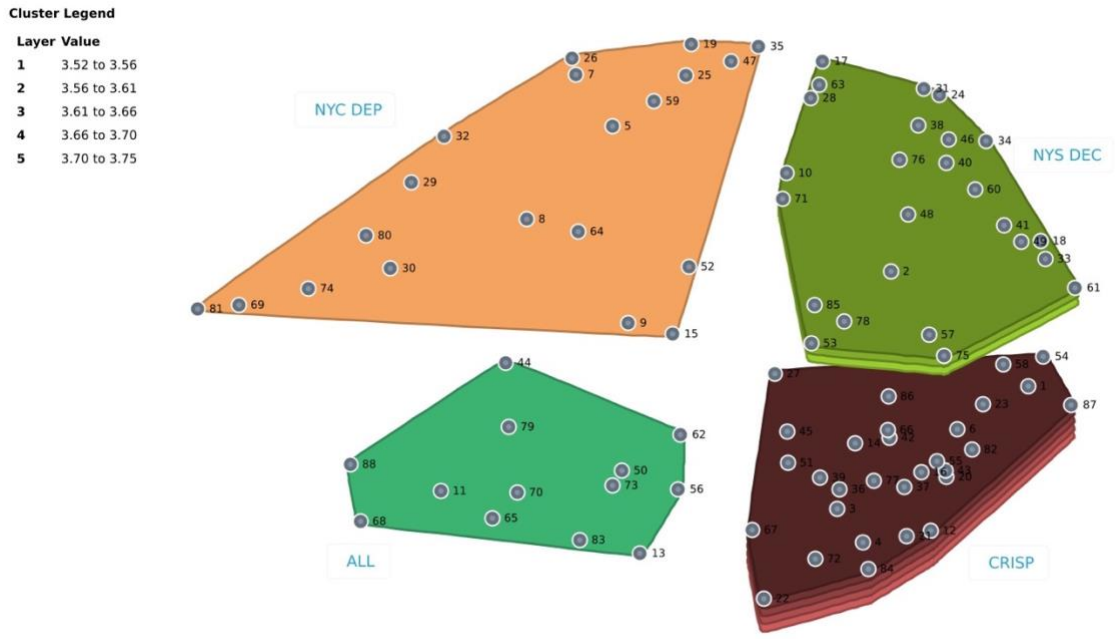


Figure 8. Cluster Rating Map, Importance

Likewise, Figure 9 illustrates that the CRISP cluster includes the statements with the highest average feasibility ratings, followed by the NYS DEC cluster.

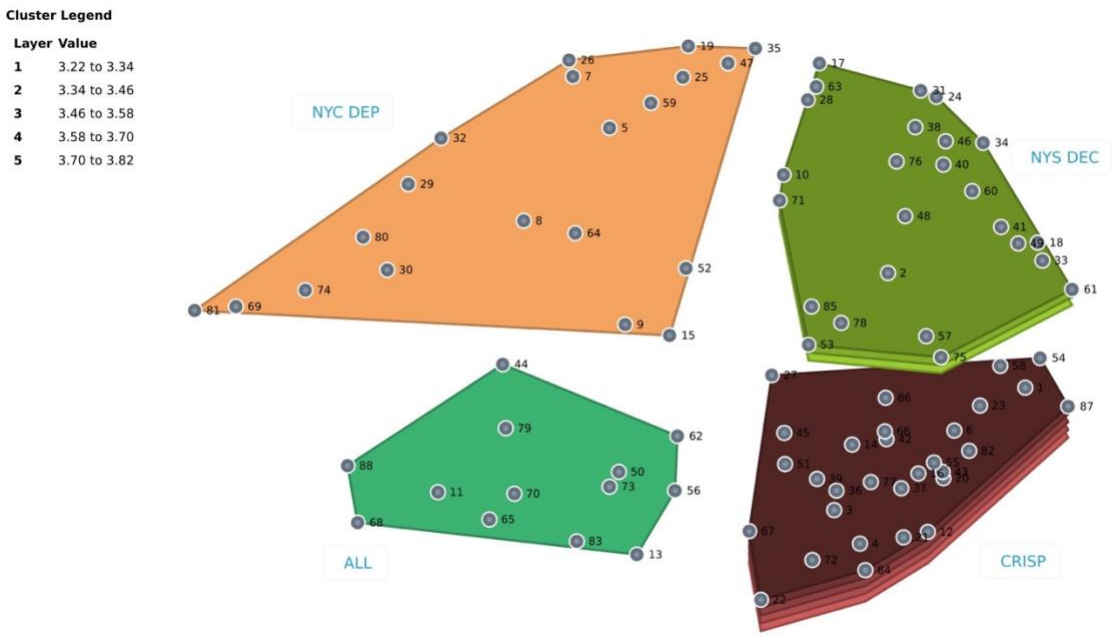


Figure 9. Cluster Rating Map, Feasibility

Another integration of sorting and rating data can be visualized with parallel coordinates, shown in the figures below. These show the average rating of each cluster by groups of participants. Each colored, horizontal line represents a cluster, which is labeled on the y-axis and is color coded to match the cluster map.

The vertical bars represent participant groups. In the figures below, the vertical line on the left includes all participants, while the groups to the right include participants from the NYC DEP, NYS DEC, and PRISM. The number of participants in each group is in parentheses next to the group name. The average high and low rating for each group is labeled at the top and bottom of the line.

It should be noted that PRISM is an optional answer for the ‘employer/affiliation’ participant question, created during the planning period of the project. CRISP is the group name that participants used when sorting. CRISP is one of the PRISMs, but in these results, PRISM represents those who selected that response in the participant questions and CRISP is the organization that the participants felt should lead the implementation on the statements in that cluster.

These can be a valuable way to highlight similar or contrasting perspectives of participant groups. Horizontally parallel lines represent agreement between groups. The degree to which cluster lines are not parallel, or even cross, indicate a lack of agreement. Like the cluster rating maps in figures 8 and 9 above, these figures show that the CRISP and DEC clusters were rated most important and most feasible.

The comparison between groups in the project, however, are not based on enough participant data to be statistically significant. The DEC group includes only two participants and the PRISM group includes just four participants. They are included primarily because all participants indicated that these organizations should lead the implementation of the statements in the two clusters, so illustrating the perspective of the participants with the closest affiliation to those organizations, albeit statistically insignificant, seemed important.

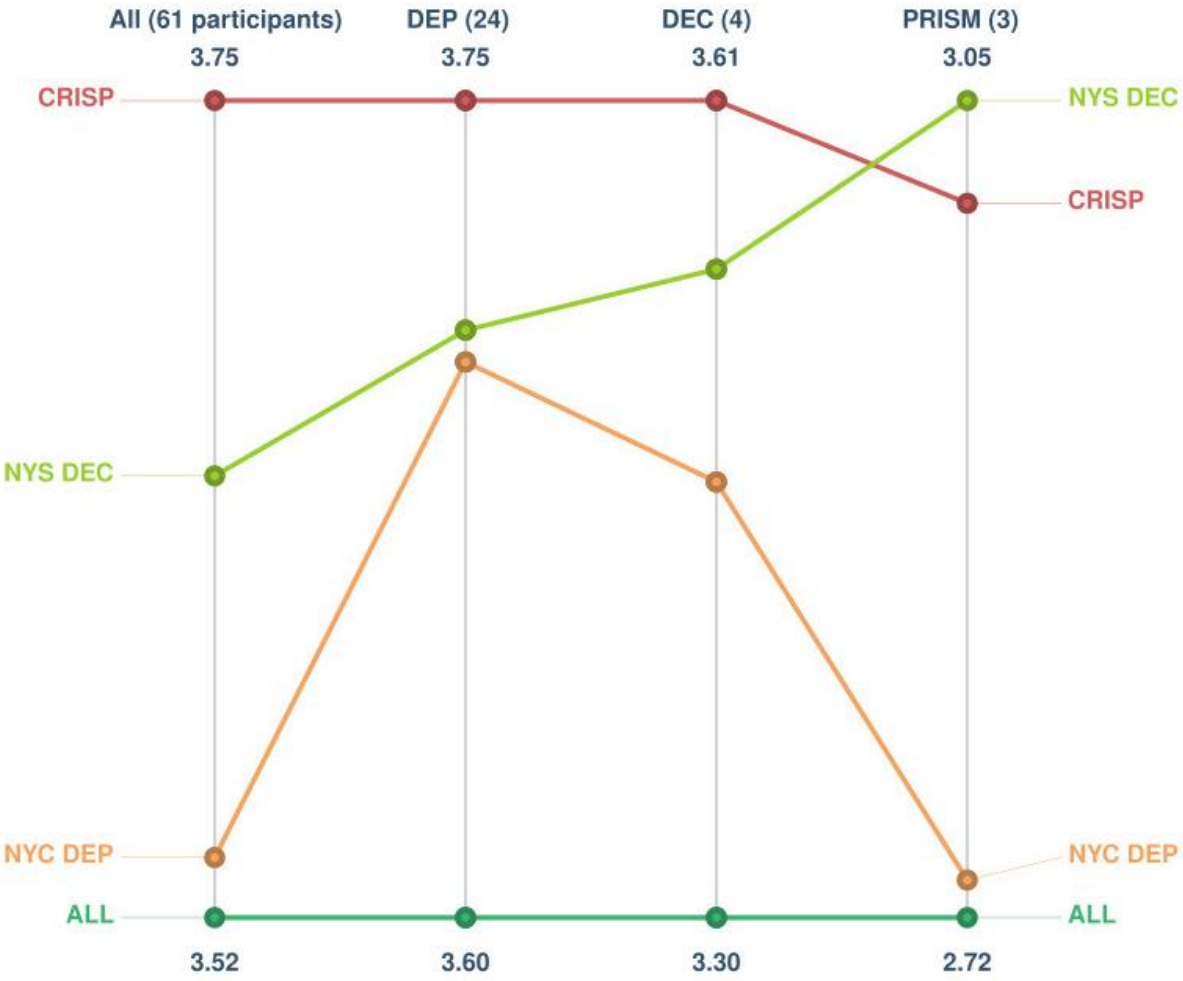


Figure 10. Parallel Coordinates, Importance

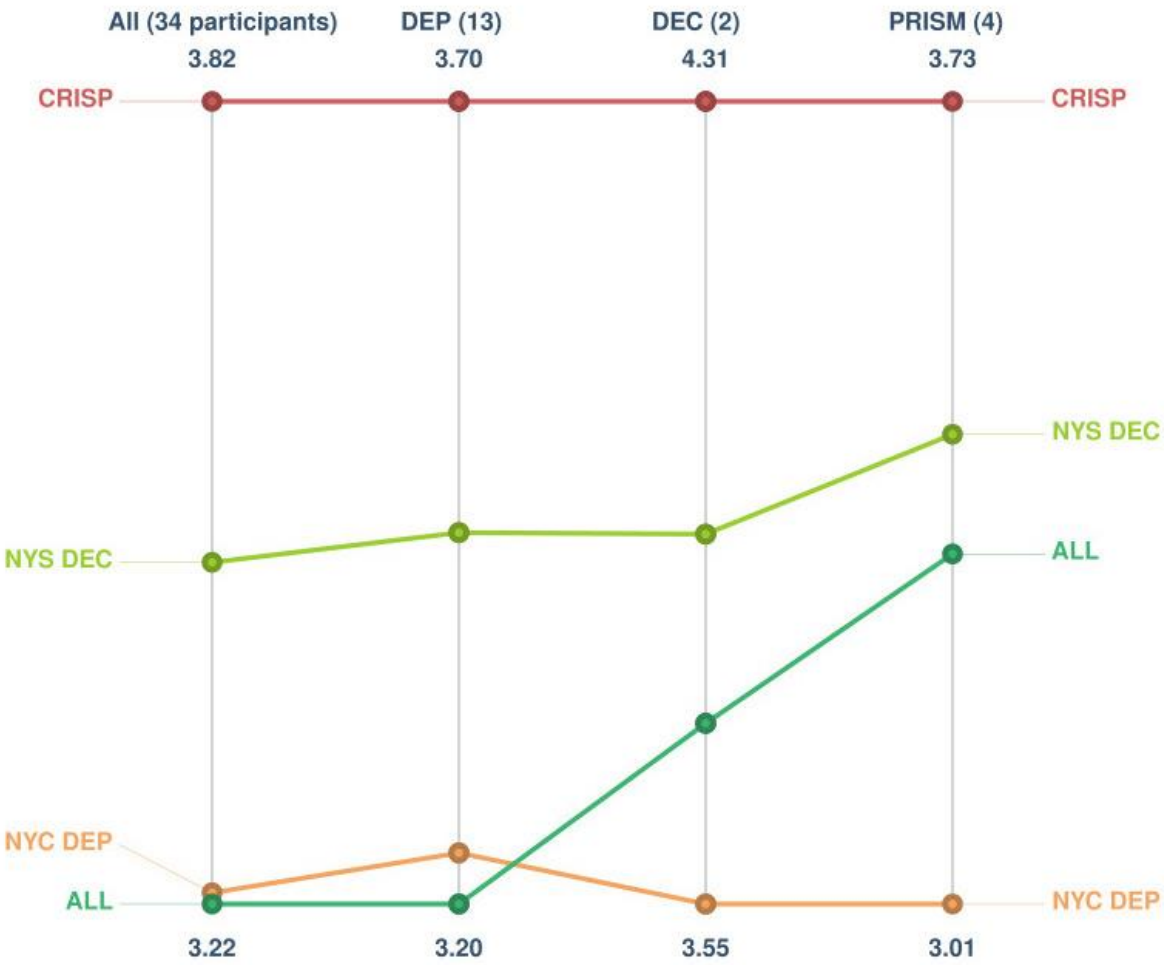


Figure 11. Parallel Coordinates, Feasibility

Discussion

The results indicate a successful process that provides insights into the makeup of the stakeholder group, the invasive species topics that they see as priorities, how the priorities compare in terms of importance and feasibility, and who the stakeholders feel should take the lead on implementing each priority.

Participants represented each of the segments that were anticipated, across role, employer or affiliation, primary habitat, and engagement with the topic. The most common responses were land managers, DEP employees, terrestrial habitat, and somewhat engaged.

