Final Report on *Corydalis incisa* rapid response and partnership building on the Bronx River corridor, December 15, 2015

Prepared for:
Lower Hudson PRISM

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City of New York Parks and Recreation
Forestry, Horticulture and Natural Resources
Bill de Blasio, Mayor
Mitchell J. Silver, FAICP, Commissioner

Corydalis incisa rapid response and partnership building on the Bronx River corridor

Background

In 2015 purple keman, also known as incised fumewort (*Corydalis incisa)* and native to East Asia (China, Korea, Japan and Taiwan), was first discovered in North America during a BioBlitz at the New York Botanical Gardens (NYBG) (Atha, Schuler, and Lumban Tobing, 2014). Purple keman has recently become established in the Bronx River corridor, which runs through both the Bronx and Westchester County. In May 2014, staff from NRG and NYBG conducted a rapid survey of Bronx Forest Park and found a large invasion of purple keman on both sides of the river's floodplain. The Bronx River corridor is the only known North American invasion. The plant has been found in Crestwood Park in Westchester County, NYBG and Bronx Forest Park where, in a heavily invaded area, 32 seedlings were counted within a 10cm x 10cm plot. It is not known how the species established in the wild and there are no known management guidelines for the plant. Purple keman is an emerging invasive species that requires financial resources and adaptive management techniques to control and reduce its population so it does not out compete native species and proliferate within the Bronx River Corridor and spread to other locations.

Purple keman has been seen growing in fine sediments that are deposited on the floodplain of the Bronx River. It is likely that the seed is carried and deposited during flood events; the seeds are less than 1mm in size and float on water. This plant is explosively dehiscent; when the seed pods are mature they burst when lightly agitated. Staff from NRG have witnessed this explosive dehiscence when seed from a plant was dispersed 10 feet away. This mechanism for seed dispersal makes purple keman an especially aggressive invasive plant.

The identification description below is from Atha, Schuler, and Lumban Tobing, (2014) (see Appendix, Figure 1).

> **"Corydalis incisa** (Thunb.) Pers.
> Biennial herb, glabrous, 10–50 cm tall, the sap watery; leaves ternate to bi- or tri-ternate; ultimate segments rhombic, the bases cuneate, the margins deeply incised; first-year plants from fusiform tuber ca 12 × 5 mm; leaves few, reduced; second-year plants from fibrous roots, erect to ascending, branched; leaves usually numerous, the petioles 5–20 cm long, the blades 4–12 × 4–12 cm; upper-most leaves reduced near the inflorescence; racemes erect, 6–9 cm long (in fruit), bracteate, the bracts rhombic, incised 4–10 mm long; flowers 10–16 per raceme; pedicels 10–15 m long, patent; sepals reduced, lacerate; corolla tubular, 8–15 mm long, the petals connivent, purple (rarely white), dilated and darker at the apex, saccate at the base; capsules pendent, oblong, 12–18 × 3 mm, green, explosively dehiscent; seeds ca 1 mm long. Flowering and fruiting May to June. (The description is derived from field observation in New York and study of preserved Asian specimens at NY)."

Project Objectives

Through this Lower Hudson PRISM grant, NRG's goal was to rapidly respond to the new emergence of corydalis incisa, commonly known as purple keman, and to inform and coordinate with partners in the process. To accomplish these goals NRG completed the following tasks (see Table 1 below):

(1) Surveyed and mapped the extent of the invasion in Muskrat Cove, Shoelace Park, and Bronx Forest Park (see Appendix, Figure 2)
(2) Developed an Adaptive Management Guidelines for purple keman
(3) Trained NYC Parks, Bronx River Alliance, and Westchester Co. Parks staff and volunteers on identifying purple keman (including its multiple life stages)
(4) Partnered with the Bronx River Alliance and their volunteers to implement a pilot management plan in Bronx Forest Park
(5) Provided digital informational materials about purple keman for partners, other natural area managers, and the general public
(6) Trained volunteers to participate in two purple keman removal events during the spring of 2015

Table 1. Project Timeline and Deliverables

Project Timeline and Deliverables										
Partner	Deliverables	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NRG	Survey and Map									
	Management Guideline Development									
	Partner Training									
	Implementation of Management Guidelines									
	Educational Material Development									
	Distribution of Educational Materials									
Bronx River Alliance	Staff Training									
	Implementation of Management Guidelines									

Approach

Survey and Mapping

Prior to collecting field data, NRG staff created shapefiles in ArcMap and prepared field datasheets to collect data efficiently and maintain organization (see Appendix, Figure 3). NRG staff collected three pieces of data:

(1) Mapped areas (polygons) where purple keman was observed
(2) Percent cover of purple keman in the mapped polygons
(3) GPS points associated with photos taken in polygons

Once NRG staff observed purple keman in a specific location, it was mapped via GPS by drawing a polygon in ArcPad to visually identify the site of observation. Before moving onto another site, NRG staff took photo points within the mapped site. Photo points are pictures of a specific location in the corresponding mapped polygon (see Appendix, Figure 4).

