1989

Migration and Control of Purple Loosestrife (Lythrum salicaria L.) along Highway Corridors

Douglas A. Wilcox
The College at Brockport, dwilcox@brockport.edu

Migration and Control of Purple Loosestrife (*Lythrum salicaria* L.) along Highway Corridors*

DOUGLAS A. WILCOX
National Fisheries Research Center-Great Lakes
US Fish and Wildlife Service
1451 Green Road
Ann Arbor, Michigan 48105, USA

ABSTRACT / The east–west density gradient and the pattern and mode of migration of the wetland exotic, purple loosestrife (*Lythrum salicaria* L.), were assessed in a survey of populations along the New York State Thruway from Albany to Buffalo to determine if the highway corridor contributed to the spread of this species. During the peak flowering season of late July to early August, individual colonies of purple loosestrife were identified and categorized into three size classes in parallel belt transects consisting of the median strip and highway rights-of-way on the north and south sides of the road. Data were also collected on the presence of colonies adjacent to the corridor and on highway drainage patterns. Although a distinct east–west density gradient existed in the corridor, it corresponded to the gradient on adjacent lands and was greatly influenced by a major infestation at Montezuma National Wildlife Refuge. The disturbed highway corridor served as a migration route for purple loosestrife, but topographic features dictated that this migration was a short-distance rather than long-distance process. Ditch and culvert drainage patterns increased the ability of purple loosestrife to migrate to new wetland sites. Management strategies proposed to reduce the spread of this wetland threat include minimizing disturbance, pulling by hand, spraying with glyphosate, disking, and mowing.

Purple loosestrife (*Lythrum salicaria* L.) is a perennial, herbaceous, wetland plant from Eurasia that has become widespread in the Northeast and North Central regions of the United States and adjoining areas of Canada (Stuckey 1980). Within this range, it poses a major threat to wetland integrity, for it is an aggressive species that produces many seeds and also reproduces vegetatively (Shamsi and Whitehead 1974, Teale 1982, Thompson and others 1987). In invading disturbed wetlands, loosestrife forms very dense, monospecific stands that crowd out native plant species; it has little value as food or cover for wildlife (Rawinski 1982). It was the best competitor of 44 wetland species investigated by Gaudet and Keddy (1988).

Purple loosestrife was introduced into North America independently at a number of port cities in the northeastern United States in the middle to late 1800s (Stuckey 1980). The major source of seeds was probably moist sand from European tidal flats that was used for ship ballast and later emptied on American shores (Thompson and others 1987). Records of purple loosestrife in New York State, USA, date to 1864 (Long Island). By the 1870s, plants had been sighted in the Finger Lakes region, near southern Lake Ontario, and near Buffalo (Stuckey 1980). Disturbance and connection of water routes created by construction of the Erie Canal from Albany to Buffalo were considered by Thompson and others (1987) to be the causes of early westward migration of the species in the state. Early road systems, railroads, and the first state and federal highway networks are not believed to have been migration routes. However, the modern superhighway network is suspected of providing new disturbed habitats and both aquatic and airborne means of seed dispersal (H. Brumsted, in Thompson and others 1987). Purple loosestrife was sighted along the New York State Thruway (I-90) as early as 1962 (Smith 1962).

My observations during travel along interstate highways led me to hypothesize that the patterns of purple loosestrife growth in the disturbed highway corridors represented migration. In addition, since purple loosestrife invaded from the east and the density of infestations is greater along the east coast than it is inland to the west (Stuckey 1980), I also hypothesized that a density gradient could be observed along an east–west highway corridor. This article presents the results of a study that addresses these hypotheses and their implications for management.

KEY WORDS: Purple loosestrife; *Lythrum salicaria;* Interstate highway; Migration; Density gradient; Control; Management

Methods

A 250-mile (402-km) section of the New York State Thruway (Interstate 90) between Albany and Buffalo, New York, was used for this study (Figure 1). The

*Contribution 719 of the National Fisheries Research Center-Great Lakes, US Fish and Wildlife Service, 1451 Green Road, Ann Arbor, Michigan 48105, USA.

