Vol. 1, No. 17 (Rev.). Approved 5/31/2017

VEGETATION MANAGEMENT GUIDELINE

Purple Loosestrife (*Lythrum salicaria* L.)

SPECIES CHARACTER

DESCRIPTION

Purple loosestrife is an herbaceous perennial that grows from 1 - 3 m (3 - 10 feet) tall, with an average height of 1.5 m (5 feet). It has stiff, 4-sided stems that may appear woody at the base of large plants and may be pubescent especially in the upper portion. The sturdy stems may remain standing over a year after flowering. The leaves are lance-shaped, 3 - 10 cm (1 - 4 inches) long, opposite or in whorls of three, sessile and lack teeth. The rose-purple flowers have 5 or 6 purple petals and 8 stamens. The most notable characteristic of purple loosestrife is the showy terminal spike of flowers it displays from early July to September. A plant can produce 30 or more spikes that can be 30 - 120 cm (1 - 4 feet) tall and interspersed with leaf-like bracts. The fruits are many-seeded capsules that may contain over 100 small, ovoid, dark brown seeds. Large mature plants can produce over 2.5 million seeds per year.

SIMILAR SPECIES

Purple loosestrife may be confused with the native winged loosestrife (*Lythrum alatum*) or fireweed a.k.a. willow-herb (*Epilobium* spp.) which it most closely resembles. Winged loosestrife is an erect, branched, perennial with a 4-angled, slightly winged stem and grows in moist, open areas, most commonly occurring in prairies. Its flowers are purple, but solitary and located in the leaf axils mostly in the upper portion of the plant. The hypanthium of winged loosestrife has 12 sharp, narrow wings. Fireweed is a fibrous-rooted or rhizomatous perennial. Its flowers are pink or purple with four petals and 8 stamens. The flowers are solitary or in short to elongate spikes. Purple loosestrife should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate manuals or keys.

DISTRIBUTION

Purple loosestrife is native to Eurasia, but has spread throughout much of the world. The date it was introduced into North America is not certain, but purple loosestrife was well-established in New England by the early 1800's. In fact it was so well established that Torrey and Gray reported it as "probably native" in the first edition of *A Flora of North America* that was published in 1840. A number of possible explanations have been offered for its introduction into North America. The most probable of these are in ship ballast, intentional introductions as purple loosestrife was a valued herb in Europe, and in raw wool or on sheep that were being imported to support the growing wool industry of the early 1800's. Regardless, the range of purple loosestrife began to expand rapidly in the early 1900's, reaching the upper Midwest in the 1930's. Today, it occurs in all of the continental United States except Florida. Purple loosestrife was recognized as a serious threat to Illinois'

Funded Cooperatively by the IDNR
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wetlands in the early 1990's. It occurs most extensively in northern Illinois, but it is becoming more common throughout the state. Purple loosestrife has been declared a noxious weed in at least 19 states.

HABITAT

Purple loosestrife occurs widely in wet habitats, such as marshes, bogs, pannes, fens, sedge meadows and wet prairies, but it also occurs in roadside ditches, abandoned fields, and along the banks of streams, rivers, ponds and reservoirs. Purple loosestrife grows best in soils high in organic matter, but tolerates a wide range of soils conditions including clay, sand, silt, muck, and gravel. It can grow under a wide range of conditions including permanent, low level flooding and low nutrient and pH levels. It prefers full sun, but can survive in 50% shade and will readily invade recently disturbed habitats.

LIFE HISTORY

Purple loosestrife possesses a range of morphological and phenological characteristics that make it a successful invader. The stems have the ability to develop adventitious roots if buried or aerenchyma (spongy, porous tissue that aids in gas diffusion and buoyancy) if submerged. Leaves can alter their morphology to maximize photosynthetic output. Its flowers are trimorphic meaning they have three forms of flowers. Charles Darwin noted three forms of flowers and three lengths of styles that occurred with three combinations of anther lengths.

Purple loosestrife seeds require temperature above 15° C (59° F) for germination with most germination occurring at temperatures above 20° C (68° F). Purple loosestrife seeds apparently do not germinate at temperatures below 14 ^{o} C (57^{o} F). Seeds will germinate on a variety of substrates, but bare moist soils with a pH range of 4.0 - 9.1 are most susceptible to invasion. Mudflats created by drought or intentional late summer drawdown provide excellent habitat for purple loosestrife seedlings. Seedlings may also germinate while submerged, rise to the surface and drift to suitable sites for establishment.

