Purple Loosestrife in Alaska

Monitoring, Control Options, and a Public Education Framework

Prepared for:

ANCHORAGE Healthy Parks Healthy People PARKS & RECREATION

Municipality of Anchorage
Parks and Recreation Department
PO Box 196650
Anchorage, AK 99519

U.S. FISH & WILDLIFE SERVICE

ANCHORAGE Healthy Parks Healthy People PARK FOUNDATION

Prepared by:

HDR Alaska, Inc.
2525 C Street, Suite 305
Anchorage, AK 99501

HDR Alaska

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Cover photos: Westchester Lagoon, Anchorage. Photos by Lori Zaumseil and University of Alaska-Fairbanks Cooperative Extension Services (UAF-CES). **Above photos:** Purple loosestrife along the Columbia River. Photo by Blythe Brown; Weed Warriors scout for purple loosestrife in Westchester Lagoon. Photo provided by UAF-CES; individual plants around Westchester Lake. Photo by Gino Graziano.

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Key Findings

- Purple loosestrife is a significant threat to the health of Alaska ecosystems, particularly wetlands, riparian zones, and coastal regions.
- Purple loosestrife can negatively affect fish and wildlife populations in Alaska, especially salmon and waterfowl.
- If left untreated, purple loosestrife has the potential to spread rapidly across the state due to its life history traits.
- Prevention is the key to keeping purple loosestrife from establishing in other locations or spreading further in its current location.
- Public education, in an early detection and rapid response (EDRR) framework, is the key to effective prevention.
- Eradication of existing populations by manual control, with the option of spot application of herbicide, is the best approach to controlling the existing population.
- Appropriate and safe herbicide application is recommended if the population spreads beyond its maximum distribution of 2007.

I. Introduction and Background

Purple loosestrife (*Lythrum salicaria* L.) is an erect, herbaceous perennial from Eurasia. The species was established in the estuaries of northeastern North America by the early 1800s (Thompson et al. 1987). By the late 1800s, the plant had spread throughout the northeastern United States and southeastern Canada, as far north and west as Manitoba. Few problems were notated until the 1930s, when it began to spread rapidly in the floodplains of the St. Lawrence River in the eastern US and Canada. Purple loosestrife has now spread to most provinces and all but three states, and is recognized as a serious threat to native ecosystems, causing severe ecological and economic damage.

A small purple loosestrife population was discovered in Anchorage, Alaska, near Westchester Lagoon, in October 2005. The US Fish and Wildlife Service's Aquatic Invasive Species and Alaska Coastal Programs, along with the Municipality of Anchorage and the Anchorage Parks Foundation, created a Citizen Weeds Warriors campaign to remove invasive species around the Municipality. The volunteer Weeds Warriors, along with city and federal workers, used manual control methods to remove purple loosestrife in 2005, 2006, and 2007. This species was quickly recognized as a major threat to Alaskan ecosystems by a number of federal, state, and municipal agencies, the UAF Cooperative Extension Service, the Alaska Natural Heritage Program,

concerned local citizens, other organizations, and the state's Committee for Noxious and Invasive Plant Management (CNIPM). The Invasive Species Advisory Committee (ISAC), a committee of the National Invasive Species Council (NISC), held a meeting on May 12-14, 2008, in Anchorage. One of their recommendations was to focus priority control by any means on invasive species with currently small populations that are widespread and destructive in other areas of the country, such as purple loosestrife. The Anchorage Park Foundation, in cooperation with the Municipality of Anchorage, Parks and Recreation Department, and the US Fish and Wildlife Service, provided funding for a Control Assessment report. The report would include information on monitoring success for purple loosestrife populations in Anchorage, potential control options, effects of control methods, recommended control methods, and a public education framework to support a future control and prevention strategy.

A. Plant Characteristics and Habitat

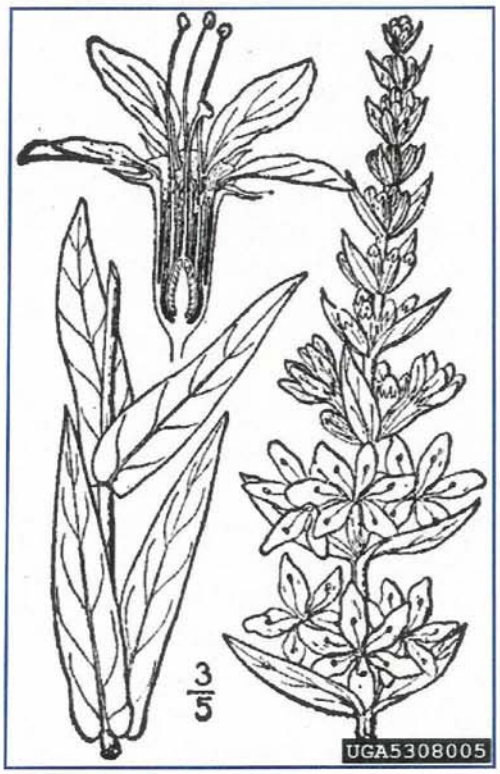

Figure 1. Purple loosestrife diagram (USDA PLANTS).

Purple loosestrife is a member of the Lythraceae (loosestrife) family, also known as purple lythrum or spiked loosestrife. Purple loosestrife has a highly variable growth form and morphology, and can grow up to 2.5 meters tall. Generally, the main leaves are 3 to 10 centimeters long, opposite along the squared stem, or can be in whorls of three or alternate (especially within the inflorescence). Leaves are either glabrous (hairless) or pubescent (hairy). The entire flowering stalk is leafy and is 10 to 40 centimeters long. The individual flowers are composed of 4 to 8 green sepals and 4 to 8 pinkish purple petals (7 to 15 mm long), with 8 to 16 stamens and 1 pistil. Sepals have 8, 10, or 12 prominent green veins. The seeds are brown to black, less than 1 mm across, and are produced in mass quantities. The fruit is a 2-chambered capsule about 6 mm long containing the seeds. Seedlings appear as cotyledons (2-leafed), 3 to 6 mm long and 2 to 3 mm wide, ovate-shaped, and hairless. The plant has a tap root with laterally spreading roots, which typically form an expanded crown up to 0.5 meters in diameter (DiTomaso and Healy 2003, Van Driesche et al. 2002, Royer and Dickinson 1999, Taylor 1990).

Many ornamental varieties (cultivars) have been developed through crossing with native *Lythrum* species or other Eurasian species. Various cultivars related to *L. salicaria* are available for sale at nurseries or horticulturalist supply companies. A related genus is *Lysimachia*, also known as loosestrife.

Similar species include the Alaska fireweed, *Chamerion angustifolium* (L.) Holub (formerly *Epilobium angustifolium*). This species also has showy pink flowers in long terminal clusters. The flowers of fireweed are distinctly different, with 4 pinkish green sepals, 4 non-fused pink petals, 8 stamens, and a 4-lobed style. Another distinguishing characteristic of fireweed is the exclusively alternate leaf arrangement (Royer and Dickinson 1999). Another similar species is the garden yellow loosestrife (*Lysimachia vulgaris* L.), which has started to aggressively colonize areas in North America where purple loosestrife has invaded. Garden yellow loosestrife can be distinguished by its bright yellow 5-petaled flowers (AKEPIC 2005). This species is currently planted in the Alaska Botanical Garden in Anchorage as a display plant.

Purple loosestrife habitat includes wet areas including marshes, sedge meadows, open bogs, streambanks, riverbanks, lake shores, ditches, and other wet soil areas.

B. Distribution

Purple loosestrife, native to Eurasia, grows all over the world except in extremely cold regions (AKEPIC 2005). Purple loosestrife is native to, and common throughout, central and southern Europe and along the coastal fringe of the Mediterranean basin. In Asia, the main islands of Japan are the core native range, with outlying populations extending from the Amur River south across the lowlands of Manchuria and other parts of China to southeast Asia and India (Hultén and Fries 1986). The European distribution extends from Great Britain across western Europe into central Russia with the 65th parallel as the northern distribution limit (Tutin et al. 1968).

Figure 2. Purple loosestrife in the Columbia River Gorge, Washington state (Blythe Brown).

The species occurs in all of the US except Florida, Hawaii, and Alaska (with the exception of the Anchorage population) and in nine Canadian provinces. Abundance varies throughout this range. The populations in the oldest infestations in the eastern United States are stable, while western populations are expanding. In the northeast and midwest, a significant portion of potential habitat has been invaded (Van Driesche et al. 2002).As of 2008, there are eight locations recorded in the state invasive plant database, the Alaska Exotic Plant Information Clearinghouse (AKEPIC), representing the population found along Chester Creek, just east of Westchester Lake and Westchester Lagoon.

C. History

Loosestrife species (*Lythrum*) have a long history of cultivation for horticultural purposes in Europe even before introduction to North American. The plant's presence near navigation terminals in 17th and 18th century Europe, followed by a quick spread to American navigation terminals, implies that spread was by ballast water (Thompson et al. 1987). Other methods of transport were by seeds trapped in wool, or by deliberate transport for landscaping or medicinal purposes. An historical reconstruction of purple loosestrife invasion was done in 1980 for the Great Lakes region of the US and southern Canada by Stuckey, illustrating the steady spread (Mooney and Hobbs 2000). Past confusion in the horticultural industry about sterility of cultivars increased the profusion of varieties produced, traded, and sold. Cultivars are not currently considered sterile and can interbreed with both native and introduced loosestrife species.

Hybridization between several European and North American varieties of purple loosestrife probably resulted in a more vigorous North American hybrid (Blossey and Notzold 1995). From the diverse hybrid pool came genetic combinations with new, larger phenotypes (appearances) adapted to North American conditions. The spectacular success of the plant in North America is likely caused by new genotypes (genetic varieties). A majority of new plant genotypes are not successful, but some display high fitness and superior colonizing ability.

Figure 3. Purple loosestrife planted at a downtown Anchorage business as an ornamental flower (UAF CES).

A series of common garden experiments compared growth size of North American and Eurasian populations by planting, under exact conditions, specimens from both the US and Europe in the same locations. The North American populations grew bigger and faster, regardless of where they were grown (Willis and Blossey 1999). The observation of North American plants being larger than the European plants led to a theory about herbivory defense, and possible biological control, for purple loosestrife. In Europe, natural insect predators (herbivores) seem to prevent large scale monospecific (single-species) stands (Batra et al. 1986). North America has vast areas of self-perpetuating monospecific stands (DiTomaso and Healy 2003). Since North American plants had no natural insect enemies to defend against, maybe they were devoting more resources to larger growth, allowing them to outcompete native vegetation. With lower defenses, North American plants might be susceptible to European herbivores, including beetles and weevils. In order to deliberately introduce new insects to North America, experiments had to illustrate that the insects would successfully feed on purple loosestrife populations, and that the insects

would not harm native plants. Experiments with beetle and root weevil herbivores compared feeding patterns of US and European specimens. The beetles and weevils did not appear to prefer one specimen to another, nor to prefer a particular size plant to another. These experiments, along with tests on native plants, formed the basis for biological control efforts in North America (Myers and Bazely 2003).

Loosestrife species that evolved in Eurasia and North America have adapted to environments within their circumpolar range. Within Europe, the northern range limit is near the 65th parallel, including populations in Iceland and other northern regions (Thompson et al. 1987). Two main plant associates, cattail (*Typha latifolia*) and reed canarygrass (*Phalaris arundinacea*), are indicators of vulnerable habitats for invasion by loosestrife (Thompson et al. 1987). Cattail is native to North America with several populations in Alaska. Reed canarygrass, another Alaskan invasive species, is common in southeast Alaska, where it was planted along logging roads for bank stabilization. It is found in various locations on the Kenai Peninsula, around Anchorage, and other locations in Southcentral Alaska. Studies have shown that purple loosestrife will not outcompete species like cattail, reed canarygrass, or other wetland species until after a disturbance (Anderson 1995, Blossey et al. 2001). Competition with reed canarygrass restricts the germination of purple loosestrife seeds. In one study, plots were set up in reed canarygrass stands, with the grass either retained or removed. Over half (53%) of the loosestrife seeds were able to establish in plots with the grass removed, but no seeds established in plots with the grass retained (Myers and Bazely 2003).

Plants may continue to adapt to local conditions (such as Alaska's cold climate) as they spread (Mooney and Hobbs 2000). Most varieties are able to self-pollinate; so even in the absence of genetic mixing, the species is able to perpetuate itself under a vast variety of ecological and climatic conditions (Myers and Bazely 2003). Of major importance in the viability of Alaska populations of purple loosestrife, and other invasive species, is the warming climate. Garden varieties are the most likely source of the Anchorage infestation, and germination may have been facilitated by the recorded warmer spring temperatures favorable to germination in the past several growing seasons prior to 2008. Purple loosestrife's newfound ability to spread to wild areas may have been the result of local adaptation or global climate change, although this is as yet unknown (Lassuy 2007).

D. Life History

Traits that directly affect the fitness of individuals are life history traits. These can include size and number of seeds, seed dormancy, time of germination, growth pattern, or plant size or age at first reproduction. Traits influence evolution, adaptation, population growth, and population dynamics of species. They have direct implications for the ability of a species to outcompete native plants (AKEPIC 2005).

Purple loosestrife has specific life history traits. Temperature at the soil surface is critical for seed germination, which requires open soil. Seeds will germinate at temperatures ranging from 15 to 20 °C (Balogh 1985). Seeds germinate in high densities, from about 10,000 to 20,000 per square meter (Rawinski 1982). The interval between germination

and flowering is eight to ten weeks (Rawinski 1982). Minimal levels of light are required for germination. Purple loosestrife grows best in highly organic soils, but tolerates a wide range of soil textures including clay, sand, muck, and silt. The plant prefers full sun, but can survive in 50% shade (AKEPIC 2005). Seedlings grow rapidly (>1 centimeter per day). Plants can flower in the first growing season. Flowering begins 8-10 weeks after germination, usually continuing through October. Seed production is prolific. An average mature *Lythrum* plant produces about 2,700,000 seeds annually (Thompson et al. 1987). First-year plants with single stems can produce 108,000 seeds (Shamsi and Whitehead 1974). Seeds are buoyant and can be dispersed by water. Spread to new areas occurs mainly by water-transported seed. Seed can also be transported by boots, waders, waterfowl, or other wetland fauna (Van Driesche et al. 2002). The seedbank is large. Seeds retain up to 80% viability after three years of submergence in water, and will germinate if disturbance brings them to the surface (Malecki 1990, Welling and Becker 1990). The lack of energy reserves in the seed suggests that viability in the field would not last more than a few weeks (Thompson et al. 1987). Others dispute this, believing that seeds can remain viable for several years if covered with soil or water. In one study, viability decreased from 99% to 80% after two years of storage in a natural body of water (Rawinski 1982). Further study is currently lacking.

Vegetative reproduction is common. New plants can grow from stem fragments, or from root sprouting in the spring. The laterally branching root, which can weigh more than one kilogram, is the main form of nutrient storage as starch. Mature plants can develop more than thirty annual shoots.

Purple loosestrife has many life history traits (prolific seeder, easily spread seed, long seed viability, root sprouting, early germination, long flowering time, perennial, monoculture formation, starchy tap root, cold tolerance) that call for assignment of a high risk of aggressive invasion potential. These life history traits, along with the ability to hybridize with native and cultivated species, make this species an ideal candidate for widespread, potentially destructive invasion in Alaskan ecosystems.

II. Potential Impacts

Purple loosestrife, because of its ability to outcompete native flora, form large monotypic stands, alter hydrological and soil regimes, and displace wildlife and fish, has tremendous destructive potential for the state of Alaska. Purple loosestrife is an environmental and economic concern to a variety of interests, including land managers, biologists, hunters, hikers, birdwatchers, anglers, commercial fishermen, farmers, naturalists, horticulturalists, and others. Elsewhere, the plant has impacted riparian and wetland habitats, agricultural areas, waterways, canals, roadside ditches and rights-of-way, farms, railway lines, and pipelines.

A. Ecological Impacts

1. Ecosystem Impacts

Purple loosestrife is one of the most aggressive invaders of wetland environments in North America. It can spread rapidly, forming dense colonies that displace native vegetation and wildlife, degrade wildlife habitat and fish spawning areas, and reduce the flow of water in rivers and canals by choking waterways (USFS 2007, Royer and Dickinson 1999). Fifty percent of the native biomass can be displaced in some wetland communities (Thompson et al. 1987). An invasion alters biogeochemical and hydrological processes in wetlands. Areas dominated by purple loosestrife show significantly lower phosphate levels in the summer compared to areas dominated by native vegetation. Leaves fall off earlier than native plants and decompose quickly in the fall rather than the spring, resulting in a nutrient flush (Barlocher and Biddiscombe 1996; Emery and Perry 1996; Grout et al. 1997). The change in nutrient release timing lowers detritivore consumer community numbers that are adapted to a spring decomposition regime (Grout et al. 1997). The plant can also invade deeper water and push out floating vegetation by closing out open water species. Quick germination and an extensive seed bank reduce the number and diversity of native plant species (Gabor et al. 1996, Welling and Becker 1990, Weiher et al. 1996). Where purple loosestrife and the native winged loosestrife (*L. alatum* Pursh.) ranges overlap, the taller, more conspicuous purple loosestrife reduces pollinator use of the native species, resulting in smaller seed sets (Van Driesche et al. 2002).