NRG staff conducted the first survey in May 2015. NRG surveyed three Bronx parks that were mapped with a Trimble GPS unit and antenna backpack to improve mapping accuracy (see Appendix, Figure 5). NRG categorized percent cover of purple keman into four ranges: 0-25% (low priority), 25-50% (medium-priority), 50-75% (medium-priority), and 75-100% (high-priority).

After NRG staff collected this data, it was uploaded into ArcMap to create visual maps to show the extent of purple keman in the three parks located in the Bronx River corridor in Bronx County. NRG used these maps while developing management strategies in addition to organizing and planning volunteer events to remove purple keman (see Appendix, Figures 6-8).

All collected data, datasheets, and shapefiles are saved in appropriate folders located on NYC Parks' shared computer drive.

Training
NRG staff trained partners in identification of purple keman during the 2015 growing season when the plants were in flower (see Appendix, Figure 9). Volunteers that worked with the Bronx River Alliance's Conservation Crew (Conservation Crew) were also trained in purple keman identification, manual removal, and trained in seeding native herbaceous plants (see Appendix, Figures 10-12). NRG provided an educational flyer to partners to distribute to their staff and volunteers (see Appendix, Figure 1).

Partner Engagement
As previously mentioned, NRG trained staff, partner organizations, and volunteers on identifying purple keman including its multiple life stages (see Appendix, Figure 1). NRG also provided project partners with Adaptive Management Guidelines to spread awareness about purple keman and the proposed management strategies.

Results

Development of Adaptive Management Guidelines
NRG staff developed Adaptive Management Guidelines to address this emerging invasive species. NRG determined that each spring, before purple keman flowers, previously mapped sites will be resurveyed (Muskrat Cove, Shoelace Park and Bronx Forest Park) (see Appendix, Figures 6-8). From this, NRG will be able to understand what management techniques worked and will then further develop these techniques to potentially eradicate purple keman.

In early spring, NRG will continue to coordinate with the Stewardship team and the Bronx River Alliance to organize volunteer events to pull the plant before the seeds mature and spread. The Stewardship team and the Bronx River Alliance will continue to work with volunteers to seed the managed areas with a native herbaceous seed mix – if seed is limited, the areas with the highest density of purple keman will be given priority.

Implementation of Adaptive Management Guidelines
NRG worked with the Bronx River Alliance and their volunteers to remove purple keman in areas of high percent cover, and to implement a pilot management plan for purple keman within the Bronx Forest Park. This pilot site is approximately 1,763 sq. ft. and is the only medium priority site located inside the volunteer pulling site (see Appendix, Figures 8, 15a-15c, and 16a-16g). This pilot management area was the main focus of this grant. NRG, the Bronx River Alliance, and volunteers worked effortlessly to manage this area and implement management techniques in accordance with the Adaptive Management Guidelines.

Volunteer Events
The Alliance hosted several volunteer events to remove purple keman in Muskrat Cove, Shoelace Park, and Bronx Forest Park. These events involved several groups such as Green Girl, Grow NYC, Clinton High School, and Christadora (see Appendix, Figures 10-12). These events took place in July, October, November and December. The Conservation Crew worked

closely with volunteers to manually remove purple keman and disposed of the plant carefully as to not spread the seed (see Appendix, Figure 13). In November, the Alliance planned one volunteer event to seed the pilot management area with a native herbaceous seed mix (see Appendix, Figure 14).

Next Steps

NRG is coordinating with the Stewardship team and the Bronx River Alliance to organize several volunteer events in early-to-mid spring of 2016 to pull purple keman before it flowers. Prior to these events, NRG will resurvey previously mapped purple keman sites in Muskrat Cove, Shoelace Park, and Bronx Forest Park to update percent cover. NRG will also work closely with the Bronx River Alliance to continue implementing the Adaptive Management Guidelines in addition to targeting purple keman during volunteer events focused on invasive removals throughout the spring, summer, and fall in 2016.

