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Purple loosestrife (Lythrum salicaria): Its status in Wisconsin and control methods

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PURPLE LOOSESTRIFE *(LYTHRUM SALICARIA)*: ITS STATUS IN WISCONSIN AND CONTROL METHODS

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ABSTRACT

Data were gathered in 1984 on the distribution, size, and habitat of populations of purple loosestrife in Wisconsin. Lythrum salicaria was found throughout Wisconsin, but most populations were still small and amenable to eradication with spot applications of herbicide.

We compared the effectiveness of three dosages of glyphosate herbicide for eradicating small populations of purple loosestrife. High dosage treatments killed a slightly higher percentage of loosestrife than low dosage, but also caused much greater destruction of desirable perennial vegetation. The increased disturbance associated with high dosage, led to a high density of purple loosestrife seedlings in the following year. Low dosages of glyphosate herbicides are, therefore, recommended for control of L. salicaria.

INTRODUCTION

Purple loosestrife is a perennial wetland plant which was introduced to North America from Eurasia in the early nineteenth century. By the late 1800's it had spread throughout the northeastern United States and adjacent Canada (Stuckey, 1980). Most wetlands in the northeastern United States currently have populations of purple loosestrife and many wetlands are occupied by extensive monocultures of this aggressive weed (Rawinski, 1982). Thousands of acres of valuable wetland habitat have been destroyed in the Northeast due to infestation by purple loosestrife, and its rapid recent spread in the Great Lakes States and other midwestern states threatens to disturb or destroy millions of additional acres of wetland.

Lythrum salicaria, once established in a wetland, has the capacity to crowd out even dense stands of cattail (Typha spp.), reed canary grass (Phalaris arundinacea), or almost any native wetland species, and form nearly monocultural stands. Purple loosestrife owes its aggressiveness to its hardiness and rapid growth, its prolific sexual and vegetative reproduction, and to the lack of its Eurasian pests and competitors in North America. Lythrum salicaria prefers moist soils but tolerates a wide range of soil types and habitats. Its seedlings

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establish most easily on bare ground or exposed mud flats. Once established, seedlings or mature plants can withstand flooding of 30 to 40 cm depth. A single, well-established plant can have 15 to 20 stalks 2 to 2.5 m tall. Each stalk can produce up to 300,000 tiny seeds which are easily dispersed by water, wind and animals. A hectare of purple loosestrife can support as many as 200,000 stalks and, therefore, produce approximately 60 billion seeds annually. The seeds are small, but have a high viability even after long periods of storage in the ground or under water.

Lythrum salicaria is not thought to spread vegetatively by rhizomes or root sprouts. Plants produce new shoots from the base each season, however, and eventually form large clumps up to 1 m in diameter. Vegetative reproduction occurs when fragments of cut stems root at the nodes. Pieces of broken or cut stems can float in a stream or impoundment and establish new plants where they lodge, thereby greatly hastening the spread of the plant. By far the most common means by which purple loosestrife has been introduced to new watersheds in the past is through horticultural planting. Recent (1987) Wisconsin legislation prohibits the planting, sale, distribution or cultivation of purple loosestrife in the State. There is currently a great deal of interest in controlling L. salicaria in Wisconsin before the infestation becomes too severe.

This paper describes two areas of research on L. salicaria conducted at the UWM Field Station since 1984. While it was known that Wisconsin was beginning to have a problem with purple loosestrife, the extent of infestation in the State was unknown. The first step in formulating a control plan for L. salicaria was to survey the extent of its spread. In 1984 a statewide survey was conducted to determine the status and distribution of purple loosestrife in Wisconsin (Reinartz and Kuchenreuther, 1985).

It was known that glyphosate herbicides (available as tradenames Roundup™ and Rodeo™ by Monsanto) were effective for killing purple loosestrife (Rawinski, 1982, 1985). There were no systematic studies of the minimum effective herbicide dose. Since glyphosate herbicide is non-selective, we reasoned that the lowest effective dose would provide optimal control of L. salicaria because it would minimize destruction of desirable perennial vegetation. Studies to determine the minimum lethal dose of glyphosate herbicide were begun in 1985 (Reinartz, Popp and Kuchenreuther, 1986). Results of both investigations are summarized here. In 1985 and 1986 the Wisconsin Department of Natural Resources continued the statewide distribution survey and some of their results are also reviewed here (Henderson, 1987).

METHODS

Distribution Survey

In the spring of 1984 the Purple Loosestrife Task Force (an organization dedicated to stopping the spread of purple loosestrife in Wisconsin) distributed over 1,700 forms for reporting the locations of purple loosestrife in Wisconsin.