2. Wildlife Impacts

Important wildlife food plants, such as cattails and pondweed, are displaced or shaded out by purple loosestrife. Native animals avoid nesting and foraging in the dense monospecific stands. Dense wetland infestations inhibit waterfowl nesting ability by reducing access to open water, displacing birds from preferred nesting habitat, and providing additional cover to predators (Mal et al. 1992). Infestations have detrimental effects on specialized marsh bird populations, which are declining in the eastern US and Canada. These include black tern (*Clidonias niger* L.), pied-billed grebe (*Podilymbus podiceps*), Virginia rail (*Rallus limicola* Vieillot), sora (*Porzana carolina* L.), least bittern (*Ixobrychus exilis* Gmelin), American bittern (*Botaurus lentiginosus* Rackett), and long billed marsh wren (*Cistothorus palustris* Wilson) (Hickey and Malecki 1997, Rawinski and Malecki 1984, Whitt et al. 1999). Black terns, once a common breeding species within the Montezuma National Wildlife Refuge in upstate New York, became locally extinct by 1987, coinciding with a population explosion of purple loosestrife that covered over 40% of marsh habitat. The federally endangered bog turtle (*Clemmys muhlenbergi* Schoepff) loses basking and breeding sites (Malecki et al. 1993) to purple loosestrife infestations.

Species in Alaska with similar ecological traits to waterfowl affected by purple loosestrife are at risk from infestations. Alaska has nearly 500 recorded bird species, with about twenty percent of the waterfowl of the United States nesting in the state. Species

are risk include tundra swans, trumpeter swans, sea ducks, northern pintails, geese, and others.

3. Fish Impacts

Purple loosestrife affects shorelines and estuaries that salmon, trout, and other fish populations depend on for food, cover, and reproduction. Food webs are disrupted with large-scale infestation of purple loosestrife, which has a cascade effect throughout the entire food web (Grout et al. 1997). Purple loosestrife leaves decompose quickly in the fall, leaving few available nutrients for detritivores in the spring. Salmon and trout populations rely on healthy spring detritivores populations. The fall nutrient flush causes a direct decline of fish populations that depend on detritivores (Grout et al. 1997). Purple loosestrife changes water quality and chemistry, which can have direct effects on a fish population's ability to reproduce (Ketterer and Abrahamson 2006). Research based in the Pacific Northwest of the US indicates that purple loosestrife would have severe and long-lasting impacts to fisheries populations because of its high potential to spread in salmon habitat in coastal areas and anadromous streams. Both commercial and sport fishing, important industries and recreation pursuits in Alaska, could be negatively affected by purple loosestrife infestations (Pimentel 2005).

4. Agricultural Impacts

Purple loosestrife causes unwanted effects to agricultural lands. Wetland pastures in the northeastern US and Canada, and riparian hay meadows in the west, are susceptible to invasion by purple loosestrife. Low palatability to livestock reduces the quality of forage in affected areas. Additionally, it clogs irrigation ditches, reducing water flow to irrigated areas (Thompson et al. 1987). Purple loosestrife is also an alternate host for cucumber mosaic virus (Royer and Dickinson 1999).

B. Economic Impacts

The negative impact from purple loosestrife in wetland habitats far outweighs any economic gain for horticultural purpose (Thompson et al. 1987). Economic impacts of purple loosestrife include reductions in wildlife viewing, hunting, fishing, subsistence, and recreational opportunities and associated industries, reduced forage value, degraded irrigation systems, reduced productivity of wetland pasture crops, and social and financial costs associated with loss of use to affected areas.

Impacts to wildlife have economic and social impacts on the wildlife viewing, hunting, subsistence, and recreational uses of the affected areas (Van Driesche et al. 2002). Recreational activities such as hunting and trapping may be impacted, as hunting grounds are often lost to monotypic stands of purple loosestrife. Subsistence activities are similarly affected. Loss of bird species impacts birdwatchers and other wildlife viewing opportunities. Loosestrife-congested waterways may obstruct recreational activities such as boating and swimming by restricting water access. Commercial fishing, as well as sportfishing, may also be impacted by fish population reductions.

Purple loosestrife reduces palatability of hay in infested fields. Establishment of the plant in drainage ditches can lower land value, reduce resale value, and increase maintenance burdens on farmers and other landowners. The California wild rice and hay industries are being negatively impacted as purple loosestrife encroaches. Many of the cultivated wet meadows affected by purple loosestrife are harvested for hay that serves a variety of uses, including dunnage for ship cargo, fiber for carpets, and forage and bedding for livestock. Invaded irrigation systems can cause economic losses to agriculture of over 2.6 million dollars annually (Malecki 1990). An estimated 190,000 hectares of wetlands, marshes, pastures, and riparian meadows are affected in North America each year. Heavily infested areas become difficult to mow and manage (Malecki et al.1993).

III. Current Anchorage Population

Monitoring recent manual control efforts on the population in Anchorage shows varied results. The population appears to have spread from a source on the small island to the east of the Spenard Road bridge, first noticed in fall of 2005. Figure 7 (attached map) shows the distribution of populations in 2006, 2007, and 2008. The population was hand-pulled but not precisely documented in 2005. The population included 292 stems in 2006, 289 stems in 2007, declining to five stems in 2008. Individual location tracking indicates that the three recorded locations of stems from 2008 were in the exact same location as two recorded locations of stems in 2007 and 2006. Several 2006 and 2007 stem locations overlap. Appearance of individuals in 2006, 2007, and 2008, after manual control efforts removed every apparent plant, indicates that pulling plants did not immediately eradicate the population.

The potential of new individual purple loosestrife plants growing from the seedbank, spreading from local garden plantings, and resprouting from existing roots is high. Since seeds can remain viable for years, warmer temperature may cause higher germination rates in future growing seasons. Monitoring the site in the upcoming growing season is essential to assess the success of the past control efforts. Specifics on a monitoring strategy are given in Section V, Recommendations.

Figure 4. Purple loosestrife in the Anchorage infestation near Chester Creek (Lori Zaumseil).

Factors that may have contributed to the decline in population are the unusually cool and wet growing season in 2008, and restoration and construction activities taking place in Westchester Lagoon in 2008. The germination requirements for purple loosestrife are temperatures of between 15 to 20 °C (59 to 68 °F). The average temperature in June 2008 was 52.2°F, 2.5°F cooler than normal while the average high

and low temperatures were 59°F and 46°F, respectively. The high for the month was 67°F. In July, the average monthly temperature was 55.4°F, 3°F cooler than normal for July. On the 4th, the high for the month of 72°F was reported (one of only 2 days when the daytime high was more than 70°F), and on the 1st, the low of 40°F occurred. Average daytime high temperatures were 62°F and nighttime lows were 49°F, both of which are several degrees cooler than normal. In August, the noticeable lack of warm afternoons during the first two weeks helped result in a monthly mean 1.1°F below average at 55.3°F. Daytime highs averaged 62°F while nighttime lows were 48°F. The high and low temperatures for the month were 68°F on the 20th and 41°F on the 8th (Alaska Climate Research Center 2008). The reduced 2008 population may have been due to cooler summer temperatures. While the temperatures in July did reach germination temperatures, the recorded highs did not occur for a long period of time. The temperature may have been too low for purple loosestrife to germinate successfully. The dramatic decrease from 2007 to 2008 compared to the lack of any decline between 2006 and 2007, with the exact same treatment applied, indicates that conditions in 2008 were possibly different.

The Westchester Lagoon area is the site of projects being implemented through a partnership between the Municipality of Anchorage, the US Fish and Wildlife Service, other government agencies, private business, and individual citizen partners called "Salmon in the City." The purple loosestrife population is located between two restoration efforts underway through this partnership, aimed at increasing healthy salmon populations in Anchorage by improving fish passage, stream structure, and riparian health (Lassuy 2007). The water level in Westchester lagoon was lowered in 2008 for construction activities to take place near the mouth of the lagoon. The lowering of the water may have affected the ability of the plants to germinate or to reach maturity by reducing the plant's access to adequate water, although this is unlikely since the overall hydrology of the region was unaffected by the temporary activity.

IV. Control Options

A. Strategies

Several main strategies may be used to manage a population of invasive species. The main approaches (AKEPIC 2005, Claudi et al. 2002) include:

1. Monitoring/No Action

This approach is also called "do nothing" or the "wait and see" approach. Monitoring is recommended even in a no action strategy (Claudi et al. 2002). In areas with large populations, aerial surveys should be conducted to establish yearly positions (Bender 1987). Surveys should be conducted at the same time each year during the flowering stage in order to document advancing and receding boundaries.

Although the monitoring/no action control strategy is relatively low cost, its cost in terms of ecosystem risk can be high. This strategy is not appropriate for purple loosestrife in

Alaska, as this species has already been identified as a serious threat to wetlands in most of North America.

2. Eradication

Complete eradication of an established species can be costly and difficult. For a small population, removal of all individuals can be an achievable goal. The methods in an eradication program are similar to those in a maintenance management program (below). Certain criteria can be applied to a specific population to determine whether an eradication program is appropriate. Before implementation, ensure that:

- Resources are sufficient to see an eradication program through to completion and are commensurate with expected benefits.
- The authority for carrying out an eradication program is clear and sufficiently powerful to allow an individual, agency, or interagency program to undertake all necessary activities.
- The biology and life history of the target organism has been sufficiently researched to form a scientific basis for selecting an appropriate method, with a predictable level of success.

In addition, there must be a reasonable prospect that reinvasion will not reestablish a population that has been eradicated. If the stakes are high enough, resources are sufficient, and the method is effective, eradication may be appropriate, even if occasional reinvasion is likely. Care should be taken so that eradication does not lead to a worse problem, such as opening habitat to other invasive species.

3. Maintenance Management

If eradication fails or is not an option, and a decision has been made to intervene, then the strategy may be to maintain populations of the invasive species at low enough levels to be acceptable. A minimal goal may be to maintain a purple loosestrife population at its present position. A key for success in coping with established purple loosestrife populations is to avoid habitat manipulations or actions that stress the native vegetation (Thompson et al. 1987). Costs in money and labor can be low to high.

4. Ecosystem Management

Management of an entire ecosystem can sometimes create conditions more favorable to native than to introduced species. Most methods involve agricultural principles to address large-scale infestations. Cost in time, labor, and money can be high. In Alaska, the population of purple loosestrife is not large enough to require large-scale ecosystem management strategies.

B. Available Control Methods

Control methods, or combinations of methods, work best when selected with a strong knowledge of the plant's ecology and life history. Managers need to understand the

biology of the plant to be controlled, such as what kind of soil favors the plant's growth, what conditions favor seed germination, how fast the plant grows, what type of life cycle it has (annual, biennial, perennial), how long seeds remain viable, if it reproduces vegetatively (by stolons, runners, rootstock, or rhizomes), what animals or insects feed on the plant, and what kind of climatic conditions the plant grows under. This information is presented in section I. Introduction and Background and discussed throughout the following pages.

The overall control program should be scaled to the size of the infestation. Large (1.21 hectares or greater) and small purple loosestrife populations show different responses to control methods, which vary in time, labor, and monetary investments (Bender 1987). Control options must be carefully evaluated for individual purple loosestrife infestations. Hand pulling can work well for small, isolated populations, while herbicides work well on the scale of a few square meters up to a few hectares. Infestations of thousands of hectares can only be reasonably managed over the long term with the use of biocontrol agents.

1. Prevention

Maintaining habitats so that purple loosestrife cannot invade and establish is an important part of controlling this species. Purple loosestrife is slow to spread in undisturbed habitats due to germination requirements of open conditions (Thompson et al. 1987). Seedlings under favorable conditions tend to be numerous and aggressive, outcompeting other seedlings and resulting in a monotypic stand of purple loosestrife (Skinner et al. 1994). Ground disturbance and degradation of the vegetative canopy should be minimized in areas where purple loosestrife has the potential to spread.

Disturbance that encourages establishment of purple loosestrife in natural habitats has been well documented (Thompson et al. 1987, Bender 1987). It includes manipulation of water levels, natural drawdown of water levels in dry years, dredging, siltation, shore line manipulation, bulldozing, and disturbances to the vegetative mat. Recently disturbed areas should be quickly reclaimed with non-invasive, native vegetation. Any drawdowns planned for the population area should be delayed until the growing season peak has passed in mid-July (Thompson et al. 1987). Purple loosestrife seedlings that germinate after this time usually do not have sufficient time left in the growing season to become well-established, although high light levels in Alaska may alter the peak growing time compared to other locations.

Even in stands of other highly competitive invasives, purple loosestrife seeds readily establish in disturbed areas except in reed canarygrass stands (Landis et al. 2003). Any future management efforts of reed canarygrass in the Westchester Lagoon area should be carefully considered by managers.

2. Manual Control

Hand-pulling is the most selective type of control. This control method is recommended for small purple loosestrife populations and isolated stems. While the monetary costs of

hand-pulling programs are relatively low, particularly if volunteers are used, time and labor costs are high. Monitoring of hand-pulled areas, usually requiring additional hand-pulling efforts, is necessary for several seasons. Proper training is required for participants in the control program.

Cautions: (1) Hand-pulling is literally pulling the plant by hand. Use of a shovel to remove larger, woodier plants increases the risk of missed plant fragments that can resprout. Shovel use also increases ground disturbance, which can increase germination from the extensive seedbank. If shovels are used, keep roots intact and remove all plant fragments. (2) Plant parts should not be composted, as this can spread the population. (3) All participants must be extremely careful not to transport seeds and plant fragments to new habitats on boots, clothing, and other items.

Limitations: (1) Hand pulling is labor- and time-intensive. (2) Root stock or plant parts may be left, and it does not work well for deep-rooted plants. Also, the seedbank is left intact. (3) Hand pulling is often required over several seasons to remove plants that have regenerated.

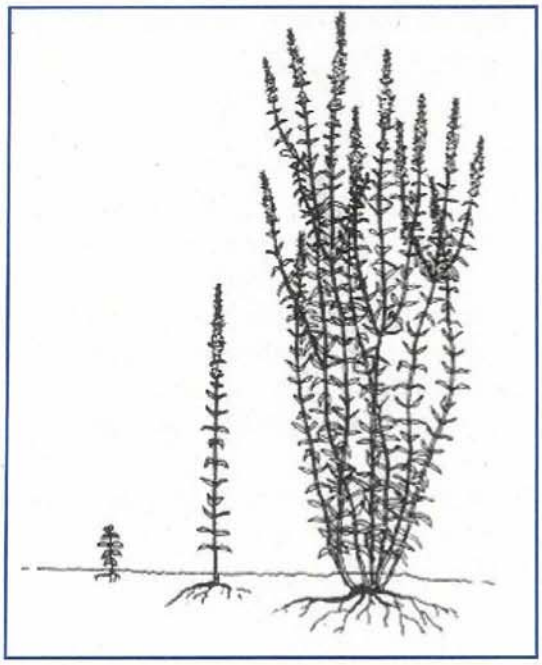

Figure 5. Purple loosestrife seedling, one year-old plant, and three year-old plant. Adapted from Thompson et al. (1987).

Ecological Impacts: Hand pulling is not effective on its own in extensive or dense populations (Tu 2000). Delaying more effective control methods in these situations may allow spread to adjacent or connected habitats.

Method: If purple loosestrife is in flower, cut off and bag all flower heads before pulling the plant. It is important that the entire root stock is pulled, as purple loosestrife will regenerate from root fragments. The area should be monitored regularly until frost, to cut and remove any subsequent flowers and pull missed or regenerating plants. All plant parts should be bagged onsite. Remove bagged plant parts from the area and dispose of as trash.

Winter hand-pulling may be the most effective method of manual control because the area is wetter, the plants pull up more readily and completely, there is less biomass to remove and dispose of, and the area can be revisited the following summer to remove remaining roots that have resprouted (Tu 2000). Although winter pulling is not a practical option in Alaska, pulling may take place in fall, after die-back (senescence) and before the ground is frozen. Generally this would occur between mid-September and early October in Anchorage.

Disturbances to soil and native vegetative cover should be minimized. It is important that participants brush off boots and clothing before leaving the infested area, as the small, lightweight seeds are easily transported. When removing vegetation near streams and wetlands, use barriers to prevent sediment and vegetative debris from entering surface flow.

Timing: Effective hand-pulling takes place before plants have set seed. If hand-pulling takes place while plants are very young, vegetative spread through root fragments is less likely (KCNWCP 2005). If hand-pulling takes place after the growing season, the site should be visited multiple times during the growing season to remove and bag all flower heads, so as to prevent additional contributions to the seed bank.