Appendix

Figure 1: Educational document created to hand out to project partners and volunteers.
Figure 2: Location of Muskrat Cove, Shoelace Park and Bronx Forest Park.
Figure 3: Purple keman Datasheet.
Figure 4: Example of photo point taken during field survey.
Figure 5: NRG staff collecting field data via Trimble GPS unit.
Figure 6: Muskrat Cove plots of purple keman.
Figure 7: Shoelace Park plots of purple keman.
Figure 8: Bronx Forest plots of purple keman. The medium (orange) priority site located within the volunteer pulling site is the location of the pilot management area.
Figure 9: NYC Parks, New York Botanical Gardens. Bronx River Alliance, and Westchester County Parks learning about purple keman in the field.
Figure 10: Green Girls volunteers being trained on how to identify purple keman and other invasive species in the field.
Figure 11: Christadora volunteers being trained on how to identify purple keman and other invasive species in the field.
Figure 12: Grow NYC and Clinton High School volunteers being trained on how to identify purple keman and other invasive species in the field.
Figure 13: Proper way to remove and bag purple keman.
Figure 14: NRG staff seeding pilot management area after removal of purple keman and Japanese hops.
Figure 15a: Before photo of removing purple keman and Japanese hops from pilot management area (east and west side of trail).
Figure 15b: Before photo of removing purple keman and Japanese hops from pilot management area (east side of trail).
Figure 15c: Before photo of removing purple keman and Japanese hops from pilot management area (west side of trail).
Figure 16a: Purple keman and Japanese hops removal event in the pilot management area.
Figure 16b: Purple keman and Japanese hops removal event in the pilot management area.
Figure 16c: Purple keman and Japanese hops removal event in the pilot management area.
Figure 16d: Purple keman and Japanese hops removal event in the pilot management area.
Figure 16e: Purple keman and Japanese hops removal event in the pilot management area.
Figure 16f: Purple keman and Japanese hops removal event in the pilot management area.
Figure 16g: Purple keman and Japanese hops removal event in the pilot management area.

Figure 1: Educational document created to hand out to project partners and volunteers.

Listing from left-to-right:

1) On the far left, a second year plant is in flower (note the purple flowers);

2) Located to the right of the quarter, a first year plant is shown; and

3) On the far right, a second year plant with has developed fruit (pea pods located at the top).

Figure 2: Location of Muskrat Cove, Shoelace Park and Bronx Forest Park.