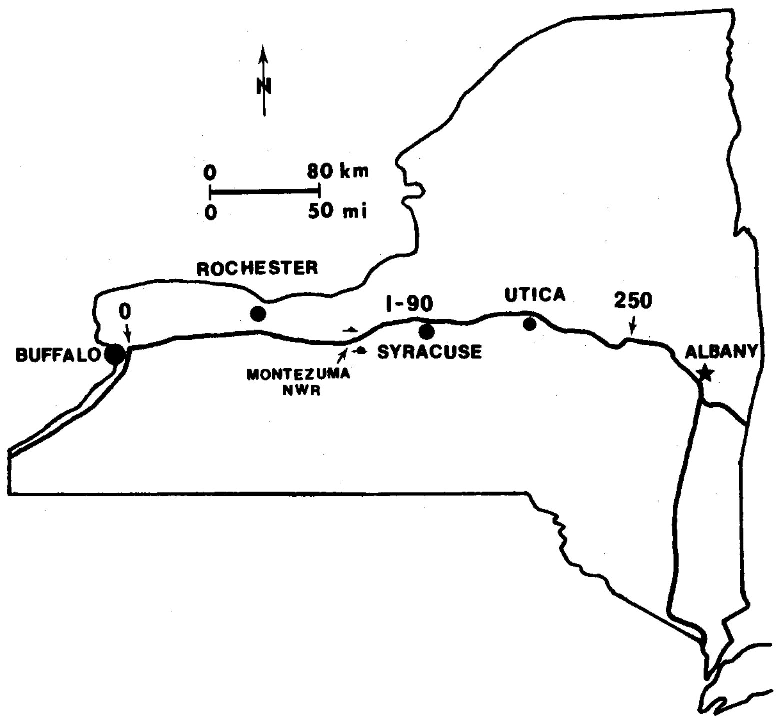

Figure 1. New York State showing the location of the sampling transect and Montezuma National Wildlife Refuge along the thruway (I-90).

highway passes through the Mohawk Valley and Erie–Ontario Plain physiographic provinces of the state in a general east–west direction. Sampling was conducted along three parallel belt transects that consisted of the median strip between the east- and west-bound lanes and the highway rights-of-way, bounded by the pavement and by the property fence lines that border the highway on both the north and south sides. The sampling quadrats were contiguous 1-mile-long portions (1.6 km) of the belt transects that had been previously measured and labeled (highway mileage markers). For the purpose of this study, the quadrats were assigned numbers 1–250 from west to east. Although the quadrats were not of uniform width along the entire transect, they accurately reflected the boundaries of the disturbed highway corridor.

Sampling was conducted in late July and early August of 1985 while traveling by automobile along the highway in both east- and west-bound directions. Purple loosestrife was in full bloom and was easily recognized from a moving vehicle, even at a distance. Three observers spotted individual colonies of purple loosestrife, and each colony was assigned to one of three population-size categories: (1) from single plants to areas of about 10 m^2, (2) from 10 m^2 to about 250 m^2, and (3) more than 250 m^2. Data were recorded for each transect by quadrat number, as noted from highway mileage markers. Similar data were collected and recorded for purple loosestrife colonies on lands immediately adjacent to the north and south sides of the highway. Notes were also taken on the presence of highway culverts, other drainage patterns, and highway maintenance practices when they were coincident with local populations of purple loosestrife.

The east–west density gradient was assessed graphically by combining quadrats in successive groups of ten across all transects and totaling the numbers of colonies (weighted by the above factors of 1–3 according to size class). Migration of purple loosestrife along the highway corridor was assessed by the McNemar test for significance of changes (Conover 1980). To allow this statistical treatment, 70 of the 140 quadrats that contained purple loosestrife within the highway right-of-way were randomly selected for analysis. The number of quadrats where purple loosestrife was also found on the adjacent lands was compared to the number where it was found in adjoining corridor quadrats. This comparison allowed assessment of whether adjacent lands or adjoining quadrats were the source of seeds or propagules responsible for establishment of the colonies in each quadrat.

Results and Discussion

Density Gradient

There were more colonies of purple loosestrife within the highway corridor at the eastern end of the transect than at the western end (Figure 2), suggesting

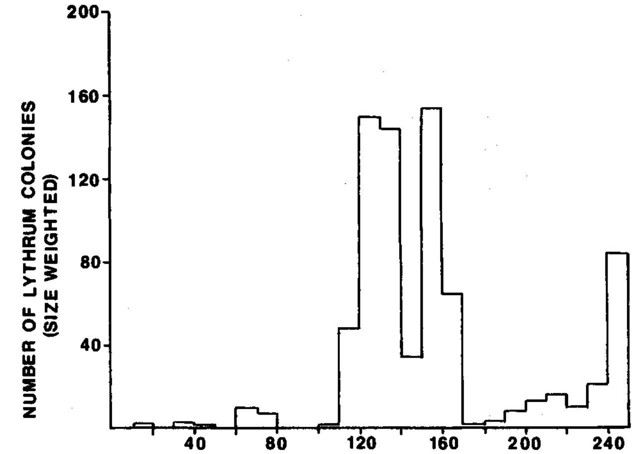

Figure 2. Size-weighted densities of purple loosestrife colonies in the highway corridor.