3. Barriers

Barriers are black polyethylene or landscape fabric stretched over the ground to slow growth and seed production of undesirable vegetation. Barriers are relatively low cost, but are ineffective over the long term. They should be viewed only as an interim or emergency option to control dense seedling infestations. Use of barriers is not an appropriate control treatment in Alaska at this time.

Limitations: (1) Barriers do not kill the roots of mature purple loosestrife plants (KCNWCP). (2) Barriers do not eliminate the existing seedbank. (3) Barriers are susceptible to tearing, and purple loosestrife will grow in these openings. In field trials in Michigan, black plastic needed to be left on the ground for over one year to produce results for purple loosestrife control. Even then, purple loosestrife individuals pushed through the plastic covering (McGowan-Stinski 2009, pers. comm.).

Ecological Impact: Using barriers is a non-selective treatment that prevents growth of all underlying vegetation, impacting both the native community and the invasive species. Once the barrier is removed, lack of native vegetative cover may promote purple loosestrife reestablishment in the disturbance area.

4. Mechanical Control

Mechanical equipment, such as shears, trimmers, or mowers, is used to remove vegetation. This method is not recommended to control purple loosestrife populations. Cost is low, but effects are limited. If timed correctly, mowing may prevent flowering and seed set. If mowing takes place too early, resprouting of mowed plants can occur in the same season. This control method may be used as a stop-gap measure, until more effective means can be employed. It is not recommended for Alaska populations.

Cautions: (1) This control method may ultimately exacerbate the problem by encouraging vegetative reproduction. (2) Mowing can result in the spread of seeds. (3) Equipment, if not cleaned properly, may transport seeds and plant fragments to new habitats.

Limitations: (1) Mechanical control will not eliminate the seedbank. (2) Mowing will produce plant and root fragments, from which purple loosestrife will reproduce. (3) If cut too early in the year, purple loosestrife can resprout, flower, and set seed that same season (Skinner et al. 1994).

Ecological impact: In open marsh habitats that have been colonized by purple loosestrife, heavy equipment use will generally benefit this species. Purple loosestrife can reproduce from adventitious buds growing from crushed stem segments.

Method: If large areas of purple loosestrife are removed through mechanical control methods, replant with native or non-invasive vegetation to stabilize the soil against erosion and prevent re-invasion by purple loosestrife. Clean all equipment before transporting off-site. Prevent water used for cleaning from entering storm drains.

5. Cultural Control

Cultural control is an ancient agricultural approach and a key component of early integrated pest management in agricultural systems. Replacement may be the most useful form of cultural control for treating infestations of purple loosestrife. Because no infestations are known from agricultural lands in Alaska at this time, cultural control is not recommended.

a. Fire

Fire is a cost- and labor-intensive control method that can be used to manage some invasive species by burning off all aboveground biomass. In some species, seed germination or regrowth may be inhibited. Purple loosestrife growth may instead be encouraged by fire.

Michigan purple loosestrife control efforts have included the use of fire to burn off all aboveground purple loosestrife biomass, resulting in rapid colonization of the disturbance site by purple loosestrife seedlings. This was an expected result as managers used fire to encourage germination of the seedbank. The seedlings were then treated using other means, such as chemical control (McGowan-Stinski 2009, pers. comm.).

Cautions: Fire as a control option requires extreme care and planning, as well as specialized wildland fire training to implement.

Limitations: (1) Purple loosestrife is not susceptible to this method of control. Its overwintering growing points on the crown of the rootstock are fairly well insulated from the heat of a fire, unless it penetrates to their location at about two centimeters below the soil surface (Thompson et al. 1987). (2) This method of control does not eliminate the seedbank.

Ecological Impact: (1) Fire is a non-selective control method. (2) Using fire as a treatment to control purple loosestrife can open a disturbance area that may be reinvaded

by purple loosestrife or other invasive species. Carpets of purple loosestrife seedlings reappeared after a controlled burn of herbicide-killed purple loosestrife (Skinner et al. 1994).

b. Flooding

Flooding is a control treatment option in areas where the water level can be controlled. It has demonstrated some success in suppressing growth of purple loosestrife seedlings. Shallow flooding has the most potential as a control treatment if it occurs before plants grow tall enough to survive as aquatic emergents. Flooding may also promote growth of purple loosestrife in new shallow water habitats and in formerly flooded areas after drawdown takes place, such as newly exposed mudflats. This control effort is not recommended for purple loosestrife control in Alaska.

Limitations: (1) Flooding will not eliminate the seedbank. (2) When the water level is again dropped, it is likely that seeds will germinate in the disturbance area.

Ecological Impact: Flooding is a non-selective control method that may be detrimental to desirable, native vegetation. Flooding may promote the spread of purple loosestrife to shallow areas.

Method: Survival of purple loosestrife individuals, most likely mature plants, has been noted for several years in water depths of up to one meter. Flooding to at least 70 centimeters will kill most first-year plants (Thompson et al.). It may be necessary to flood an area in excess of seven weeks to ensure that seedlings do not survive (Skinner et al. 1994).

c. Saltwater Intrusion

This control method was used in attempts to reduce the vigor of the purple loosestrife population in Parker River National Wildlife Refuge, Massachusetts (Thompson et al. 1987). Although purple loosestrife may not tolerate salinity well, there is little mention of this control method in recent literature. As a non-selective method with undesirable consequences to native vegetation and soil and water quality, including possible longer-term ecological consequences, this is not a recommended control option in Alaska.

d. Replacement

Replacement of purple loosestrife populations with non-invasive species has been attempted in several wildlife refuges (Bender 1987). Species competitive with purple loosestrife may be used to successfully control the spread of this invasive on buffer property surrounding natural areas or infested sites or in newly exposed areas. Replacement should be considered on a case-by-case basis. When summer drawdown of water levels in purple loosestrife-infested wetlands is necessary, seeding exposed muck flats with Japanese millet is a good temporary measure to prevent purple loosestrife growth (Thompson et al. 1987).

Intentional plantings of Japanese millet (*Echinochloa frumentacea*) have been shown to outcompete naturally generating loosestrife seedlings. Millet seeding was especially successful on deep-muck sites (Thompson et al. 1987). Japanese millet status in Alaska is currently undocumented. Curlytop knotweed (*Polygonum lapathifolium*) seedlings, when intentionally planted, have been demonstrated to compete successfully during a native replanting of marsh drawdown study areas. This success was demonstrated when planted immediately after drawdown had occurred (Thompson et al. 1987). Curlytop knotweed is listed on the state invasive species list (AKEPIC 2008) and is not recommended for use in Alaska.

Cautions: (1) Introducing a new species to the state without any testing of potential spread is undesirable.

Limitations: (1) Replacement does not eliminate the seedbank. (2) This may be a time and labor-intensive method if manual seeding takes place, and thus may be a less useful control method on large expanses of newly exposed flats or in remote areas.

Ecological Impact: Replacement of purple loosestrife with other non-native species may change the character of the natural area, an effect that may not be desirable. In some cases, replacement may be as detrimental as the previous purple loosestrife infestation.

Recommendations: When using replacement as a control method, species selection should be done carefully. Seed or plant the area using a minimum disturbance technique (Thompson et al. 1987).

6. Chemical Control

Chemical control uses pesticides, of which herbicides are a subset, to kill plants. Options include both non-selective (all plants are targeted) and selective herbicides (only a specific plant or group of plants is targeted). Non-selective herbicides are generally more effective in control of purple loosestrife than selective herbicides. While chemical controls yield results, repeated treatments are often needed and can be costly. Long-term effects of chemical controls on natural systems are not fully understood.

In Alaska, training and certification by the Department of Environmental Conservation (ADEC) is required by state law for commercial use of pesticides or any restricted-use pesticides. Some common household herbicides (such as RoundUp) require no special certification. Before use of any pesticide, it is important to consult the latest regulations regarding permissible and recommended pesticides.

Pesticides are usually combined with an adjuvant and a surfactant. Adjuvants are substances other than water which enhance or are intended to enhance the effectiveness of the pesticide with which they are used. Adjuvants for use with agricultural pesticides are categorized by function and purpose. Many states require registration of adjuvants and surfactants (see Appendix C for links to definitions through the Pesticide

Management Education Program (PMEP), Cornell University). Surfactants (**surf**ace **act**ing ag**ents**) are materials that reduce the surface tension of water when used in very low concentrations, such as soap. Pesticide surfactants are nonionic (do not ionize, but have a slight electrostatic charge due to the polarity of dissimilar atoms in the molecule), anionic (ionized, have a strong negative charge), or cationic (ionized, have a strong positive charge). Further pesticide definitions are given in Appendix C, Montana State University Pesticide Glossary.

a. Glyphosate

Glyphosate is the herbicide most commonly used to control purple loosestrife. It is a non-selective, systemic herbicide, available in salt form. Trade names include RoundUp, Rodeo, Accord, Aquaneat, and AquaMaster. RoundUp is not approved for use in aquatic habitats. Glyphosate formulas that are not approved for use in aquatic habitats contain a relatively high percent per volume of pre-mixed surfactants.Glyphosates approved for use in aquatic habitats (such as Rodeo, Accord, and AquaMaster) are not sold as a pre-mixed formula.These glyphosates require the addition of a relatively small percentage of non-ionic surfactant, such as Ortho X-77 Spreader, to be sprayed or broadcast.Glyphosates approved for use in aquatic habitats and are the recommended glyphosates for control of purple loosestrife.

Cautions: Consult the appropriate Material Safety Data Sheet (MSDS), available from the manufacturer, before use of any herbicide (Appendix C provides examples for Rodeo and AquaMaster). Avoid contact with eyes, skin, and clothing. Avoid inhalation. Proper personal protective equipment (PPE) should be worn at all times by those handling and working near herbicides. PPE recommended by Worker Protection Standards (Dow AgroSciences 2008, included in Appendix C) consists of a long-sleeved shirt, long pants, and shoes with socks. Chemical-resistant, waterproof gloves should be worn. Coveralls and safety glasses may be advised. Entry into treated area should be restricted for four hours.

Required certifications: Glyphosate sold as Rodeo, Accord, Aquaneat, and AquaMaster is not listed on state or federal restricted use lists (ADEC 2007).

Permitting requirements: If application of pesticides, including herbicides, is to plants on land, no ADEC permit is required unless the land is owned by the state or by multiple private owners. Application to any waters of the state, including to any plants in waters of the state, requires an ADEC permit. The permitting process takes a minimum of 100 days. Any standing water is considered a water of the state (Hendrickson 2009, *pers. comm.*).

Limitations: (1) Some plants will be missed or will survive the application, so additional applications are often required. (2) This method does not eliminate the seedbank. (3) Glyphosate is a non-specific systemic chemical and will damage adjacent, non-target vegetation. (4) If adjacent vegetation is damaged or killed, purple loosestrife density may increase with seed germination following the removal of competing vegetation.

Ecological impact: The average soil half-life of glyphosate is two months in soil and twelve days to two weeks in water. Glyphosate adsorbs (binds) strongly to soil particles, which prevents its uptake by non-target plants. The mobility potential of this herbicide is low. Strong adsorption can inhibit metabolism of soil microbes but has not been shown to cause significant long term effects on the microbe population (Tu et al. 2001).Glyphosate has relatively low toxicity to birds and mammals, including herbivores, omnivores, and carnivores. It may be moderately toxic to fish. Toxicity is generally higher in the surfactant used than the glyphosate itself.

Recommended methods of application: Care must be taken in choosing the method of application.

(1) Broadcast spraying is not recommended but may be necessary when purple loosestrife vegetation is very dense. Use of the spray technique for glyphosate application should be evaluated on a case-by-case basis. When spraying is necessary, consider applying concentrations of 1% by volume of Rodeo (or other aquatic-approved brand) spray solution to only 25-50% of foliage to avoid overspray (Tu 2000). Low pressure and large drop size is recommended (KCNWCP 2005). When treating water bodies with glyphosate, treat 1/3 to 1/2 of the waterbody at a time. This prevents fish kills due to dissolved oxygen depletion (Tu et al. 2001).

(2) Spot application of glyphosate prevents large holes from developing in marsh vegetation, so competitiveness of desirable vegetation is not affected. Spot application also does not require the use of a surfactant, so it is recommended for use for the Anchorage population. Spot application is suggested through one of the two following methods, which treat individual purple loosestrife plants:

i. Cut Stem Method

Cut off all purple loosestrife stems just below the inflorescence. Using a 2.5 to 5% by volume glyphosate solution (such as Rodeo, a glyphosate with specific gravity (ai) = 53.8%), wipe up the stem and apply directly onto the cut surface using a PVC applicator with sponge tip. Dye may be added to help identify treated plants.

Different opinion exists as to whether the cut should be made at the base of the stem, fifteen centimeters up the stem, or just below the inflorescence (Tu 2000, Bender 1987). Cutting just below the inflorescence is one recommendation (McGowan-Stinski 2009, pers. comm.); if the cut is made too low, the purple loosestrife individual will give up on the leader and resprout from the roots (Tu 2000). In Michigan, solutions of less than 2.5% and more than 5% glyphosate were less effective (McGowan-Stinski 2009, pers. comm.). The glyphosate needs to be absorbed all the way to the roots of purple loosestrife to be an effective control treatment. At concentrations of more than 5%, chemical solution kills plant cells before it can be absorbed.

ii. Bloody Glove Method

Use a 5% solution of Rodeo in a spray bottle, with dye added. The herbicide applicator wears chemical-resistant nitrile or latex gloves on both hands, covered by a fleecy, cotton glove on one hand. Working in a team of two, the applicator follows behind someone removing and bagging the flower heads. The applicator grabs the loosestrife with the cotton-gloved hand, sprays herbicide into that hand (trying not to hit non-target plants), and wicks the herbicide up the top 1/3 of the plant. As the cotton glove becomes saturated, spraying may take place less often. The glove can be re-used after application, if placed in a plastic container with the lid cracked so that the cotton does not become moldy. This treatment was adapted by the Ann Arbor Department of Parks and Recreation from McGowan-Stinski's cut stem technique (Tu 2000).

Timing of glyphosate application: Multiple treatments may be needed through the season for each stage of growth, including active growth during flowering in summer, in fall when plants are mature, and in early spring when seedlings come up (KCNWCP 2005). Some studies show that repeated treatments throughout the season may not be necessary, if application of this herbicide is timed correctly with the first treatment. Glyphosate application during late flowering showed almost 100% shoot reduction and was the most effective of the three stages of growing season treatments in Montezuma National Wildlife Refuge in central New York. Timing of application also affected the establishment of purple loosestrife seedlings. Plots sprayed in June became reinfested with seedlings, whereas the plots sprayed in July and August were free of purple loosestrife seedlings. Application may be most effective at inhibiting growth of, or causing mortality in, mature plants and preventing reinfestation by seedlings in the treatment season if the treatment occurs during late flowering, in August.

b. Broadleaf Herbicides

Broadleaf herbicides (Table 1) are selective herbicides that do not harm monocot species, such as grasses and sedges, which are dominant in many wetland types. Broadleaf herbicide use may be considered for control of large populations of purple loosestrife, where spot application of glyphosate is not practical. Broadleaf herbicide application may be less labor intensive than application of glyphosate because broadcast spraying is a theoretical option. Broadleaf herbicide treatments are costly and may need to be repeated. Effectiveness differs by particular herbicide. Triclopyr is more effective at killing the entire purple loosestrife plant than 2,4-D herbicides (Skinner et al. 1994), but it may need to be applied via spot treatment or cut stem methods in order to be effective (Tu et al. 2001). Triclopyr has greater potential ecological impact than glyphosate, so there may be little advantage to using this selective herbicide. Also, many broadleaf herbicides cost more than glyphosate.

Cautions: Consult the product MSDS before the use of any herbicide.

Certifications required: Due to the wide range of broadleaf herbicides available, the current ADEC Restricted Use Pesticide list should be consulted before use of broadleaf herbicides.

Permitting requirements: The state permitting process, at a minimum, will be the same as for glyphosate application. ADEC should be contacted with details if a broadleaf herbicide is chosen for purple loosestrife control.

Limitations: (1) In order to be effective, broadleaf herbicides must be applied early in the season, when plants may be easily overlooked because they are not flowering. (2) This chemical control method does not eliminate the seedbank. (3) Some plants will be missed in the application of herbicides and some plants will survive application, so additional applications are often required.

Method: Broadcast spraying may be used when effective for the herbicide in question. Regardless of broadleaf herbicide used, encourage growth of monocots to fill in gaps left by purple loosestrife mortality (KCNWCP 2005).

Timing: Application of broadleaf herbicides may be effective if it takes place in late May or early June, when plants have reached 10-15% of mature growth (Bender 1987).