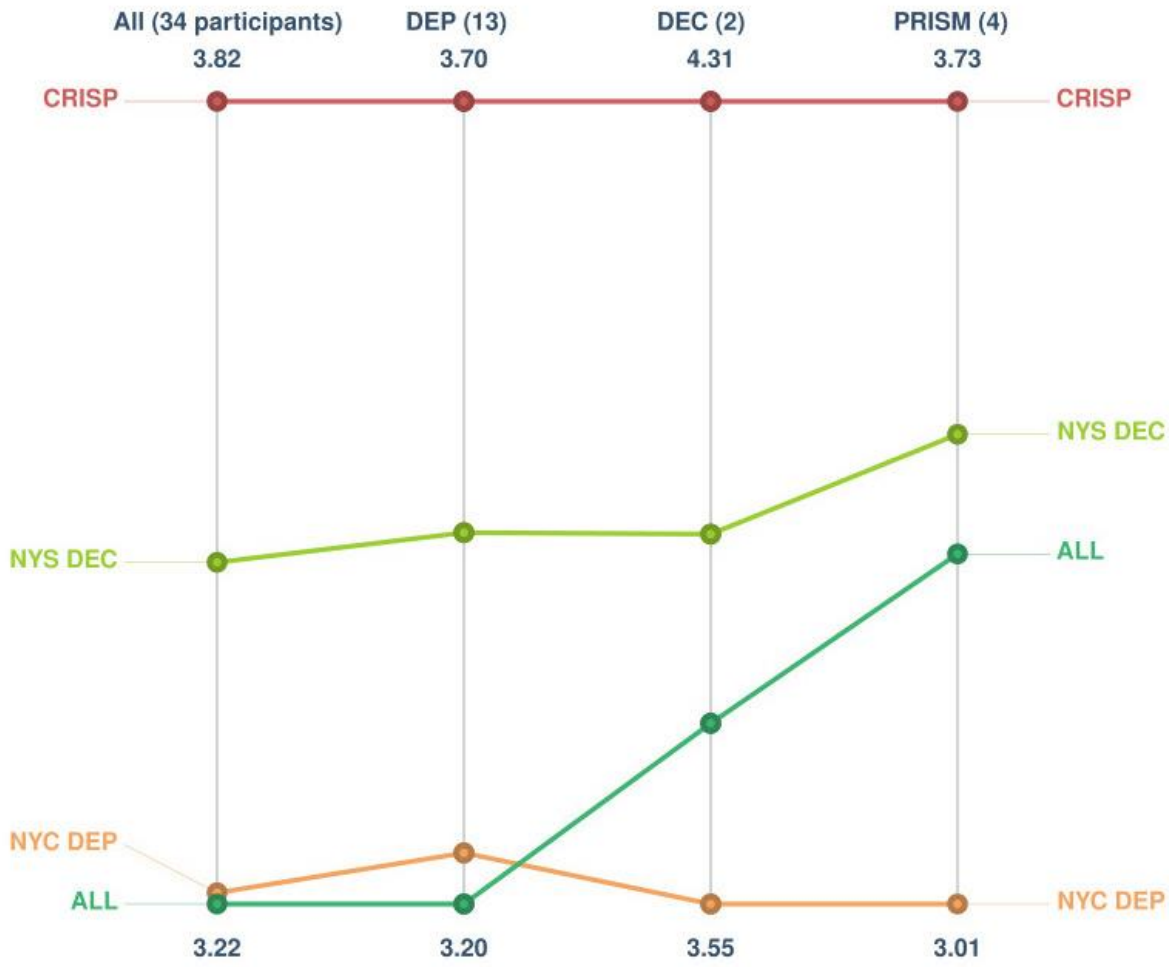


Figure 11. Parallel Coordinates, Feasibility

Discussion

The results indicate a successful process that provides insights into the makeup of the stakeholder group, the invasive species topics that they see as priorities, how the priorities compare in terms of importance and feasibility, and who the stakeholders feel should take the lead on implementing each priority.

Participants represented each of the segments that were anticipated, across role, employer or affiliation, primary habitat, and engagement with the topic. The most common responses were land managers, DEP employees, terrestrial habitat, and somewhat engaged.

Of the 88 priorities that were identified, 29 were above average in importance and feasibility. Interestingly, the variance of the ratings decreased with increased importance and feasibility, meaning that there is an increasing level of consensus regarding the top priorities.

The alternative sorting methodology may have reduced the participant data that could be included, but the results were interesting and likely more valuable than the conventional approach. Sorting produced four clusters of statements, identifying which organization should take the lead on implementation. These included NYC DEP, NYS DEC, CRISP, and All. Collaboration seemed to be a strong theme, not only for the All cluster, but also for collaborating organizations in the other three clusters.

When the ratings and clusters are combined, the CRISP cluster was rated both most important and most feasible, followed by the NYS DEC cluster. The combination of both ratings, with the identification of lead organizations, should be useful as a pipeline of prioritized projects for each organization, along with their collaborators.

References

Concept Systems, I. (2022). *The Concept System® groupwisdom™*. In (Version 2021.24.01) https://groupwisdom.com/

Trochim, W. M. K. (1989b). An introduction to concept mapping for planning and evaluation. *Evaluation and program planning*, *12*(1), 1-16. https://doi.org/http://dx.doi.org/10.1016/0149-7189(89)90016-5

Appendix A. Invitation Emails

Subject Your Input is Requested on CRISP/NYC DEP Invasive Species Management Priorities

Date 12-3-21

Catskill Regional Invasive Species Partnership (CRISP) is working with partners to address invasive species issues in the greater Catskills region (https://www.catskillinvasives.com/updates). New York City Department of Environmental Protection (NYC DEP) has an invasive species program to protect the upstate water supply from invasive species threats to water quality and infrastructure. CRISP and NYC DEP are working together on a group concept mapping project to guide strategic planning specifically for invasive species management for the next 5 years. To assist us in this effort, we are looking for input from a variety of stakeholders with expertise in a broad range of geographic and taxonomic areas. When responding, please keep in mind that we are expecting ideas related to invasive species applied management goals (as opposed to general education or research goals).

You will find a link below to start the process. The first phase is brainstorming, where we invite you to contribute your ideas. You will see a single prompt to respond to. This phase will be open from December 3rd to December 31st This brainstorming can be completed in as little as 2 minutes, but we appreciate the time and thought you put into it.

Your participation is voluntary, and your input will be anonymous and aggregated with the input from other participants.

Please let us know if you have any questions.

https://participant.groupwisdom.tech/project/2005/brainstorming

Subject: Importance Rating for CRISP/NYC DEP Invasive Species Management Priorities

Date: 1-11-22

We received excellent input on our joint Catskill Regional Invasive Species Partnership (CRISP) and New York City Department of Environmental Protection (NYC DEP) group concept mapping to guide invasive species management for the next 5 years. We received 160 statements from 83 contributions. Thank you!

Our next step is to rate the importance of 88 statements, synthesized from the original input. This activity is open until January 24. First, we ask you to **register with an email address and answer four quick questions**. These questions allow us to segment the

responses into similar groups, but your email address and responses are confidential and aggregated - individual responses are not identified.

Please click the link below to get started! You can log back in anytime to continue where you left off and let us know if you have any questions.

https://participant.groupwisdom.tech/project/2005/rating/3297

Subject Feasibility Rating for CRISP/NYC DEP Invasive Species Management Priorities

Date: 1-18-22

Our next step in Catskill Group Concept Mapping is to rate the **feasibility** of 88 statements, synthesized from the original input. This activity is open until January 24. If you previously registered, click the 'login' link. You'll be asked to answer the participant questions if you haven't already.

Those who have not yet registered, will be asked to **register with an email address** and to **answer four quick questions**. These questions allow us to segment the responses into similar groups, but your email address and responses are confidential and aggregated - individual responses are not identified.

Please click the link below to get started or continue. You can log back in anytime to continue where you left off. Please let us know if you have any questions.

https://participant.groupwisdom.tech/project/2005/rating/

Subject: Invitation to Catskill Group Concept Mapping Sorting
Date: 1-31-21
Our final participant activity in the CRISP/NYC DEP Group Concept Mapping project is to sort the statements. We would like you to determine which organization should implement each statement. Please determine if CRISP, NYC DEP, or other agency, or organization, is best positioned to implement the action. Please complete the sorting by Monday February 8th. A sorting demonstration video is available here: https://youtu.be/9PH0e0Md1qU
We greatly appreciate your time and consideration in contributing to our Group Concept Mapping! We will analyze the results and have them available this spring.

Please click the link below to get started or continue. You can log back in anytime to continue where you left off. Please let us know if you have any questions.

https://participant.groupwisdom.tech/login

Appendix B. Statements Sorted by Statement Number

State-ment #	Statement
1	Increase capacity to perform early detection and rapid response
2	Facilitate expanded rapid response by providing funds for groups/organizations that can coordinate local response
3	Build Catskills specific citizen science program, adaptable to a wide audience (include college ecology programs), to provide information to volunteers and critical data to researchers, land managers, and agencies
4	Prioritize mitigation of threats to Catskills ecosystems and forest ecosystem processes (i.e. forest regeneration)
5	Assess impacts of beech leaf disease and support identifying strategies to mitigate the impacts in the Catskills and potential loss of beech
6	Increase Jumping Worm mitigation and outreach, adapting program according to new research and successful strategies from other programs
7	Mount a coordinated Spotted Lanternfly rapid response
8	Introduction of Eriophyid mites as a biological control of tree of heaven in order to slow the spread of the spotted lantern fly,
9	Actively monitor areas where spotted lantern fly has established in CRISP and Hudson Valley, and is likely to, and mitigate tree canopy loss (also applies to areas hit by emerald ash borer).
10	Actively monitor areas where EAB has established/is likely to and mitigate tree canopy loss
11	Treat and remove tree of heaven in satellite populations and introduce Eriophyid mites as biocontrol
12	Increase outreach on spread prevention to Catskill recreationists and tourists
13	Consider management of Jumping Worms based on their synergistic impacts with other invasives and soils
14	Identify and manage Invasive Species Prevention Zones based on low current invasion and critical habitats
15	Increase pesticide application capacity for rapid responses
16	Investigate and implement the most effective education and outreach strategies
17	Increased access to treatment for pests like Hemlock Woolly Adelgid and Emerald Ash Borers for private landowners, including providing funding
18	Create a BMP training program for municipal highway departments and landscapers to minimize introduction and spread of invasives
19	Explore feasibility of standalone solar powered boat washing facilities for anglers and boaters at high traffic waterways
20	Provide BMP training and demonstrations for management of Tier 3 & 4 species
21	Create a "teaching trail" for public education and to showcase management
22	Streamline data streams (citizen, agency, academics) and dissemination for use in outreach, management, and research
23	Prioritize European Frogbit for Early Detection and Rapid Response
24	Prevent introduction of new forest pests and pathogens including advocating for federal action
25	Limit the spread of snakehead within the Delaware River watershed
26	Incentivise Japanese knotweed utilization
27	Build capacity to perform site restoration at treatment sites and provide resources to partners for restoration

28	Identify a suitable facility for invasive species or invasive-contaminated soil disposal
29	Treat Japanese knotweed in headwaters and systematically work downstream
30	Support riparian restoration programs through invasive plant suppression (knotweed)
31	Continue to protect hemlock forests
32	Assess threats to riparian forest overstory that maintain channel morphology and the presence of likely replacement species
33	Advocate for State budget line to provide hemlock woolly adelgid and emerald ash borer treatment certification free or low cost to arborists
34	Create an adoption program for state lands for people to to support invasive pest management, either financially or through volunteer work (Adopt a hemlock grove or a knotweed stand, for example)
35	Repopulate native brook trout instead of annual stocking with non-native trout species
36	Increase management capacity through training students, citizen scientists, volunteers, landowners, and forest owners
37	Focus on important goals/outcomes and how IS management supports those goals/outcomes, not on invasive species per se.
38	Strategically incorporate climate change impacts and carbon sequestration into all management decisions
39	Coordinate with local colleges and universities to investigate research needs and facilitate invasive species field learning labs/volunteer days for students in environmental fields
40	Provide funding to train certified applicators to safely control target invasive species
41	Work with DEC Region 3 and 4 permit staff to make sure that invasive species issues (SLF transport quarantines, clean equipment, native plant lists etc.) are flagged in permit reviews.
42	Collaborate with neighboring PRISMs to manage species that may be moving in from the border areas
43	Work with local governments to build invasive species prevention and management into their planning and review processes
44	Eradicate water chestnut from the region
45	Survey around nurseries, arboretums, and formal gardens for invasive ornamental escapes
46	Create a strategic plan to deal with future hemlock loss
47	Provide funding/reimbursement for landowners treating hemlocks that are a critical part of restoring or maintaining their riparian buffer
48	Identify potential resistant hemlock trees
49	Obtain alternative funding to build up capacity beyond the NYS EPF funding for CRISP to provide resilience in case of future contract gaps
50	Tackle invasive species that host ticks in high traffic areas in order to prevent the spread of invasives to other areas and also prevent tick borne illness
51	Develop the next generation of invasive species professionals through meaningful internships that provide hands on experience in the Catskills
52	Create an eDNA program for the Catskills to regularly survey throughout the region for invasive fish and aquatic plants as the technology matures
53	Work with county soil and water conservation districts on native plant sales, offering a free native replacement for any invasive plants removed
54	Create a clearinghouse for information on available biological control organisms for partners
55	Create a simple flow-chart based graphic for actions based on the detection of species from each tier as public facing tool to manage expectations on PRISM response and landowner responsibilities
56	Conduct an assessment of trailheads and determine the best locations for boot brush stations
57	Create an annual campground and lake survey program for new introductions

58	Develop/adopt best management practices for spread prevention on construction equipment and fill following the SLELO PRISM model
59	Improve invasive species prevention infrastructure and inspection steward staffing and capacity at public boat launches
60	Maintain an active list of licensed pesticide applicator businesses with expertise at invasive plant removal for partners
61	Collaborate with the NY Hemlock Initiative on the release of hemlock woolly adelgid biocontrol agents and their efficacy
62	Focus on early detection of aquatic invasive species
63	Create a program to collect existing data and prioritize lakes for surveying, monitoring, and control efforts
64	Engage watercraft stewards in aquatic invasive species management
65	Research & compare the range of methods available for reducing invasive annual plants (mile-a-minute, stiltgrass)
66	Advocate for prioritizing and funding treatment strategies for known infestations
67	Develop uniform approaches to data collection by field crews
68	Determine what data can easily be collected in the field to validate remote sensing imagery for the purposes of invasive species detection
69	Conduct a survey of high erosion sites in Catskill streams to assess invasive species impacts on erosion rates in Catskill aquatic systems
70	Assess the success of management projects
71	Track the spread of invasive forest insect pests
72	Develop a procedure for objectively ranking invasives in order to triage the limited resources
73	Prevent aquatic invasive species spread
74	Assess water quality impacts associated with each invasive species
75	Identify initial source(s) of invasives and pathways to Catskills
76	Track the spread of emerald ash borer
77	Promote use of boot brushes, cleaning of ATVs/vehicles, shoes, etc.
78	Manage invasive plants that influence human health such as giant hogweed
79	Collaborate to use plant species and water quality data to identify Invasive Species Prevention Zones
80	Manage riparian zone invasive species and restore these areas with native riparian plant communities
81	Eradicate the hydrilla in New Croton Reservoir
82	Coordinate activities between partners so there is minimal redundancy in management strategies to maximize the funding available for specific monitoring and research proposals
83	Map areas of native plants that could provide regional seed stock for revegetation for post-control restoration efforts
84	Provide specific models/examples of communities that have successfully organized campaigns across multiple organizations and stakeholders to manage invasive species in their area
85	Use continuing education credits as a tool to promote early detection species education among professionals working across the landscape.
86	Create a quick and easy way for landowners/stakeholders to ask questions and get answers and feedback to specific invasive species management topics via the web page
87	Finalize an invasive species management and monitoring protocol
88	Develop early detection tools (possibly remote sensing) to better understand the spatial extent of invasive species of concern and the ecological impacts they might be having

