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CONTROLLING PURPLE LOOSESTRIFE (*LYTHRUM SALICARIA*) ALONG ROADSIDES IN ST. LAWRENCE COUNTY: MONITORING AND BIOLOGICAL CONTROLS

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ABSTRACT

Purple Loosestrife (*Lythrum salicaria*) has begun a march through the roadsides and wetlands in New York to replace native wetland vegetation. While purple loosestrife, an herbaceous perennial reaching 2.5 meters in height, can grow in many different soil types, it tends to be found in cattail marshes, bogs, and will often be found in roadside ditches and along waterways. The problem with this is the robustness of the species, growing in dense stands that begin to replace native vegetation. Ultimately, this becomes a threat to local and migratory wildlife, particularly waterfowl that frequently use wetlands in the St. Lawrence Valley as part of migratory routes. The St. Lawrence-Eastern Lake Ontario (SLELO) Partnership for Regional Invasive Species Management (PRISM) looks to gather information on this invasion. While this species is listed by the NY DEC as a regulated and prohibited plant, it has not been well studied or documented within the St. Lawrence Valley ecosystem. Currently, a purple loosestrife website for sightings of purple loosestrife in St. Lawrence County has only four confirmed sightings outside the Blue Line of the Adirondack Park from the New York iMap Invasives group (NYISI 2015), and very little specific research has been done in our area.

The objective of our study is to document the actual size of the infestation in this area along major highways in an effort to increase awareness of a local invasive species and promote its eradication. By documenting the current extent of the purple loosestrife north of the Adirondack Park to the St. Lawrence River and along the River, we hope to see which wetlands have been invaded by purple loosestrife and where to focus our eradication efforts. Over the course of two four-week sessions from mid-July to mid-August in 2017 and 2018, we recorded GPS points and imported into the ArcGIS computer program to create a map of the current locations and extent in the North Country. This information will be valuable to begin any sort of eradication program—the targeted introduction of the *Galerucella spp*. beetle that feeds almost. exclusively on purple loosestrife could serve as a remedy to the invasion. We were able to introduce *Galerucella* beetles to the Upper and Lower Lakes Wildlife Management Area in July 2018 and will continue monitoring those areas in the future.

INTRODUCTION

In the last 30 years, the changing roadsides in the North Country, particularly along State Routes 56, 68, 37 and 12, have become obvious to any motorist in late July and August when the purple blooms of *Lythrum salicaria* (purple loosestrife) create a lovely landscape. However, that landscape hides the problems that may arise in the future.

Purple loosestrife was introduced into North America in the early 19th century (Lavoie 2010). The plant itself is of Eurasian origin (Tredici 2010). By the 1930s, the plant species had invaded hundreds of hectares of wetlands (Lavoie 2010). In Canada, purple loosestrife is commonly found in moist locations in Quebec, Ontario and the Fraser Valley of British Columbia (Mulligan 1976). For many years this plant continued to spread and establish itself in North America without people really taking notice. It wasn't until the end of the 1980s that environmental managers and ecologists became interested in the invasive plant species (Lavoie 2010). It is believed that purple loosestrife was introduced into North America both inadvertently and for horticulture (Lavoie 2010). The plant was also believed to be used for washing wounds and other medicinal purposes (Tredici 2010). Both American and Canadian nurseries are recorded selling purple loosestrife seeds as early as 1829 (Lavoie 2010). The plant was also likely introduced to the United States by ships when they dumped sand containing the seeds, or even by sheep and raw wool that had been contaminated with purple loosestrife seeds brought over from Europe (Lavoie 2010). This invasive plant species has spread rapidly over the years and across North America, particularly from beekeepers and horticulturalists (Thompson et al. 1987).

Purple loosestrife is a tall (1 to 2 m) herbaceous wetland perennial plant (Stuckey 1980, Tredici 2010). Purple loosestrife's main ecological function is the uptake of nutrients in wetland ecosystems (Tredici, 2010). This plant will invade wetland areas and absorb the nutrients found in an area and displace most other wetland plants such as cattails (*Typha* spp.) and water lilies (*Nymphaeaceae*). When purple loosestrife invades wetland areas, it degrades natural habitats for fish, amphibians, waterfowl, and other wetland-dependent animal species that can be found in surrounding wetland areas (Thompson et al. 1987). The published data is mixed on the effect of purple loosestrife on other wetland plant diversity (Schooler et al. 2006), amphibians (Brown et al. 2006) and birds (Tavernia & Reed 2012), suggesting further research is required.