Table 1. Broadleaf herbicides used to control purple loosestrife

Common Name	2,4-D	Imazapyr	Triclopyr-TEA
Forms	Salt, ester (most degrade to anionic form)	Acid, salt	Salt, ester (both degrade to an acid form)
Trade Names - approved for use in aquatic habitats	AquaKleen, Navigate, DMA*4IVM	Habitat	*Not yet approved.* Garlon 3A (salt form), Renovate3
Cautions	• Most forms are highly volatile- do not apply in high temperatures or windy conditions • Can cause severe eye damage • Can be absorbed through skin and lungs		Can cause severe eye damage.
Ecological Impact			
Environmental accumulation	Low	Determined by pH	Moderate
Environmental persistence	Low	Relatively persistent in soil	Acid is relatively persistent
Adsorption to soil	Low (salt) to moderate (ester)	Low	Moderate
Half-life	10 days in soil, <10 days in water; but can significantly increase in cold, dry soils or soils lacking microbial populations	1-5 months in soil. In water, can undergo photodegradation in as little as 2 days. Shorter in cooler temperatures.	30 days in soil
Mobility potential	High (anionic form)	Determined by pH. Above pH 5, can be highly mobile.	Intermediate
Toxicity to aquatic organisms	Most ester forms are highly toxic to fish and aquatic invertebrates.	Low toxicity to fish. Does not affect algae or aquatic vegetation.	Garlon 4 is extremely toxic to fish and aquatic invertebrates, but Garlon 3A is only slightly toxic.
Toxicity to terrestrial organisms	All forms have moderate toxicity to mammals.	• Relatively low toxicity to birds and mammals. • Some forms cause severe, irreversible eye damage.	• Slight toxicity to birds and mammals. • Garlon 3A can cause severe eye damage. • May reduce growth of fungi associated with conifer roots.
Bioaccumulation	Yes	No	?
Recommended Method of Application			
	Most effective on first-year seedlings (Skinner et al. 1994). Reduce volatilization by using corn or cottonseed oil adjuvants. Set spray nozzles to deliver coarse spray. When used as an aquatic herbicide, treat 1/3 to 1/2 of the water body at	Do not broadcast spray. Apply directly to target vegetation during active growth stage (KCNWCP 2005).	Apply 1.5-2% by volume spray solution until plant is wet (Prather et al. 2003, Skinner et al. 1994).May need to be applied through spot treatment, with the addition of a

	one time.		surfactant, or via cut stem method in order to be effective.
Limitations			
	The ability of 2,4-D to control purple loosestrife is inconsistent. Although it may eliminate a year's production of seeds, it does not typically kill the plant (Skinner et al. 1994).	Imazapyr is readily absorbed through roots and foliage and may impact non-target vegetation through drift, run-off, or leaching from the roots of target plants. Target plants may leach chemical from root system and remain unaffected.	The salt form cannot readily penetrate plant cuticles. More labor-intensive than herbicides that can be broadcast sprayed.

Source: Tu et al. (2001). Note: check updated federal and state regulations annually as changes are frequent.

7. Biological Control (Biocontrol)

This method involves the use of herbaceous or parasitic organisms, generally introduced from a plant's home environment, to prey upon an undesirable species in order to limit its distribution and abundance. Biocontrol is considered by many to be the most promising method for managing extensive infestations of purple loosestrife (Landis et al. 2003). This method is usually applied to large scale infestations; smaller scale infestations in proximity may benefit by natural dispersal of biocontrol species. Purple loosestrife infestations in Alaska are not yet large enough to meet this condition.

Results from sites where insects were tested indicate that biocontrol can be an effective method of purple loosestrife suppression. At several biocontrol release sites, complete defoliation of large purple loosestrife stands has been reported; and biomass reductions of more than 95% have been observed in some locations (Van Driesche et al. 2002, Landis et al. 2003). Native plant species appear to be re-establishing at some of the most advanced release sites, and an increase in species richness is generally observed with a decrease in purple loosestrife plant height and percent cover. Ongoing studies are testing the assumption that biocontrol agents are more effective in combination (Myers and Bazely 2003). Although combinations of biocontrol agents may be more destructive to purple loosestrife plants than the use of a single species, these insect herbivores may compete with each other for resources (their host plant), and ultimately impede one another (Van Driesche et al. 2002).

a. Fungi

Spores of native North American fungi of the species *Alternaria alternata, Botrytis cinerea,* and *Phoma sorghina* applied to purple loosestrife foliage via a carrier matrix have been shown to be pathogenic to six-week-old plants (Nyvall and Hu 1997). *Harknessia lythri* also attacks purple loosestrife and may have potential for use as a biocontrol agent (Farr and Rossman 2001). There is little available information on the use of fungi as a control for purple loosestrife beyond these laboratory experiments. This treatment should not be considered an option at this time.

b. Insects

Four species of insects have been approved as purple loosestrife biological control agents in the United States. All four introduced species have been successfully established in North America. There are no known populations of approved purple loosestrife biocontrol agents in Alaska. These insects are:

Galerucella calmariensis and *Galerucella pusilla*
These two leaf beetles, the black-marginated and golden loosestrife beetles, are sympatric species, occurring as natural enemies of purple loosestrife throughout its European home range. *G. calmariensis* populations demonstrate a slower growth in sites with little to no standing water throughout the season (Landis et al. 2003). Adult beetles feed on young plant tissue, while beetle larvae feed on all aboveground plant parts. At high beetle

densities, defoliation of the entire purple loosestrife population may occur. At lower beetle densities, plants may retain foliage; but observed impacts to purple loosestrife individuals are reduced growth of shoots and roots and failure to produce seeds (Van Driesche et al. 2002). Plant height and percent cover may also be significantly reduced (Landis et al. 2003).

Hylobius transversovittatus
The loosestrife root weevil occurs throughout purple loosestrife habitats in Europe, with the exception of permanently flooded sites. Although adults eat leaf and stem tissues, it is the root-feeding larvae that are most destructive to purple loosestrife populations. Herbivory of the roots reduces shoot growth, seed output, and root and shoot biomass. Ultimately, the root-mining weevil can cause plant mortality (Van Driesche et al. 2002).

Nanophyes marmoratus
Adults and larvae of this flower-feeding weevil feed on both leaves and flowers of purple loosestrife plants. Their herbivory causes flower bud abortion, which reduces the seed output of purple loosestrife. More than 70% of the plants at test sites were attacked by the weevil (Van Driesche et al. 2002).

Limitations: It may take several years for a biocontrol agent species' population to become established enough to have moderate to severe impacts to the purple loosestrife population (Landis et al. 2003).

Ecological impact: The four species approved as biocontrol agents for purple loosestrife are largely host-specific. Two native North American plant species may be potential hosts for the *Galerucella* beetles and, with less probability, the loosestrife root weevil (Van Driesche et al. 2002). Swamp loosestrife (*Decodon verticillatus*) and winged lythrum (*Lythrum alatum*) are both closely related to *L. salicaria*. Neither of these plant species is found in Alaska or neighboring Canada (USDA 2009). The flower and seed feeding weevil, *N. marmoratus,* was found to be entirely host specific to *L. salicaria* (Van Driesche et al. 2002).

Noteworthy Control Points

- Monitoring is the first and last step in any control program.
- Minimize disturbance in wetland habitats. Ground and vegetative cover disturbance increases their susceptibility to purple loosestrife infestations.
- Retain a vegetative canopy.
- Most control options will not eliminate the seedbank. Repeat treatments are necessary over several seasons.
- A combination of hand-pulling and treatment with glyphosate, through spot application, is the most effective control method for isolated, small populations of purple loosestrife.
- Larger populations of purple loosestrife are successfully treated in the short-term with herbicide applications. Biocontrol is the only long-term option for large populations.
- Management of purple loosestrife is a success when desirable replacement vegetation develops. Care must be taken so that suppression of one invasive does not open a niche for other invasives!
- Do not promote the spread of reed canarygrass when treating purple loosestrife. Do not promote the spread of purple loosestrife when treating reed canarygrass. Treat them simultaneous where they occur in adjacent areas.

V. Recommendations

In control activities, the threat that a plant poses to ecological, economic, or aesthetic values is balanced against the likelihood of treatment success. Prevention, early detection, and rapid response against new infestations are more likely to succeed than a major assault on a well-established or widespread population (AKEPIC 2005). Given the knowledge of plant biology, history of spread, the current limited distribution, and the effectiveness of available control methods, our recommendation is that the Municipality of Anchorage, Parks and Recreation Department, adopt an eradication strategy for purple loosestrife.

The findings in this report in terms of monitoring, treatment, and education, can be directly applied to any future populations of purple loosestrife that may be found in other Parks or other locations in Anchorage and around the state.

A. Implementation

To implement an eradication strategy for purple loosestrife in Anchorage, the following components and actions are recommended. A suggested five year management plan of actions is given in Appendix F for planning purposes, for both options.

1. Monitoring

- Establish a monitoring plan and enact an early detection and rapid response system (Table 1). Use a standardized form for reporting (see Appendix B for an example).
- Conduct surveys in waterways and wetland habitats around Westchester Lagoon, along Chester Creek, and in waterways with connections to known purple loosestrife populations to identify newly-establishing populations.
- Monitor the known population. Survey these areas in August for seedling growth and again in September, when the plants are in flower and are easiest to detect.
- Monitor treated populations multiple times throughout the growing season for re-establishing plants or plants missed during treatment.
- Monitor for at least five growing seasons to identify the need for repeated treatments and/or additional control measures and to ensure effective eradication of the purple loosestrife population.
- Maintain consistent records within the managing authority.

2. Prevention

- Consider ground disturbance activities taking place in the Westchester area associated with the current restoration project or for any other reason. Minimize ground disturbance, including the use of heavy equipment that could damage native vegetative cover.
- Clean any equipment used in areas where purple loosestrife has been observed before its use in other areas. Do not allow water used for washing this equipment to enter storm drains. Ensure that all volunteers that may work in the area on control actions are informed of proper procedures to minimize spread.
- Carefully time water level manipulations in the Westchester area. In order to discourage the spread of purple loosestrife from the existing seedbank at Westchester Lagoon, any planned drawdowns should take place after mid-July.

> "A process that assesses and grades the impact of harmful alien species could lead to priority-setting initiatives and remedial planning. Sound scientific assessments and remedial plans to deal with these unwanted aliens would have to be part of an action program that could be endorsed politically and publicly" (Claudi et al. 2002).

3. Control Methods

Option 1: Hand pulling only:

- Hand-pull young plants before they have set seed. Purple loosestrife begins flowering in late July and continues until late September in Anchorage. As the same plant can have flowering stalks and fruiting stalks, it may be necessary to visit the same site multiple times.
- Bag all fragments on site and dispose of as trash.
- Do not compost any plant parts.
- Inform volunteers about proper methods to prevent spread on their footwear, clothes, or belongings.

- Repeat the hand-pulling as necessary throughout the season, if funding allows.
- Revisit the site in October to observe any stems prior to fall die-back.
- Repeat monitoring every season for at least five years.
- If populations increase beyond the boundary and number of stems in 2007, consider applying chemical methods.

Option 2: Hand pulling with spot application of herbicide

"A process that assesses and grades the impact of harmful alien species could lead to priority-setting initiatives and remedial planning. Sound scientific assessments and remedial plans to deal with these unwanted aliens would have to be part of an action program that could be endorsed politically and publicly" (Claudi et al. 2002).

- Hand pull the population as described in Option 1 above. Focus on younger plants that are easier to remove. When performing hand pulling actions, identify any large, old, or particularly difficult to remove individuals with flagging for spot application of herbicide.
- Select the desired herbicide to use for spot application. The recommended chemical is an aquatic-approved glyphosate product. There are many trademark glyphosate brands approved for use in aquatic habitats, including Rodeo, Accord, Aquaneat, and Aquamaster.
- IMPORTANT: Read all information on the herbicide label. All instructions must be followed for the chemical to work safely and effectively.
- Check with the State of Alaska's Department of Environmental Conservation's Pesticide Control Program (Environmental Specialist: Rosemarie Lombardi V.M.D. (800)478-2577 or (907)376- 1870, http://www.dec.state.ak.us/eh/pest/index.htm) for any specific regulations that may apply to the chemical and the application site.
- If the herbicide application is to be performed by an outside agency, organization, or a contractor, ensure that all applicators are certified. Parks and Recreation may be able to partner with an agency for herbicide application, if a certified applicator is available. For contracting this type of work, check with well-established landscape and nursery companies. Generally, a infestation in the size of the 2007 infestation would cost approximately $350 to $500 for a contractor landscape company to spot apply the herbicide as described.

- Ensure that all applicators are wearing proper protective equipment.
- Use the spot application cut stem method procedure to treat older, well-established plants that are deeply-rooted with glyphosate.
- Cut off all purple loosestrife stems just below the inflorescence. Use a 2.5 to 5% by volume glyphosate solution approved for use in aquatic habitats (such as Rodeo, a glyphosate with specific gravity (ai) = 53.8%), wipe up the stem and apply directly onto the cut surface using a PVC applicator with sponge tip. Dye may be added to help identify treated plants.
- Apply this herbicide treatment during late flowering, in late August or September. Monitor populations during the growing season to identify the optimal time for application.
- Repeat the chemical treatment as necessary for five years. Continue monitoring efforts each growing season.

4. Education

- Undertake a public education campaign to illustrate the importance of purple loosestrife control and prevention in the Municipality of Anchorage, and the entire state. See section VI. Public Education Framework. Adopt the messages described in Section V.B. Rationale.
- Increase public and agency understanding of the tradeoffs involved in not treating the population by illustrating the potentially far ranging, widespread effects of infestation versus the short term effects of treatment, including pesticide use.
- Spread the message of how devastating the effects of purple loosestrife could be to Alaskan ecosystems if the population is not treated immediately by any means necessary. Major outreach is needed to spread the message around the state to the public. It is important to state and reiterate the message that the time for action is now, and to give the scientific reasons outlined in this report why this is so.
- Identify constituents, organizations, groups, agencies, and stakeholders that may be uncertain about chemical methods. It is critical to employ proactive outreach to these groups to allow the use the application of chemicals for control. Focus on the message of time, space, and severity (short time application versus long term purple loosestrife effects; small area of application versus large areas potentially infested; minor to no environmental effects versus large-scale, devastating, and increasingly severe impacts to Alaskan ecosystems).
- Work with agencies, organizations, and other groups involved in invasive species management to adopt a message as part of their strategic work with invasive species in Alaska.
- Work specifically with garden clubs, Master Gardener Associations, Nurseries, and the Alaska Botanical Garden to employ a "seek and destroy" program for purple loosestrife and its cultivars.

B. Rationale

Invasive species can rapidly spread over a large geographic area, causing widespread and severe impacts to natural habitats. This is demonstrated in the history of purple loosestrife invasion over many parts of North America. With the current small population size and early stage of infestation, it is critical that the Anchorage Parks and Recreation Department implement a plan for effective purple loosestrife eradication as soon as possible.

Large-scale infestations can happen in Alaska. Populations of white sweetclover cover vast hectares of river corridors in many parts of the state. Bird vetch has spread along many miles of Alaska highways. Other species are increasing each year, and more and more non-native species are brought to the state. Focusing on high-risk species with small populations is the best approach to prevent wide-scale ecosystem damage.

Timing is critical. At this population size, it is worth the investment to treat each plant individually through a combination of hand-pulling and chemical control (McGowan-Stinski 2009, pers. comm.). These control methods will allow managers to target a small but critically important area. If chemical control methods are not currently acceptable, focus on hand-pulling, and work to increase support for spot application of herbicides to treat the older and larger plants.

Impacts to fish and wildlife of an established purple loosestrife population are long-lasting and increase over time. Effects to salmon populations in Alaska are potentially terrible if critical habitats are overtaken by purple loosestrife. Bird populations will decline if habitat is eliminated by large-scale purple loosestrife populations.

Balancing potential impacts is important. When thinking about invasive species populations, and framing a message to stakeholders, consider time, space, and severity. Herbicide is only applied to a small space, but purple loosestrife, if not treated, can cover vast hectares of land. Herbicide application is fast, and chemicals break down quickly. Purple loosestrife effects are long-lasting and continue to cause worse problems over time. Finally, the negative impacts of herbicides are low, regulated, and carefully considered before application. The impacts of uncontrolled spread of purple loosestrife are severe and potentially irreversible.

Using chemical control. Manual, chemical, and biocontrol methods have demonstrated the most success at controlling purple loosestrife populations in the rest of North America. Biocontrol is not a viable option in Alaska at this time, as the purple loosestrife population is small. Investment in a control program should be at a scale commensurate with the scale of the infestation. Biocontrol would take time and money far beyond that which can be rationalized for the current Anchorage infestation. Biocontrol is additionally most successful in locations where the control agents can move back and forth between populations of purple loosestrife. The Anchorage population is isolated. Thus, a combination of hand-pulling and chemical control is our best and most effective remaining option for an eradication strategy.

One approach alone may not be enough. Examination of the data on locations of purple loosestrife plants from 2006 to 2008 indicates that manual control efforts alone did not prevent plants from resprouting in the same location. Spot application of herbicide will help remove plants that resprout by systematically killing the entire plant, including the roots.

Hand-pulling, while labor- and time-intensive, is an effective means of eradicating small purple loosestrife populations, such as the population at Westchester Lagoon and Chester Creek. However, hand-pulling is limited in that it is not effective for eliminating large and well-established plants. Pulling or digging these plants may create easily overlooked plant fragments. Purple loosestrife has demonstrated great success at reinvading a site through vegetative reproduction, in combination with seedling establishment from the existing seedbank.