Following germination, seedling growth averages about 1 mm per day. At 10 days, the seedling can be 6 mm (1/4 inch) long, with most of the growth in the primary root. By 20 days, seedlings have a set of true leaves and lateral and secondary roots. At about 25 days, stem elongation begins and true leaves and vascular tissue are well developed. By this time, the aboveground portion of the plant is less than 1 cm (3/8 inch) tall, but the seedling is well established. From this point, seedlings can grow rapidly (>1 cm/day) and plants can flower in their first growing season. A Minnesota study found seedlings that emerged in July or early August had the highest survival rates and were taller the following spring than seedlings that emerged in late August. As the plants grow, they develop a large, laterally branching rootstock that has starch as the main form of nutrient storage. Root crowns can grow to be 0.5 m (20 inches) in diameter. Mature plants can develop rootstocks in excess of 1 kg (2.2 lbs) and have stem densities as high as 100 stems/m^2. Once established, purple loosestrife can persist for decades.

The reproductive capacity of purple loosestrife is one of its most significant and relevant life history characteristics. Flower production typically begins in May. Seed set begins in mid to late July and continues through late summer. A single plant can produce 30 or more flowering

stems and stem densities as high as 80,000 stems per acre have been recorded. Each spike can produce as many as 300,000 seeds and dense stands have the potential of producing as many as 24 billion seeds per acre. Capsules from early flowers can produce ripe seed while the plants are still green. Seeds may be dispersed by wind, water, animals, humans and equipment. Dispersal by wind seems to be limited to about 10 m (30 feet) from the parent plant. The seeds can remain viable even after 20 months of submergence in water.

Purple loosestrife can also spread vegetatively. New plants can develop from root or stem segments. An Ohio study reported that 80% of stem fragments 5 – 10 cm (2 – 4 inches) long developed adventious roots after 28 days if they remained moist during that time. Muskrat cuttings and mowing can contribute to rapid spread by dispersing cuttings into riverine and lacustrine systems.

EFFECTS UPON NATURAL AREAS

Purple loosestrife quickly crowds out most native vegetation in communities it invades, creating a monoculture that provides minimal food or shelter for native wildlife. The natural character of several Illinois nature preserves is threatened by this exotic species. Some studies report the native winged loosestrife may have contributed some unique genes to North American populations of purple loosestrife through introgression although the number of winged loosestrife genes retained is thought to be low.

Purple loosestrife can affect animal populations as well as plant communities. Purple loosestrife leaves have high levels of tannins and changes in sediment chemistry have been associated with decomposition of purple loosestrife leaves. Compounds leached from decomposing purple loosestrife leaves can hinder the performance of some tadpoles. American toads (*Bufo americanus*) may be more susceptible because their lung development occurs at a later age than some other amphibians. Purple loosestrife invasion has also been linked to a decrease in avian species diversity and a reduction in high quality habitat for mammals and turtles.

CURRENT STATUS

Purple loosestrife has been declared an aquatic or terrestrial noxious weed in 29 states. It is categorized as an exotic weed under the Illinois Exotic Weed Control Act of 1987. As such, its commercial sale in Illinois is prohibited.

CONTROL RECOMMENDATIONS

Some studies report that purple loosestrife seedlings have little competitive advantage over native seedlings in areas that have well-established native plant species. However, once purple loosestrife becomes established, it is able to suppress native seedling recruitment. Therefore, restoration and maintenance of high quality natural communities is imperative.

RECOMMENDED PRACTICES IN HIGH QUALITY NATURAL COMMUNITIES

In areas with a few small plants (1 - 2 years old), control can be achieved by hand-pulling. Pulling is not recommended after flowering as it may aid in seed dispersal. Older plants,

especially those in bogs or in deep organic soils, can be dug out. Roots of older plants can be "teased" loose with a hand cultivator, spading fork or similar device. All of the root should be removed as purple loosestrife will readily re-sprout from fragments left in the ground. Plants should be bagged and removed from the site to prevent seed dispersal or fragmentation of the plant. Dispose of the plant by burning (preferable) or in a landfill, if permissible under local codes. Follow-up treatments are recommended for at least three years after the plants are removed. If purple loosestrife has produced seed, clothing, equipment and personnel should be cleaned to insure seeds are not spread.

