THE EFFECTS OF AN INTRODUCED WETLAND PLANT SPECIES ON POLLINATION SUCCESS IN NATIVE SPECIES

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Sustainability of our natural ecosystems is jeopardized by invasive species. Past introductions of plant and animal species have often resulted in lowered biodiversity. Wetland systems perform valuable ecological functions including water filtration and provision of habitat for waterfowl. Alterations of the balance of species in a wetland may have profound implications for nearby bodies of water and upland habitats.

Introduction

Purple loosestrife *(Lythrum salicaria)* is an invasive flowering plant that was introduced from Europe in 1814 where it was valued as an herbal treatment for diarrhea, dysentery and ulcers (Nyvall, 1995). This species has expanded its distribution through canals and waterways and is successfully displacing cattails and other native vegetation (Balogh and Bookhout, 1989; Mal et. al., 1997). One of its most negative impacts has been on waterfowl and muskrat populations which require native vegetation for forage and nest sites (Rawinski and Malecki, 1984). This plant is also responsible for degradation of wetland pastures and the clogging of irrigation lines. Purple loosestrife has prolific seed production allowing it to quickly develop a large seed bank. Seeds of this species can germinate under a wide range of environmental conditions and can survive for years (Charvat and Stenlund, 1990; Right and Drea, 1991). In an attempt to control this pervasive weed, the USDA has introduced a specialist beetle which feeds on the leaves and reduces its reproduction (Malecki et al, 1993).

Previous studies on the impact of purple loosestrife have focused on its competition with other plant species for space and soil nutrients (Rawinski and Malecki, 1984). This plant attracts a large assemblage of pollinators (honeybees, bumblebees, flies, butterflies and moths) during its blooming period (pers. obs.) and the dense patches of loosestrife provide a valuable nectar resource for these organisms; however the pollinator implications with the introduction of this species have not been widely studied (see Grabas and Laverty, 1999). Pollinators have coevolved with plants in a mutually beneficial relationship whereby plants reward pollinator visits with sugary nectar and the pollinator transfers pollen from one flower to another flower of the same species. Species faithfulness in pollination is essential for plants because pollen exchange between different species of plants will not result in successful fertilization and seed production. The diversity of pollinator types is considerable and many are specialized on certain floral colors, shapes or odors; this helps in maintaining the specificity of the relationship (Proctor et. al, 1996). The introduction of a new plant with copious nectar has the potential to draw pollinators away from coexisting species.

Recent discussion has centered on the reduction of pollinators in agricultural communities (Cane and Tepedino, 2001). Chronic agricultural shortfalls in pollinators for self- incompatible crop species have forced farmers to rely on imported bees (Kevan and Phillips, 2001). Habitat fragmentation has altered the number and size of patches available to pollinators and insecticides are often used along buffers to golf courses and agricultural fields (Johansen and Mayer, 1990) impacting both harmful and beneficial insects. Reductions in pollinators due to changes in land use coupled with increased pollinator visitation to invasive species may significantly lower the rates of successful pollen transfer. The consequences of this reduction are uncertain. A pollinator decline is presumed to result in reduced seed production, but plants may reallocate resources not expended on fruits and seeds to other parts of the plant (Thomson, 2001).

In preliminary observations last summer, I observed in excess of sixteen different pollinator species foraging on purple loosestrife in a 1 m^2 patch. Densities of pollinators were higher on these plants than on any adjacent native species, though five native species were blooming nearby. Patches of loosestrife often extend across entire marshes (acres), potentially attracting pollinators nom sites farther away. If pollinators relocate due to attraction by purple loosestrife, it is possible that native species may benefit from increased visitation. Pollinators are known to forage optimally, seeking patches rich in nectar sources; however, bumblebees often include several floral species in their foraging and may visit rare plants during foraging bouts (Heinrich. 1979).

Although purple loosestrife is identified as a wetland species, I have observed new populations of this plant in more upland habitats. Its tolerance of a wide-range of soil types and moisture regimes may allow it to continue to expand its range and increase its persistence.

In this study, I propose to a) characterize the pollinator community visiting loosestrife, b) compare pollinator densities between sites with and without loosestrife, c) quantify the proportion of pollen of each plant species carried by bees in the presence of loosestrife and d) quantify seed set of native plants (a measure of reproductive success) in patches with and withoutt loosestrife. I would also like to generate maps of purple loosestrife distribution in Western New York and correlate its locations with soil type and soil water content.