Selection of glyphosate as a recommended chemical control. Application of glyphosate herbicides has demonstrated great success at eliminating mature purple loosestrife individuals, through absorption of the solution all the way to the roots. As this herbicide is non-selective, spot application is the safest treatment option to avoid impacts to surrounding vegetation. The cut stem method treats individual purple loosestrife plants with a low dose of aquatic-habitat-approved glyphosate. Glyphosate has relatively low toxicity to wildlife. The aquatic-habitat-approved solutions have relatively low toxicity to fish and other aquatic organisms. Herbicide application takes place once or twice in a season, and the chemical is not lasting in either terrestrial or aquatic habitats.

VI. Public Education Framework

The evidence of a problem with any invasive species must be presented to the public in a way that people can understand. An important step in an eradication and prevention strategy is building public awareness of the existence of purple loosestrife and its potential threat to Alaska's ecosystems. The challenge in Alaska is two-fold. Purple loosestrife is not a species that has been in the spotlight in Alaska. The present population is its first known occurrence, outside of intentional plantings in gardens. This presents the second challenge of a public education campaign, changing public attitudes toward *Lythrum* varieties. One of the biggest challenges to preventing the spread of purple loosestrife is that it is a popular garden plant that is still widely available commercially.

> "A major task is to link the potential extensive presence of purple loosestrife with the absence of other things, to convince the public that this beauty is a beast" (Claudi et al. 2002).

A strategy for increasing awareness and getting public buy-in for purple loosestrife control in Alaska includes the following components:

A. Present Scientific Evidence

The purple loosestrife problem needs to be brought to the public's attention through effective use of communication tools and education initiatives. Build upon initiatives already in place for invasive species education in Alaska, adding purple loosestrife-specific information and materials. One example of an initiative that might include purple loosestrife is the Invasive Plants Taking Root in Alaska curriculum for Grades 9-12, designed by the Homer Soil and Water Conservation District (SWCD) in cooperation with the USDA Forest Service (see Appendix D for details and more examples).

Presentation of factual information is critical. Have professional public relations staff work with scientists to capture a concise and accurate message for presentation in brochures and other materials in a way that anyone in the public can understand.

The public may want a specific measurement of loss or impact. Prepare honest, factual responses to potential questions and resistance in advance. Realize that no one can have all the answers, so be prepared to admit to a lack of information or data. If appropriate, give assurance that an answer is coming with some further research.

Talk to your audience about specific issues. Some gardeners argue that *Lythrum* (loosestrife) varieties in interior Alaska respond as annuals due to the cold temperatures and are not an invasive threat in the seasons following intentional planting. However, both annuals and biennials are known to be invasive, often due to copious seed production and early growth of seedlings. Both of these traits characterize purple loosestrife. Share the message that both annuals and biennials, along with perennials, can be invasive and potentially damaging to Alaska.

Link purple loosestrife infestation to a potential decline in salmon populations. Although scientific evidence is limited, a number of studies show that purple loosestrife can reduce habitat for salmon to reproduce in, leading to a population decline. Every Alaskan cares about fish.

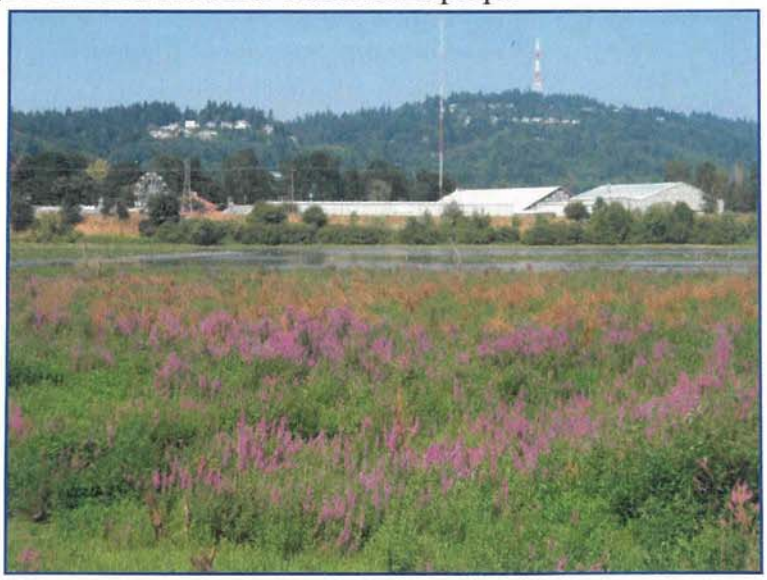

Figure 6. Purple loosestrife growing throughout a Municipality of Portland Parks and Recreation site, Oaks Bottom Wildlife Refuge. An important message is that we don't want Anchorage Parks to look like this! Photo by Blythe Brown.

B. Communicate to the Public and the Media

Consider the success of other local campaigns, such as Alaska Grown. Alaskans are proud of Alaska. Find ways to make local pride part of the campaign. Promote the idea of a weed-free Alaska as a desirable condition that all Alaskans, as well

as visitors, can enjoy over time and be proud of. Include the idea of involving children, and preserving our landscape and our resources for future generations.

Design an attractive, simple brochure with an eye-catching title. One of the original brochures used in Canada for their extensive public purple loosestrife control campaign was called "Beautiful Killer." This provocative title was used as a catalyst to start their control program. The first document should be hard-hitting, factual, and dramatic, yet hopeful. Follow it by increasingly positive and constructive messages and brochures. Incorporate the key messages in section V. B. Rationale.

Brochures work well with good distribution, particularly if paired with other media. These days, website links are important to reach the public, but they risk the danger of becoming outdated. Employ web sites only if a commitment can be made to keep the information relevant.

Consider local radio campaigns by creating a public service announcement (PSA) about the potential dangers of purple loosestrife, and the need for rapid action. Parks and Recreation has already successfully used PSAs for invasive species issues in municipal park lands. Having local media on board is valuable in spreading the message of the problems the invader can cause.

C. Build Support through Involvement

In Alaska, since our purple loosestrife population is small and perhaps not easily noticed, maintaining support for a detection and response program is key to keeping the plant in the public's eye. Public and interest group involvement and concern can help accelerate general awareness and control efforts.

Involving local interest groups, organizations, outing clubs, and associations is an important step in spreading the message about purple loosestrife. Some local groups that are directly involved in invasive species issues around Anchorage are the Anchorage Cooperative Weed Management Area (ACWMA), which meets monthly to discuss and plan actions for invasive populations around the municipality. Another group is Citizens Against Noxious Weeds Invading the North (CANWIN). Some local nurseries feature native plants and offer native plant alternatives to possible invasive species. Statewide, the Committee for Noxious and Invasive Plant Management in Alaska (CNIPM) and the Alaska Invasive Species Working Group (AISWG) provide resources, information, and a framework for sharing information about invasive species. Native plant conservation and study in Alaska has wide support. University of Alaska – Fairbanks, Cooperative Extension Service, has a variety of resources about gardening and pest management. The Alaska Botanical Garden features many gardens with native plants, and has been pro-active in identifying and removing other potential invasives in their gardens. They also offer some Alaska-grown native plants in their retail section. The Alaska Native Plant Society studies and conserves Alaska native plants. Outing or sport club groups, school groups, and after-school organizations may be interested in issues affecting local parks and statewide wildlands. Boy and Girl Scout groups are often willing to participate in

invasive plant control as a service project. Further resource links are found in Appendix E.

In building a support network, include representatives of groups that use, trade, sell, or support the plant in the campaign to stop its spread. These groups might include the horticultural industry, the Alaska Master Gardener Association, Anchorage Chapter, landscaping companies, and local business owners who use landscaping services. Convince these groups to stop selling garden cultivars of loosestrife and seed packets that might contain loosestrife. Provide these groups with information pamphlets, such as the Pocket Guide to Responsible Landscaping in Alaska or the Voluntary Codes of Conduct for both nursery professionals and for the gardening public (both included in Appendix D). The Pocket Guide includes information regarding invasive species and suggested alternative species for gardens and landscaping. Spreading the word at these local annual events and trade shows is a great way to get information to target audiences:

- Fur Rendezvous, Dimond Center, March
- Alaska Pesticide Applicator Training Recertification Conference, UAA, March
- Alaska Botanical Garden Spring Conference, UAA, April
- Spring Garden Show, Mall at Sears, April
- Alaska Women's Show, Sullivan Arena, April
- Master Gardener Conference, The Alaska Zoo, May
- Alaska Botanical Garden Annual Garden Fair and Garden Art Show, June
- Alaska Garden and Art Festival, Palmer State Fairgrounds, July
- Home Remodeling and Redecorating Show, Sullivan Arena, August
- Alaska State Fair, Palmer, August to September
- Fall Home and Garden Show, Sullivan Arena, September

Source: Michael Rasy, CES-UAF

Building a support network for control activities is an essential step in eradication. Hand pulling and manual control methods rarely invite controversy. However, the use of pesticides is often a source of public concern. Early and sustained contact with groups, organizations, and agencies that may oppose or be uncertain about the use of pesticides for control is important to gain the support of these entities for the combination of manual control and chemical control. Outreach efforts should focus on the probable long-term negative effects of purple loosestrife and the short-term potential effects on control, discussed in section V.B. Rationale. The support of these groups for control activities would provide an even stronger framework for state-wide outreach, due to the variety of user groups represented. Some may be powerful allies and supporters of control, given the potential negative effects on fish and wildlife species. Some groups are likely already involved in many Municipality activities. Groups that may be interested in control activities that involve chemical control include, but are not limited to, the following:

- Alaska Center for the Environment, ace@akcenter.org, http://www.akcenter.org/
- Alaska Clean Water Alliance, acwa@seaknet.alaska.edu
- Alaska Community Action on Toxics (ACAT), info@akaction.net, http://www.akaction.org/

- Alaska Conservation Alliance, unite@akvoice.org, http://www.akvoice.org/
- Alaska Conservation Foundation, acfinfo@akcf.org, http://www.akcf.org/
- Alaska Forum for Environmental Responsibility, afervdz@alaska.net, http://www.alaskaforum.org/
- Alaska Friends of the Earth, holloway@alaska.net
- Alaska Marine Conservation Council, amcc@akmarine.org, http://www.akmarine.org/
- Alaska Rainforest Campaign, info@akrain.org, http://www.akrain.org/
- Alaska Wilderness League, info@alaskawild.org, http://www.alaskawild.org/
- Alaska Wilderness Recreation and Tourism Association, awrta@alaska.net
- Alaska Wildlife Alliance, awa@alaska.net, http://www.akwildlife.org/
- Anchorage Waterways Council, awc@alaska.net, http://www.anchwaterwayscouncil.org/
- Center for Alaskan Coastal Studies, cacs@xyz.net, http://www.akcoastalstudies.org/
- Cook Inlet Keeper, keeper@xyz.net, http://www.inletkeeper.org/
- Defenders of Wildlife, http://www.defenders.org/index.php
- Greenpeace Alaska, dritzman@dialb.greenpeace.org
- Kachemak Bay Conservation Society, kbcs@xyz.net
- National Audubon Society, Alaska Regional Office, jschoen@audubon.org
- National Wildlife Federation, Alaska Office, turrini@nwf.org
- The Nature Conservancy of Alaska, http://www.nature.org/wherewework/northamerica/states/alaska/
- The Ocean Conservancy, Alaska Field Office, cmc@arctic.net
- Prince William Sound Regional Citizens' Advisory Council, rcac@anch.pwsrcac.org, http://www.pwsrcac.org/
- Sierra Club Alaska , Alaska Field Office, nw-ak.field@sierraclub.org
- The Wilderness Society, Alaska Regional Office, allen_smith@tws.org
- Wildlife Federation of Alaska, wfa@micronet.net

Make it easy for these groups to identify loosestrife cultivars, which can reproduce and invade, by providing a list of garden varieties, including:

- *Atropurpureum*
- Brightness
- Columbia Pink
- Dropmore Purple
- Firecandle
- Flashfire
- Floralie
- Florarose
- Gypsy Blood
- Happy
- Lady Sackville
- Morden Gleam
- Morden Pink
- Morden Rose
- Pink Spires
- Purple Dwarf
- Purple Spires
- Robert
- Rose Gem
- Rose Gleam
- Rose Queen
- *Roseum superbum*
- Rosy Glow
- The Beacon
- The Rocket
- *Tomentosum*

Source: Minnesota Sea Grant (2009)

Include interested members of the public in the purple loosestrife control plan through programs such as Citizen Weed Warriors. Establish a reporting method that is standardized and easy to use.

With increased public education and awareness of purple loosestrife threats to Alaska, implementing an early detection and rapid response (EDRR) system will increase reporting of suspected populations in Anchorage and elsewhere. The existing online system for Alaska, EDDMapS, can be accessed online through the CNIPM or AISWG websites, or directly at: http://www.eddmaps.org/alaska/report/report.cfm. The Alaska Department of Fish and Game also has an invasive species reporting line (1-877-INVASIV, or 1-877-468-2748).

Parks and Recreation might also consider instituting its own reporting mechanisms, which can work with those already in place.

D. Deliver Solutions

Actual delivery of the solution can be a time consuming and expensive part of the program. Maintaining interest over time is difficult. Demonstrate your commitment to purple loosestrife control while simultaneously asking the public for a commitment. Make information regarding the status of the current purple loosestrife population and control efforts available and easily accessible.

Be sure to highlight any program successes annually to provide stakeholders with a sense of accomplishment and the feeling of belonging to a common solution. Program successes can be highlighted on websites, as a PSA thanking the community and other stakeholders for their support in control efforts, and as announcements at board meetings and at conferences. Always thank participants for their efforts.

Parks and Recreation should consider a replacement plant campaign, in which non-invasive plants would be substituted for purple loosestrife cultivars planted in private, local gardens. Attractive replacement species could be provided by interested local gardeners, commercial nurseries, the Alaska Botanical Garden, and the Municipality greenhouses. Native species that are good replacements for purple loosestrife include fireweed (*Chamerion angustifolium*) and lupine (*Lupinus* spp.). A wide variety of alternative perennial plants with similar growth form and color are available. Alternatives that are may be appropriate for Alaska include:

- Lilies (*Lilium* spp.)
- Blue flag iris (*Iris versicolor*)
- Siberian iris (*Iris sibirica*)
- Spiked speedwell (*Veronica spicata*)
- Siberian iris (*Iris sibirica*)
- Spiked gayfeather, Blazing star (*Liatris* spp.)
- Garden sage (*Salvia sp.*)
- Purple coneflower (*Echinacea purpurea*)
- Blue vervain (*Verbena hastata*)
- Cardinal flower (*Lobelia cardinalis*)
- Delphinium (*Delphinium* spp.)
- False spirea (*Astilbe* spp.)
- Foxglove (*Digitalis purpurea*)
- Joe-pye weed (*Eupatorium* spp.)
- Obedient plant (*Physostegia virginiana*)

Sources: Ellis (2007), Ducks Unlimited Canada (2009)

Care should be taken with any non-native perennial before planting or advocating use to assess its potential to escape and become another invader.

E. Generate Political Support

Concern for the natural resources that may be harmed by invasives in Alaska is of primary importance in obtaining the support of the public and the politicians. With proper presentation and framing of the issues regarding invasive species, the public and political support will follow. Political support for invasive species prevention, education, control, and management has been growing. Alaska has maintained a prohibited and restricted noxious plant list (11 AAC 34.020), which was updated in 2006. On June 24, 2008, as part of Alaska Weeds Awareness Week activities, Governor Sarah Palin signed House Bill 330, "an act relating to noxious weed, invasive plant and agricultural pest management and education." The legislation directed the Alaska Division of Agriculture to establish the now-filled position of weed and pest coordinator for the state. Currently, House Bill 12 proposes an Alaska Council on Invasive Species. It is important for stakeholders to lobby legislators, especially focusing on the idea that in Alaska we have the chance to catch the problem early.

Attachments

Figure 7: Map: Purple Loosestrife Locations 2006 - 2008 (Westchester Lagoon)

Authors

Elizabeth Bella (lead), Vegetation Ecologist
elizabeth.bella@hdrinc.com
907-644-2118
HDR Alaska, Inc.
2525 C Street, Suite 305
Anchorage, AK 99516

Megan Boldenow, Ecologist
megan.boldenow@hdrinc.com
907-328-3322 ex. 2
HDR Alaska, Inc.
714 4th Avenue, Suite 302A
Fairbanks, AK 99701

Technical Support (GIS):
Bridget Brown, Senior GIS Analyst
bridget.brown@hdrinc.com
907-644-2067
HDR Alaska, Inc.
2525 C Street, Suite 305
Anchorage, AK 99516

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References

Alaska Climate Research Center. 2008. Alaska climatology monthly means for 2008. http://climate.gi.alaska.edu/Summary/current_sum.html.

Alaska Department of Environmental Conservation (ADEC). 2007. Alaska Pesticide Management Plan to Protect and Restore Water Quality. Anchorage, AK.