For larger infestations, spot application of herbicide will be necessary. If standing water is present, be sure to use an herbicide that is labeled for such use. Selective herbicides are recommended for high quality areas. Triclopyr (trade name Garlon 3A, Tahoe 3A) is a broadleaf specific herbicide that will not harm most grasses and sedges. Garlon 3A is labeled for use over standing water, but Tahoe 3A is not. If standing water is present, **do not use Tahoe 3A**. For Garlon 3A or Tahoe 3A, a 0.6 % active ingredient solution should be effective. The addition of 0.25% (1/3 ounce per gallon) of a nonionic surfactant is recommended. Triclopyr is most effective when applied while purple loosestrife is in bud to early flower stage and when applied close to the root mass.

Care should be taken to avoid contacting non-target plants. **Do not spray so heavily that herbicide drips off the target species.** The herbicide should be applied while backing away from the area to avoid walking through wet herbicide. By law, herbicides may only be applied as per label instructions and by licensed herbicide applicators or operators when working on public properties.

RECOMMENDED PRACTICES ON BUFFER AND SEVERELY DISTURBED SITES

For buffer, disturbed sites or in monocultures, application of a 1.0% active ingredient solution of glyphosate may be used when hand pulling is not feasible. Glyphosate (trade name Roundup, Rodeo, Accord, Glyphomax, Touchdown, Pondmaster) is nonselective so care should be taken not to let it come in contact with nontarget species. Rodeo is registered for use over open water. Glyphosate application is most effective when applied during late flower stage. Scattered plants are also easier to find at this time. The addition of a wetting agent may be needed as specified on the label.

Another option is to apply glyphosate twice during the growing season. Foliage should be sprayed as described above, once when flowering has just started and a second time 2-3 weeks later. With this procedure, control is likely more effective because plants are not allowed to set seed and those missed because they were not flowering the first time are treated the second time. Complete coverage is not required to affect control. Since purple loosestrife is usually taller than the surrounding vegetation, application to the tops of plants alone can be very effective and limit exposure of non-target species. Excessive application of herbicide (causing dripping from the plant) can kill desirable plants under the loosestrife. These plants, left unharmed, will be important in recolonizing the site after the loosestrife has been controlled. If the desirable plants are killed, the newly emerged purple loosestrife seedlings will fill the void. In areas where purple loosestrife is very dense, a follow-up treatment to control late emerging purple loosestrife

seedlings may be needed. The herbicide should be applied while backing away from treated areas to avoid walking through the wet herbicide. Equipment, clothing and personnel should be cleaned completely before entering other un-infested sensitive areas, if seeds were present in the treated area. It will be necessary to treat the same area again annually until missed plants and plants originating from the seed bank are eliminated.

Cutting purple loosestrife and subsequently flooding the area so that cut plant stalks are completely immersed has controlled purple loosestrife in at least one case. However, flooding may encourage the spread of purple loosestrife if seeds are present in the soil. Artificial flooding should not be used in high-quality natural communities with an intact natural flooding regime.

Effort in areas with large monocultures (greater than 4 acres in size)

For large purple loosestrife populations, an assessment should be made to determine if the loosestrife can be eradicated with available resources. If it can not be eradicated, then efforts should be placed on keeping the loosestrife out of the highest quality areas. Applying glyphosate from a vehicle or airboat mounted sprayer is usually necessary in areas with extensive stands of purple loosestrife. The most effective control can be achieved by beginning treatment at the periphery of large patches and working towards the center. In most areas, purple loosestrife seedlings will emerge following treatment of mature plants. These seedlings should be treated as soon as possible to prevent re-invasion. At least one study has reported purple loosestrife reinfesting areas the following year where seedlings were treated in June while areas treated in July and August did not experience re-infestation.

A Nebraska study examined the effects of a single application of various herbicides at 10 weeks, 1 year and two years after treatment. The herbicides were applied using a CO_2 pressurized backpack sprayer at a total solution volume of 200L/ha. Chemicals used in the study included glyphosate at 1.25% and 1.875% active ingredient solution, triclopyr (trade name Garlon 3A, Tahoe 3A) at 0.8 and 1.33% active ingredient solution, imazapyr (tradename Arsenal, Chopper, Habitat, Stalker) at 0.19%, 0.40%, 0.64%, and 1.0% active ingredient solution, metsulfuron (trade name Ally XP, Escort XP), a dry flowable, at 1.0 ounce per 100 gallons of water, and fosamine (trade name Krenite) at 5.8 % and 9.8% active ingredient solution. Greater than 90% control that lasted more than one year was achieved with all four rates of imazapyr and both rates of metsulfuron. The two highest rates of imazapyr and both rates of metsulfuron provided greater than 90% for more than two years. The study reported a higher percentage of grasses and grass-like species in plots treated with triclopyr, metsulfuron and fosamine treatments compared to a higher percentage of broadleaf species in the glyphosate and imazapyr treatments. The study also reported that metsulfuron was the only herbicide tested that provided satisfactory control of purple loosestrife for more than one season without detrimental effects on grassy vegetation. Imazapyr at the two highest rates had the greatest negative impacts on total ground cover for the longest period of time and the greatest negative effect of local vegetation. Fosamine and triclopyr treatments had higher rates of purple loosestrife cover after one and two seasons than did metsulfron and glyphosate. Metsulfuron, triclopyr, and glyphosate are the preferred treatments in high quality natural areas. Additionally, fosamine at the rate of 6.0 % active ingredient solution and imazapyr at the rate of 0.40% active ingredient solution may be used in buffer or severely disturbed sites. Higher rates of imazapyr are not recommended for