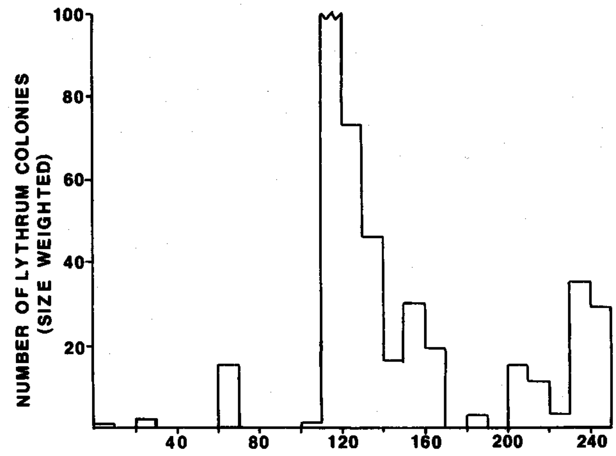

Figure 3. Size-weighted densities of purple loosestrife colonies on lands adjacent to the highway corridor.

a geneal east-to-west density gradient. This would be consistent with the generally acknowledged belief that purple loosestrife first entered North America along the eastern seaboard and spread from there (Stuckey 1980, Thompson and others 1987). However, the number of colonies in the middle part of the transect was greater than at either end. This fact can be reconciled by recognizing that corridor densities along the entire transect reflected the densities on the adjacent lands (Figure 3).

Segment 110–120 of the transect (Figure 3) included the portion of the thruway that passes through the Montezuma National Wildlife Refuge (MNWR), an extensive wetland with large expanses of purple loosestrife (Rawinski 1982, Rawinski and Malecki 1984). The plant was so abundant that counting of individual colonies in this area was impossible in three quadrats on the south side of the highway and one quadrat on the north side. Purple loosestrife is believed to have been introduced into this area by way of the nearby Erie Canal system, not the thruway, and it became well established in the refuge as a result of water-level manipulations initiated in the mid-1960s (Thompson and others 1987). Large populations of purple loosestrife were found on both the highway corridor and adjacent lands well to the east of MNWR, and there were abrupt changes in density at several points along the transect (e.g., see quadrats 110 and 170 in Figures 2 and 3). These phenomena were caused by local physiographic changes, with fewer wet sites occurring on sloping or topographically higher lands. The pattern of the adjacent-lands data suggests that purple loosestrife was able to migrate eastward from MNWR but not westward. The density pattern on the transect then shows an east–west gradient interrupted by a west–east gradient emanating from the purple loosestrife stronghold in Montezuma National Wildlife Refuge.

Table 1. Contingency table and results of McNemar test for significance of changes to assess migration of purple loosestrife along a highway corridor[a]

	Adjacent lands source	No adjacent lands source
Adjoining quadrat source	27	31
No adjoining quadrat source	4	8

[a]Numbers of quadrats with either of two possible sources of seeds or propagules responsible for establishment of colonies are compared ($\chi^2 = 20.83$; $P < 0.001$)

Migration

The highway corridor serves as a migration route for purple loosestrife. The major source of seeds or propagules for establishing purple loosestrife colonies in quadrats along the highway corridor is adjoining quadrats in the corridor, not adjacent land. The McNemar test indicated that the number of quadrats with adjoining corridor populations vs the number with adjacent-land populations is significantly greater ($P < 0.001$) than would be expected in the absence of migration along the highway (Table 1). The local physiographic changes, however, prevent migration along the highway corridor from being a long-distance process. Instead, short-distance migration occurs at many sites and is controlled by drainage patterns, topographic features, and physical barriers.

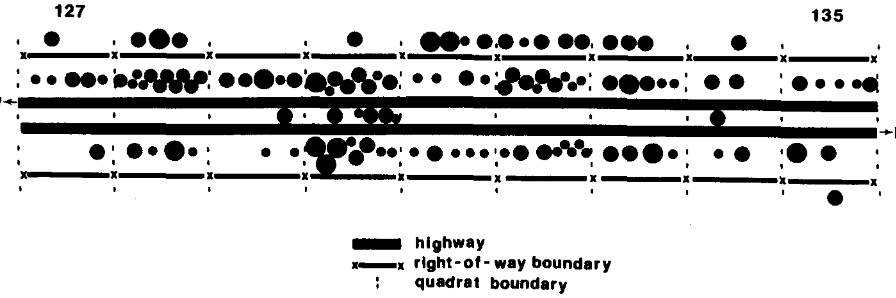

Figure 4. Distribution of purple loosestrife colonies in quadrats 127–135 along the New York State Thruway. Circles represent individual colonies in three size (area) classes (<10 m^2, 10–250 m^2, and >250 m^2).