Alaska Exotic Plant Information Clearinghouse (AKEPIC). 2005. Invasive Plants of Alaska. Alaska Association of Conservation Districts Publication. Anchorage, AK. 294 p.

------. Non Native Plants of Alaska Database. http://akweeds.uaa.alaska.edu/

Anderson, W. 1995. Interaction between *Lythrum salicaria* and native organisms: a critical review. Environmental Management 19:225-231.

Balogh, Greg. 1985. Ecology, distribution, and control of purple loosestrife in northwest Ohio. Annual report from October 1984-September 1985. Cooperative Wildlife Research Unit, Ohio State University.

Barlocher, F., & N. R. Biddiscombe, N.R. 1996. Geratology and decomposition of *Typha latifolia* and *Lythrum salicaria* in a freshwater marsh. Archiv fuer Hydrobiology 136:309-325.

Batra, S. W. T., D. Schroeder, P. E. Boldt, & W. Mendl. 1986. Insects associated with purple loosestrife (*Lythrum salicaria* L.) in Europe. Proceedings of the Entomological Society of Washington 88:748-759.

Bender, J. Element Stewardship Abstract for *Lythrum salicaria*. 1987. The Nature Conservancy (TNC). Arlington, VA.

Blossey, B., & R. Notzold. 1995. Evolution of increased competitive ability in invasive non-indigenous plants: a hypothesis. Journal of Ecology 83:887-889.

Blossey, B., L. Skinner, & J. Taylor. 2001. Impact and management of purple loosestrife (*Lythrum salicaria*) in North America. Biodiversity and Conservation 10:1787-1807.

Claudi, R., P. Nantel, & E. Muckle-Jeffs. 2002. Alien Invaders in Canada's Waters, Wetlands, and Forests. Natural Resources Canada, Canadian Forest Service, Science Branch, Ottawa, Canada. 320 p.

DiTomaso, J. M., & E. A. Healy. 2003. Aquatic and Riparian Weeds of the . Publication 3421. University of California Agricultural and Natural Resources, Oakland, CA. 442 p.

Ducks Unlimited Canada. 2009. Purple Loosestrife in Western Canada. http://www.purpleloosestrife.org/infosite/

Ellis, D. R. 2007. Purple Loosestrife is Not Just Another Pretty Plant. University of Connecticut Integrated Pest Management, Storrs, CT. http://www.hort.uconn.edu/IPM/general/biocntrl/notprty.htm

Emery, S. L. & J. A. Perry. 1996. Decomposition rates and phosphorous concentrations of purple loosestrife (*Lythrum salicaria*) and cattail (*Typha* spp.) in fourteen Minnesota wetlands. Hydrobiologia 323:129-138.

Farr, D. F. & A. Y. Rossman. 2001. *Harknessia lythri,* a new species on purple loosestrife. Mycologia 93: 997-1001.

Gabor T.S., T. Haagsma, & H. R. Murkin. 1996. Wetland plant responses to varying degrees of purple loosestrife removal in southeastern Ontario, Canada. Wetlands 16:95-98.

Grout, J.A. C. D. Levis, & J. S. Richardson. 1997. Decomposition rates of purple loosestrife (*Lythrum salicaria*) and Lyngbei's sedge (*Carex lyngbyeii)* in the Fraser River Estuary. Estuaries 20:96-102.

Hendrickson, K. 2009. Telephone conversation. Alaska Department of Environmental Conservation (ADEC), Pesticide Control Program, Permitting Process. February 25.

Hickey, J. M., & R. A. Malecki. 1997. Nest site selection of the black tern in western New York. Colonial Waterbirds 20:582-595.

Hultén, E., & M. Fries. 1968. Atlas of North European vascular plants north of the Tropic of Cancer. Book 1. Koeltz Scientific Books, Germany. 498 p.

Ketterer, E., & W. G. Abrahamson. 2006. Purple loosestrife on the Susquehanna River's Branch: distribution and environmental correlates. Northeastern Naturalist 23:213-234.

King County Noxious Weed Control Program (KCNWCP). 2005. Best Management Practices, Purple Loosestrife (*Lythrum salicaria*) Lythraceae, Class B Noxious Weed. Department of Natural Resources and Parks, Water and Land Resources Division. WA.

Landis, D. A, D. C. Sebolt, M. J. Haas, and M. Klepinger. 2003. Establishment and Impact of *Galerucella calmariensis* L. (*Coleoptera: Chrysomelidae*) on *Lythrum salicaria* L. and associated plant communities in Michigan. Biological Control 28:78-91.

Lassuy, D. E. 2007. Alaskans are "pulling together." Endangered Species Bulletin. 32:20-21.

Mal, T.K., J. Lovett-Doust, L. Lovett-Doust, & G.A. Mulligan 1992. The biology of Canadian weeds. 100. *Lythrum salicaria*. Canadian Journal of Plant Science Review and Canadian Phytotechnology 72:1305-1330.

Malecki, R. A. 1990. Research update-Biological control of purple loosestrife. Report of New York Cooperative Fish and Wildlife Research Unit, Cornell University, Ithaca, New York. 4pp + 2 figs.

Malecki, R. A., B. Blossey, S. D. Hight, D. Schroeder, L. T. Kok, & J. R. Coulson. 1993. Biological control of purple loosestrife. Bioscience 43:680-686.

McGowan-Stinski, J. 2009. Telephone conversation. The Nature Conservancy (TNC), Michigan Chapter. February 20.

Minnesota Sea Grant. 2009. Purple Loosestrife: What you should know, what you can do. University of Minnesota, Duluth, MN. http://www.seagrant.umn.edu/ais/purpleloosestrife_info

Mooney, H. A., & R. J. Hobbs (eds.). 2000. Invasive Species in a Changing World. Island Press, Washington, DC. 457 p.

Myers, J. H., & D. R. Bazely. 2003. Ecology and Control of Introduced Plants. Cambridge University Press, Cambridge, UK. 313 p.

Nyvall, R. F., & A. Hu. 1997. Laboratory evaluation of indigenous North American fungi for biological control of purple loosestrife. Biological Control 8(1): 37-42.

Pimentel, D. 2005. Aquatic nuisance species in the New York State Canal and Hudson River systems and the Great Lakes Basin: an economic and environmental assessment. Environmental Management 35:692-702.

Prather, T. S, S. S. Rabins, D. W. Morishita, L.W. Lass, R. H. Callihan, & T. W. Miller. 2003. Idaho's Noxious Weeds. University of Idaho Extension, Moscow, ID.

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

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

Royer, F., & R. Dickinson. 1999, Weeds of Northern U.S. and Canada. Lone Pine Publishing, The University of Alberta Press, Edmonton, Alberta, Canada. 434 p.

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

Skinner, L. C., W. J. Rendall, & E. L. Fuge. 1994. Minnesota's Purple Loosestrife Program: History, Findings, and Management Recommendations. Minnesota Department of Natural Resources, Ecological Services Section. Special Publication 145, St. Paul, MN. 32 p.

Taylor, R. J. 1990. North Weeds. Mountain Press Publishing Company, Missoula, MT. 177 p.

Thompson, D. Q., R. L. Stuckey, & E. B. Thompson. 1987. Spread, Impact, and Control of Purple Loosestrife (*Lythrum salicaria*) in North American Wetlands. U.S. Fish and Wildlife Service. 55 pages. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/plants/ loosstrf/index.htm (Version 04JUN1999).

Tu, M. (ed.). 2000. Techniques from The Nature Conservancy (TNC) stewards for the eradication of *Lythrum salicaria* (purple loosestrife) and *Phragmites australis* (common reed) in wetlands. The Nature Conservancy, Wildland Invasive Species Program, Dept. of Vegetable Crops and Weed Sciences. University of California – Davis, Davis, CA.

Tu, M., C. Hurd, & J. M. Randall. 2001. Weed Control Methods Handbook: Tools and Techniques for Natural Areas. The Nature Conservancy Wildland Invasive Species Team Online. http://tncinvasives.ucdavis.edu/handbook.html (Version April 2001, revised 2003, 2004).

Tutin, T. G., V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters, & D. A. Webb (eds.) 1968. Flora Europaea. Vol. 2. Cambridge University Press, Cambridge, UK. 455 p.

US Department of Agriculture, Forest Service (USFS). 2007. Selected Invasive Plants of Alaska, R10-TP-130B. Anchorage, AK. 55 p.

US Department of Agriculture (USDA). 2009. PLANTS database. http://plants.usda.gov/.

Van Driesche, R., B. Blossey, M. Hoddle, S. Lyon, & R. Reardon (eds.). 2002. Biological Control of Invasive Plants in the Eastern United States. USFS Publication #FHTET-2002-04. USDA Forest Service, Morgantown, WV. 413 p.

Weiher E., I. C. Wisheu, P. A. Keddy, & D. R. J. Moore. 1996. Establishment, persistence, and management implications of experimental wetland plant communities. Wetlands 16:208-218.

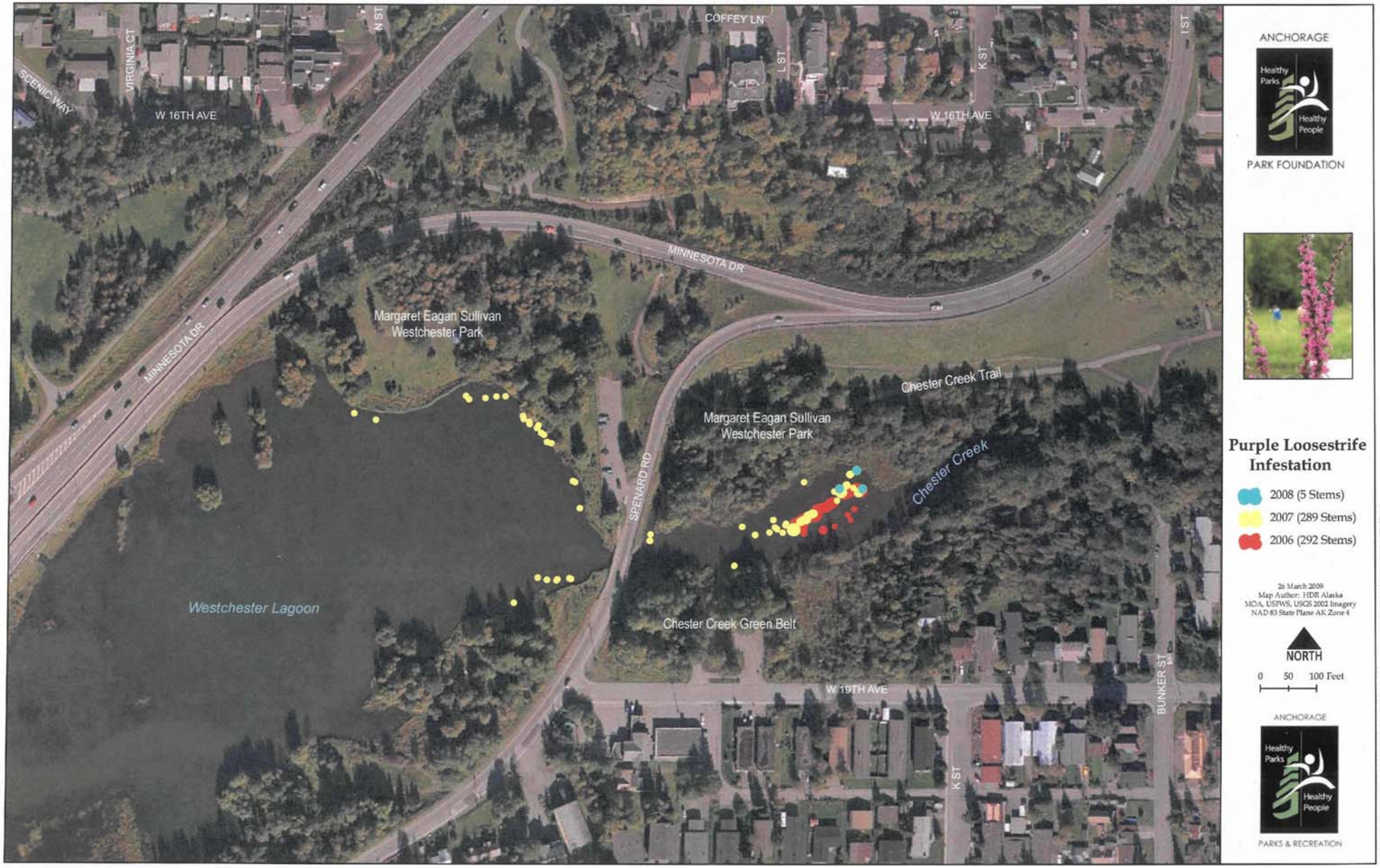
Welling, C. H., & R. L. Becker. 1990. Seed bank dynamics of *Lythrum salicaria* L.: implication for control of this species in North America. Aquatic Botany 38:303-309.

Whitt, M.B., H. H. Prince, & R. R. Cox Jr. 1999. Avian use of purple loosestrife dominated habitat relative to other vegetation types in a Lake Huron wetland complex. Wilson Bulletin 111:105-114.

Willis, A., & B. Blossey. 1999. Benign climates don't explain the increased plant size of non-indigenous plants: a cross-continental transplant experiment. Biocontrol Science and Technology 9:567-577.

Purple Loosestrife Locations 2006 - 2008 (Westchester Lagoon)

Figure 7



Appendices

Appendix A: Purple Loosestrife Legal Status in the US and Canada

State or Province	Status
Alabama	Class B noxious weed
Alberta	Noxious weed
Arizona	Prohibited noxious weed
Arkansas	Noxious weed
British Columbia	Noxious weed in Comox-Strathcona District
California	B list (noxious weeds)
Colorado	A list (noxious weeds)
Connecticut	Invasive, banned
Florida	Prohibited aquatic plant, Class 1
Idaho	Noxious weed
Indiana	Permit required
Iowa	Secondary noxious weed[1]
Manitoba	Noxious weed
Massachusetts	Prohibited
Michigan	Sale prohibited[2]
Minnesota	Prohibited noxious weed
Missouri	Noxious weed
Montana	Category 2 noxious weed
Nebraska	Noxious weed
Nevada	Noxious weed
New Mexico	Class A noxious weed
North Carolina	Class B noxious weed[3]
North Dakota	Noxious weed
Ohio	Prohibited noxious weed
Oregon	"B" designated weed, Quarantine
Pennsylvania	Noxious weed[4]
Saskatchewan	Noxious weed
South Carolina	Invasive aquatic plant, Plant pest
South Dakota	Noxious weed, Regulated non-native plant species
Tennessee	Plant pest[5]
Texas	Noxious plant
Utah	Noxious weed
Vermont	Class B noxious weed
Virginia	Noxious weed
Washington	Class B noxious weed, Quarantine[6]
Wisconsin	Nuisance weed[7]
Wyoming	Noxious weed

1 it is illegal to import, sell, offer for sale, or distribute the seeds or the plants of purple loosestrife in any form

2 any nonnative member of the genus *Lythrum* or hybrid of the genus is prohibited from sale

3 any *Lythrum* spp. not native to North Carolina

4 including all cultivars 5 and related cultivars

6 any hybrid cross 7 any nonnative member of the genus *Lythrum* or hybrids thereof

Source: http://plants.usda.gov/, http://www.ec.gc.ca/eee-ias/Default.asp?lang=En

Appendix B: Example Inventory Form

AKEPIC (2008) Inventory Form

Included as a Word document:
AKEPIC_Field Data Sheet2008.doc

AKEPIC Mapping Project Inventory Field Data Sheet (2005)

**=Required item

**Survey Date: _____/_____/_____ **Observers: _____
mm / dd / yyyy *Last Name, First Name Initial. (e.g.: Smith, J.; Williams, R.)*

Observers Affiliation: *(circle one)* AKNHP ARS BLM CES NPS SCS SCWD TECI UAF USFS USFWS USGS Other

A. Site Information

**Site Code: _____ Visit Type: Recon Monitoring Research Control Is this a Revisit: Yes No
**Study Type: Exhaustive Species Inventory Highest Priority species Single Species study

**Area Surveyed: _____acres
(Note: 1/10 acre = 37ft radius, 1/2 acre = 83ft radius, 1 acre = 118ft radius)

Site Vegetation Community Description (Viereck Code):_____
Disturbance Type (see instructions below): _____

B. Location Information

**Latitude:_____ **Longitude:_____ Elevation: _____ft

Note: Datum is NAD 83 and Coordinate Format is decimal degrees [-146.123456°]

**Collection Method (circle one and complete details): GPS 15 min topo Aerial photo Roadmap Other
Quad name _____ Quad number (i.e. A1, B2,C3, D4) _____
**GPS precision _____ft (0-5, 0-30, 0-100, 0-1000, 1000+)
If 15 min Topographic Map was used: Source _____ Scale _____ Date _____

Notes (location):
_____
_____
_____

C. Survey Information

**Exotic Plant Species Code *(see below)*	**Infested Area (acres) *(see below)*	**Canopy Cover (%) *(see below)*	Disturbance Age (Yrs.) *(see below)*	Stem Count *(see below)*	**Collection Information *(see below)*	Control Action *(see below)*	Aggressiveness *(see below)*