One of the known biological control agents of purple loosestrife is *Galerucella spp.* beetles, specifically *Galerucella calmariensis* and *Galerucella pusilla* (Blossey 1995). These beetles and their impact on purple loosestrife have been well studied in the United States since the early 1990s (Malecki et al. 1993, Blossey et al. 1994, Hight et al. 1995). The beetles create a natural balance with the purple loosestrife, eating the leaves, reducing flower and seed production which limits spread and keeps the population under control (Blossey et al. 1994, Blossey and Schat 1997). The New York State Department of Environmental Conservation (NYSDEC) permits release of beetles and will catch and provide beetles upon request and availability (Winston et al. 2017).

The goal of this project is to collect data on where this invasive species occurs in the St. Lawrence Valley, outside of the Adirondack Park and to use this information to create localized management plan. The only way to engage State and agency resources and to remove this and other invasive species is to know where it is located and to document its spread throughout the Valley.

STUDY SITE AND METHODS

Study Site

The study was focused on St. Lawrence County outside of the Adirondack Park. Because that area includes thousands of miles of roads, we prioritized the state highways that are near the St. Lawrence River and connect to the Blue Line, the most likely path that purple loosestrife might take crossing the River. Therefore, the route we took started at the Adirondack Park boundary (the Blue Line) in South Colton on Route 68 to Ogdensburg, and then on Route 37 to Morristown and then maintaining the route along the St. Lawrence River on Route 12 to Alexandria Bay. From Ogdensburg, we continued north along Route 37 from Ogdensburg to Waddington. The total route was 141.55 km (88 miles) on both sides of the road (Figure 1).

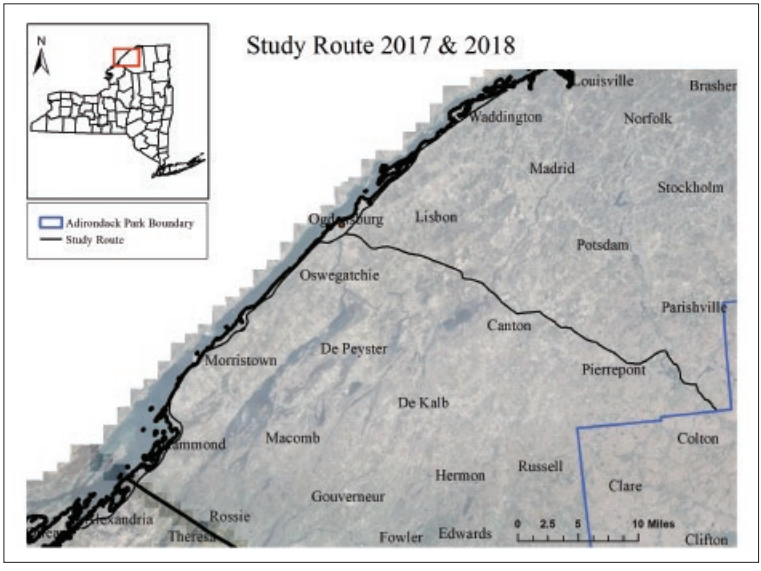

Figure 1: *Map of the route followed in 2017 and 2018.*

Figure 2: *Interns Matthew King and Robert Luckman surrounded by purple loosestrife outside of Colton, NY.*

Methods

From July 17 to August 13, 2017, two interns, Matthew King and Robert Luckman (Figure 2), worked with me to develop methods to map these areas. The following description are the methods we followed, and we continued to follow for the successive seasons of data collection.

We used the ESRI Collector application on our cell phones, both Android or iOS support the app. This contained the uploaded base map with the route that was planned. The Collector app is cloud-based so all data collection was done in real time and could be seen by all participants simultaneously as well as be continuously saved to the ArcGIS online platform. Data collection began the third week of July after plants had started to bloom to make identification by all participants easier and more consistent. We always walked with traffic to ensure THE mapping of points was consistent each time. Because nearly all the land along these highways is private land, with a few exceptions such as Upper and Lower Lakes Wildlife Management Area, our protocol was limited to linear distances rather than three dimensional areas of infestations. For any infestation of purple loosestrife, indicated by a minimum of 1 plant with blooming flowers, we collected a data point with the following characteristics:

Date/time, GPS location, person collecting, distance from the highway (< 5 meters), the length of the invasion along the road (m), the estimated number of plants, average height of the plants (m), whether herbivory was present (indicated by holes in the leaves/petals or presence of insects), type of water it stood in, other species present, and what type of mowing was being done (e.g., a lawn mowed by land owners to the road, or the 2.5-5 m (8-16.5 ft) of mowing done by the DOT or no mowing at all). A minimum of one photo was taken at each location of purple loosestrife and was attached to its geographic point.