purple loosestrife control on sites within the Illinois Nature Preserves system.

BIOLOGICAL CONTROL

Surveys for potential biocontrol agents began in Europe in 1986. Nine potential control agents were identified in Europe and six species were tested for their host specificity. These included a root-mining weevil, *Hylobius transversovittatus*; two leaf beetles, *Galerucella calmariensis* L. and *Galerucella pusilla*; a flower-feeding weevil, *Nanophyes marmoratus*; a seed-feeding weevil, *Nanophyes brevis*; and a gall midge, *Bayeriola salicariae*. After subsequent testing the gall midge was not proposed for introduction. The seed-feeding weevil *N. brevis*, while approved for introduction, was not released into North America.

Initial introductions of the leaf beetles and root feeder occurred in Virginia, Maryland, Pennsylvania, New York, Minnesota, and southern Ontario in August, 1992. Introductions of the flower-feeding weevil *N. marmoratus* were conducted in New York and Minnesota in 1994. Since that time, G. *calmariensis* and *G. pusilla* have been released in over 30 states.

Galerucella calmariensis and *G. pusilla* were released at five locations in Michigan in 1994 with releases of *G. calmariensis* at eight additional sites in 1997, six sites in 1998 and five sites in 1999. *G. pusilla* apparently failed to become established; however, *G. calmariensis* became established and persisted for at least seven years and large populations developed from each of the 1994 releases. These large populations resulted in 100% defoliation of purple loosestrife. Between 1995 and 2000, purple loosestrife stem height was reduced by 73 - 85%, purple loosestrife cover was reduced by 61-95%, non-target native plant species richness increased significantly and the beetles had spread 3 - 10 km (3.125 - 6.25 miles) from the original release sites. By 2002, four of the 1997 release sites had developed large *G. calmariensis* populations that produced severe damage to purple loosestrife, moderate impacts were observed at the 1998 release sites and no clear impacts were observed at the 1999 release sites.

A New York study examined the impacts of *G. calmariensis* and *G. pusilla* on purple loosestrife at 36 release sites and 22 non-release sites ten years after the initial release in 1994. Of the 36 release sites, 22 sites had *G. pusilla* population in 2004 and 10 had *G. calmariensis*. These numbers were similar to 1997 results of 21 and 12 sites with populations, respectively. At the release sites, seven experienced an increase in purple loosestrife stand area, 11 sites experienced a decrease, and 13 sites remained approximately the same. Purple loosestrife completely disappeared at only one site. This was a small 185 m^2 patch with a moderately low purple loosestrife stem density and diverse vegetation at the time of release. Mean stem density at release sites did not change significantly from 1994 to 2004. A significant reduction in stem height and flower production was observed between 1994 and 2004. The overall average stem height decline was 25.8% while nearly half of the sites exhibited substantial or complete reduction in flower production. Similar results have been reported from a 6-year study in Michigan and a 4-year study in Coastal British Columbia. *Galerucella* were found at only 6 of 22 sites located near 1994 release sites. Beetle abundance and damage to purple loosestrife were lower than at the release sites.

Feeding by adults and larvae of *Galerucella calmariensis* and *G. pusilla* can reduce seed production in purple loosestrife even at low levels of feeding. In Minnesota, purple loosestrife

inflorescence length, and number of flower buds and seed capsules were reduced at low levels of feeding (10% defoliation of the plant). Few or no flower buds or seed capsules formed on plants with 70% defoliation and feeding on the main shoot of purple loosestrife did not result in an increase of axillary inflorescences.