D. Notes (species):

_____
_____
_____
_____

Disturbance Type : Fill Importation (e.g., Road or Railroad Grade), Material Extraction (e.g., Rock Quarry or Gravel Pit, ORV Disturbance, Mowing, Trampling, Logging, Mining, Grazing, Plowing, Mechanical Brush/Tree Cutting, Herbicide Application, Other Mechanical Substrate Alteration Or Removal, Abandoned Homesite, River Action (i.e., Flooding,/Erosion-Ice Scour/Deposition, Stream Action, Forest Fire, Land Slide/Avalanche, Caribou/moose/animal related disturbed site, Windthrow, Wind Erosion/Deposition, Thermal Disturbance (Solifluction, Thermokarst, Permafrost Melt, etc.), Glaciation, Volcanic Action, Coastal/Beach

Exotic Plant Species Code: use the USDA name code (http://plants.usda.gov/, or find it at http://akweeds.uaa.alaska.edu)

Infested Area: 1/1000 acre minimum area for data collected (**0.001 acre** = 3.7 ft radius, **0.01 acre** = 12 ft radius, **0.1 acre** = 37 ft radius, **1/2 acre** = 83 ft radius, **1 acre** = 118 ft radius)

Canopy Cover: recommended 1%, 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 95%, 100%

Stem Count: 1-5, 6-25, 26-50, 51-150, 151-500, 500+

Collection Location: ALA, UAA, Not Collected, Not Curated, TNES, WTU, Other, None

Control Action: Manual (Pulling/Digging), Mechanical (Mowing/Weedwacking), Broadcast Herbicide, Spot Herbicide, Aerial Herbicide, Other, None

Aggressiveness: Low, Medium, High

Appendix C: Pesticide Information

Included as Adobe files:

Rodeo and AquaMaster Materiel Safety Data Sheets (MSDS):
AquaMaster_MSDS.pdf, Rodeo_MSDS.pdf

Worker Protection Standards Example Matrix:
Worker_Protection_Standards-DowAg.pdf

Alaska Department of Environment Conservation (ADEC)
Division of Environmental Health
Pesticide Control Program
http://www.dec.state.ak.us/EH/pest/index.htm

Environmental Protection Agency, Region 10
Pesticides in the Pacific North and Alaska
Federal guidelines and regulations
http://yosemite.epa.gov/R10/ecocomm.nsf/Pesticides/Pesticides+Homepage

Washington State, Department of Ecology
Pesticides Currently Allowed for Use in Washington State Waters (includes information on adjuvants and surfactants that are permitted).
http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html

Pesticide Management Education Program (PMEP), Cornell University
http://pmep.cce.cornell.edu/

Agricultural Spray Adjuvant Definitions (through the PMEP website):
http://pmep.cce.cornell.edu/facts-slides-self/facts/gen-peapp-adjuvants.html

Montana State University Pesticide Glossary:
http://www.pesticides.montana.edu/Glossary.htm

MATERIAL SAFETY DATA SHEET

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Dow AgroSciences

RODEO* HERBICIDE

Effective Date: 3/23/04
Product Code: 84825
MSDS: 006694

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: Rodeo* Herbicide

COMPANY IDENTIFICATION:
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268-1189

2. COMPOSITION/INFORMATION ON INGREDIENTS:

Glyphosate IPA: N-(phosphono-methyl) glycine, Isopropylamine Salt	CAS # 038641-94-0	53.8%
Balance, Total		46.2%

3. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW

Clear, pale yellow liquid. May cause eye irritation. Slightly toxic to aquatic organisms.
EMERGENCY PHONE NUMBER: 800-992-5994

4. FIRST AID:

EYE: Flush eyes thoroughly with water for several minutes. Remove contact lenses after initial 1-2 minutes and continue flushing for several additional minutes. If effects occur, consult a physician, preferably an ophthalmologist.

SKIN: Wash skin with plenty of water.

INGESTION: No emergency medical treatment necessary.

INHALATION: Remove person to fresh air; if effects occur, consult a physician.

NOTE TO PHYSICIAN: No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

5. FIRE FIGHTING MEASURES:

FLASH POINT: >214°F (>101°C)
METHOD USED: Setaflash

FLAMMABLE LIMITS:
LFL: Not applicable
UFL: Not applicable

EXTINGUISHING MEDIA: Foam, CO_2, Dry Chemical

FIRE AND EXPLOSION HAZARDS: Foam fire extinguishing system is preferred because uncontrolled water can spread possible contamination. Toxic irritating gases may be formed under fire conditions.

FIRE-FIGHTING EQUIPMENT: Use positive-pressure, self-contained breathing apparatus and full protective equipment.

6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS: Absorb small spills with an inert absorbent material such as Hazorb, Zorball, sand, or dirt. Report large spills to Dow AgroSciences on 800-992-5994.

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapors and spray mist. Handle concentrate in ventilated area. Wash thoroughly with soap and water after handling and before eating, chewing gum, using tobacco, using the toilet or smoking. Keep away from food, feedstuffs, and water supplies. Store in original container with the lid tightly closed. Store above 10°F (-12°C) to keep from crystallizing.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where the potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINES: None established

ENGINEERING CONTROLS: Good general ventilation should be sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

EYE/FACE PROTECTION: Use safety glasses.

SKIN PROTECTION: No precautions other than clean body-covering clothing should be needed.

RESPIRATORY PROTECTION: For most conditions, no respiratory protection should be needed; however, if discomfort is experienced, use a NIOSH approved air-purifying respirator.

APPLICATIONS AND ALL OTHER HANDLERS: Please refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES:

APPEARANCE: Clear, pale yellow liquid
DENSITY: 10.0 - 10.5 lbs/gal
pH: 4.8 – 5.0
ODOR: None
SOLUBILITY IN WATER: Miscible
SPECIFIC GRAVITY: 1.21 gm/L
FREEZING POINT: -7°F - -10°F (-21°C - -25°C)

10. STABILITY AND REACTIVITY:

STABILITY: (CONDITIONS TO AVOID) Stable under normal storage conditions.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) Galvanized or unlined steel (except stainless steel) containers or spray tanks may produce hydrogen gas which may form a highly combustible gas mixture.

HAZARDOUS DECOMPOSITION PRODUCTS: None known.

HAZARDOUS POLYMERIZATION: Not known to occur.

11. TOXICOLOGICAL INFORMATION:

EYE: May cause slight temporary eye irritation. Corneal injury is unlikely.

SKIN: Essentially non-irritating to skin. Prolonged skin contact is unlikely to result in absorption of harmful amounts. The LD_{50} for skin absorption in rabbits is >5000 mg/kg. Did not cause allergic skin reactions when tested in guinea pigs.

INGESTION: Very low toxicity if swallowed. Harmful effects not anticipated from swallowing small amounts. The oral LD_{50} for rats is >5000 mg/kg.

INHALATION: Brief exposure (minutes) is not likely to cause adverse effects. The aerosol LC_{50} for rats is >6.37 mg/L for 4 hours.

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: For a similar material, glyphosate, in animals, effects have been reported on the following organ: liver.

CANCER INFORMATION: A similar material, glyphosate, did not cause cancer in laboratory animals.

TERATOLOGY (BIRTH DEFECTS): For glyphosate IPA, available data are inadequate for evaluation of potential to cause birth defects.

REPRODUCTIVE EFFECTS: For glyphosate IPA, available data are inadequate to determine effects on reproduction.

MUTAGENICITY: For a similar material, glyphosate, in-vitro and animal genetic toxicity studies were negative.

12. ECOLOGICAL INFORMATION:

ENVIRONMENTAL DATA:

ECOTOXICOLOGY:
Material is practically non-toxic to aquatic organisms on an acute basis (LC_{50} or EC_{50} is >100 mg/L in most sensitive species tested).
Acute LC_{50} for rainbow trout *(Oncorhynchus mykiss)* is >2500 mg/L.
Acute immobilization EC_{50} in water flea *(Daphnia magna)* is 918 mg/L.
Material is practically non-toxic to birds on an acute basis (LD_{50} is >2000 mg/kg).
Acute oral LD_{50} in bobwhite *(Colinus virginianus)* is >2000 mg/kg.
The LC_{50} in earthworm Eisenia foetida is >1000 mg/kg.
Acute contact LD_{50} in honey bee *(Apis mellifera)* is >100 µg/bee.
Acute oral LD_{50} in honey bee *(Apis mellifera)* is >100 µg/bee.
Growth inhibition EC_{50} in green alga *(Selenastrum capricornutum)* is 127 mg/L.
Growth inhibition EC_{50} in duckweed *(Lemna sp.)* is 24.4 mg/L.

13. DISPOSAL CONSIDERATIONS:

DISPOSAL METHOD: If wastes and/or containers cannot be disposed of according to the product label directions, disposal of this material must be in accordance with your local or area regulatory authorities.

MATERIAL SAFETY DATA SHEET

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Dow AgroSciences

RODEO* HERBICIDE

Effective Date: 3/23/04
Product Code: 84825
MSDS: 006694

This information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations.

If the material as supplied becomes a waste, follow all applicable regional, national and local laws and regulations.

14. TRANSPORT INFORMATION:

U.S. DEPARTMENT OF TRANSPORTATION (DOT) INFORMATION:

For all package sizes and modes of transportation:
This material is not regulated for transport.

15. REGULATORY INFORMATION:

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

U.S. REGULATIONS

SARA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

Not to have met any hazard category

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

STATE RIGHT-TO-KNOW: This product is not known to contain any substances subject to the disclosure requirements of

New Jersey
Pennsylvania

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

CATEGORY	RATING
Health	1
Flammability	1
Reactivity	0

16. OTHER INFORMATION:

MSDS STATUS: Revised Sections: 3,4,11,12,13,14 & 15
Reference: DR-0361-8028
Replaces MSDS Dated: 1/12/00
Document Code: D03-148-002
Replaces Document Code: D03-148-001

The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult Dow AgroSciences For Further Information.

MONSANTO COMPANY

Material Safety Data Sheet
Commercial Product

1. PRODUCT AND COMPANY IDENTIFICATION

Product name
AquaMaster® Herbicide

EPA Reg. No.
524-343
Product use
Herbicide
Chemical name
Not applicable.
Synonyms
None.
Company
MONSANTO COMPANY, 800 N. Lindbergh Blvd., St. Louis, MO, 63167
Telephone: 800-332-3111, **Fax:** 314-694-5557
Emergency numbers
FOR CHEMICAL EMERGENCY, SPILL LEAK, FIRE, EXPOSURE, OR ACCIDENT Call CHEMTREC - Day or Night: 1-800-424-9300 toll free in the continental U.S., Puerto Rico, Canada, or Virgin Islands. For calls originating elsewhere: 703-527-3887 (collect calls accepted).
FOR MEDICAL EMERGENCY - Day or Night: +1 (314) 694-4000 (collect calls accepted).

2. COMPOSITION/INFORMATION ON INGREDIENTS

Active ingredient
Isopropylamine salt of N-(phosphonomethyl)glycine; {Isopropylamine salt of glyphosate}

Composition

COMPONENT	CAS No.	% by weight (approximate)
Isopropylamine salt of glyphosate	38641-94-0	53.8
Water	7732-18-5	46.2

OSHA Status
This product is not hazardous according to the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

3. HAZARDS IDENTIFICATION

Emergency overview
Appearance and odour (colour/form/odour): Colourless - Amber / Liquid, (viscous) / Odourless

CAUTION!

Potential health effects
Likely routes of exposure
Skin contact, eye contact, inhalation
Eye contact, short term
Not expected to produce significant adverse effects when recommended use instructions are followed.
Skin contact, short term
Not expected to produce significant adverse effects when recommended use instructions are followed.
Inhalation, short term

Not expected to produce significant adverse effects when recommended use instructions are followed.

Refer to section 11 for toxicological and section 12 for environmental information.

4. FIRST AID MEASURES

Eye contact
Immediately flush with plenty of water.
If easy to do, remove contact lenses.

Skin contact
Take off contaminated clothing, wristwatch, jewellery.
Wash affected skin with plenty of water.
Wash clothes and clean shoes before re-use.

Inhalation
Remove to fresh air.

Ingestion
Immediately offer water to drink.
Do NOT induce vomiting unless directed by medical personnel.
If symptoms occur, get medical attention.

Advice to doctors
This product is not an inhibitor of cholinesterase.

Antidote
Treatment with atropine and oximes is not indicated.

5. FIRE-FIGHTING MEASURES

Flash point
none

Extinguishing media
Recommended: Water, foam, dry chemical, carbon dioxide (CO2)

Unusual fire and explosion hazards
None.
Environmental precautions: see section 6.

Hazardous products of combustion
Carbon monoxide (CO), phosphorus oxides (PxOy), nitrogen oxides (NOx)

Fire fighting equipment
Self-contained breathing apparatus.
Equipment should be thoroughly decontaminated after use.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protection recommended in section 8.

Environmental precautions
SMALL QUANTITIES:
Low environmental hazard.

LARGE QUANTITIES:
Minimise spread.
Keep out of drains, sewers, ditches and water ways.
Notify authorities.

Methods for cleaning up
SMALL QUANTITIES:
Flush spill area with water.
LARGE QUANTITIES:
Absorb in earth, sand or absorbent material.
Dig up heavily contaminated soil.
Collect in containers for disposal.
Refer to section 7 for types of containers.
Flush residues with small quantities of water.
Minimise use of water to prevent environmental contamination.

Refer to section 13 for disposal of spilled material.

7. HANDLING AND STORAGE

Good industrial practice in housekeeping and personal hygiene should be followed.

Handling
Avoid contact with skin and eyes.
When using do not eat, drink or smoke.
Wash hands thoroughly after handling or contact.
Thoroughly clean equipment after use.
Do not contaminate drains, sewers and water ways when disposing of equipment rinse water.
Refer to section 13 for disposal of rinse water.
Emptied containers retain vapour and product residue.

Storage
Minimum storage temperature: -15 °C
Maximum storage temperature: 50 °C
Compatible materials for storage: stainless steel, aluminium, fibreglass, plastic, glass lining
Incompatible materials for storage: galvanised steel, unlined mild steel, see section 10.
Keep out of reach of children.
Keep away from food, drink and animal feed.
Keep only in the original container.
Partial crystallization may occur on prolonged storage below the minimum storage temperature.
If frozen, place in warm room and shake frequently to put back into solution.
Minimum shelf life: 5 years.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Airborne exposure limits

Components	Exposure Guidelines
Isopropylamine salt of glyphosate	No specific occupational exposure limit has been established.
Water	No specific occupational exposure limit has been established.

Engineering controls
No special requirement when used as recommended.

Eye protection

No special requirement when used as recommended.

Skin protection
No special requirement when used as recommended.

Respiratory protection
No special requirement when used as recommended.

When recommended, consult manufacturer of personal protective equipment for the appropriate type of equipment for a given application.

9. PHYSICAL AND CHEMICAL PROPERTIES

These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.

Colour/colour range:	Colourless - Amber
Form:	Liquid, (viscous)
Odour:	Odourless
Flash point:	none
Specific gravity:	1.206 @ 20 °C / 15.6 °C
Solubility:	Water: Completely miscible.
pH:	4.6 - 4.8 @ 63 g/l
Partition coefficient (log Pow):	< 0.000 (active ingredient)

10. STABILITY AND REACTIVITY

Stability
Stable under normal conditions of handling and storage.

Hazardous decomposition
Thermal decomposition: Hazardous products of combustion: see section 5.

Materials to avoid/Reactivity
Reacts with galvanised steel or unlined mild steel to produce hydrogen, a highly flammable gas that could explode.

11. TOXICOLOGICAL INFORMATION

This section is intended for use by toxicologists and other health professionals.

Data obtained on product, similar products and on components are summarized below.

Mutagenicity
Micronucleus test(s):
Not mutagenic.
Ames test(s):
Not mutagenic with and without metabolic activation.

Isopropylamine salt of glyphosate (62%)

Acute oral toxicity
Rat, LD50 (limit test): > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.

Mouse, LD50 (limit test): > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.

Acute dermal toxicity

Rabbit, LD50 (limit test): > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.

Skin irritation

Rabbit, 6 animals, Draize test:
Days to heal: 3
Primary Irritation Index (PII): 0.0/8.0
Essentially non irritating.
FIFRA category IV.

Acute inhalation toxicity

Rat, LC50, 4 hours, aerosol: > 4.24 mg/L
Practically non-toxic.
FIFRA category IV.
No mortality. Maximum attainable concentration.

Skin sensitization

Guinea pig, Buehler test:
Positive incidence: 0 %

N-(phosphonomethyl)glycine; {glyphosate}

Mutagenicity

In vitro and in vivo mutagenicity test(s):
Not mutagenic.