The accuracy of the Collector application was at least 16 m (50 ft), though repeated measures indicated that most points were within 5 m (16.5 ft) accuracy. After being certain it was an isolated infestation, we identified any blooming or non-blooming plants to measure the full size of the invasion. If they were further than 20 m (65 ft) apart along the road, they were recorded as separate invasions. Distance along the highway was measured using a Bushnell viewfinder. The point was placed at the start of the invasion, and the intern

would walk to the end of the invasion and measure back to the start using a range finder. All points are measured in the direction of traffic and were linear measurements along the road. This means for a point that has an invasion size of 30 meters, the location of the point is the start of the invasion, and it continues 30 m linearly along the highway in the direction of traffic before stopping. The number of plants was estimated based on counting the stems of approximately 25 plants to get a sense of spatial extent of 25 plants, and then using that as an approximation for larger areas. Anything under 25 plants was manually counted. Because we were restricted from walking onto private land throughout the study area, the total number of plants is likely an underestimation of the total infestation. With the use of drones (unmanned aerial vehicles) in the future, we hope to get more accurate area estimations of the full spatial extent along this route.

At each invasion site, all other plant species larger than 6 inches off the ground and smaller than full bushes or trees, in the grasses, forbs, and sedge families were recorded. We had several different field guides upon which to base our assessment (Uva et al 1997, Kaufman and Kaufman 2013). A sample of each less common plant was taken and confirmed with local experts.

In addition, for each private property having a lawn mown all the way to the roadside, a single point was recorded with the lawn indicated as an area that loosestrife was unlikely to inhabit. This information will likely be used as part of a measure of how much of the route *could* be invaded. We wanted to try to get a full measure of available habitat for purple loosestrife along this route and regularly mowed lawns are not likely to be invaded or sources of seeds to spread loosestrife.

In 2018, two new interns, Randy Monica, Jr. and Nolan Rishe, were hired and trained. To prepare for field work, they created a field guide with all the species from the previous summer. They repeated the same procedures as 2017, though to avoid post-processing requirements from typos in the field in 2017, all fields were created with a drop-down set of choices rather than open spaces to type. This ensured minimal variation in data collection. They identified an additional 25 species found near purple loosestrife. We were also able to use a Bad Elf GNSS Surveyor Receiver that increased our accuracy to ~3 m (~10 ft), but the previous minimum of separate infestations being 20 m apart was maintained.

Beetles

Based upon research done by Bernd Blossey at Cornell University since the early 1990s, and at his suggestion, we reexamined the 14 largest infestations from 2017 during June 10-11, 2018 to look for evidence of beetles. In April 2018, I applied to the NYSDEC for *Galerucella* sp. beetles, and 1100 were caught outside our region and delivered to the NYSDEC office in Canton, NY in early July. Because NYSDEC regulations only permitted release on public lands, we released them at the Upper and Lower Lakes Wildlife Management Area the day they arrived. This was one of the sites examined earlier in the summer for having large infestation, and beetles were only found on one side of the highway (the Northeast side). Thus, we released about 250 beetles at four different sites along the southwest side of Route 68. Those sites were then established as monitored sites using Blossey and Skinner's (2000) methods. The monitoring was repeated at the end of August.

Results and Discussion

Over the course of two summers, almost 3000 points were collected using the above methods (Table 1). In 2017, 700 points of purple loosestrife were documented spanning nearly 29.25 km of the total route of 283.05 km (including both sides of the roads separately). In 2018, 703 locations were recorded for a total of 29.23 km of infestation. The average length of the invasions was 41.78 m (137 ft) and 41.68 m (136 ft) for 2017 and 2018

respectively. However, the average estimated number of plants per invasion increased from 71 in 2017 to 80 in 2018. This makes sense based on the increase in the estimated total number of purple loosestrife plants from 49,693 to 56,540, which is not a statistically significant difference at this point, but it worth noting as part of a possible trend. More years of data will need to be collected to claim a significant increasing trend.

Table 1. Summary and comparison of purple loosestrife invasion in 2017 and 2018.