Reporting forms were two-sided; a county road map was printed on one side and a form for description of populations on the other. A fact sheet describing unambiguous characters for the positive identification of purple loosestrife was included with each reporting form. Reporters were asked to mark sites of purple loosestrife populations and the roads traveled in search of loosestrife or the areas otherwise surveyed. An estimate of the size of the area occupied by the population, a rough estimate of the number of plants (e.g., 10's, 100's, or 1,000's), the type of habitat (marsh, pond or lake, stream or river, or ditch), and additional notes about the location were also requested.

To complete the survey, specimens of Lythrum salicaria in the University of Wisconsin-Madison and UW-Milwaukee herbaria were examined and their dates and locations mapped. Additional locations from an herbarium record map by Ugent (1962) were also added. Methods used in the Wisconsin Department of Natural Resources survey are described briefly by Henderson (1987).

Herbicide Control Study

Glyphosate herbicide is non-selective and acts by being taken in through green tissue (primarily leaves) and being subsequently translocated throughout the plant. Glyphosate has no activity in the soil and is not taken up by plant roots. Furthermore, it is degraded almost immediately upon contact with wet soil or dirty water. It has a very short life in the environment before it decomposes into innocuous, naturally occurring, compounds.

Glyphosate herbicide was applied in mid-September 1985 to loosestrife growing in 6 different habitats (Table 1) located 3.7 km west-northwest of the UWM Field Station (T 11 N, R 20 E, SE 1/4 Sec. 23). The land on which the study sites were located was the site of a severe infestation of purple loosestrife which occurred in a wide variety of wetland habitats. The glyphosate herbicide applied was Rodeo^{TM}, manufactured by Monsanto, mixed at 1.5% concentration with 0.5% Ortho, X-77 Spreader^{TM} as a surfactant. Three plots were established in each habitat and the loosestrife plants in each plot were given a different treatment level. Plot size was at least 25 m^2, and larger in those areas where a larger plot was required to contain at least 100 plants. The individual plants within a treatment plot were spot treated with one of three dosages of herbicide; in the low dosage plots, 10-25% of the leaf area of each plant was wetted; in the intermediate dosage plots, 40-60% of the leaf area was wetted; and in the high dosage plots, 75-95% of the leaf area was wetted. In the low and medium dosage treatments, most of the wetted leaf area was on the upper portion of the plant.

Each of the six treatment sites was characterized as to the average height of purple loosestrife plants, the average number of stems per plant, the density of Lythrum salicaria, and the percent of the total area of the treatment plots covered by the purple loosestrife leaf canopy.

In late July and early August of 1986 (the year following treatment) the percent of L. salicaria plants killed in each treatment plot was determined.

Purple loosestrife seedlings were counted in five 0.25 m^2 quadrats in each of the 18 treatment plots. Quadrats were placed below killed L. salicaria plants in order to sample seedling establishment in the areas vacated by a loosestrife plants, the areas most likely to have received any drip of the non-selective herbicide. In quadrats with extremely high seedling densities, a smaller area of the quadrat was counted and the number of seedlings in the whole quadrat was estimated.

RESULTS

Distribution Survey

The first herbarium record of purple loosestrife in Wisconsin was collected in Milwaukee County in 1928. By 1950 L. salicaria had been collected from five counties in southeast Wisconsin and Marinette and Waushara Counties (Fig. 1). While introduction and early spread was probably confined to southeast Wisconsin, by 1952 loosestrife had been collected from Douglas County in the far northwest corner of the state. In general, the distribution trends reflected by herbarium specimens paralleled the findings of our 1984 survey. Herbarium records, however, underestimate the number of invaded counties.

From the 1984 survey, 251 reports were received (24% of those distributed) showing the locations of 486 populations of Lythrum salicaria in Wisconsin (Fig. 2). At least 10,900 miles (17,500 km) of roads were traveled in search of loosestrife, totaling about 10% of Wisconsin's 107,000 miles (172,000 km) of roads. Some surveyors reported populations but did not indicate what areas they surveyed. The road mileage figures, therefore, underestimated the actual number of miles surveyed. Individual counties varied greatly in the extent of coverage, from over 30% of road miles in Jefferson and Iron Counties, to zero for two counties (Adams and Menominee) which remained unsurveyed. Survey coverage was best in the southeast, east central, west and northwest parts of Wisconsin.

The worst infestation was in southeast Wisconsin, especially Waukesha and eastern Jefferson Counties and in Waupaca County. Fourteen counties reported more than 10 populations of loosestrife: Columbia, Crawford, Jefferson, Kenosha, Marathon, Oneida, Outagamie, Ozaukee, Sheboygan, Washburn, Washington, Waukesha, Waupaca and Winnebago. These counties can be grouped into three categories: i) those where most populations were located along specific river systems, ii) those where most loosestrife was located near centers of population, and iii) those where roadside ditches were the most common habitat.