At several release sites, complete defoliation of purple loosestrife stands covering several acres and purple loosestrife biomass reduction of more than 95% has been reported. Patience is required when initiating biocontrol for loosestrife. Typically, it takes three to five years before significant reduction in stem height, biomass, or flowering to occur, but some reports indicate it may take as many as eight years. *Galerucella calmariensis* and *G. pusilla f*eeding on purple loosestrife may not result in plant mortality even after several years of repeated defoliation. A New York study found that *Galerucella calmariensis* and *G. pusilla* appeared to undergo a period of quiescence following severe defoliation of purple loosestrife, but beetles were observed at the site the following year. The study also found the decline of purple loosestrife was accompanied by an increase in richness of other wetland species.

Several studies report rather slow colonization rates by *Galerucella* into new areas following releases and that the spread of *Galerucella* into new areas may be limited by predation of eggs and larvae by predacious insects. Egg predation rates can be can be as high as 60%. A British Columbia study reported larvae disappearance rates ranging from 22 – 46%. In an Iowa study, egg predation rates were highest in July which coincided with the *G. pusilla* oviposition on purple loosestrife. The predatory stinkbug *Apoecilus bracteatus* is believed to limit *Galerucella* population growth in Manitoba, Canada.

Non-target feeding by *Galerucella* has been observed on several species including *Alnus incana* (speckled alder), *Juncus effusus* (common rush), *Rosa multiflora* (multiflora rose), *Potentilla anserina* (Silverweed cinquefoil), *Decodon verticillatus* (swamp loosestrife), *Salix interior* (sandbar willow), *Typha* spp. (cattails), *Cornus stolonifera* (red osier dogwood), and *Lagerstroemia indica* (crepe myrtle). These episodes have been localized, usually occurring within a few meters of established *Galerucella* populations shortly after emergence of a new generation, and after most purple loosestrife plants had been defoliated. Most reports indicate that damage to non-target species was not of sufficient intensity or duration to have substantial impacts.

The aphid *Myzus lythri* was first observed in the U.S. in the 1930's and was observed feeding on purple loosestrife in Indiana in 1992. Subsequent studies reported significantly lower dry weight of roots and shoots for purple loosestrife plants that were infested with the aphid. A recent Iowa study reported that a combination of *Myzus lythri* and *Galerucella calmariensis* did not produce an additive negative on purple loosestrife during cage studies. That study also reported that two predatory insects *Harmonia axyridis* (multi-colored Asian lady beetle) and *Chrysoperla carnea* (green lacewing) decreased *Myzus lythri* survival and also decreased *Galerucella calmariensis* survival when *Myzus lythri* was present. However, predator presence did not appear to indirectly benefit the plant.

INTEGRATED PEST MANGANEMENT

In Manitoba, Canada, the most effective control was achieved using an integrated

management approach combining herbicide applications with biocontrol. Herbicide applications included the use of a 1.5% solution of triclopyr applied when purple loosestrife was in early bud stage or a 2% solution of glyphosate applied when purple loosestrife was in late bloom stage. Purple loosestrife can be treated with herbicide and *Galerucella* released the following year or an area can be left untreated and *Galerucella* released the same year. The seedlings that emerge in treated areas can serve as hosts for the biocontrol agent.

FAILED OR INEFFECTIVE PRACTICES

Most mechanical and cultural attempts to control purple loosestrife are ineffective. A single known exception is cutting followed by flooding as described earlier. Mowing or cutting young purple loosestrife plants can reduce biomass for that year, but rarely results in the death of plants and, in most cases, cutting is not sustainable. Cut plants will likely re-sprout and some studies have reported plants cut during the pre-flower stage produce more seed than uncut plants. Cutting may aid in vegetative reproduction and result in disturbance of native vegetation which could increase purple loosestrife density.

Flooding is not a reliable control for purple loosestrife as its effectiveness is dependent upon the frequency and duration of flooding and the age of the plants. Flooding may need to be extended for up to eight weeks for 100% control of purple loosestrife seedlings. Maintaining high water levels during purple loosestrife's most active growing period may result in mortality of some mature plants, but the reproductive output of surviving plants is rarely affected. Flooding may aid in dispersal of purple loosestrife seed into new area, have negative impacts to native plant communities, or produce mudflats that are ideal habitat for purple loosestrife seedlings. Timing of the drawdown following flooding is also important. A Minnesota study found the seedlings that emerged in July or August had the greatest overwinter survival rate.