Appendix C. Statements Sorted by Combined Rating Mean

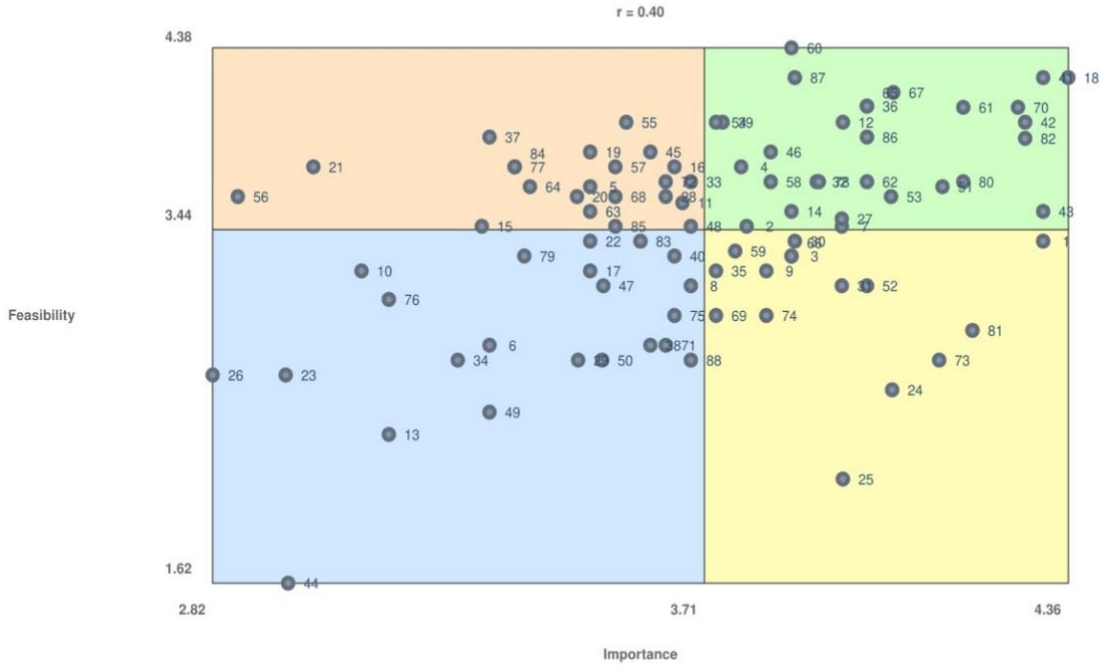
State-ment #	Statement	Import-ance Mean	Feas-ibility Mean	Combined Mean
18	Create a BMP training program for municipal highway departments and landscapers to minimize introduction and spread of invasives	4.29	4.24	8.52
42	Collaborate with neighboring PRISMs to manage species that may be moving in from the border areas	4.33	4.00	8.33
61	Collaborate with the NY Hemlock Initiative on the release of hemlock woolly adelgid biocontrol agents and their efficacy	4.02	4.23	8.24
36	Increase management capacity through training students, citizen scientists, volunteers, landowners, and forest owners	4.11	4.03	8.14
1	Increase capacity to perform early detection and rapid response	4.38	3.73	8.11
70	Assess the success of management projects	4.22	3.86	8.08
86	Create a quick and easy way for landowners/stakeholders to ask questions and get answers and feedback to specific invasive species management topics via the web page	3.98	4.09	8.07
41	Work with DEC Region 3 and 4 permit staff to make sure that invasive species issues (SLF transport quarantines, clean equipment, native plant lists etc.) are flagged in permit reviews.	4.09	3.97	8.06
43	Work with local governments to build invasive species prevention and management into their planning and review processes	4.36	3.67	8.02
87	Finalize an invasive species management and monitoring protocol	3.91	4.09	8.00
4	Prioritize mitigation of threats to Catskills ecosystems and forest ecosystem processes (i.e. forest regeneration)	4.09	3.91	8.00
12	Increase outreach on spread prevention to Catskill recreationists and tourists	3.86	4.09	7.95
16	Investigate and implement the most effective education and outreach strategies	3.98	3.94	7.92
60	Maintain an active list of licensed pesticide applicator businesses with expertise at invasive plant removal for partners	3.71	4.21	7.92
39	Coordinate with local colleges and universities to investigate research needs and facilitate invasive species field learning labs/volunteer days for students in environmental fields	3.89	4.00	7.89
58	Develop/adopt best management practices for spread prevention on construction equipment and fill following the SLELO PRISM model	3.95	3.94	7.89
82	Coordinate activities between partners so there is minimal redundancy in management strategies to maximize the funding available for specific monitoring and research proposals	4.15	3.73	7.88
67	Develop uniform approaches to data collection by field crews	3.88	3.97	7.84
51	Develop the next generation of invasive species professionals through meaningful internships that provide hands on experience in the Catskills	3.85	3.91	7.76

72	Develop a procedure for objectively ranking invasives in order to triage the limited resources	3.82	3.91	7.73
27	Build capacity to perform site restoration at treatment sites and provide resources to partners for restoration	4.04	3.66	7.69
14	Identify and manage Invasive Species Prevention Zones based on low current invasion and critical habitats	3.89	3.79	7.68
78	Manage invasive plants that influence human health such as giant hogweed	3.80	3.82	7.62
62	Focus on early detection of aquatic invasive species	3.98	3.64	7.62
46	Create a strategic plan to deal with future hemlock loss	3.79	3.79	7.58
80	Manage riparian zone invasive species and restore these areas with native riparian plant communities	4.07	3.42	7.49
66	Advocate for prioritizing and funding treatment strategies for known infestations	3.78	3.68	7.46
77	Promote use of boot brushes, cleaning of ATVs/vehicles, shoes, etc.	3.42	4.03	7.45
31	Continue to protect hemlock forests	3.98	3.45	7.44
3	Build Catskills specific citizen science program, adaptable to a wide audience (include college ecology programs), to provide information to volunteers and critical data to researchers, land managers, and agencies	3.80	3.61	7.41
20	Provide BMP training and demonstrations for management of Tier 3 & 4 species	3.48	3.91	7.39
54	Create a clearinghouse for information on available biological control organisms for partners	3.41	3.97	7.38
2	Facilitate expanded rapid response by providing funds for groups/organizations that can coordinate local response	3.88	3.48	7.36
65	Research & compare the range of methods available for reducing invasive annual plants (mile-a-minute, stiltgrass)	3.69	3.63	7.32
63	Create a program to collect existing data and prioritize lakes for surveying, monitoring, and control efforts	3.58	3.73	7.31
85	Use continuing education credits as a tool to promote early detection species education among professionals working across the landscape.	3.52	3.79	7.31
55	Create a simple flow-chart based graphic for actions based on the detection of species from each tier as public facing tool to manage expectations on PRISM response and landowner responsibilities	3.24	4.06	7.30
79	Collaborate to use plant species and water quality data to identify Invasive Species Prevention Zones	3.67	3.62	7.29
45	Survey around nurseries, arboretums, and formal gardens for invasive ornamental escapes	3.38	3.91	7.29
64	Engage watercraft stewards in aquatic invasive species management	3.50	3.77	7.27
19	Explore feasibility of standalone solar powered boat washing facilities for anglers and boaters at high traffic waterways	3.43	3.82	7.25
84	Provide specific models/examples of communities that have successfully organized campaigns across multiple organizations and stakeholders to manage invasive species in their area	3.26	3.94	7.20
53	Work with county soil and water conservation districts on native plant sales, offering a free native replacement for any invasive plants removed	3.71	3.45	7.17

7	Mount a coordinated Spotted Lanternfly rapid response	3.71	3.45	7.16
57	Create an annual campground and lake survey program for new introductions	3.50	3.64	7.14
28	Identify a suitable facility for invasive species or invasive-contaminated soil disposal	3.52	3.61	7.12
30	Support riparian restoration programs through invasive plant suppression (knotweed)	3.81	3.30	7.12
32	Assess threats to riparian forest overstory that maintain channel morphology and the presence of likely replacement species	3.80	3.30	7.10
59	Improve invasive species prevention infrastructure and inspection steward staffing and capacity at public boat launches	3.62	3.47	7.09
48	Identify potential resistant hemlock trees	3.76	3.27	7.03
9	Actively monitor areas where spotted lantern fly has established in CRISP and Hudson Valley, and is likely to, and mitigate tree canopy loss (also applies to areas hit by emerald ash borer).	3.87	3.12	6.99
15	Increase pesticide application capacity for rapid responses	3.36	3.63	6.99
71	Track the spread of invasive forest insect pests	3.78	3.20	6.98
88	Develop early detection tools (possibly remote sensing) to better understand the spatial extent of invasive species of concern and the ecological impacts they might be having	3.79	3.18	6.97
83	Map areas of native plants that could provide regional seed stock for revegetation for post-control restoration efforts	3.53	3.44	6.97
22	Streamline data streams (citizen, agency, academics) and dissemination for use in outreach, management, and research	3.53	3.44	6.97
52	Create an eDNA program for the Catskills to regularly survey throughout the region for invasive fish and aquatic plants as the technology matures	3.75	3.18	6.94
40	Provide funding to train certified applicators to safely control target invasive species	3.52	3.41	6.93
21	Create a "teaching trail" for public education and to showcase management	3.07	3.85	6.92
5	Assess impacts of beech leaf disease and support identifying strategies to mitigate the impacts in the Catskills and potential loss of beech	3.40	3.50	6.90
37	Focus on important goals/outcomes and how IS management supports those goals/outcomes, not on invasive species per se.	3.24	3.61	6.85
73	Prevent aquatic invasive species spread	4.14	2.71	6.84
33	Advocate for State budget line to provide hemlock woolly adelgid and emerald ash borer treatment certification free or low cost to arborists	3.32	3.52	6.84
69	Conduct a survey of high erosion sites in Catskill streams to assess invasive species impacts on erosion rates in Catskill aquatic systems	3.52	3.27	6.79
68	Determine what data can easily be collected in the field to validate remote sensing imagery for the purposes of invasive species detection	3.31	3.47	6.79
38	Strategically incorporate climate change impacts and carbon sequestration into all management decisions	3.62	3.15	6.77

35	Repopulate native brook trout instead of annual stocking with non-native trout species	3.41	3.31	6.72
75	Identify initial source(s) of invasives and pathways to Catskills	3.62	3.06	6.68
47	Provide funding/reimbursement for landowners treating hemlocks that are a critical part of restoring or maintaining their riparian buffer	3.48	3.18	6.66
24	Prevent introduction of new forest pests and pathogens including advocating for federal action	3.96	2.67	6.63
17	Increased access to treatment for pests like Hemlock Woolly Adelgid and Emerald Ash Borers for private landowners, including providing funding	3.42	3.15	6.57
11	Treat and remove tree of heaven in satellite populations and introduce Eriophyid mites as biocontrol	3.23	3.32	6.55
56	Conduct an assessment of trailheads and determine the best locations for boot brush stations	2.93	3.61	6.53
34	Create an adoption program for state lands for people to to support invasive pest management, either financially or through volunteer work (Adopt a hemlock grove or a knotweed stand, for example)	3.33	3.12	6.45
8	Introduction of Eriophyid mites as a biological control of tree of heaven in order to slow the spread of the spotted lantern fly,	3.28	3.15	6.43
49	Obtain alternative funding to build up capacity beyond the NYS EPF funding for CRISP to provide resilience in case of future contract gaps	3.48	2.94	6.42
6	Increase Jumping Worm mitigation and outreach, adapting program according to new research and successful strategies from other programs	3.33	3.03	6.36
74	Assess water quality impacts associated with each invasive species	3.52	2.82	6.34
29	Treat Japanese knotweed in headwaters and systematically work downstream	3.38	2.91	6.28
81	Eradicate the hydrilla in New Croton Reservoir	3.55	2.69	6.23
23	Prioritize European Frogbit for Early Detection and Rapid Response	3.02	3.16	6.18
25	Limit the spread of snakehead within the Delaware River watershed	3.70	2.42	6.13
50	Tackle invasive species that host ticks in high traffic areas in order to prevent the spread of invasives to other areas and also prevent tick borne illness	3.29	2.68	5.96
76	Track the spread of emerald ash borer	2.95	2.97	5.92
10	Actively monitor areas where EAB has established/is likely to and mitigate tree canopy loss	2.89	2.97	5.86
13	Consider management of Jumping Worms based on their synergistic impacts with other invasives and soils	3.13	2.65	5.77
26	Incentivise Japanese knotweed utilization	2.46	2.76	5.23
44	Eradicate water chestnut from the region	2.81	2.00	4.81

Appendix D. Priority Matrix (DEP Participants Only)



Appendix E. Statements Sorted by Combined Rating Mean (DEP Participants Only)

State-ment #	Statement	Import-ance Mean	Feas-ibility Mean	Combined Mean
18	Create a BMP training program for municipal highway departments and landscapers to minimize introduction and spread of invasives	4.36	4.23	8.59
41	Work with DEC Region 3 and 4 permit staff to make sure that invasive species issues (SLF transport quarantines, clean equipment, native plant lists etc.) are flagged in permit reviews.	4.32	4.23	8.55
70	Assess the success of management projects	4.27	4.08	8.35
42	Collaborate with neighboring PRISMs to manage species that may be moving in from the border areas	4.29	4.00	8.29
61	Collaborate with the NY Hemlock Initiative on the release of hemlock woolly adelgid biocontrol agents and their efficacy	4.17	4.08	8.25
60	Maintain an active list of licensed pesticide applicator businesses with expertise at invasive plant removal for partners	3.86	4.38	8.25
82	Coordinate activities between partners so there is minimal redundancy in management strategies to maximize the funding available for specific monitoring and research proposals	4.29	3.92	8.20
67	Develop uniform approaches to data collection by field crews	4.05	4.15	8.20
87	Finalize an invasive species management and monitoring protocol	3.87	4.23	8.10
36	Increase management capacity through training students, citizen scientists, volunteers, landowners, and forest owners	4.00	4.08	8.08
65	Research & compare the range of methods available for reducing invasive annual plants (mile-a-minute, stiltgrass)	4.00	4.08	8.08
12	Increase outreach on spread prevention to Catskill recreationists and tourists	3.96	4.00	7.96
86	Create a quick and easy way for landowners/stakeholders to ask questions and get answers and feedback to specific invasive species management topics via the web page	4.00	3.92	7.92
80	Manage riparian zone invasive species and restore these areas with native riparian plant communities	4.17	3.69	7.87
43	Work with local governments to build invasive species prevention and management into their planning and review processes	4.32	3.54	7.86
51	Develop the next generation of invasive species professionals through meaningful internships that provide hands on experience in the Catskills	4.14	3.67	7.80
39	Coordinate with local colleges and universities to investigate research needs and facilitate invasive species field learning labs/volunteer days for students in environmental fields	3.74	4.00	7.74
54	Create a clearinghouse for information on available biological control organisms for partners	3.73	4.00	7.73
1	Increase capacity to perform early detection and rapid response	4.32	3.38	7.70