Statewide, purple loosestrife was found to be still in the early stages of invasion. Small populations (<20 individuals) constituted 32% of all populations for which size was estimated. Over half of the reported populations were smaller than 100 individuals. The northwest half of the state not only had a lower density of populations, but also a high proportion of small populations. On a statewide basis, roadside ditches appeared to be a very important means of spread

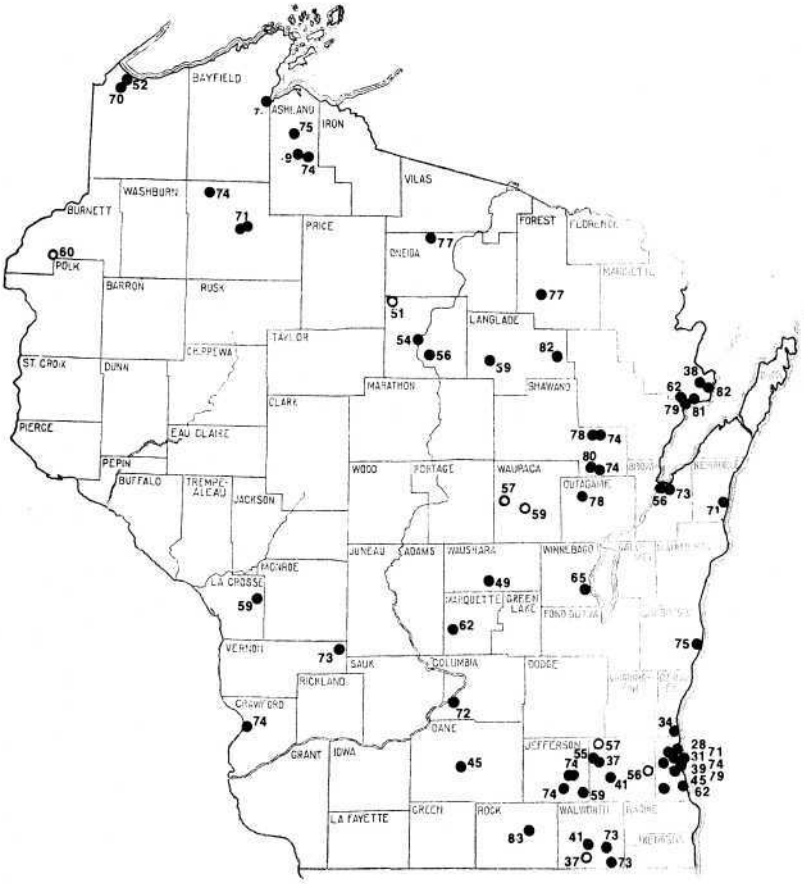


Figure 1. Herbarium records of Lythrum salicaria. Solid circles represent specimens from the UW-Madison and UW-Milwaukee herbaria. Open circles are collections in other herbaria as reported by Ugent (1962).