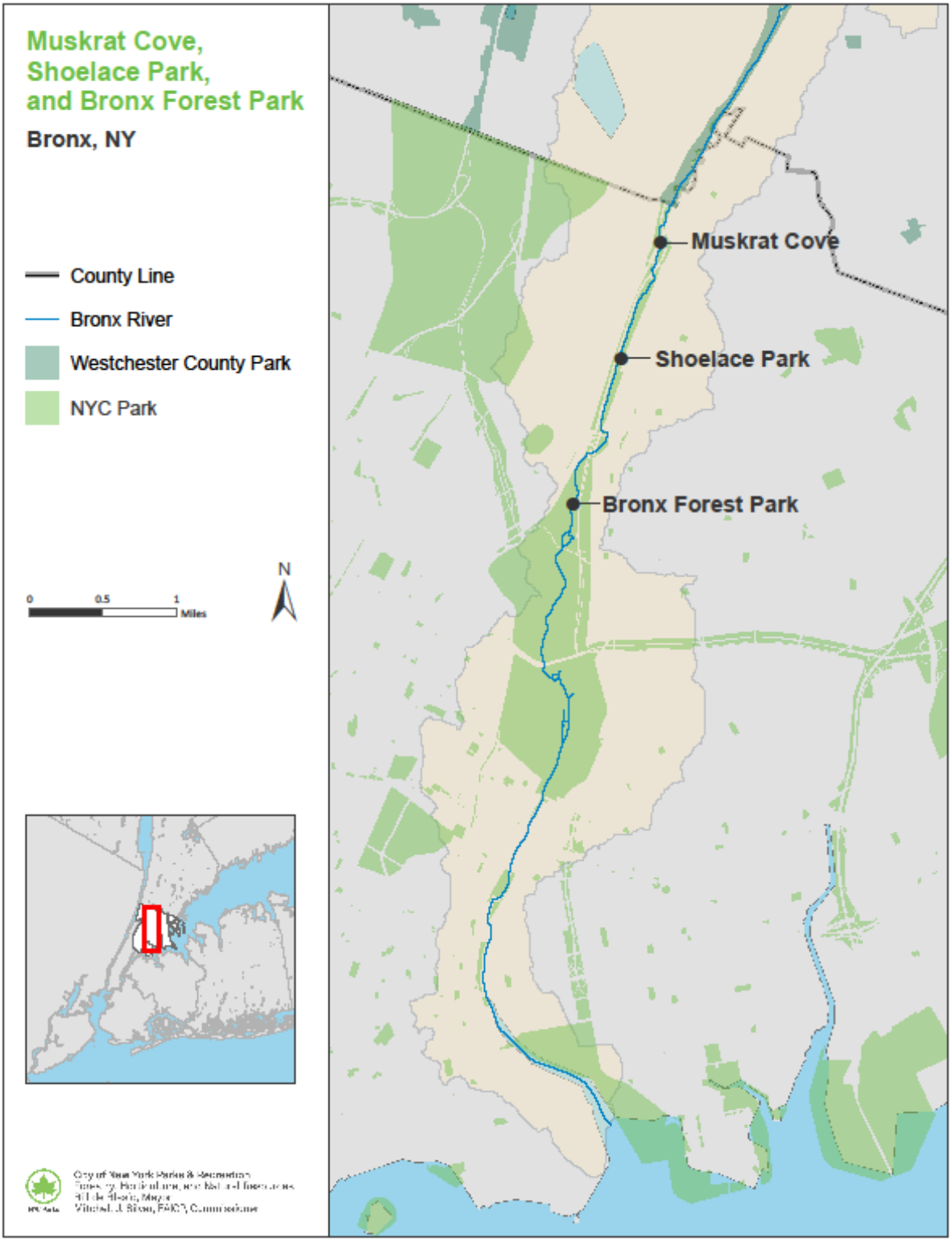

Figure 3: Purple keman Datasheet.

Park Name	Polygon ID (GPS)	Percent Cover	Photo ID (GPS)	Photo Number	Notes

Figure 4: Example of photo point taken during field survey.

Figure 5: NRG staff collecting field data via Trimble GPS unit.

Figure 6: Muskrat Cove plots of purple keman.

Figure 7: Shoelace Park plots of purple keman.