62	Focus on early detection of aquatic invasive species	4.00	3.69	7.69
46	Create a strategic plan to deal with future hemlock loss	3.83	3.85	7.67
53	Work with county soil and water conservation districts on native plant sales, offering a free native replacement for any invasive plants removed	4.04	3.62	7.66
78	Manage invasive plants that influence human health such as giant hogweed	3.91	3.69	7.61
32	Assess threats to riparian forest overstory that maintain channel morphology and the presence of likely replacement species	3.91	3.69	7.60
55	Create a simple flow-chart based graphic for actions based on the detection of species from each tier as public facing tool to manage expectations on PRISM response and landowner responsibilities	3.57	4.00	7.57
4	Prioritize mitigation of threats to Catskills ecosystems and forest ecosystem processes (i.e. forest regeneration)	3.77	3.77	7.54
58	Develop/adopt best management practices for spread prevention on construction equipment and fill following the SLELO PRISM model	3.83	3.69	7.52
45	Survey around nurseries, arboretums, and formal gardens for invasive ornamental escapes	3.61	3.85	7.45
27	Build capacity to perform site restoration at treatment sites and provide resources to partners for restoration	3.95	3.50	7.45
16	Investigate and implement the most effective education and outreach strategies	3.65	3.77	7.42
7	Mount a coordinated Spotted Lanternfly rapid response	3.95	3.46	7.42
14	Identify and manage Invasive Species Prevention Zones based on low current invasion and critical habitats	3.86	3.54	7.40
33	Advocate for State budget line to provide hemlock woolly adelgid and emerald ash borer treatment certification free or low cost to arborists	3.68	3.69	7.37
19	Explore feasibility of standalone solar powered boat washing facilities for anglers and boaters at high traffic waterways	3.50	3.85	7.35
72	Develop a procedure for objectively ranking invasives in order to triage the limited resources	3.64	3.69	7.33
57	Create an annual campground and lake survey program for new introductions	3.55	3.77	7.31
30	Support riparian restoration programs through invasive plant suppression (knotweed)	3.87	3.38	7.25
28	Identify a suitable facility for invasive species or invasive-contaminated soil disposal	3.64	3.62	7.25
11	Treat and remove tree of heaven in satellite populations and introduce Eriophyid mites as biocontrol	3.67	3.58	7.25
2	Facilitate expanded rapid response by providing funds for groups/organizations that can coordinate local response	3.78	3.46	7.24
37	Focus on important goals/outcomes and how IS management supports those goals/outcomes, not on invasive species per se.	3.32	3.92	7.24
3	Build Catskills specific citizen science program, adaptable to a wide audience (include college ecology programs), to provide information to volunteers and critical data to researchers, land managers, and agencies	3.86	3.31	7.17

66	Advocate for prioritizing and funding treatment strategies for known infestations	3.86	3.31	7.17
5	Assess impacts of beech leaf disease and support identifying strategies to mitigate the impacts in the Catskills and potential loss of beech	3.50	3.67	7.17
68	Determine what data can easily be collected in the field to validate remote sensing imagery for the purposes of invasive species detection	3.55	3.62	7.16
52	Create an eDNA program for the Catskills to regularly survey throughout the region for invasive fish and aquatic plants as the technology matures	4.00	3.15	7.15
48	Identify potential resistant hemlock trees	3.68	3.46	7.14
77	Promote use of boot brushes, cleaning of ATVs/vehicles, shoes, etc.	3.36	3.77	7.13
84	Provide specific models/examples of communities that have successfully organized campaigns across multiple organizations and stakeholders to manage invasive species in their area	3.36	3.77	7.13
81	Eradicate the hydrilla in New Croton Reservoir	4.19	2.92	7.11
31	Continue to protect hemlock forests	3.95	3.15	7.11
59	Improve invasive species prevention infrastructure and inspection steward staffing and capacity at public boat launches	3.76	3.33	7.10
20	Provide BMP training and demonstrations for management of Tier 3 & 4 species	3.48	3.62	7.09
64	Engage watercraft stewards in aquatic invasive species management	3.39	3.67	7.06
9	Actively monitor areas where spotted lantern fly has established in CRISP and Hudson Valley, and is likely to, and mitigate tree canopy loss (also applies to areas hit by emerald ash borer).	3.82	3.23	7.05
63	Create a program to collect existing data and prioritize lakes for surveying, monitoring, and control efforts	3.50	3.54	7.04
85	Use continuing education credits as a tool to promote early detection species education among professionals working across the landscape.	3.55	3.46	7.01
83	Map areas of native plants that could provide regional seed stock for revegetation for post-control restoration efforts	3.59	3.38	6.98
40	Provide funding to train certified applicators to safely control target invasive species	3.65	3.31	6.96
35	Repopulate native brook trout instead of annual stocking with non-native trout species	3.73	3.23	6.96
73	Prevent aquatic invasive species spread	4.13	2.77	6.90
22	Streamline data streams (citizen, agency, academics) and dissemination for use in outreach, management, and research	3.50	3.38	6.88
8	Introduction of Eriophyid mites as a biological control of tree of heaven in order to slow the spread of the spotted lantern fly,	3.68	3.15	6.84
74	Assess water quality impacts associated with each invasive species	3.82	3.00	6.82
21	Create a "teaching trail" for public education and to showcase management	3.00	3.77	6.77

15	Increase pesticide application capacity for rapid responses	3.30	3.46	6.77
17	Increased access to treatment for pests like Hemlock Woolly Adelgid and Emerald Ash Borers for private landowners, including providing funding	3.50	3.23	6.73
69	Conduct a survey of high erosion sites in Catskill streams to assess invasive species impacts on erosion rates in Catskill aquatic systems	3.73	3.00	6.73
79	Collaborate to use plant species and water quality data to identify Invasive Species Prevention Zones	3.38	3.31	6.69
47	Provide funding/reimbursement for landowners treating hemlocks that are a critical part of restoring or maintaining their riparian buffer	3.52	3.15	6.68
24	Prevent introduction of new forest pests and pathogens including advocating for federal action	4.05	2.62	6.66
75	Identify initial source(s) of invasives and pathways to Catskills	3.65	3.00	6.65
71	Track the spread of invasive forest insect pests	3.64	2.85	6.48
56	Conduct an assessment of trailheads and determine the best locations for boot brush stations	2.86	3.62	6.48
38	Strategically incorporate climate change impacts and carbon sequestration into all management decisions	3.61	2.85	6.45
88	Develop early detection tools (possibly remote sensing) to better understand the spatial extent of invasive species of concern and the ecological impacts they might be having	3.68	2.77	6.45
10	Actively monitor areas where EAB has established/is likely to and mitigate tree canopy loss	3.09	3.23	6.32
50	Tackle invasive species that host ticks in high traffic areas in order to prevent the spread of invasives to other areas and also prevent tick borne illness	3.52	2.77	6.29
29	Treat Japanese knotweed in headwaters and systematically work downstream	3.48	2.77	6.25
76	Track the spread of emerald ash borer	3.14	3.08	6.22
6	Increase Jumping Worm mitigation and outreach, adapting program according to new research and successful strategies from other programs	3.32	2.85	6.16
25	Limit the spread of snakehead within the Delaware River watershed	3.96	2.15	6.11
34	Create an adoption program for state lands for people to to support invasive pest management, either financially or through volunteer work (Adopt a hemlock grove or a knotweed stand, for example)	3.26	2.77	6.03
49	Obtain alternative funding to build up capacity beyond the NYS EPF funding for CRISP to provide resilience in case of future contract gaps	3.32	2.50	5.82
23	Prioritize European Frogbit for Early Detection and Rapid Response	2.95	2.69	5.64
13	Consider management of Jumping Worms based on their synergistic impacts with other invasives and soils	3.14	2.38	5.52
26	Incentivise Japanese knotweed utilization	2.82	2.69	5.51
44	Eradicate water chestnut from the region	2.95	1.62	4.57

Appendix F. Statements Sorted by Organization Cluster and Combined Rating Mean

State-ment #	Statement	Cluster	Import-ance Mean	Feas-ibility Mean	Combined Mean
80	Manage riparian zone invasive species and restore these areas with native riparian plant communities	NYC DEP	4.07	3.42	7.49
64	Engage watercraft stewards in aquatic invasive species management	NYC DEP	3.50	3.77	7.27
19	Explore feasibility of standalone solar powered boat washing facilities for anglers and boaters at high traffic waterways	NYC DEP	3.43	3.82	7.25
7	Mount a coordinated Spotted Lanternfly rapid response	NYC DEP	3.71	3.45	7.16
30	Support riparian restoration programs through invasive plant suppression (knotweed)	NYC DEP	3.81	3.30	7.12
32	Assess threats to riparian forest overstory that maintain channel morphology and the presence of likely replacement species	NYC DEP	3.80	3.30	7.10
59	Improve invasive species prevention infrastructure and inspection steward staffing and capacity at public boat launches	NYC DEP	3.62	3.47	7.09
9	Actively monitor areas where spotted lantern fly has established in CRISP and Hudson Valley, and is likely to, and mitigate tree canopy loss (also applies to areas hit by emerald ash borer).	NYC DEP	3.87	3.12	6.99
15	Increase pesticide application capacity for rapid responses	NYC DEP	3.36	3.63	6.99
52	Create an eDNA program for the Catskills to regularly survey throughout the region for invasive fish and aquatic plants as the technology matures	NYC DEP	3.75	3.18	6.94
5	Assess impacts of beech leaf disease and support identifying strategies to mitigate the impacts in the Catskills and potential loss of beech	NYC DEP	3.40	3.50	6.90
69	Conduct a survey of high erosion sites in Catskill streams to assess invasive species impacts on erosion rates in Catskill aquatic systems	NYC DEP	3.52	3.27	6.79
35	Repopulate native brook trout instead of annual stocking with non-native trout species	NYC DEP	3.41	3.31	6.72
47	Provide funding/reimbursement for landowners treating hemlocks that are a critical part of restoring or maintaining their riparian buffer	NYC DEP	3.48	3.18	6.66
8	Introduction of Eriophyid mites as a biological control of tree of heaven in order to slow the spread of the spotted lantern fly,	NYC DEP	3.28	3.15	6.43
74	Assess water quality impacts associated with each invasive species	NYC DEP	3.52	2.82	6.34

29	Treat Japanese knotweed in headwaters and systematically work downstream	NYC DEP	3.38	2.91	6.28
81	Eradicate the hydrilla in New Croton Reservoir	NYC DEP	3.55	2.69	6.23
25	Limit the spread of snakehead within the Delaware River watershed	NYC DEP	3.70	2.42	6.13
26	Incentivise Japanese knotweed utilization	NYC DEP	2.46	2.76	5.23
18	Create a BMP training program for municipal highway departments and landscapers to minimize introduction and spread of invasives	NYS DEC	4.29	4.24	8.52
61	Collaborate with the NY Hemlock Initiative on the release of hemlock woolly adelgid biocontrol agents and their efficacy	NYS DEC	4.02	4.23	8.24
41	Work with DEC Region 3 and 4 permit staff to make sure that invasive species issues (SLF transport quarantines, clean equipment, native plant lists etc.) are flagged in permit reviews.	NYS DEC	4.09	3.97	8.06
60	Maintain an active list of licensed pesticide applicator businesses with expertise at invasive plant removal for partners	NYS DEC	3.71	4.21	7.92
78	Manage invasive plants that influence human health such as giant hogweed	NYS DEC	3.80	3.82	7.62
46	Create a strategic plan to deal with future hemlock loss	NYS DEC	3.79	3.79	7.58
31	Continue to protect hemlock forests	NYS DEC	3.98	3.45	7.44
2	Facilitate expanded rapid response by providing funds for groups/organizations that can coordinate local response	NYS DEC	3.88	3.48	7.36
63	Create a program to collect existing data and prioritize lakes for surveying, monitoring, and control efforts	NYS DEC	3.58	3.73	7.31
85	Use continuing education credits as a tool to promote early detection species education among professionals working across the landscape.	NYS DEC	3.52	3.79	7.31
53	Work with county soil and water conservation districts on native plant sales, offering a free native replacement for any invasive plants removed	NYS DEC	3.71	3.45	7.17
57	Create an annual campground and lake survey program for new introductions	NYS DEC	3.50	3.64	7.14
28	Identify a suitable facility for invasive species or invasive-contaminated soil disposal	NYS DEC	3.52	3.61	7.12
48	Identify potential resistant hemlock trees	NYS DEC	3.76	3.27	7.03
71	Track the spread of invasive forest insect pests	NYS DEC	3.78	3.20	6.98
40	Provide funding to train certified applicators to safely control target invasive species	NYS DEC	3.52	3.41	6.93
33	Advocate for State budget line to provide hemlock woolly adelgid and emerald ash borer treatment certification free or low cost to arborists	NYS DEC	3.32	3.52	6.84