Prescribed burning is not an effective management tool for purple loosestrife. Purple loosestrife typically grows in wet soil conditions that are not conducive to fire. The dead upright stems do not carry fire well and the fine fuels are often lacking. The growing points of the root crown are about 2 cm (0.8 inch) below the soil surface, so surface fires are not likely to inflict much damage. Purple loosestrife begins spring growth about a week or 10 days after broad-leaved cattails, so a fire of sufficient intensity to damage purple loosestrife could also damage desirable native species. Burning may provide indirect control by increasing vigor and density of native vegetation. The affect of prescribed burning on purple loosestrife seed germination has not been thoroughly examined.

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PERSONAL COMMUNICATIONS

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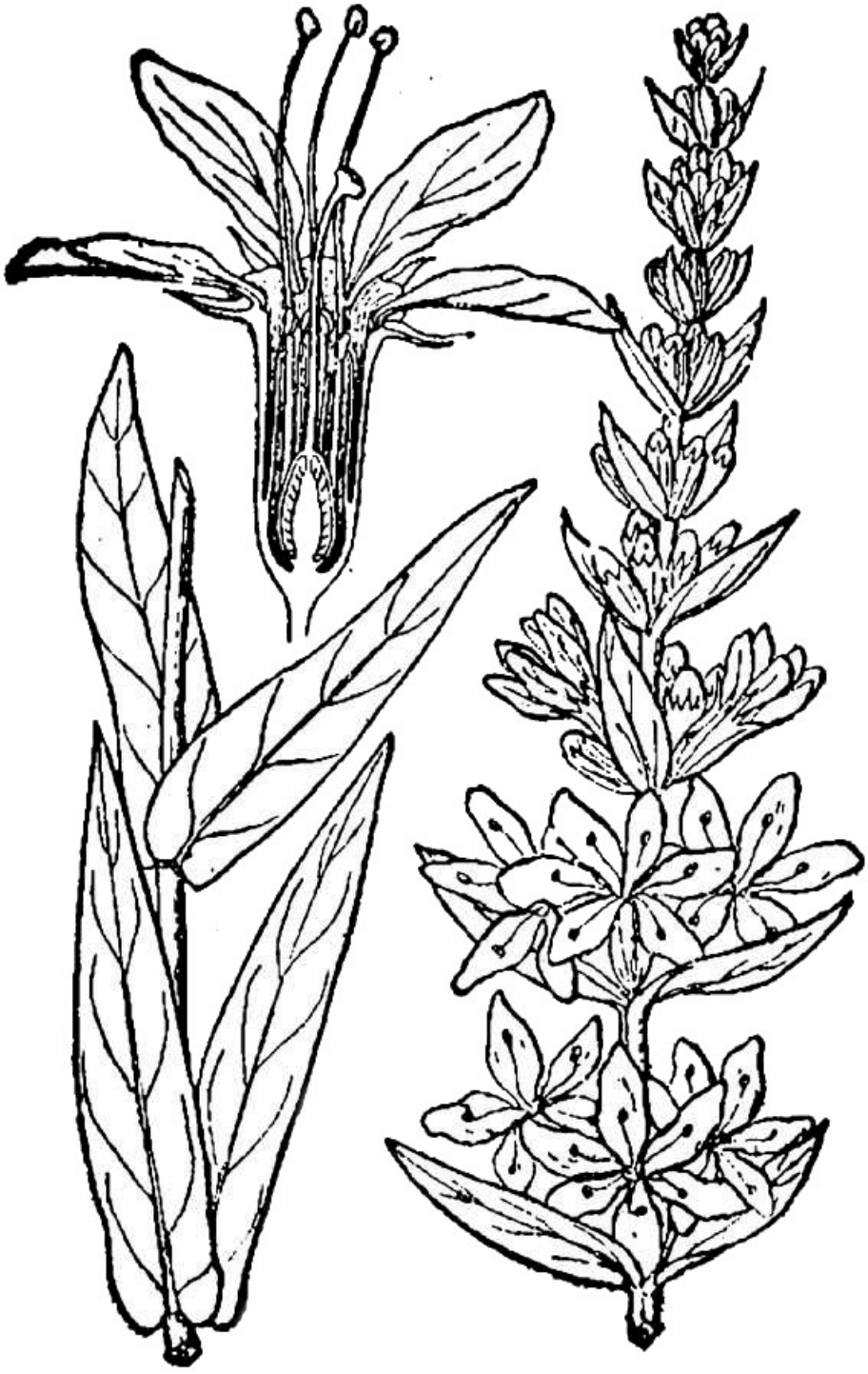

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