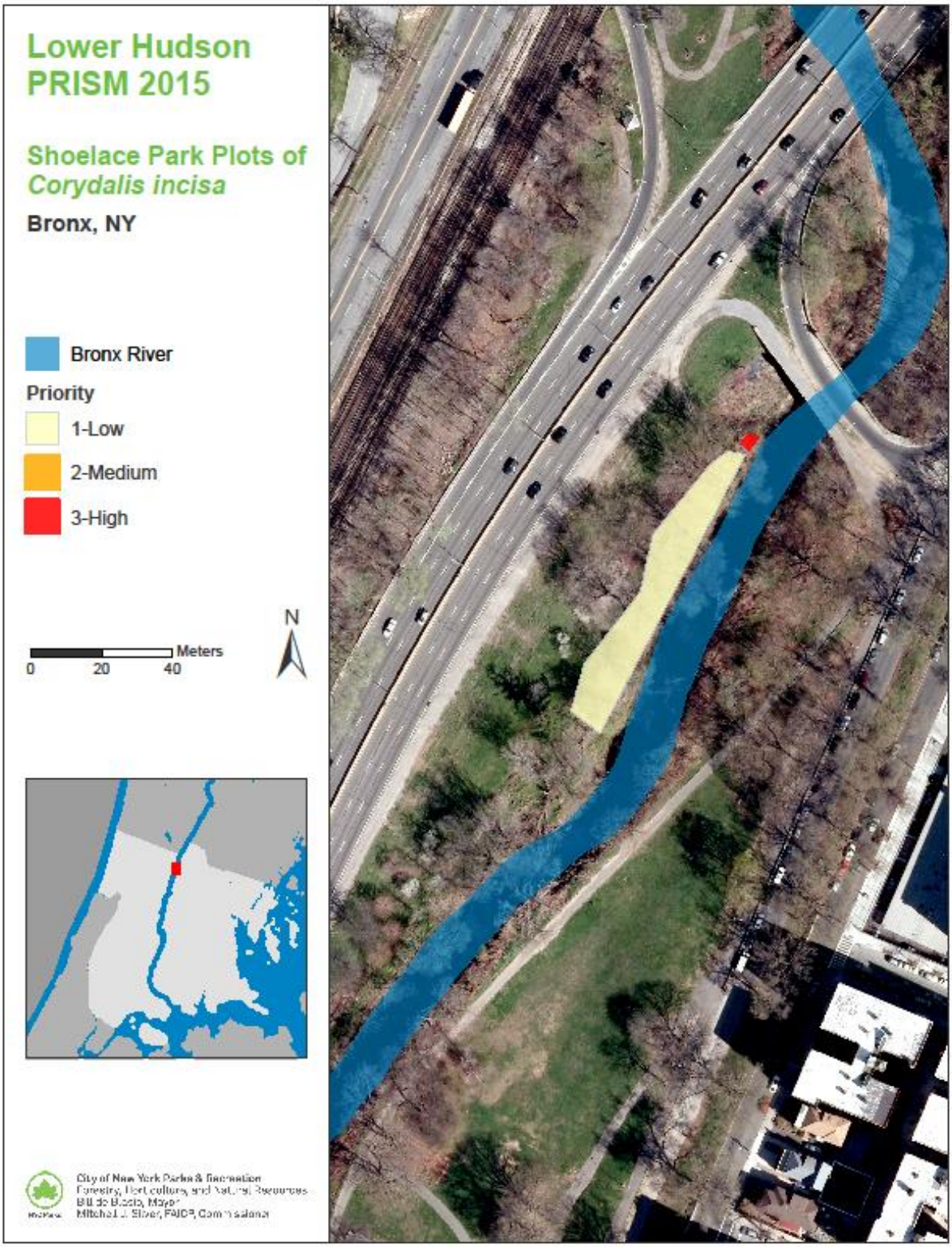

Figure 8: Bronx Forest plots of purple keman. The medium (orange) priority site located within the volunteer pulling site is the location of the pilot management area.

Figure 9: NYC Parks, New York Botanical Gardens. Bronx River Alliance, and Westchester County Parks learning about purple keman in the field.

Figure 10: Green Girls volunteers being trained on how to identify purple keman and other invasive species in the field.

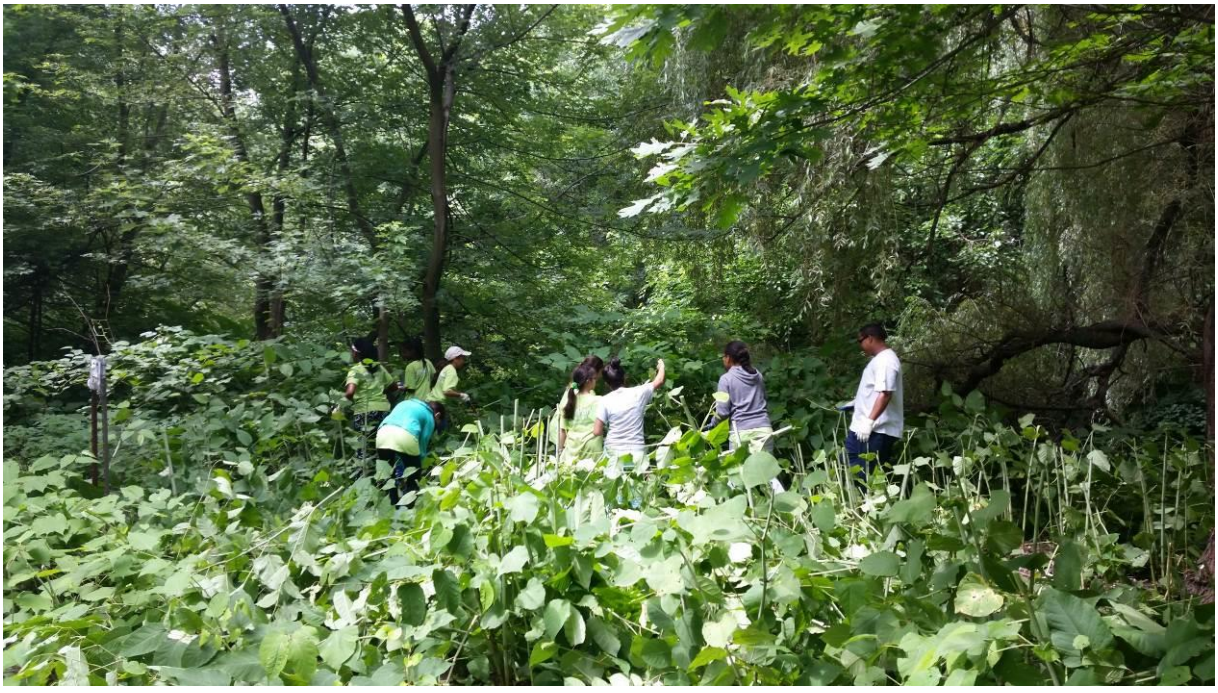

Figure 11: Christadora volunteers being trained on how to identify purple keman and other invasive species in the field.