38	Strategically incorporate climate change impacts and carbon sequestration into all management decisions	NYS DEC	3.62	3.15	6.77
75	Identify initial source(s) of invasives and pathways to Catskills	NYS DEC	3.62	3.06	6.68
24	Prevent introduction of new forest pests and pathogens including advocating for federal action	NYS DEC	3.96	2.67	6.63
17	Increased access to treatment for pests like Hemlock Woolly Adelgid and Emerald Ash Borers for private landowners, including providing funding	NYS DEC	3.42	3.15	6.57
34	Create an adoption program for state lands for people to to support invasive pest management, either financially or through volunteer work (Adopt a hemlock grove or a knotweed stand, for example)	NYS DEC	3.33	3.12	6.45
49	Obtain alternative funding to build up capacity beyond the NYS EPF funding for CRISP to provide resilience in case of future contract gaps	NYS DEC	3.48	2.94	6.42
76	Track the spread of emerald ash borer	NYS DEC	2.95	2.97	5.92
10	Actively monitor areas where EAB has established/is likely to and mitigate tree canopy loss	NYS DEC	2.89	2.97	5.86
42	Collaborate with neighboring PRISMs to manage species that may be moving in from the border areas	CRISP	4.33	4.00	8.33
36	Increase management capacity through training students, citizen scientists, volunteers, landowners, and forest owners	CRISP	4.11	4.03	8.14
1	Increase capacity to perform early detection and rapid response	CRISP	4.38	3.73	8.11
86	Create a quick and easy way for landowners/stakeholders to ask questions and get answers and feedback to specific invasive species management topics via the web page	CRISP	3.98	4.09	8.07
43	Work with local governments to build invasive species prevention and management into their planning and review processes	CRISP	4.36	3.67	8.02
87	Finalize an invasive species management and monitoring protocol	CRISP	3.91	4.09	8.00
4	Prioritize mitigation of threats to Catskills ecosystems and forest ecosystem processes (i.e. forest regeneration)	CRISP	4.09	3.91	8.00
12	Increase outreach on spread prevention to Catskill recreationists and tourists	CRISP	3.86	4.09	7.95
16	Investigate and implement the most effective education and outreach strategies	CRISP	3.98	3.94	7.92
39	Coordinate with local colleges and universities to investigate research needs and facilitate invasive species field learning labs/volunteer days for students in environmental fields	CRISP	3.89	4.00	7.89

58	Develop/adopt best management practices for spread prevention on construction equipment and fill following the SLELO PRISM model	CRISP	3.95	3.94	7.89
82	Coordinate activities between partners so there is minimal redundancy in management strategies to maximize the funding available for specific monitoring and research proposals	CRISP	4.15	3.73	7.88
67	Develop uniform approaches to data collection by field crews	CRISP	3.88	3.97	7.84
51	Develop the next generation of invasive species professionals through meaningful internships that provide hands on experience in the Catskills	CRISP	3.85	3.91	7.76
72	Develop a procedure for objectively ranking invasives in order to triage the limited resources	CRISP	3.82	3.91	7.73
27	Build capacity to perform site restoration at treatment sites and provide resources to partners for restoration	CRISP	4.04	3.66	7.69
14	Identify and manage Invasive Species Prevention Zones based on low current invasion and critical habitats	CRISP	3.89	3.79	7.68
66	Advocate for prioritizing and funding treatment strategies for known infestations	CRISP	3.78	3.68	7.46
77	Promote use of boot brushes, cleaning of ATVs/vehicles, shoes, etc.	CRISP	3.42	4.03	7.45
3	Build Catskills specific citizen science program, adaptable to a wide audience (include college ecology programs), to provide information to volunteers and critical data to researchers, land managers, and agencies	CRISP	3.80	3.61	7.41
20	Provide BMP training and demonstrations for management of Tier 3 & 4 species	CRISP	3.48	3.91	7.39
54	Create a clearinghouse for information on available biological control organisms for partners	CRISP	3.41	3.97	7.38
55	Create a simple flow-chart based graphic for actions based on the detection of species from each tier as public facing tool to manage expectations on PRISM response and landowner responsibilities	CRISP	3.24	4.06	7.30
45	Survey around nurseries, arboretums, and formal gardens for invasive ornamental escapes	CRISP	3.38	3.91	7.29
84	Provide specific models/examples of communities that have successfully organized campaigns across multiple organizations and stakeholders to manage invasive species in their area	CRISP	3.26	3.94	7.20
22	Streamline data streams (citizen, agency, academics) and dissemination for use in outreach, management, and research	CRISP	3.53	3.44	6.97
21	Create a "teaching trail" for public education and to showcase management	CRISP	3.07	3.85	6.92

37	Focus on important goals/outcomes and how IS management supports those goals/outcomes, not on invasive species per se.	CRISP	3.24	3.61	6.85
6	Increase Jumping Worm mitigation and outreach, adapting program according to new research and successful strategies from other programs	CRISP	3.33	3.03	6.36
23	Prioritize European Frogbit for Early Detection and Rapid Response	CRISP	3.02	3.16	6.18
70	Assess the success of management projects	ALL	4.22	3.86	8.08
62	Focus on early detection of aquatic invasive species	ALL	3.98	3.64	7.62
65	Research & compare the range of methods available for reducing invasive annual plants (mile-a-minute, stiltgrass)	ALL	3.69	3.63	7.32
79	Collaborate to use plant species and water quality data to identify Invasive Species Prevention Zones	ALL	3.67	3.62	7.29
88	Develop early detection tools (possibly remote sensing) to better understand the spatial extent of invasive species of concern and the ecological impacts they might be having	ALL	3.79	3.18	6.97
83	Map areas of native plants that could provide regional seed stock for revegetation for post-control restoration efforts	ALL	3.53	3.44	6.97
73	Prevent aquatic invasive species spread	ALL	4.14	2.71	6.84
68	Determine what data can easily be collected in the field to validate remote sensing imagery for the purposes of invasive species detection	ALL	3.31	3.47	6.79
11	Treat and remove tree of heaven in satellite populations and introduce Eriophyid mites as biocontrol	ALL	3.23	3.32	6.55
56	Conduct an assessment of trailheads and determine the best locations for boot brush stations	ALL	2.93	3.61	6.53
50	Tackle invasive species that host ticks in high traffic areas in order to prevent the spread of invasives to other areas and also prevent tick borne illness	ALL	3.29	2.68	5.96
13	Consider management of Jumping Worms based on their synergistic impacts with other invasives and soils	ALL	3.13	2.65	5.77
44	Eradicate water chestnut from the region	ALL	2.81	2.00	4.81

Appendix B

NYC DEP Small Boat Program Invasive Species Protocols

1.0 Purpose

To provide a streamlined procedure for steam cleaning and inspection of equipment that is used in the water by BWS personnel and contractors.

2.0 References

N/A

3.0 Definitions

Equipment – means a small vessel and related gear used in the water (such as motors, anchors, chains and ropes, etc) and trailer parts.

BWS vessel – for the sake of this procedure means equipment less than or equal to 27 feet in length owned and/or directly operated by an SBP Operator (i.e., DEP personnel).

Contractor vessel – for the sake of this procedure means equipment less than or equal to 16 feet in length that is operated by a Contractor (an entity under contract to DEP.)

Organism – for the sake of this procedure means non-native and/or invasive plant or animal species, including but not limited to Zebra Mussels, Quagga Mussels, Eurasian Water Milfoil and Water Chestnut.

Steam Cleaning – the application of high-pressure, hot water (operating specifications: minimum of 160°F, 700 psi, and 2 gallons per minute spray rate) for the purpose of destroying organisms as defined herein.

4.0 Responsibility

The **SBP Operator** and **Contractor** are responsible for following this procedure, which is designed to stop the spread of invasive organisms.

5.0 Discussion

It is imperative that boating activities on New York City reservoirs contribute minimal negative impact to water quality. This section details the procedures to be followed by SBP Operators and Contractors to prevent the introduction of non-native, aquatic nuisance species into BWS lakes, streams and reservoirs. **Emphasis** is placed on equipment inspection and cleaning as described herein.

6.0 Inspection and Cleaning Procedure

1. Steam cleaning is required year round and applies to all BWS and Contractor equipment. All equipment, new or not, must be steam cleaned when called for by this procedure.

2. Equipment must be steam cleaned daily with the following exceptions:

   (a) It does not have to be steam cleaned on any day that it is not used.

   (b) It does not have to be steam cleaned before continued use on a body of water if it remained in that body of water overnight.

   (c) It does not have to be steam cleaned if it is taken from a body of water and then **consecutively returned** to the **same** body of water the next use.

3. Steam cleaning requirements are contained in the **Equipment Steam Cleaning Table** found at the end of this procedure.

4. Equipment serviced at a marina or tested off-site must be steam cleaned prior to use.

5. **For BWS Directorates other than Operations**, those staffs may steam clean their equipment with their own steam cleaning apparatus without attendance or oversight by DEP Operations. All other instructions related to the method of cleaning as described herein must be followed.

6. Contact the watershed-applicable DEP office[1] to schedule a cleaning and inspection date, time and location:

   - Catskill Watershed Operations Office (845) 657-7677
   - Croton Watershed Operations Office (845) 225-8144
   - Delaware Watershed Operations Office (845) 985-2211
   - Reservoir Operations Office (Hillview & Jerome Park) (718) 652-5705

7. **For Contractors**, all equipment as defined herein must be inspected by DEP Operations prior to entry into a NYC reservoir. DEP Operations is equipped to steam clean small contractor vessels (16 feet in length or less). Contractors must make

[1] SBP Operators are not required to contact these Operation offices if the inspection and cleaning will be performed by other suitably equipped Directorate staffs.

provisions to have all larger equipment steamed cleaned by an outside source; however, DEP Operations staff must attend to ensure adherence to protocol.

8. Equipment steam cleaning and inspection must be **scheduled with the Operations Office at least one week in advance** of the scheduled date for equipment entry into a watershed body.

9. **Contractors** must provide to DEP a list of the water bodies on which the contractor equipment has been deployed, along with the dates and duration of deployment, for the four months preceding each new deployment under BWS contract.[2]

10. Prior to arrival at the steam cleaning and inspection site, all water, including bilge (if applicable) and machinery raw intake water, is to be drained from the equipment in a location where the water will not discharge into a NYC reservoir or any tributary to any NYC reservoir, waterbody, or storm drain.

    (a) If it is not possible to empty completely the bilge of a boat and a thorough steam cleaning of the interior portion of the boat that holds the bilge is not possible, then the bilge should be treated with a 1:20 dilution of household bleach. The diluted bleach solution should remain in the bilge for at least 48 hours in a manner acceptable to the **Zebra Mussel Project Manager (718 595-5356)**. A 1:20 solution, sometimes considered a 5% chlorine solution, can be prepared by adding 6.5 ounces of household bleach to one gallon of water or 50 mL of household bleach to one liter of water.

    (b) Once treatment is complete, the operator/contractor will then need to de-chlorinate the bilge water and pump the water out far from any reservoir or stream that flows into a reservoir or lake or any other body of water.

    It is the responsibility of the operator/contractor to conduct this procedure, including the discharge of the chemically treated bilge into any lands or surface waters, in accordance with all laws and regulations and obtain and hold any permits that may be required. EHS can be contacted for disposal instruction or assistance.

11. The equipment shall be inspected for organisms and then shall be steam cleaned inside and out by DEP Operations staff.

[2] This requirement should be documented in the contractual language.

(a) Staff from other BWS Directorates may steam clean their equipment if suitably equipped,

(b) Contractors may steam clean their equipment if DEP cannot perform this service. However, DEP Operations staff must attend to ensure adherence to the steam cleaning protocol that is detailed in Appendix 1.

12. A sample of any organisms, including but not limited to those defined as organisms above, found during the inspection shall be taken from the equipment by the operator/contractor, suitably contained (secure) for carriage, and presented to the DEP Fisheries Biologist for examination. If an organism is found, Appendix 1 details the full procedure that shall be followed including all required notifications, species identification, and quarantine protocols.

13. After a suitable number of samples are collected, any organisms remaining on the equipment shall be removed and carefully discarded so as to destroy. The equipment shall then be thoroughly steam cleaned inside and out (exposed surfaces).

14. If lab-examined organisms prove to be Zebra Mussels, the equipment shall be dry[3]-quarantined for two weeks, then re-inspected and re-cleaned at an agreed upon date and location.

Important – Regarding the control of invasive species, **NO EQUIPMENT** shall be put into any watershed body until it is deemed safe to do so by DEP staff!

7.0 Post-use inspection

After removing the equipment from the water and prior to departing the launch site, the operator shall inspect equipment, including boat engine and trailer, for vegetation. All plant filaments and related materials shall be removed and carefully disposed of in a manner to desiccate or destroy.

8.0 Further Information

Zebra Mussel Project Manager – (718) 595-5356

Invasive Species Coordinator – (845) 340-7856

Fisheries Biologist – (845) 340-7857

9.0 Records

[3] If the boat is rained on during this period, it may extend the time under quarantine.

N/A

Equipment Steam Cleaning Table

In this table, **Y** (yes) denotes **steam cleaning is required** or **N** (no) **is not required** when moving equipment from a specific body of water to another **on the same day.**

Taking out from here… / ***ON SAME DAY*** then putting in here →	Cannonsville	Neversink	Pepacton	Rondout	Ashokan	Esopus Creek	Schoharie	Amawalk	Bog Brook	Boyds Corner	Cross River	Croton Falls	Diverting	East Branch	Kensico	Kirk Lake	Lake Gilead	Lake Gleneida	Middle Branch	Muscoot	New Croton	Titicus	West Branch
	Delaware				**Catskill**			**Croton Watershed System**															
Cannonsville	**N**	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Neversink	Y	**N**	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pepacton	Y	Y	**N**	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rondout	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ashokan	Y	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Esopus Creek	Y	Y	Y	Y	**N**	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Schoharie	Y	Y	Y	Y	**N**	**N**	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Amawalk[4]	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bog Brook	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	**N**	**N**	**N**	Y	Y	Y	Y	Y	**N**	**N**	Y	Y
Boyds Corner	Y	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	**N**	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	**N**
Cross River	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	Y
Croton Falls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	Y
Diverting	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	Y
East Branch	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	**N**	**N**	**N**	Y	Y	Y	Y	Y	**N**	**N**	Y	Y
Kensico	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	Y
Kirk Lake	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	Y	**N**	**N**	Y	Y
Lake Gilead	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	Y	**N**	**N**	Y	Y	**N**	**N**	Y	Y
Lake Gleneida	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	Y	**N**	**N**	**N**	Y	**N**	**N**	Y	**N**
Middle Branch	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	Y	**N**	Y	Y	**N**	**N**	**N**	Y	Y
Muscoot	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	Y	Y
New Croton	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y
Titicus	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	**N**	**N**	Y
West Branch	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**N**	Y	Y	**N**	Y	Y	**N**	Y	**N**	**N**	Y	**N**

[4] Note: Any boat retrieved from Amawalk must be steam cleaned immediately thereafter because of the known presence of zebra mussel veligers in this reservoir. If a boat is used on Amawalk a with a bilge that cannot be completely drained or a trailer constructed of rectangular tubes that cannot be completely drained, procedures outlined in 6.10.a must be followed. (R-4 13-NOV-18)

Appendix C
Invasive Species Communication Plan

Invasive Species Communication Plan

Meredith Taylor
NYC DEP Bureau of Water Supply
Watershed Protection Programs, Natural Resources Division
March 2022

Introduction

Effectively communicating priority messages to internal and external audiences regarding the threats associated with invasive species, and the importance of preventing, detecting and controlling them is critical to the success of an invasive species management program in the NYC Watershed and on city- owned lands. Invasive species threaten the NYC water supply through their alteration of terrestrial environments with changes to soil and water chemistry and impacts such as erosion, increased herbicide and pesticide use. Aquatic invasive species (AIS) can degrade infrastructure, impede recreation, impact water quality, and threaten human health.