The effectiveness of the highway corridor as a migration route is illustrated in the raw data from quadrats 127–135 (Figure 4). This section of the thruway is about 10–18 miles (16–29 km) east of MNWR. There were numerous established colonies of purple loosestrife on adjacent lands on the north side of the highway but almost none on the south side. The many colonies in the right-of-way on the north side could represent spread from immediately adjacent lands, but the colonies in quadrats 129 and 135 were probably established from seeds transported along the highway corridor. Water flow through a culvert in quadrat 130 allowed purple loosestrife to establish and spread in the median strip at that point. It also spread to the south side of the highway through the culvert and in both easterly and westerly directions along the right-of-way.

Construction and maintenance of interstate highways creates the disturbed sites generally required for the establishment of purple loosestrife. The small seeds or floating propagules can be transported by water to new colonization sites, either through surface sheet-flow or along roadside ditches. Corridor migration by this route is limited only by topographic changes that prevent further flow along the highway. Drainage culverts or natural water bodies that cross under the highway allow seeds or propagules to be transported to the median strip and to the opposite side of the corridor. Seeds may also be transported by wind currents created by the high-speed passage of large trucks or even normal winds blowing across exposed areas created by the highway corridor. In areas where purple loosestrife plants are not immediately adjacent to the pavement and surface drainage is confined, the highway berm may prevent migration of seeds by either mechanism.

Management Recommendations

Highway managers should be apprised of the consequences of purple loosestrife invasion of wetlands, the role that highway corridors play in migration, and the methods that have been tried in attempting to control the species. They should be encouraged to develop management strategies and tactics for use along the highways that could limit the continued spread of this exotic. Such an approach would be of greatest importance in areas where limited seed sources are present but many potential new colonization sites exist.

The best chance for attaining control of purple loosestrife in North America is through the biological control program currently being studied in Europe (Thompson and others 1987). Three natural enemies of purple loosestrife, a weevil and two beetles, are now being tested (Skinner 1988). However, even if the program is successful, it will still take a number of years before results can be obtained in the field. Until that time, other measures must be used on a site-specific basis to protect wetlands and bare soils from take-over by purple loosestrife.

One of the major problems in attaining long-term control of purple loosestrife is posed by the vast number of seeds that are produced. Estimates of annual seed production per plant range from about 100,000 (Shamsi and Whitehead 1974) to 300,000 (Teale 1982) to 2.7 million (Thompson and others 1987). Furthermore, the seeds may remain viable for several years (Shamsi and Whitehead 1974, Rawinski 1982). These characteristics suggest that the foundation for control efforts should be the careful reduction and mitigation of disturbances that create optimal conditions for seed germination and plant growth.

Barren, moist soil that is exposed during land clearance or water-level reduction associated with construction activities is easily warmed to the temperature range of 15–20° required for germination of purple loosestrife seeds (Shamsi and Whitehead 1974). The range of tolerance for soil nutrient levels, moisture levels, and pH is wide (reviewed by Thompson and others 1987). Therefore, the early establishment of plant cover by another species to reduce light penetration and soil warming may be critical in reducing the germination rate of purple loosestrife seeds in the seed bank at a highway corridor site (Rawinski 1982, Balogh 1986, Wilcox and Seeling 1986, Wilcox and others 1988).

When purple loosestrife is already established within or adjacent to a highway corridor, an eradication program should be developed that concentrates on cutting off the migration. Initially, the topographic and water drainage patterns of lands that surround existing colonies should be assessed. All plants near culverts or along drainage paths leading to uncolonized wetlands or disturbed areas should be eradicated first. Control efforts should then be continued upstream.

Individual plants or small colonies of purple loosestrife may be effectively removed by the labor-intensive method of pulling by hand. This method works best when water levels are at or slightly above the ground surface, and care must be taken to avoid disturbance from excessive trampling. All of the rootstock must be pulled to prevent resprouting (Rawinski 1982), and since other plant parts may form adventitious roots and grow also, all plant parts must be removed to a disposal site. A concrete or asphalt pad generally presents a safe location where plants can be dried prior to destruction by burning (Wilcox and others 1988). Hand-pulling becomes impractical for large areas and is not effective if plants are more than a few years old because the underground parts become too large to be removed.