CATEGORY (UNITS)	2017	2018
Purple Loosestrife Locations	700 locations	703 locations
Lawns (points)	526* (not collected the first week)	713
Average length of infestation (meters)	41.78m	41.68m
Total length of highway invaded (km)	29.25km	29.23km
Average Number of Plants/Invasion	71 plants	80 plants
Total number of plants	49,693 plants	56,540 plants

Based on preliminary GIS analysis using ESRI's ArcMap, only about 340 locations of the 2018 sites were within 10 meters of a 2017 site meaning those precise infestations were recorded in both seasons. It will require further analysis and likely a refining of data collection methods to ensure accuracy from year to year regarding specific infestations. There was some variation in the weather from year to year (Figure 3), and while the monitoring was done following the same path on nearly the same days from year to year, the actual blooming dates for infestations may have varied somewhat, explaining the difference in total blooms from 2017 to 2018. 2017 was cooler in July (Figure 3) as the plants are blooming, possibly delaying their inflorescences resulting in a lower estimation of plants than in 2018.

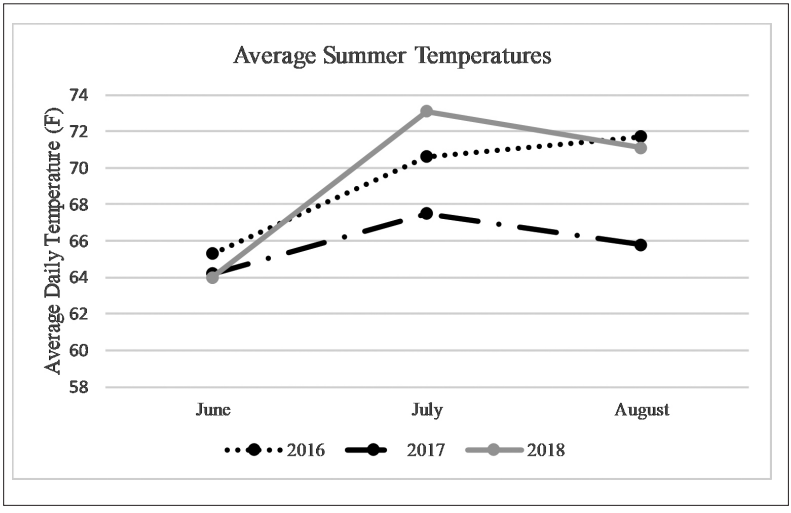

Figure 3: *Average Summer Temperatures as recorded by the Network for Environmental and Weather Applications (NEWA) at Cornell University for 2016, 2017, and 2018. The data from 2016 is only included for comparison (NEWA, 2018).*

A total of 67 plants were identified within 1 m of purple loosestrife invasions, 28 native and 34 non-native that encompass the full range of types of non-native species from ornamental to invasive, but for simplicity, they are simply labeled as native or non-native (Table 2). For a few species, particularly asters, we could not identify below family, usually because they were not in bloom. Species were listed as native species if the identification books listed their range within our study area. Non-native species included all species whose range is in another country. Many have become naturalized in North America and have not posed a threat to native species, while others, such as *Phragmites* (common reed) are highly invasive and are taking over large areas of disturbed habitat, particularly along roadsides.

Table 2. Other species found with purple loosestrife. 67 total species, 28 native, 34 nonnative, 5 unknown due to lack of species identification.

SPECIES	NATIVE/NON-NATIVE	SPECIES	NATIVE/NON-NATIVE
Black Eyed Susan	Native	Bittersweet nightshade	Non-native
Blue Vervain	Native	Bladder campion	Non-native
Canada Thistle	Native	Burdock	Non-native
Cattails	Native	Canary Grass	Non-native
Common Boneset	Native	Chicory	Non-native
Common Yarrow	Native	Common Bracken	Non-native
Dark Green Bulrush	Native	Common Mullein	Non-native
Ditch Stonecrop	Native	Common Plantain	Non-native
Evening primrose	Native	Common soapwort	Non-native
Flat-topped goldenrod	Native	Cow vetch	Non-native
Goldenrod	Native	Curly Dock	Non-native
Jerusalem Artichoke	Native	Daisy Oxeye	Non-native
Joe Pye Weed	Native	Ditch Lily(Orange Day-lily)	Non-native
Lambs quarter/Goosefoot	Native	Golden buttons (Tansy)	Non-native
Milkweed	Native	Great willow herb	Non-native
Morning Glory	Native	Honeysuckle	Non-native
Ragweed	Native	Italian Rye Grass	Non-native
Round Fruited Rush	Native	Johnson Grass	Non-native
Silverweed	Native	Meadowsweet	Non-native
Smooth Rush	Native	Pepperweed	Non-native
Soft-stem bulrush	Native	Phragmites (Common Reed)	Non-native
Spotted Touch-me-not	Native	Red Clover	Non-native
St. John's Wort	Native	Ribwort plantain	Non-native