The purpose of this plan is to lay out a strategy for reaching target audiences within the Agency and within the Watershed with priority messages in order to promote efficient collaboration among all internal outreach efforts and outside initiatives including national and statewide invasive species programs. Cultivating informed audiences will empower these groups to play a greater role in minimizing the risk associated with certain key vectors for introduction, identify new detections of species that can be eradicated if detected early, and take measures that are the most effective in controlling some of the more widespread and/or threatening invasive species.

Background

Internal audiences (DEP staff) have been targeted with bureau-wide efforts to raise awareness of invasive species issues since the establishment of the ISWG and the creation of the Invasive Species Biologist position within the Bureau of Water Supply in 2007. The charge of ISWG is to be proactive in dealing with invasive species issues by bringing together DEP staff that have knowledge and experience to coordinate the development of plans and policies that address emerging invasive species issues. Prior to the establishment of ISWG, awareness levels varied among staff and tended to center around a single species such as zebra mussels or Japanese knotweed. Baseline information on ISWG members' knowledge and attitudes is available from an initial survey that was completed in early 2009 and in an evaluation completed in mid-2010 (Appendices A & B). The members' knowledge and attitudes represent a cross-section of bureau divisions; however, they provide a slightly skewed response given that they were selected to participate in the working group due to interest and experience with invasive species.

The CRISP and the Lower Hudson PRISM (PRISM), as part of the statewide PRISM network have been targeting external audiences throughout the watershed with invasive species messages since their establishment in the mid 2000's. Baseline information on knowledge and attitudes of several key external audience groups, large forest landowners, local government officials, and foresters and loggers operating in the watershed was gathered as of December 2007 in a study by Cornell University's Human Dimensions Research Unit (Connelly, 2007). This study, commissioned by the Watershed Agricultural Council (WAC), also looked at the most effective vehicles to reach these target audiences with communications.

Intent

This plan serves as a guidance document to shape DEP's invasive species communication priorities for internal and external audiences. It is critical to take a strategic approach in capitalizing on all existing outreach mechanisms that are already employed to reach each target audience such as the recreation newsletter, existing staff trainings, regular invasive species partnership meetings, and special workshops to promote specific messages (communication vehicles listed under each message are in no particular order). These messages can be layered for each audience over the course of several years in order to achieve desired outcomes.

By explicitly identifying concurrent programs, duplication of effort, time and resources can be minimized and DEP can be a better partner to the organizations that are involved in existing invasive species outreach programs. This plan can also be used to help advocate for partner support on outreach specific to species DEP is most concerned about (i.e., zebra and quagga mussels). Taking advantage of the expertise and networks already established by partners will help maximize the message.

For each priority message, specific outreach outcomes and measures will need to be identified to help monitor implementation of the plan and to identify successes and challenges. New invasive species outreach initiatives are being put into place across the state and it is important that effectiveness is tracked so that the most successful programs can be replicated by interested partners and less successful programs can be adapted to better meet audience needs.

Goals

The four priority messages outlined in this plan are designed to achieve changes in the various audiences in order to achieve the following goals:

1. To increase internal knowledge and capacity to respond to the threat of invasive species through prevention, early detection and rapid response on city lands and within the watershed;

2. To increase the efficiency with which invasive species infestations are controlled on city lands and within the watershed; and

3. To garner support for prevention, early detection/rapid response, and control of invasive species.

Target Audiences

This plan is intended to guide communication to targeted internal and external audience groups that have the potential to introduce, spread, detect or control invasive species on city lands and within the watershed. The methods used to reach each audience group will vary depending on their receptiveness to various outreach vehicles and many will be complemented by concurrent state and national efforts. Initially, focus will be given to internal audiences so that they are able

to assist to greater degree in reaching out to external audiences. Audience groups are broken out below.

Internal DEP staff

- Source Water Operations – This directorate should be engaged in preventing the introduction of invasive species by taking measures to limit the spread of invasive species through equipment use and transport, especially when equipment is shared or used throughout the operational regions – east and west of the Hudson River- and the City itself. Operations personnel should be planting native species in road and other maintenance projects and when possible replacing non-native species in key landscaped locations with native ones. Watershed maintainers and supervisors, through ongoing City land and conservation easement inspections, could also provide a strong network for early detection of low abundance species throughout East and West of Hudson lands if they were trained in how to identify early detection species and had a communication protocol to follow. Operations staff is also at the front line for steam cleaning boats providing an excellent opportunity for detecting AIS and educating recreational users.

- Water Quality and Innovation – Field staff collecting water samples from streams and reservoirs are the first line of defense for the detection of many early detection aquatic invasive species. While performing their regular duties they could be looking for new, potentially damaging species with proper training and support. Additionally, lab staff should be trained and supported in identifying invasive organisms that can be detected in water samples.

- Watershed Protection Programs (WPP) - WPP Outreach Working Group – This group is comprised of staff from throughout the directorate that interacts with the public through fairs, the development of outreach materials and work with partners that do outreach in the watershed. They are a good means of personal communications and distributing print materials to landowners and external natural resources professionals.

- Natural Resources Division
    - Forest Management Program - The foresters already have a strong skill set in invasive plant and insect identification and could benefit from training in early detection species identification and reporting as well as the use of best practices for control projects.

    - Wetlands & Aquatic Ecology Programs – The Wetlands Scientists and Aquatic Ecologists have a high level of awareness of common wetland and aquatic invasive species and could be engaged at a higher level in early detection given their strong skill sets in plant/fish identification and in best practices for control projects at wetland mitigation and forest management sites.

- Regulatory Engineering Programs - The engineering field inspection staff are regularly visiting sites on private properties interacting with contractors and landowners. With

increased training, field staff could provide early detection of easily identified species. Field staff may also act as a vehicle for conveying information to these external audiences on both early detection species and spread prevention BMPs. Project review staff currently review site development and stormwater management plans within the watershed, and through increased training can be prepared to suggest BMPs to consultant engineers and developers. Through the SEQRA Compliance Section's interaction with local Planning Boards and the public hearings related to development projects in the watershed, DEP will be able to spread the various invasive species priority messages both directly and indirectly to local planning officials, professional consultants, and the public.

- Watershed Lands & Community Planning
    - Stream Management – The stream staff spends time working in stream channels and has done work to inventory and control Japanese knotweed. With additional support they could be doing more early detection reporting. They also have the potential to prevent spread of species and use best practices through their work with contractors that are hired to complete projects in the streams.

    - Recreation – As the internal interface for an important external audience, staff in this program should be informed and supportive of the messages that are directed at recreation users and identify opportunities for reaching this audience.

    - Property Management – When conducting easement monitoring, pre-closing inspections, land use permit assessments and other field work, staff can be looking for early detection species and reporting them. This could be made a regular part of each property monitoring visit after some initial training. Staff interacting with landowners is also an important vehicle for communicating information regarding BMPs for control to easement grantors.

- DEP Police – DEP Police will be assisting Natural Resources Division staff in an expanded AIS monitoring as part of the recreational boating program. This effort will build AIS identification and detection skills which can be utilized when Police are performing other diving activities. They can then report suspected AIS to the Invasive Species Biologist. Incoming recruits should be trained in early detection as part of the DEP Police Academy.

- Policy Makers – By enacting policies that would both prevent the spread of invasive species and implement best practices in invasive species management, work to combat invasive species at the agency level would be much more efficient and DEP would be a model for other land managers in the watershed.

- Bureau of Environmental Design and Construction (BEDC) – Integrating spread prevention measures, including not planting non-native species, and BMPs for control into the design phase of projects and contract specifications can help to eliminate the need to remediate or restore sites later. The design staff needs to be more aware of the elements that are most important for invasive species control in their work and the work of their contractors.

External

- Contractors
    - Forest Management – When forest management operations take place on City-owned lands, to the Conservation Practices for forestry projects requires contracted loggers to take preventative measures to keep them from bringing in invasive species on equipment or from disturbing areas where invasive plants have gone to seed to prevent their spread. Information (e.g., fact sheets, DEP Forester interactions) on BMPs to be engaged on the project are used to reach this audience. Contract specifications are also to be included to require certain BMPs (i.e., washing equipment before being deployed on City land). Work via partners in the watershed and the PRISMs to educate loggers and other contractors working in the watershed on BMPs should also continue. The Watershed Agricultural Council (WAC) provides trainings that reach nearly all of the loggers operating in the watershed.

    - Construction – Work that is being done by construction crews on infrastructure in the reservoirs and in streams has great potential for the spread of invasive species on equipment or in fill. Contracts can also be used to engage this audience in activities to prevent spread and to control invasive species on projects.

    - Design Consultants and Landscape Architects – When designing construction projects, land clearing and grubbing and site restoration consultants should be considering invasive species spread prevention and engaging in best management practices.

- Recreation users
    - Anglers – Fishing activities pose a risk of spread of invasive species by gear, contaminated bait, and release of invasive bait species making it essential to communicate the threats associated with these activities. Anglers could also provide early detection information for a number of aquatic species and many already have a skill set in species identification. Existing groups, such as Trout Unlimited and Rod and Gun clubs provide a good opportunity to reach large numbers of anglers at once.

    - Hunters – Hunters visiting multiple parcels could spread invasive plant seeds in their boots or on their clothing or they could be a source of early detection information, particularly for feral swine. Communicating the threats associated with invasive species and the skills needed to identify them and prevent their spread would benefit the relationship with this audience.

    - Boaters – With the opening of four reservoirs to recreational boating, the risk of spread of invasive species by this audience has greatly increased. Boats have the potential to contain plant propagules or small organisms that can persist in moist environments for long periods of time. With adequate outreach, the risk

associated with this vector can be greatly decreased and boaters can become a source of early detection reports for aquatic species that are easily observed from the surface.

- Hikers – Invasive plant seeds can be transported in hiking boot treads or on clothing. Reaching hikers with messaging on the threats associated with invasive species and spread prevention techniques could help to minimize the risk of spread and they could also be trained to be a source of early detection reporting. This is an audience that could potentially be skilled in plant identification and can cover a large amount of land in a given season.

- Natural Resource Professionals
  - Land Managers – Watershed lands that are not owned by the city and are managed by natural resource professionals such as Frost Valley YMCA, The Ashokan Center, or land trusts could be engaging in best management practices for controlling invasive species. Additionally, they likely have skills to engage in early detection identification and reporting. The vehicles identified by the 2007 Cornell Human Dimensions Research Unit to best reach this audience were printed materials and personal communications (Connelly, 2007). WAC and PRISMs are great avenues for communicating with this audience.

  - Scientists – University and state agency scientists that are involved in research in the watershed could be a great source of early detection reporting. This audience could also be critical to establishing new best practices for control of invasive species and helping to get this message out to other groups.

  - Officials and Policy Makers – Local, state and federal policy makers have the ability to make changes to or develop new laws that can prevent the introduction or spread of invasive species. This audience can also influence the use of BMPs when a species that poses a significant threat arrives. DEP will look for opportunities to support legislation by providing comments and going through the proper channels to support new legislation. Outreach to these groups may be best conducted through partners.

    - Building inspectors – When conducting inspections on properties in the watershed, building inspectors could be looking for and reporting early detection species. They could also pass information along to landowners on BMPs and spread prevention tips.

    - Planning boards – In reviewing site plans, planning boards have the ability to provide information to landowners and developers regarding invasive species spread prevention.

    - Planning Professionals – Invasive species issues spread prevention and BMPs can be addressed in planning documents such as

Comprehensive and Master Plans, which in turn will elevate awareness of this issue.

- Media
    - Newspapers – In addition to acting as a vehicle to get out messages, newspapers can be an audience to reach with the message that invasive species pose a significant threat. Having primed, receptive local newspapers could be vital in an early detection crisis situation.

    - Radio Stations – Establishing relationships with local radio stations can also be critical to getting the word out quickly in an invasive species crisis situation. It is important that this audience is aware that invasive species pose a significant threat. Local stations in the Catskills like WIOX already work with partners like WAC and other PRISM partners.

    - Web-based Media – Social media and online news outlets are an additional vehicle and audience group. Establishing a relationship with groups that have large Facebook or local online news followings, is important. They can reach many people at a moment's notice.

- Landowners
    - Large landowners – Similar to land managers, landowners who are responsible for greater than 5 acres could be engaging in best management practices for invasive species. This audience is generally less engaged in active management, so it is more challenging to achieve this behavior change. Landowners also may serve as a source for early detection reports for easier to identify species. The vehicles identified to best reach this audience by the 2007 Cornell Human Dimensions Research Unit study were printed materials (brochures and fact sheets), websites, and personal communications (Connelly, 2007). WAC reaches many farmers through the agriculture program trainings and the PRISMs, DEP Stream Management and Land Acquisition Programs will also be critical in reaching this audience.

    - Small landowners – While smaller landowners' activities have minimal impacts individually, if a BMP is undertaken by many small landowners it could be a positive impact for the watershed. This audience also may serve as a source for early detection reports for easy to identify species. PRISMs will be critical in reaching this audience.

    - Streamside landowners – This subset of landowners also has unique abilities to impact water quality and the spread of invasive species. Many terrestrial plant species spread downstream and can rapidly colonize many miles of stream banks. Having educated streamside landowners that are able to report new populations of invasive species can help to prevent large infestations from occurring. This is

also an audience that receives outreach on a number of other issues from a variety of sources, including the DEP's Stream Program.

- Land Use Permittees
    - DEP issues revocable land use permits to entities using City land. Conditions are incorporated into permits requesting permittees to utilize BMPs, report possible invasive species and/or perform removal of certain invasive species. For example, DEP requires that permittees for hiking trails monitor and remove invasive species. DEP should continue to expand this.

Priority Messages

1. Invasive Species Pose a Significant Threat

The first step in achieving desired behavior changes in nearly every audience is to communicate the threat that invasive species pose to the water supply, environment, economy or human health. Identifying direct threats to a constituency's interest (i.e. Didymo and trout fisherman) can be an important tool and spur those groups to action. Without understanding the risk of inaction, it is much less likely that they will be receptive to any message that is attempting to change their knowledge, awareness, skills, attitudes, and behaviors regarding invasive species. This message has been conveyed in the past through a number of efforts including an invasive species health and safety training for staff, personal communications, PRISM programs, DEP funded watershed programs and the establishment of prevention policies.

Working collaboratively with concurrent state and national efforts to convey this message will help elevate the importance of invasive species to the audiences targeted in this plan. Resources can be shared among agencies and organizations and the audience acceptance of this message will only be increased by the number of sources. Unfortunately, invasive species issues will only be increasing with the expansion of global trade and climate change making it all the more important to get this message out now, while small actions can still help to prevent or alleviate larger problems.