Figure 12: Grow NYC and Clinton High School volunteers being trained on how to identify purple keman and other invasive species in the field.

Figure 13: Proper way to remove and bag purple keman.

Figure 14: NRG staff seeding pilot management area after removal of purple keman and Japanese hops.

Figure 15a: Before photo of removing purple keman and Japanese hops from pilot management area (east and west side of trail).

Figure 15b: Before photo of removing purple keman and Japanese hops from pilot management area (east side of trail).

Figure 15c: Before photo of removing purple keman and Japanese hops from pilot management area (west side of trail).

Figure 16a: Purple keman and Japanese hops removal event in the pilot management area.

Figure 16b: Purple keman and Japanese hops removal event in the pilot management area (2).

Figure 16c: Purple keman and Japanese hops removal event in the pilot management area.

Figure 16d: Purple keman and Japanese hops removal event in the pilot management area.

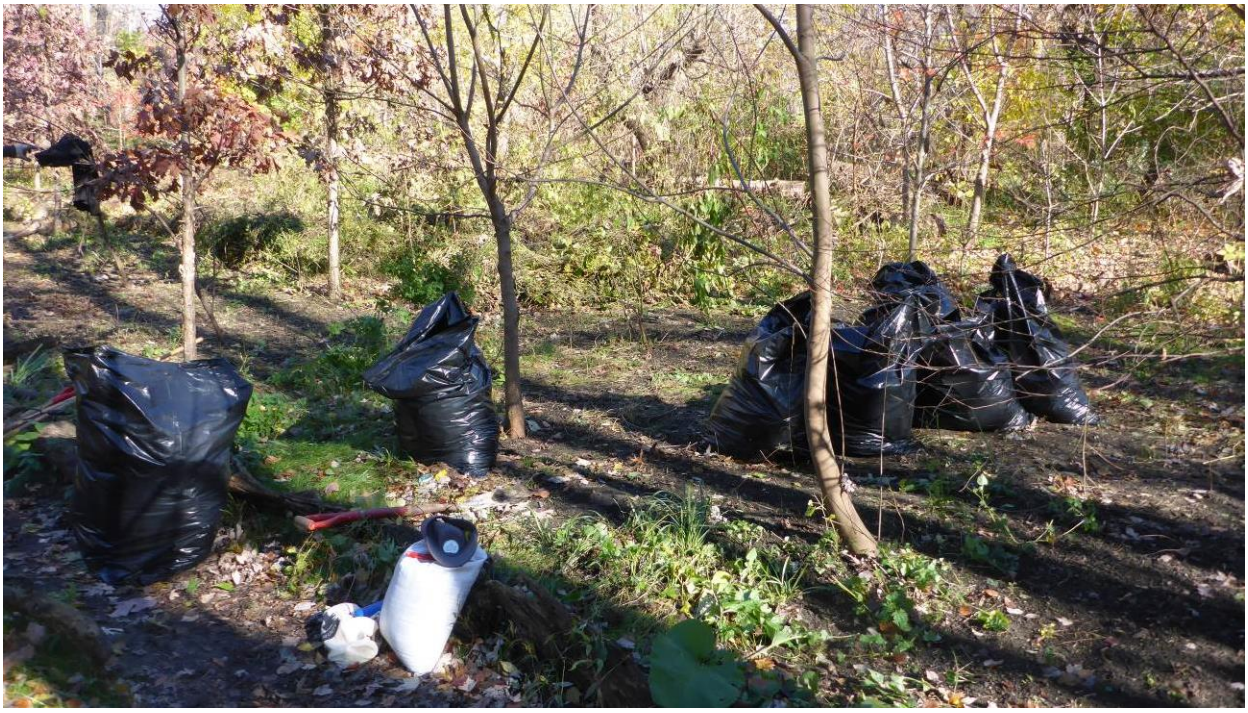

Figure 16e: Purple keman and Japanese hops removal event in the pilot management area.

Figure 16f: Purple keman and Japanese hops removal event in the pilot management area.

Figure 16g: Purple keman and Japanese hops removal event in the pilot management area.