Significance of the research

Data on pollinator dynamics and species faithfulness in pollinator visits is necessary to empirically test several ecological theories. Introduced species pose a significant threat to native ecosystems and there have been minimal attempts at understanding how they affect pollinator dynamics in the ecosystems that they have invaded. Thus, research in this particular system should have both benefits for both applied and basic research. These data should provide initial insight into the magnitude of the effects of this species on the reproduction of native species. Creating a distribution profile and maps for the species using GIS will allow for long- term monitoring of purple loosestrife in this region.

Methods

1. Characterize pollinator community

Purple loosestrife is extremely abundant in wetland areas in western New York. I will be observing pollinators in at least three sites. At each of these sites, I will maintain two hour collection and observation periods for four different days. Pollinators are most active in the early afternoon on days with air temperatures of at least 20 °C and I will attempt to monitor the different sites under comparable conditions. Numbers of pollinators of each type will be recorded. I will collect some insects for later identification using the staff and collections of the Buffalo Museum of Science for assistance. I may mark individual honeybees *(Apis mellifera)* and bumblebees *(Bombus sp.*) with uniquely numbered tags so that they can be monitored during other parts of the study. Tags can be applied with superglue and do not impede bee movement (Kearns and Inouye, 1993). A photographic record will also be created to document the pollinator community.

2. Quantify pollinator densities in areas with and without purple loosestrife

In order to quantify pollinator densities in different patches of flowers, I will establish 1 m^2 quadrats at multiple sites. Several quadrats will contain only native species and other quadrats will be selected that have both purple loosestrife and native species. Pollinator densities are likely to be correlated with flower densities so I will document the number of stalks and inflorescences (clusters of flowers) for each flowering plant species in the quadrat. Purple loosestrife produces inflorescences along tall stalks and the number of stalks would be a better indicator of resource quality to pollinators than the actual number of plants. Pollinators will be counted and identified as they visit the quadrats. I will record the plant species visited and the proportion of time spent visiting each species, if they visit more than one plant species. These data will allow me to compare visitation rates to patches with only native species to those with the introduced species. I will also be able to quantify the proportion of visits within a patch to native or introduced species and will adjust this value to account for the relative densities of the plant species.

3. Quantify pollen load components in patches with and without purple loosestrife for two pollinator types

In order to detemine the consequences of pollinator visits, I will be collecting pollen from honeybees and bumblebees after they have removed pollen from flowers. I use vials with mesh ends to catch bees and I am able to remove clumps of pollen from bee legs without harming the insects. Pollen collected will be placed in numbered vials. Representative pollen will be collected from each of the plants in bloom. Pollen grains can be examined microscopically and easily identified to plant species. Pollen collected will be spread on slides coated with fuchsin-stained gelatin (Kearns and Inouve. 1993) for quantification and species identification. These data will allow me to determine a) how faithful an individual bee is to a given plant species (proportion of a bee's pollen load for each plant species), b) how much of the bees' pollen is that of the introduced species, c) whether there are bumblebee and honeybee differences in purple loosestrife utilization and d) whether the proportion of pollen of each plant species correlates with the floral density for that species (ex. 50% of the quadrat is purple loosestrife, but 75% of the pollen carried is from that plant).

4. Quantify reproductive success by monitoring seed set

Pollination involves the transfer of pollen from the male part of one flower to the female part of another flower of that species. If viable pollen is delivered, fertilization may occur which will ~ad to seed production. To monitor reproductive success in areas with and without loosestrife, I will be establishing I m^2 quadrats with transplanted flowering species. I will create three types of quadrats: pure purple loosestrife, pure native species (I species per quadrat) and mixed loosestrife and native species. After observations of pollinator visits for at least one week, I will cover inflorescences in the plot with mesh bags. These bags will prevent seed predators from damaging developing seeds and will also prevent seeds from being blown from the plants. Seed maturation requires several weeks in most of these species. After seed maturation, I will harvest the plants and weigh the seed produced. Seed weight will be adjusted for the dry weight of the plant. Comparisons of seed set will be made between plants in single species patches and those from mixed species patches to determine whether reproductive success is adversely affected by the presence of purple loosestrife.

Expected Outcome of Research

I anticipate that this research will generate substantial data that will yield a scientific publication in a peer-reviewed journal. I also feel that future research questions will develop from these results. Because of the importance of this introduced species, I may be able to use the data from this study to request funding from external sources for subsequent work. I also plan to use student help in this project and this will provide opportunities for research for our undergraduates to better prepare them for graduate school or future jobs.

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