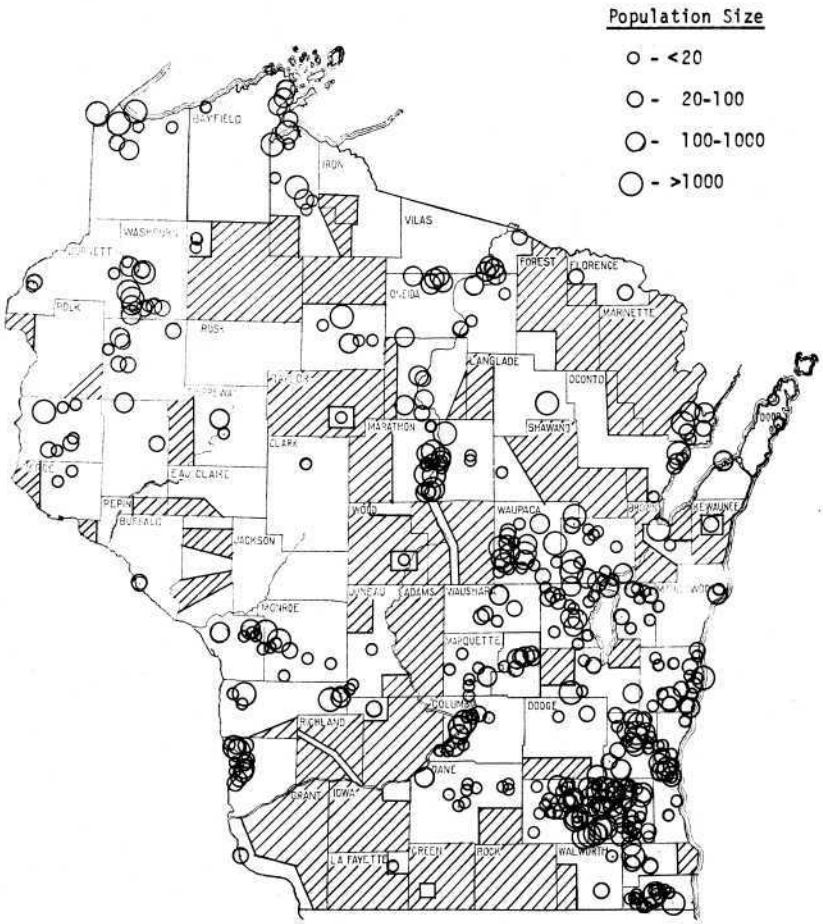


Figure 2. Reported populations of Purple Loosestrife, 1984 Survey. Hatched areas were not surveyed. A total of 486 populations were reported.

of loosestrife from one river system to another. Roadside ditches were the reported habitat for 28% of the populations statewide.

Herbicide Control Study

Plant height in the various treatment sites ranged from 1 to 1.5 m in the driest site (#1) to 2-2.5 m in an intermediate "wet meadow" habitat (#3) (Table 1). The number of stems per plant ranged from 7 to 8 in the dry pasture (#1) to 20-40 in the "wet meadow". The study, therefore, encompassed a wide range of habitat types and plant sizes. The dry pasture site (#1) was one of the driest sites on which we have ever seen loosestrife and the pond site (#6) had loosestrife growing to the apparent maximum water depth tolerated by L. salicaria. Plant density varied from less than one plant/m^2 (#4) to 4.5 plants/m^2 (#2); and cover of ground area by L. salicaria from less than 10% to 85%.

Table 1. Habitat and characteristics of purple loosestrife at six sites used for herbicide dosage experiments.

	TREATMENT SITES					
Site #	1	4	2	3	5	6
Habitat	Dry Pasture	Wet Meadow/ Shrub Carr	Moist Pasture	Wet Meadow	Ditch Bank	Pond Bank
Plant ht. (m)	1-1.5	seedlings to	1.5-2	2-2.5	1.5-2.5	1-2.5
Stems/plant	7-8	very large	10-15	20-40	5-20	5-25
Density (plants/m^2)	3	<1 (scattered)	4.5	2.5	3.5	4.0
Loosestrife coverage (%)	20	<10	80	85	60	70

Kill of L. salicaria was most complete in the high dosage treatment (90-100% reduction in live plant density) (Figs. 3 and 4), intermediate in the medium dosage treatment (86-97%) and lowest in the low dosage treatment (74-90%). The size and vigor of loosestrife plants which survived the herbicide treatments were greatly reduced by all three treatments. The mean reduction in live L. salicaria density was 82% for the low dosage treatment and 96% for the high dosage (Fig. 4).

Figure 3. Percent of purple loosestrife plants killed in low (L), medium (M) and high (H) dosage treatments in each of the six sites.

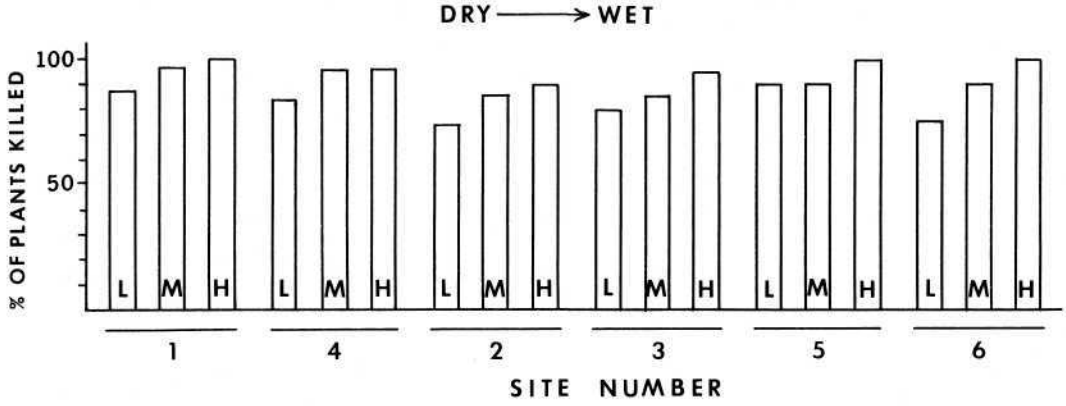
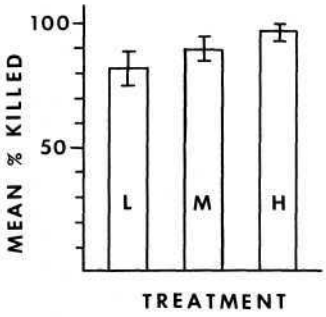


Figure 4. Mean percent of purple loosestrife plants killed in low (L), medium (M) and high (H) dosage herbicide treatments. Each treatment was done in six plots. Bars show standard errors of the means.