Vehicles for conveying this message to internal audiences –

- Pipeline / Tributaries newsletter articles
- Weekly Bullets
- Establishment of policies for prevention and management
- Personal communications
- Trainings
- Conferences and workshops
- Demonstration projects

Vehicles for conveying this message to external audiences –

- Websites – (DEP and others such as catskillstreams.org)
- Recreation newsletter article

- Press releases
- Policies for contracts
- DEP branded invasive species giveaway
- DEP invasive species logo
- DEP booth at festivals
- CWC reservoir kiosks
- PRISM efforts
- Participation in the NYS Invasive Species Advisory Committee
- Land use permits
- Vendors for recreational boating and DEP staff for boat steam cleaning
- Conservation easement landowners
- Direct email communication to recreation users and conservation easement property owners
- Green social messaging

Concurrent State and National Efforts

- New York State Invasive Species Unit
- New York State Invasive Species Council
- United States Invasive Species Council
- PRISMs
- NYIS (Cornell Clearinghouse)
- Hungry Pests (USDA)
- Plantwise (National Park Service)

2. Look For & Report Priority Early Detection Species

It is imperative to the success of DEP's EDRR Program that new species to an area are reported by any and all potential observers. Agency personnel are regularly out on DEP lands and waters and could provide an excellent source for observation data. Recreation users on publicly accessible properties could also be reporting observations of several easy-to-identify species. Without extensive outreach to these groups, limited success at getting new reports can be expected.

As new methods for reporting invasive species become available, such as an invasive species hotline, email listserv, WaLIS report form, and website report form, information on how to use them will need to be distributed in order to facilitate their use. This message has been conveyed solely by personal communications in the past. A much broader messaging campaign will be required to get the desired response.

Supporting Facts and Statistics

- Every new detection of Asian long-horned beetle has been found by a member of the public

There is a better chance of controlling invasive plant populations population by finding and treating the populations while they are small, we have

- The larger the infestation the greater the control costs in time and money.

- Support for ED&RR efforts by a wide-range of stakeholders is essential. (National Invasive Species Council)

- EDRR requires collaboration among federal, tribal, state, local governments, nongovernment organizations (NGOs) and the private sector. (National Invasive Species Council)

Vehicles for conveying the message to internal audiences

- Trainings
- WaLIS reporting form
- Print materials
- Personal Communications
- Email list
- Bullets, Pipeline, Tributaries

Vehicles for conveying the message to external audiences

- Website
- Summits
- Select print materials
- PRISM efforts
- Watershed Agricultural Council outreach
- Cornell Invasive Species In-Service
- Recreation permit holder newsletter
- Fishing boat permit renewal notices
- Direct email communication to recreation users and conservation easement property owners
- Press releases
- CWC reservoir kiosks and boat launch kiosks
- Trailhead kiosks
- DEP Booth at festivals
- County tourism boards

Concurrent State and National Efforts

- New York State Invasive Species Unit
- PRISMs
- NYIS (Cornell Clearinghouse)
- iMapinvasives
- Hungry Pests (USDA)
- Beetle Busters (USDA)

3. Don't Spread Invasive Species

Spread prevention is critical to slowing the rate of introduction of new species to a given area. With Asian long-horned beetles, northern snakehead fish, and other invasive species within close proximity to the New York City watershed, promoting messages such as *don't move firewood*, *don't dump aquaria*, and *clean, check, and dry* can help to keep them out. Impacts of the species present within parts of the watershed, such as emerald ash borer, mile-a-minute vine and swallow-wort, can be minimized by slowing the rate with which they move to un-invaded areas. Simple actions can be taken by internal and external groups that will greatly reduce the chance of a new introduction or the spread of invasive species within the watershed.

There are several national campaigns that aim to combat the vectors of spread for invasive species that can be incorporated into existing communication efforts. These should be targeted to both internal audiences that may inadvertently spread invasive species through regular work activities that move equipment and materials throughout the watershed and external audiences that also have the potential to transport species into the region from great distances. Education and policies regarding steam cleaning boats for staff and recreation users as well as practices to use gear and cleaning techniques to avoid spreading didymo have already been implemented. Continued efforts should be made to formalize these practices and expand on them to exemplify the DEP as a leader in spread prevention and convey a stronger message to all audiences.

Vehicles for conveying the message to internal audiences

- Trainings
- Time-lapse maps showing spread over time
- Implementation of policies
- Print materials
- Personal Communications
- Email list
- Bullets, Pipeline, Tributaries

Vehicles for conveying the message to external audiences

- Implementation of policies
- Website
- Use of the SEQRA process
- Time-lapse maps showing spread over time
- Print materials
- PRISM efforts
- Recreation permit holder newsletter
- Press releases
- CWC reservoir kiosks
- DEP Booths at festivals

Concurrent State and National Efforts

- iMapInvasives
- Habitatitude (National Partnership)
- Clean, Check, Dry -Stop Aquatic Hitchhikers
- Don't Move Firewood (TNC and National Partners)
- NYIS (Cornell Clearinghouse)
- Hungry Pests (USDA)
- Beetlebusters
- NYSDEC

4. Use Best Management Practices to Control Invasive Species

Once invasive species become established, even at a small-scale, they become very challenging to successfully control. Site specific conditions will often warrant different control techniques for the same species and ongoing research frequently results in new recommendations for best practices making it difficult for managers to select the best technique for a problem area. Additionally, control projects take a high level of patience and commitment since they are rarely effective overnight and it can take several years before significant progress can be seen. Thoughtful planning is also critical given that pesticides and herbicides can be an important element in effective management and must be used judiciously. Managers can easily become overwhelmed by the degree of involvement needed to mount a successful control project and may not attempt it without support or they may use inappropriate techniques that can waste time and resources.

By promoting BMPs for controlling invasive species within the watershed the entire process will be simplified allowing for more efficient management. Best practices can guide project selection to favor projects that have a higher chance of success. Communicating the details of BMPs to both internal and external audiences has occurred to a limited extent primarily through personal communications. The implementation of BMPs should be encouraged through a more comprehensive communication campaign in order to maximize the efficiency of control efforts within the watershed.

Supporting Facts and Statistics

- The National Invasive Species Council's Implementation Task P.3.5 provides support for efforts by non-federal stakeholders to develop/enhance codes of conduct and BMPs and to publish codes of conduct and BMPs on the Web. (National Invasive Species Council)

- Effective implementation of BMPs will be a process of continuous learning. Over time, training programs for foresters, landowners, and loggers will be necessary to ensure a successful BMP effort. (Wisconsin's Forestry Best Management Practices for Invasive Species)

- Without BMPs it is expected that rates of implementation of control projects will not increase, and the issues associated with invasive species will continue to worsen.

Vehicles for conveying the message to internal audiences

- Trainings (Tool-box Talks)
- Species summits
- Shared resource server folder
- Implementation of policies (Forestry Conservation Practices)
- Print materials
- Personal communications
- Email list
- PRISM efforts

Vehicles for conveying the message to external audiences

- Implementation of policies
- Use of the SEQRA process
- Website
- Select print materials
- PRISM efforts
- Species summits
- Demonstration projects
- Recreation permit holder newsletter
- Press releases
- CWC reservoir kiosks
- DEP Booth at festivals

Concurrent State and National Efforts

- New York State Invasive Species Unit
- NYIS (Cornell Clearinghouse)
- New York State Invasive Species Council
- PRISMs
- National Invasive Species Council
- US Department of the Interior
- US Department of Agriculture

Appendix D
Early Detection and Rapid Response Plan

NYCDEP Invasive Species Working Group

Updated Early Detection & Rapid Response Plan (2022)

BACKGROUND

In October 2008, DEP's Bureau of Water Supply formed the ISWG comprised of staff members from three Directorates: Watershed Protection Programs, Water Quality and Innovation, and Source Water Operations. The purpose of the ISWG is to form a coordinating body that develops and makes recommendations to Bureau management regarding an overarching invasive species strategy and related policy issues. The ISWG is also charged with staying abreast of emerging issues and serving as a forum for information exchange, rapid response needs, and budget prioritization. Subcommittees are formed as needed to work on specific tasks including an Invasive Species Management Strategy and additional guidance documents on monitoring, preventing, and responding to invasive species threats in the New York City Water Supply Watersheds.

Between 2009 and 2012, the ISWG scoped and developed an EDRR strategy that focuses primarily on City-owned lands (including water bodies) but includes the ability to collaborate with watershed partners. This document serves as a broad strategic roadmap for use by Bureau management staff when discussing invasive species policy issues, allocating budget resources, and deciding upon appropriate actions necessary to achieve DEP goals with respect to monitoring, preventing, and responding to invasive species threats in the New York City Watersheds. Two prominent themes of this EDRR plan are the importance of clear and timely internal communication and the need for external coordination with partners.

This document was revised and updated in 2022 to reflect the experience and advances made on EDRR over the last decade and to support the 2022 update to the Invasive Species Strategy. Several of the original tasks were completed while others still need to be addressed and many lessons have been learned.

INTRODUCTION & OVERVIEW

An effective invasive species management program includes five strategic elements: (1) prevention; (2) early detection and rapid response; (3) control and management; (4) rehabilitation and restoration; and (5) organizational collaboration. These key elements are supported by the National Invasive Species Council's *Management Plan: 2016-2018,* the United States Department of Agriculture *Forest Service National Strategic Framework for Invasive Species Management* (2013), the Final Report of the New York State Invasive Species Task Force (2005), and the U.S. Department of the Interior's national framework for early detection and rapid response, *Safeguarding America's Lands and Waters from Invasive Species: A National Framework for Early Detection and Rapid Response* (2016).

The first line of defense against invasive species is to prevent their introduction in the first place. However, since it is virtually impossible to prevent all introductions, early detection & rapid response (EDRR) is considered the second line of defense and one of the most critical components of any invasive species strategy. Early detection requires vigilance and regular monitoring to detect a species at the earliest possible time after an introduction is known or believed to occur. When an invasive species is detected, a rapid response is initiated to determine

the water supply and environmental (and potentially economic) risks, extent of its establishment and distribution, potential for spread, and to evaluate response options.
A meta-analysis of federal EDRR plans and programs (Reaser et al., 2020) has found that the hallmarks of successful EDRR efforts typically include:

(a) adequate information provided to decision makers in a standardized and timely manner;
(b) effective coordination among neighboring landowners/jurisdictions;
(c) enactment of detection and response measures prior to species establishment;
(d) institutionally, logistically, and socially well-supported response measures;
(e) response measures that include actions taken to prevent re-invasion or spread;
(f) incorporation of lessons learned from previous EDRR experiences;
(g) investments made in preparation to address future invasion.

Ideally, eradication of a newly detected invasive species is both practical and achievable. More frequently, however, invasive species are managed to contain or slow their spread. In some cases, EDRR may trigger no response because the invasive species is determined to be too widespread, potential threats are not considered high priority, and/or the necessary resources are unavailable to ensure successful mitigation. Regardless of the scenario, any delay in supporting EDRR favors the target pest and significantly increases the costs of management or the implementation of a longer-term mitigation program for an established population. With respect to the New York City Watersheds, not being able to effectively implement the EDRR plan could negatively impact water quality, threaten or damage water supply infrastructure, disrupt DEP's Long-term Watershed Protection Program, or a tarnished reputation if DEP's response to a serious new infestation is deemed slow or ineffectual.

Over the past decade, there have been several examples of early detections with differing outcomes. In 2014 water chestnut was detected in Muscoot Reservoir. DEP staff and interns surveyed the area and developed a plan to remove the plants through hand-pulling until a mechanical harvester could be procured. Procurement and permitting delays made the project impossible to complete in a timely manner. By 2015, plants were too dense to consider hand-pulling and the removal project was deemed secondary in importance to the control of Hydrilla in New Croton Reservoir, which was first detected in late 2014.

From 2014 to 2018, DEP surveyed the extent of Hydrilla in New Croton Reservoir, reviewed treatment plans, and funded an in-depth expert panel and research review into the treatment of Hydrilla with the Water Research Foundation. The results of the surveys and expert panel review all pointed toward chemical treatment with the herbicide fluridone. DEP staff worked through a lengthy procurement process to initiate a reservoir-wide herbicide treatment program. In 2018, 2019, and 2020 DEP piloted treatments in small areas of the reservoir to investigate the effectiveness of using fluridone and its movement in the reservoir. Reservoir-wide treatment began in 2021 under a three-year contract with the understanding that this will be a long-term project. From the initial discovery and assessment to the commencement of full-scale treatment the estimate of the total project cost more than tripled as the infestation grew.

In 2015, The New York State Department of Environmental Conservation (NYSDEC) detected zebra mussels in Lake Mahopac, a lake in Putnam County upstream of the Amawalk Reservoir. DEP monitored the downstream spread of adult mussels and the juvenile veliger stage, researched treatment alternatives, and discussed necessary modifications to mitigate the impacts of zebra mussels to critical infrastructure. In years with higher-than-average flows, increased numbers were observed downstream of Lake Mahopac, with many adults observed in Amawalk Reservoir in late 2021.

All of these examples have illustrated strengths and challenges in DEP's ability to mount a rapid response. These lessons learned have been incorporated into the plan below.

PLAN SUMMARY: GOAL, OBJECTIVES & METRICS

This EDRR Plan focuses on City-owned lands and reservoirs and includes coordination and collaborate with other stakeholders and especially the PRISMs. CRISP and the Lower Hudson PRISM, the PRISM regions covering the watershed, are funded by the NYSDEC through the Environmental Protection Fund and serve to direct and guide invasive species management efforts across regions to improve efficiency and efficacy. The National Academies of Sciences, Engineering, and Medicine reviewed the Invasive Species Program as part of a larger review of DEP's Watershed Protection Programs in 2020 and recommended that DEP "clarify the terrestrial and aquatic invasive species programs' responsibilities within the regional invasive species collaborative network and support these responsibilities adequately. Given the potential environmental, economic, and water quality impacts of invasive species, responding to important outbreaks should be prioritized."

Although water supply reservoirs and City-owned lands are the highest priority for DEP in terms of EDRR efforts, it is important to recognize that the CRISP and Lower Hudson PRISM framework provides DEP with the opportunity to build and enhance internal EDRR capacity through staff training opportunities, secure access to reliable and up-to-date scientific information (including early notification of new detections or approaching species of concern that are not already known by DEP), potential access to state or federal funding, and the ability to leverage regional efforts and ensure widespread public participation in watershed activities pertaining to invasive species.

The overarching goal of this EDRR Plan is to prioritize and then minimize both potential and direct threats to water quality, water supply infrastructure, and the ecosystem functions that support them, as well as to reduce budgetary impacts that could result from the establishment and spread of non-native invasive species within the Catskill/Delaware and Croton Systems.