SPECIES	NATIVE/NON-NATIVE	SPECIES	NATIVE/NON-NATIVE
Virginia Creeper	Native	Smooth Bedstraw	Non-native
White turtlehead	Native	Spotted Knapweed	Non-native
Wild Grape	Native	Tall Fescue	Non-native
Yellow Loosestrife	Native	Timothy	Non-native
Aster**	Unknown	Velvet Grass	Non-native
Buttercup	Unknown	White Sweet Clover	Non-native
Creeping Bentgrass	Unknown	Wild Asparagus	Non-native
Foxtail	Unknown	Wild Parsnip	Non-native
True sedge	Unknown	Yellow Hawkweed	Non-native
		Queen Anne's Lace	Non-native
28 Native / 34 Non-native / 5 unknown			
* Native to North America, Non-native includes introduced, ornamental, and invasive species.			

There are clearly non-native species following the same invasion pathway as purple loosestrife, though the 2 most common co-habitants are native species found in 2018 within 1 m of purple loosestrife were goldenrod (368 locations), cattails (353 locations), Queen Anne's Lace (338 locations), yellow hawkweed (321 locations), and wild parsnip (314 locations). Further analysis will examine any specific connections with these or other species and any possible opportunities for collaboration in removal. The Department of Transportation already sprays and/or pulls wild parsnip around any road signs at least once per summer (during 2017 and 2018), and it is clearly a species spreading rapidly throughout the North Country causing rashes or blisters on people who come in direct contact with it.

Beetles

In early June we went to the 14 largest or densest sites in 2017 (number of plants/meter along the highway), and found *Galerucella* beetles at 9 of the 14 locations. Based on their distinctive dark stripes, we feel confident that they were *Galerucella calmariensis.* In several areas, beetles were found on one side of the road, but not the other. In two sites, beetles were found with no evidence of herbivory on the surrounding plants, and in one other, evidence of herbivory existed but no beetles were found. In July, 1100 *Galerucella pusilla* beetles were released at four separate sites at the Upper and Lower Lakes Wildlife Mangement Area under permit from the DEC. These sites were set up with quadrants made of 1 inch PVC pipe create 1 m^2. All the plants within that quadrant were recorded and the purple loosestrife evaluated using methods from Blossey (1997). At the end of August this was repeated to ensure that when monitoring of those sites is repeated in 2019, we will have data to compare the effect these beetles have had on the purple loosestrife.

Future Work

We hope to continue this work for at least one to two more summers to confirm that the methods can be consistent and to begin to understand the progression of the invasion. With only two years of data, it will be incumbent to record at least one to two more years to confirm the variance of infestations from year to year. We hope to release *Galerucella* beetles at several more sites throughout the region to ensure we can create a breeding population of the biological control and confirm which species exist throughout the North Country. The plan is to continue monitoring the beetle release locations in the spring and at the end of August of 2019, as well as along the entire route at the largest infestations to get a better sense of the presence of biological controls throughout the North Country. We will also set up control sites to continue monitoring and compare the effects of beetles at these sites and in these ecosystems.

This work has created several new hypotheses that will continue to be tested. The spread of purple loosestrife is suspected to be influenced by the state mowing the sides of highways. There are areas where the spread is moving in the direction of traffic, which is also the direction the mowers tend to follow. In addition, culverts under roads seem to aid in the spread of purple loosestrife from one side of the street to the other. The extent of this influence will be examined through further geospatial analysis and improved data collection with drones (UAVs).

In addition to our work along the roadsides, we hope to expand the project to work with private landowners starting in spring 2019. We will be sending letters to all the landowners along the route that had purple loosestrife on their property and asking for their assistance and cooperation with management efforts going forward. All of the people we have met while out collecting data have been very receptive to the possibility of removing a threat to our local ecosystems.

We have moved past the first stage of the invasion when we had a chance to prevent purple loosestrife's establishment. We have even moved past the second stage when control and entire removal is possible. We are firmly in the third stage of invasion when ongoing management and careful intervention and removal are possible. The only way to know where to focus our efforts is to continue monitoring these road sides and eventually enlist the help of landowners and state agencies to improve our control efforts.

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