The three treatments also differed in the amount of desirable (anything other than loosestrife) perennial vegetation surviving the treatments and the density of loosestrife seedlings which germinated in the year following spraying (Table 2). In those habitats where loosestrife was most dense, almost no desirable perennials survived the high dosage treatment, and loosestrife seedlings were very dense. In habitats where loosestrife was scattered, the high dosage created large "holes" in the vegetation and these also were colonized by loosestrife seedlings. In the low dosage treatment, survival of desirable perennials was high and very few loosestrife seedlings were found. The medium dosage treatment was intermediate (Table 2).

Table 2. Density of purple loosestrife seedlings in the area immediately surrounding treated plants (seedlings/m^2) in the year following spraying at three different dosages.

Dosage	Density
Low	32
Medium	2,700
High	12,000

DISCUSSION

Wisconsin's wetlands are a valuable resource. Without an active effort to control purple loosestrife, Wisconsin will undoubtedly experience the loss of thousands of acres of valuable wetland habitat as has occurred in the northeastern United States. Currently there is still hope of stemming the spread of

L. salicaria in Wisconsin. The distribution of L. salicaria in Wisconsin and the preponderance of small populations indicate that it is still in the early stages of spread.

The results of the Wisconsin Department of Natural Resources distribution survey (Henderson, 1987) confirm that most populations are still small. They found purple loosestrife in 70 of the state's 72 counties. However, 70% of the colonies reported in their study were smaller than 100 individuals and 44% had fewer than 20 plants. In their study, 2,202 separate populations were reported, covering about 2,600 acres (1,050 ha). Henderson (1987) extrapolates from these figures by estimating that the surveys represent 8% of the total state population. He estimates that a total of approximately 30,000 acres in Wisconsin are covered by loosestrife. This acreage represents only about 3% of the wetland acreage which is suitable habitat for loosestrife (Henderson, 1987).

We are obviously in a crucial period if we hope to control purple loosestrife before it reaches epidemic proportions in Wisconsin. Rawinski (1982) showed that glyphosate herbicides could be effective at killing purple loosestrife. Since glyphosate herbicide is completely non-selective, however, it is effective only when spot applied to individual plants. This control method is only tractable and affordable for small populations which are treatable by hand; methods of eradicating extensive populations are not yet available. Broadcast spraying invariably results in a dense bed of L. salicaria seedlings in the following year. It is most important at this time, therefore, that small populations be eradicated, especially those in areas having little loosestrife, so that the pest can be quarantined to those wetlands and drainage basins where large populations are already established.

Heavy dosages of glyphosate herbicide are slightly more effective at killing L. salicaria than low doses. However, there is a dramatic increase in destruction of desirable perennial vegetation with large doses and a concomitant increase in the density of loosestrife seedlings which become established in the disturbed areas. Because of the differences in seedling density following treatment, a low dosage (25% or less of the leaf area of the plant wetted) is the most effective for the long-term control of purple loosestrife with spot applications of the herbicide from a hand-held sprayer. Follow-up treatments are necessary in the years following the initial spraying in order to treat plants that were missed or not killed during the first treatment, and to catch plants that have become newly established.

The most effective and efficient control strategy at this time is to quarantine loosestrife to sites that are already severely infested: 1) monitor wetlands that don't currently have loosestrife to ensure that any invasion is detected early, and eradicate any small populations near the wetland to remove sources of seed, 2) eradicate small populations in wetlands that are not severely infested, and 3) remove plants around the edges of severe infestations to prevent further spread of the patch. A number of control or eradication methods have been

tested, including: pulling, digging, cutting, burning, flooding, and broadcast and spot spraying with various herbicides (Rawinski, 1982).

Relatively young (1-2-year old) and isolated plants can be pulled by hand. Pulling is impractical for older plants or for larger populations. The most effective, efficient and least costly method for contolling loosestrife in situations where the plants cannot be pulled is with careful spot applications of small quantities of glyphosate herbicide. None of the other control methods tested have proven effective.

ACKNOWLEDGMENTS

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