Larger plants can be controlled by spraying glyphosate directly on the leaves with a hand-sprayer (Rodeo[1] mixed with a nonionic surfactant is approved for use in aquatic systems in many states). This nonselective herbicide is translocated to the roots and can kill the entire plant, not just the aboveground portion. Over 90% of the treated plants should be killed by spraying to wetness with a 2% (v/v) solution at a rate of 2.6 kg/ha (Balogh 1986). Favored weather conditions are hazy, cloudy days with no wind, high humidity, temperatures of 15–25°C, and no rain forecast for the next 24 h. Follow-up treatments in the second year are also recommended to kill the plants that survived the first treatment (Balogh 1986). Treatment date affects the results of herbicide application; however, a late-July treatment has the advantage of killing plants before many of the seeds have matured. Rawinski (1982) found that 53% of the seeds from August-treated plants were viable.

Treatment of large areas by hand-spraying of glyphosate may not be practical. In this situation, which is not likely to be common along narrow highway corridors, power-spraying from the roadside or aerial spraying from a helicopter or airplane may be more efficient (Thompson and others 1987). However, this method would also affect nontarget species and should be confined to sites where purple loosestrife forms nearly monospecific stands. Helicopters should not be used when viable seeds are present because propeller wash may broadcast the seeds. In some locations, large, well-established stands may be susceptible to mechanical control by plowing or disking (Thompson and others 1987). Observations along the thruway also suggest that repeated mowing may keep colonies under control. Caution should be exercised in implementing mechanical control, however. Plants should be mowed or cultivated prior to seed development to prevent further additions to the seed bank, and hot, dry days on dry sites should be selected to prevent sprouting from cut plant parts.

[1]Mention of trade names or manufacturers does not imply US government endorsement of commercial products.

Acknowledgments

I thank Nancy Wilcox, Jeffrey Wilcox, and Julie Wilcox for their help in spotting purple loosestrife colonies along the thruway transects; Dr. Daniel Thompson and Dr. Richard Malecki for reviewing the manuscript; Anthony Frank for consultation on statistical analyses; and Keith Edwards for drafting the figures.

Literature Cited

Balogh, G. R. 1986. Ecology, distribution, and control of purple loosestrife (*Lythrum salicaria*) in northwest Ohio. MS thesis. Ohio State University, Columbus, Ohio, 107 pp.

Conover, W. J. 1980. Practical nonparametric statistics. John Wiley & Sons, New York.

Gaudet, C. L., and P. A. Keddy. 1988. A comparative approach to predicting competitive ability from plant traits. *Nature* 334:242–243.

Rawinski, T. J. 1982. The ecology and management of purple loosestrife (*Lythrum salicaria* L.) in central New York. MS thesis. Cornell University, Ithaca, New York, 88 pp.

Rawinski, T. J., and R. A. Malecki. 1984. Ecological relationships among purple loosestrife, cattail, and wildlife at the Montezuma National Wildlife Refuge. *New York Fish and Game Journal* 31:81–87.

Shamsi, S. R. A., and F. H. Whitehead. 1974. Comparative ecophysiology of *Epilobium hirsutum* L. and *Lythrum salicaria* L. 1. General biology, distribution, and germination. *Journal of Ecology* 62:279–290.

Skinner, L. 1988. Purple loosestrife control studies in Hennepin Parks. *North Central Chapter Society of Wetland Scientists Newsletter* 11:8–10.

Smith, S. J. 1962. Purple loosestrife—weed or beauty? *Conservationist* 17:32.

Stuckey, R. L. 1980. Distributional history of *Lythrum salicaria* (purple loosestrife) in North America. *Bartonia* 47:3–21.

Teale, E. W. 1982. Stems beyond counting, flowers unnumbered. *Audubon* 84:38–43.

Thompson, D. Q., R. L. Stuckey, and E. B. Thompson. 1987. Spread, impact, and control of purple loosestrife (*Lythrum salicaria*) in North American wetlands. US Fish and Wildlife Service, Fish and Wildlife Research 2, 55 pp.

Wilcox, D. A., and M. K. Seeling. 1986. Cattails as a competitive control for purple loosestrife (Indiana). *Restoration and Management Notes* 4(2):85.

Wilcox, D. A., M. K. Seeling, and K. R. Edwards. 1989. Ecology and management potential for purple loosestrife (*Lythrum salicaria*). *In* L. K. Thomas (ed.), Ecology and management of exotic species on wild land communities. George Wright Society and US National Park Service, Hancock, Michigan (in press).