To achieve its overarching goal, this EDRR Plan is divided into three main components – (1) Risk Assessment, (2) Early Detection, and (3) Rapid Response – and it comprises the following primary objectives embedded within the three plan components:

1. Ensure new invasive species are identified and their risks assessed promptly
2. Ensure early reporting of new invasive species occurrences/infestations both internally within DEP and externally with watershed partners
3. Define decision-making responsibilities and response protocols

4. Establish and maintain capacity to act
5. Incorporate adaptive management in plan implementation

The ISWG is working to developing a comprehensive monitoring program that will track the success of eradication of the target species when conducting a rapid response. This is being done simultaneously with a multi-year statewide effort to establish a set of metrics that can be applied more broadly for the success of invasive species management efforts, yet in a way that captures the unique circumstances of each project. Currently, monitoring is being done on a project-by-project basis. For example, DEP monitors for aquatic species using point-intercept surveys for plant densities of Hydrilla and other invasive plants, and are also exploring drone surveys for the floating water chestnut. DEP will continue to explore additional techniques to track efforts and outcomes.

Risk Assessment

1. Priority List
   Compile and maintain a prioritized DEP-specific "unwanted invaders" list of invasive species including:
   a. Species already known to occur in the watershed
   b. Species that are not yet known to exist in the watershed but are considered an imminent threat to water quality or the water supply. This can be taken from the "Tier Lists" the PRISMs developed where Tier 1 species are approaching the region and Tier 2 species are emerging in the region.

   This "unwanted invaders" list should be recirculated annually at all DEP facilities/locations in order to promote and facilitate staff awareness.

Status: List will be updated annually

2. Reporting Program
   Maintain a centralized web-based reporting system and accompanying set of procedures for reporting suspicious species found on City-owned lands and to facilitate tracking and documentation of confirmed sightings.
   - Refer reports to appropriate state and local authorities as needed.
   - Promote reporting via the watershed Facebook page
   - Maintain a central ISWG contact person through which external sightings are reported and documented, requests are submitted to experts (when necessary), and responses are received/confirmed.

NOTE: The ISWG represents the core DEP team of internal invasive species experts, with DEP also having access to external expertise through participatory involvement with CRISP, Lower Hudson PRISM, and the NYS Invasive Species Advisory Council.

Status: A web-based form is currently in use

3. Formal Risk Assessments

Update the established risk assessment methodology and assess new species at least every five years. Revisit and revise the assessment form as needed.

NOTE: The ISWG has completed rapid risk assessments on several priority species of concern to DEP and will continue to conduct rapid risk assessments for new species detected on City-owned lands as well as those located on non-City watershed lands or in proximity to the New York City Watersheds and representing a likely future invasion.

Status: Risk assessments have been done. The assessment form will be reviewed, and new species assessed.

Early Detection

1. Active Monitoring Network
   Maintain an active DEP monitoring network for those invasive species of highest concern/threat/risk to water quality and water supply ecosystems and infrastructure. Active monitoring focuses on likely points of entry and other high-risk locations, such as reservoir boat launches, popular recreational areas, and City-owned lands that are in proximity to known infestations.
   - Schedule internal training of DEP field staff regarding highest priority species (top 5-10) that may be encountered during the course of routine watershed field work every five years (see #5 below).
   - This task will also require clear and direct channels of internal communication to ensure timely reporting and documentation of invasive species detections.

Status: Additional training is due for many groups within DEP, for example, Source Water Operations, DEP Police and West of Hudson Water Quality and Innovation field staff.

2. Passive Monitoring Network
   DEP will continue to implement a passive monitoring plan/network for specific invasive species of particular concern to water supply reservoirs and City-owned lands to supplement DEP's active monitoring plan/network. CRISP and Lower Hudson PRISM and their volunteers can support broad public education and outreach component that help DEP reach external audiences (boaters, hikers, loggers, contractors, etc.) to capitalize on additional chance discoveries on DEP lands. This task will also require clear and direct channels of internal and external communication to ensure timely reporting and documentation of invasive species detections. Increased recreation on City-owned lands also provides the opportunities to reach a broader audience in coordination with the Watershed Protection Program Outreach Working Group.

Status: DEP completed a communications plan that is implemented in coordination with the Outreach Working Group, early detection network has been established through CRISP contract with Cornell Cooperative Extension (CCE), iMapinvasives has a reporting form that can be used for common species

3. Invasive Species Tracking Database

DEP works with the NYS iMapInvasives Database to document and track known infestations on City-owned lands and for recording/tracking the status, progress, and efficacy of DEP management actions.

Status: iMapInvasives is widely used for reporting early detection species by DEP staff.

4. Invasive Species Webpage
   Work with DEP's Bureau of Public Affairs and Communication, the bureau charged with managing all information given to the public (both digital and print), to update the DEP Watershed Protection website and Watershed Facebook page annually to include a special webpage and invasive species reporting (especially early detection efforts). Any DEP website reporting mechanism would be linked to the EDRR centralized reporting system established pursuant to this workplan.

5. Invasive Species Passive Monitoring Training Program
   Identify appropriate staff, develop and begin to implement an internal training program for DEP watershed field staff, including necessary training materials for both office and field use, to raise their awareness of priority invasive species from the priority list that they may encounter during their routine field work and to solicit their assistance with EDRR efforts where appropriate (in order to increase the likelihood of early detections).

6. Communications Plan
   Update the invasive species outreach and communication strategy that educates watershed constituents and targeted stakeholders (especially recreational users of City-owned lands) about the importance of EDRR and who they should contact/where they should turn for immediate reporting purposes. This task will incorporate the use of Catskill Watershed Corporation reservoir kiosks, appropriate signage at key recreational areas, DEP recreation newsletters, DEP website, displays/exhibits at public events (county fairs, watershed festivals, etc.), DEP press releases, and other modes of communication.

NOTE: This task dovetails with the efforts of the WPP Outreach Working Group and as such should be incorporated into that group's workplan, if appropriate.

Rapid Response

Define internal decision-making responsibilities and response protocols.

1. Rapid Response Protocol
   Review recent rapid response projects and assess the flow of information and decision making to determine what has worked well and what needs improvement and update the existing rapid response protocol to reflect the needed flexibility and challenges. The format should be less prescriptive and more iterative.

   Status: Draft protocol has been developed and should be updated by the end of 2022

Establish and maintain capacity to act

1. Rapid Response Fund
   Establish a two-tiered approach to funding rapid response efforts. The first tier is a standing terrestrial management, and aquatic monitoring and management agreement with a certified pesticide business that should be maintained at all times to be able to rapidly address smaller infestations. A terrestrial invasive species management agreement is currently in place and can be diverted toward the highest priority early detection species in a given year. An aquatic agreement could be used for surveys in a typical year and diverted to initial management efforts in the event of an early detection.

   The second tier would be a project-specific contract that would be used to address a reservoir-wide or basin level response. Templates for these procurements should be maintained to help expedite the process. One mechanism to address infestations that cross over City-lands and onto private lands could be to work with CRISP and the Lower Hudson PRISM to fund their work on City-lands and support their capacity to act on adjacent private lands.

Status: There is currently an open purchase order for two years for terrestrial invasive species management

2. Species Response Plans
   Develop model response plans for specific invasive species from the priority invasive species list that include defined roles, protocols, response procedures, long-term action planning, and generic monitoring and assessment requirements to be incorporated into control projects. Potential response options to be considered based on degree of infestation and threats/risks might include: (1) eradication, (2) slow the spread, (3) continued monitoring, or (4) no response. Use these response plans to identify any issues that might arise in cooperating with state agencies on a statewide response and include within the plan how DEP might best be able to support statewide efforts. This has been done at the state level for plant pest species with state, federal, and local partners conducting tabletop and full-scale responses with after action reports. Plans would be updated periodically.

NOTE: This task will produce potential response scenarios tailored to individual priority species and as such will require advanced discussions with Bureau management staff about policy, potential funding and procurement implications should certain scenarios occur.

Incorporate adaptive management into EDRR plan implementation

1. Evaluation

   Review plan implementation and associated procedures on an annual basis to evaluate and improve both policy decisions and on-the-ground management activities. Measure success based on achievable and realistic metrics that will also be evaluated.

2. Amendments

Periodically amend and update the EDRR plan and metrics/procedures to reflect new technologies and lessons learned and to continue to define/refine measures of success.

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Appendix D
Timeline of Invasive Species Highlights

Invasive Species Timeline – DEP Accomplishments

1986	Zebra mussels first detected in Lake Erie
1993	Zebra mussel prevention program: monitoring, steam-cleaning and outreach
1996	Asian longhorned beetle (ALB) found in NYC
1999	Invasive species monitoring in forest health plots and continuous forest inventory plots
2000	ALB workshop-Liberty, NY
2000	ALB information mailed to DEP hiking permit holders
2002	Begin Japanese knotweed control/outreach
2003	Fund literature review on Japanese knotweed and management
2003	Japanese knotweed mapping and management study
2004	Japanese knotweed study
2004	Participate in and co-lead Japanese Knotweed Initiative
2004	DEP literature review/ white paper on invasive species
2005	The Nature Conservancy (TNC)conducts invasive plant inventory project
2005	Trees New York holds invasive species workshops (Poughkeepsie & Kingston, NY)
2005	Sponsor Japanese knotweed demonstration sites
2005	Forest health/invasive species stakeholder meetings & outreach workplan (pre-CRISP)
2005	DEP comments to DEC on NYS Invasive Species Task Force report
2006	DEP active in founding CRISP (Catskill Region Invasive Species Partnership)
2006	ALB-awareness-Upstate/downstate bus tour
2006	Lower Hudson PRISM forms
2006	DEP representative appointed to NYS Urban & Community Forestry Council
2006	Contract specs for barge work (bridge construction/repair) in streams, lakes or reservoirs
2006	Japanese knotweed Conference
2006	Public Awareness Survey of Invasive Plants and Insects in the Catskill and Lower Hudson Region
2006	Giant Hogweed first detected on City Land (Croton Falls)
2006	Met with Cary Institute for Ecosystem Studies & DEC to formulate plans for invasive species management in Catskill Preserve
2006	TNC Catskill Invasive Survey finds Swallow-wort found on City Land (Pepacton)
2007	Summer Firewood Education/Outreach Pilot Program
2007	Begin control of swallow-wort control on City Land
2007	Bait sales analysis and lobby for regulation to reduce risk of ZM introduction
2007	Fisherman reports Rock snot (Didymo) to WQ samplers
2007	DEP Invasive Species white paper completed
2007	Training on Invasive Species Health & Safety Issues developed
2007	NYS Invasive Species Legislation enacted to form a Council, Advisory Committee and PRISM's
2008	Terrestrial Eradication Grant funding to DEP-TNC for swallow-wort (Pepacton) (2008-2010)
2008	Brazilian elodea (Egeria densa), first reported in Westchester County - Lake Waccabuc
2008	Ballast (Small Boat) Administrative Operating Procedure revised (begun in 2004)
2008	DEP attends Regional Firewood Forum in New Jersey
2008	Northern Snakehead found and eradicated in Orange County, NY
2008	ALB found in Worcester MA

2008	NYS issues Emergency Regs on firewood transport & treatment
2008	Begin control of Japanese barberry, mile-a-minute, and giant hogweed on City land
2008	DEP representative appointed to NY IS Advisory Committee
2008	Organize DEP Invasive Species Working Group (ISWG)
2009	DEP partners with CRISP and TNC to do a ALB survey of campgrounds in the Catskills
2009	DEP participates in regional ALB training with USDA-APHIS
2009	ISWG begins to do risk assessments and rank species
2010	Emerald ash borer (EAB) found in Ulster County, NY
2010	Invasive species surveys conducted for giant hogweed, mile-a-minute and swallow-wort
2010	Attended Cornell Cooperative Extension training on EAB
2010	Updated zebra mussel steam-cleaning and quarantine protocols
2010	Presented on the ISWG at the Watershed Science and Technical Conference
2011	NYS issues Invasive Species Management Strategy
2011	ISWG Finalized an Early Detection and Rapid Response Plan
2012	Contracted SUNY Oneonta Biological Field Station to survey terminal reservoirs for aquatic invasive species
2012	EAB surveys conducted around Ashokan Reservoir
2013	Invasive Species Communication Plan Drafted
2013	Presented on swallow-wort eradication project at the Watershed Science and Technical Conference
2013	Presented on EAB at the New England Society of American Foresters annual meeting
2013	Training on early detection species given to field Operations staff throughout the watershed
2013	Pilot boat steward program developed with CRISP at Pepacton Reservoir
2013	Training by USDA APHIS held for DEP Police on feral swine
2013	Recreation users surveyed on invasive species awareness
2014	Hydrilla is detected in New Croton Reservoir
2014	NYS prohibits and regulates the sale of many invasive species (NYCRR Part 575)
2014	*Rhinoncomimus latipes*, biocontrol for mile-a-minute released near Kensico Reservoir
2015	DEP participates in the Lower Hudson PRISM blockbuster survey for focal species EOH
2015	Benthic barriers installed to control Hydrilla around the boat launch in New Croton Reservoir
2015	Presented on Hydrilla at the Watershed Science and Technical Conference
2015	Worked with TNC to develop a deer exclosure study of invasive species in the Ashokan Basin
2015	DEP representative named chair of the NY IS Advisory Committee
2016	NYS Aquatic Invasive Species Spread Prevention regulations are enacted (NYCRR Part 576)
2016	Extensive survey for Hydrilla conducted in New Croton Reservoir by Solitude Lake Management
2016	DEP participates in Hemlock Conservation priority setting with CRISP
2016	DEP comments to DEC on the proposed Rapid Response Framework
2017	The Water Research Foundation worked with DEP to provide an expert panel to review Hydrilla treatment in a drinking water reservoir
2018	Pilot treatments for Hydrilla in New Croton Reservoir began

2018	DEP installed a bootbrush station at the Shavertown Trailhead for invasive species prevention
2019	DEP established a monitoring program for zebra mussel veligers leaving Lake Mahopac
2019	DEP worked with the Catskill Center to use environmental DNA to evaluate presence of invasive aquatic plants in the Catskills
2019	DEP established a multi-year procurement to maintain herbicide applicator capabilities for rapid response
2019	DEP worked with the Catskill Center to assess invasive species management concerns on the Ashokan Rail Trail
2019	DEP funded research into appropriate post-treatment monitoring protocols by the Ecological Research Institute
2020	DEP hired an in-house Restoration Ecologist to support the Restoration Ecology program
2020	DEP gained in-house pesticide applicator capacity on the Forestry Program Staff
2020	DEP developed an online BINGO activity for Invasive Species Awareness Week
2020	DEP joined the statewide Spotted Lanternfly Multi-Agency Coordination Task Force
2021	DEP worked through a Town+Gown contract to assess the ability of Croton Filtration Plant to remove herbicides used in the treatment of Hydrilla
2021	Adult zebra mussels were discovered in Amawalk Reservoir
2021	DEP initiated treatment of Hydrilla in 250 acres of New Croton Reservoir