Repeated dose toxicity

Rabbit, dermal, 21 days:
NOAEL toxicity: > 5,000 mg/kg body weight/day
Target organs/systems: none
Other effects: none

Rat, oral, 3 months:
NOAEL toxicity: > 20,000 mg/kg diet
Target organs/systems: none
Other effects: none

Chronic effects/carcinogenicity

Mouse, oral, 24 months:
NOEL tumour: > 30,000 mg/kg diet
NOAEL toxicity: ~ 5,000 mg/kg diet
Tumours: none
Target organs/systems: liver
Other effects: decrease of body weight gain, histopathologic effects

Rat, oral, 24 months:
NOEL tumour: > 20,000 mg/kg diet
NOAEL toxicity: ~ 8,000 mg/kg diet
Tumours: none
Target organs/systems: eyes
Other effects: decrease of body weight gain, histopathologic effects

Toxicity to reproduction/fertility

Rat, oral, 3 generations:
NOAEL toxicity: > 30 mg/kg body weight
NOAEL reproduction: > 30 mg/kg body weight
Target organs/systems in parents: none
Other effects in parents: none

Target organs/systems in pups: none
Other effects in pups: none

Developmental toxicity/teratogenicity

Rat, oral, 6 - 19 days of gestation:
NOAEL toxicity: 1,000 mg/kg body weight
NOAEL development: 1,000 mg/kg body weight
Other effects in mother animal: decrease of body weight gain, decrease of survival
Developmental effects: weight loss, post-implantation loss, delayed ossification
Effects on offspring only observed with maternal toxicity.

Rabbit, oral, 6 - 27 days of gestation:
NOAEL toxicity: 175 mg/kg body weight
NOAEL development: 175 mg/kg body weight
Target organs/systems in mother animal: none
Other effects in mother animal: decrease of survival
Developmental effects: none

12. ECOLOGICAL INFORMATION

This section is intended for use by ecotoxicologists and other environmental specialists.

Data obtained on components are summarized below.

Isopropylamine salt of glyphosate (62%)

Aquatic toxicity, fish

Bluegill sunfish (Lepomis macrochirus):
Acute toxicity, 96 hours, static, LC50: > 1,000 mg/L
Practically non-toxic.

Rainbow trout (Oncorhynchus mykiss):
Acute toxicity, 96 hours, static, LC50: > 1,000 mg/L
Practically non-toxic.

Aquatic toxicity, invertebrates

Water flea (Daphnia magna):
Acute toxicity, 48 hours, static, EC50: 930 mg/L
Practically non-toxic.

Aquatic toxicity, algae/aquatic plants

Green algae (Scenedesmus subspicatus):
Acute toxicity, 72 hours, static, ErC50 (growth rate): 166 mg/L
Practically non-toxic.

Soil organism toxicity, invertebrates

Earthworm (Eisenia foetida):
Acute toxicity, 14 days, LC50: > 5,000 mg/kg dry soil
Practically non-toxic.

N-(phosphonomethyl)glycine; {glyphosate}

Avian toxicity

Bobwhite quail (Colinus virginianus):
Dietary toxicity, 5 days, LC50: > 4,640 mg/kg diet
No more than slightly toxic.

Mallard duck (Anas platyrhynchos):
Dietary toxicity, 5 days, LC50: > 4,640 mg/kg diet
No more than slightly toxic.

Bobwhite quail (Colinus virginianus):
Acute oral toxicity, single dose, LD50: > 3,851 mg/kg body weight
Practically non-toxic.

Arthropod toxicity

Honey bee (Apis mellifera):
Oral, 48 hours, LD50: 100 µg/bee

Honey bee (Apis mellifera):
Contact, 48 hours, LD50: > 100 µg/bee
Practically non-toxic.

Bioaccumulation

Bluegill sunfish (Lepomis macrochirus):
Whole fish: BCF: < 1
No significant bioaccumulation is expected.

Dissipation

Soil, field:
Half life: 2 - 174 days
Koc: 884 - 60,000 L/kg
Adsorbs strongly to soil.

Water, aerobic:
Half life: < 7 days

13. DISPOSAL CONSIDERATIONS

Product

Not classified as hazardous waste by the Resource, Conservation and Recovery Act (RCRA), 40 CFR 261.
Recycle if appropriate facilities/equipment available.
Burn in special, controlled high temperature incinerator.
Keep out of drains, sewers, ditches and water ways.
Follow all local/regional/national/international regulations.
Consult your attorney or appropriate regulatory officials for information on disposal.

Container

Triple or pressure rinse empty containers.
Pour rinse water into spray tank.
Store for collection by approved waste disposal service.
Dispose of as non hazardous industrial waste.
Do NOT re-use containers.
Follow all local/regional/national/international regulations.

14. TRANSPORT INFORMATION

The data provided in this section is for information only. Please apply the appropriate regulations to properly classify your shipment for transportation.

Not hazardous under the applicable DOT, ICAO/IATA, IMO, TDG and Mexican regulations.

15. REGULATORY INFORMATION

TSCA Inventory

All components are on the US EPA's TSCA Inventory

SARA Title III Rules

Section 311/312 Hazard Categories
Not applicable.
Section 302 Extremely Hazardous Substances
Not applicable.
Section 313 Toxic Chemical(s)
Not applicable.

CERCLA Reportable quantity
Not applicable.

16. OTHER INFORMATION

The information given here is not necessarily exhaustive but is representative of relevant, reliable data.
Follow all local/regional/national/international regulations.
Please consult supplier if further information is needed.
For more information refer to product label.
Please consult Monsanto if further information is needed.
In this document the British spelling was applied.
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	Health	Flammability	Instability	Additional Markings
NFPA	0	1	1	

0 = Minimal hazard, 1 = Slight hazard, 2 = Moderate hazard, 3 = Severe hazard, 4 = Extreme hazard

Full denomination of most frequently used acronyms. BCF (Bioconcentration Factor), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), EC50 (50% effect concentration), ED50 (50% effect dose), I.M. (intramuscular), I.P. (intraperitoneal), I.V. (intravenous), Koc (Soil adsorption coefficient), LC50 (50% lethality concentration), LD50 (50% lethality dose), LDLo (Lower limit of lethal dosage), LEL (Lower Explosion Limit), LOAEC (Lowest Observed Adverse Effect Concentration), LOAEL (Lowest Observed Adverse Effect Level), LOEC (Lowest Observed Effect Concentration), LOEL (Lowest Observed Effect Level), MEL (Maximum Exposure limit), MTD (Maximum Tolerated Dose), NOAEC (No Observed Adverse Effect Concentration), NOAEL (No Observed Adverse Effect Level), NOEC (No Observed Effect Concentration), NOEL (No Observed Effect Level), OEL (Occupational Exposure Limit), PEL (Permissible Exposure Limit), PII (Primary Irritation Index), Pow (Partition coefficient n-octanol/water), S.C. (subcutaneous), STEL (Short-Term Exposure Limit), TLV-C (Threshold Limit Value-Ceiling), TLV-TWA (Threshold Limit Value - Time Weighted Average), UEL (Upper Explosion Limit)

This Material Safety Data Sheet (MSDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-APPROVED PRODUCT LABELING (attached to and accompanying the product container). This MSDS provides important health, safety, and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course. Use, storage and disposal of pesticide products are regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling, and all necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of federal law to use a pesticide product in any manner not prescribed on the EPA-approved label.

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, MONSANTO Company makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for the purposes prior to use. In no event will MONSANTO Company be responsible for damages of any nature whatsoever resulting from the use of or reliance upon information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR TO THE PRODUCT TO WHICH INFORMATION REFERS.

FILE COPY

Date Out EFB: MAR 5 1981

To: Product Manager - 23 Mountfort
TS-767

From: Dr. Willa Garner
Chief, Review Section No.1
Environmental Fate Branch

Attached please find the environmental fate review of:

Reg./File No.: 239-1663

Chemical Diquat dibromide

Type Product: Aquatic Herbicide

Product Name: Ortho Diquat

Company Name: Chevron

Submission Purpose: Review of Environmental Chemistry Data

ZBB Code:

Date in:

Date Completed: MAR 5 1981

Deferrals To:

_____ Ecological Effects Branch

_____ Residue Chemistry Branch

_____ Toxicology Branch

ACTION CODE: 400

EFB # 676

TAIS (Level II)	Days
63	5

1.0 INTRODUCTION

1.1 Purpose

Chevron Chemical Company submitted environmental chemistry data requirements requesting amended registration of diquat dibromide to include the following revisions when used as an aquatic herbicide [File No. 239-1663, submitted on 8/17/77].

(a) Change in the dosage rate to floating and emersed weeds from a maximum of 1.5 lbs ai/surface acre to 2 lbs ai/surface acre/application.
(b) Add the following weed species to the list of floating and emersed weeds being controlled: Duckweed, Pennywort, and marginal weeds such as cattails.
(c) Add the following weed species to the list of submersed weeds: Coontail, Elodea, Pondweeds, and Watermilfoil.
(d) Add algae to the list of submersed, floating, and emersed weeds.
(e) Allow use of X-77 Ortho Spreader at the rate of 1 pt/100 gallons of spray.
(f) No change in the recommendation for repeat application, in which case, the maximum currently registered dosage per year is 8 lbs ai/surface acre.

1.2 Background

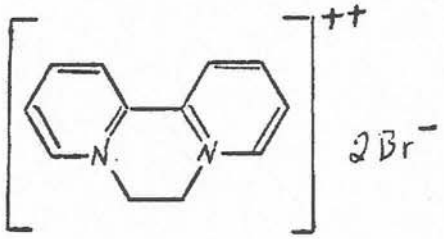
Diquat dibromide is currently registered for the following uses [EPA Reg. No. 239-1663, approved on 5/2/76]:

(a) An aquatic herbicide at a maximum dosage of 8 lbs ai/surface acre.
(b) A contact herbicide for non-crop use.
(c) A harvest aid (desiccant) of several crops which are: alfalfa, clover, grain sorghum, and soybean.
(d) An inhibitor of floral initiation of sugarcane grown in Florida, Hawaii, and Puerto Rico.

1.3 Chemical

Common name	:	Diquat dibromide
Trade name	:	Ortho diquat
Type	:	Herbicide, aquatic, plant growth regulator, and desiccant.
Chemical formula	:	6,7-Dihydrodipyrido [1,2 - a: 2', 1' - c] pyrazinediium dibromide - 35.5% (2 lbs ai/gal).

Structural formula



1.4 Previous Reviews

PP IF - 1101	4/9/74
PP IF - 1073	3/6/75
239-1663	9/10/75
PP5F1648	9/18/75
239-1663	11/28/78

2.0 USE DIRECTIONS (Aquatic use)

(a) Submersed weeds infesting still ponds, lakes, ditches, laterals, waterways, or portions thereof. To control: Bladderwort, Coontail, Elodea, Naiad, Pondweeds, Watermilifoil and algae. Use 2-4 lbs ai/surface acre. Apply by pouring directly from the container into the water while moving slowly over the surface in a boat.

(b) Floating weeds including Pennywort, Salvinia, Waterhyacinth, waterlettuce, duckweed, cattails, and algae; use 1.0 - 2.0 lbs ai/surface acre.

Use 150 to 200 gallons of water per acre plus 1 pt. Ortho X-77 Spreader (non-ionic) as an overall spray. For aerial application, use 7.5 gallons of water per acre plus 1 pt. Ortho X-77 Spreader per 100 gallons spray solution.

Retreatment may be necessary to obtain season long control.

3.0 DISCUSSION OF DATA

Environmental Chemistry data submitted were contained in Vol. II, submitted on 8/17/77, filed on 8/22/77 under accession No. 231428 and registration No. 239 - 1663.

Data submitted were reviewed by Enviro Control Inc., a contractor from Rockville, Maryland on January 16, 1981. The 81 page review was entitled: "Task 1 R: Review of Diquat, Contract No. 68-01-5830, submitted to EPA, by Enviro Control Inc., One Central Plaza 11300 Rockville Pike, Rockville, Maryland 20852".

The following four pages (4p7) were copied from Chevron's submission showing a list of all documents submitted. On 11/13/80, Enviro Control was asked to review references 2.1 - 2.8; 3.1 - 3.6; 4.1; 5.1 - 5.8. Request for review of Tab 2.1 was later deleted at the request of Enviro Control because of missing technical information. Similarly, Tab 3.6 was not reviewed because it was simply a literature review. Tab 5.2 was reviewed, however, because of missing some information, evaluation of the dissipation study could not be made.

Environmental chemistry data reviewed by Environ Control dealt with the followingr

3.1 Soil Adsorptions
Reviewed in pages 1-15 of Environ Control report of 1/16/81.

3.2 Photodegradation
Reviewed in pages 16-34 of Environ Control report of 1/16/81.

3.3 Fate in Plants
Reviewed in pages 35-43 of Environ Control report of 1/16/81.

3.4 Fate in Soil
Reviewed in pages 44-78 of Environ Control report of 1/16/81

4.0 DATA GAPS
Environmental Chemistry data gaps for the currently registered, aquatic noncrop uses are:
(a) Fish accumulation study.
(b) Field dissipation (aquatic noncrop use).

5.0 CHEVRON'S REQUEST
According to Mr. James Stone (PM-23), Chevron's request to amend diquat aquatic uses are presently incorporated on the registered label approved on 5/2/76.

6.0 CONCLUSIONS
Chevron Chemical Company must comply with Environmental Chemistry data gaps to satisfy Diquat's aquatic noncrop uses.

Sami Malak

Sami Malak, Ph.D.
Review Section #1
Environmental Fate Branch
Hazard Evaluation Division

12.03 RESIDUE CHEMISTRY DATA TO SUPPORT LABEL AMENDMENT FOR Diquat Water Weed Killer (EPA Reg. No. 239-1663)

Volumes II and III (Metabolism Studies)

TABLE OF CONTENTS

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Worker Protection Standards Quick Reference

Product Signal Word	EPA Reg. #	Active Ingredient(s) % and (lbs./gal)	Personal Protective Equipment (PPE)	Restricted Entry Interval	Early Entry PPE
ACCORD® CONCENTRATE Herbicide Caution	62719-324	Glyphosate 53.8% (5.4 lbs. a.i.)	Long-sleeved shirt and long pants Shoes plus socks	4 hours	Coveralls Chemical-resistant, waterproof gloves Shoes plus socks
ACCORD® XRT II Herbicide Caution	62719-556	Glyphosate 50.2% (5.4 lbs. a.i.)	Long-sleeved shirt and long pants Chemical-resistant, waterproof gloves Shoes plus socks	4 hours	Coveralls Chemical-resistant, waterproof gloves Shoes plus socks
DMA® 4 IVM Herbicide Danger	62719-3	2,4-D 46.3% (3.8 lbs. a.i.)	Long-sleeved shirt and long pants Waterproof gloves Shoes plus socks Protective eyewear **Note:** For containers of more than 1 gallon, but less than 5 gallons: Mixers and loaders who do not use a mechanical system (such as probe and pump or spigot) to transfer the contents of this container must wear coveralls or a chemical-resistant apron in addition to other required PPE.	48 hours	Coveralls Waterproof gloves Shoes plus socks Protective eyewear
FORESTRY GARLON® XRT Specialty Herbicide Warning	62719-553	Triclopyr BEE 83.9% (6.3 lbs. a.i.)	Long-sleeved shirt and long pants Shoes plus socks Chemical-resistant gloves Protective eyewear	12 hours	Coveralls Chemical-resistant gloves Shoes plus socks Protective eyewear

Product Signal Word	EPA Reg. #	Active Ingredient(s) % and (lbs./gal)	Personal Protective Equipment (PPE)	Restricted Entry Interval	Early Entry PPE
GARLON® 3A Specialty Herbicide Danger	62719-37	Triclopyr TEA 44.4% (3.0 lbs. a.i.)	Long-sleeved shirt and long pants Shoes plus socks Protective eyewear Chemical-resistant gloves	48 hours	Coveralls Chemical-resistant gloves Shoes plus socks Protective eyewear
GARLON® 4 Ultra Specialty Herbicide Caution	62719-527	Triclopyr BEE 43.46% (4.0 lbs. a.i.)	Long-sleeved shirt and long pants Chemical-resistant gloves Shoes plus socks	12 hours	Coveralls Chemical-resistant gloves Shoes plus socks
MILESTONE® VM Specialty Herbicide Caution	62719-537	Aminopyralid 40.6% (2.0 lbs. a.i.)	Long-sleeved shirt and long pants Shoes plus socks	Until spray has dried	N/A
MILESTONE® VM PLUS Specialty Herbicide Caution	62719-572	Aminopyralid 2.22% (0.1 lb. a.i.) Triclopyr 16.22% (1 lb. a.i.)	Long-sleeved shirt and long pants Shoes plus socks Chemical-resistant gloves	48 hours	Coveralls Shoes plus socks Protective eyewear Chemical-resistant gloves
PATHFINDER® II Specialty Herbicide Caution	62719-176	Triclopyr BEE 13.6% (0.75 lbs. a.i.)	Long-sleeved shirt and long pants Chemical-resistant gloves Shoes plus socks	12 hours	Coveralls Chemical-resistant gloves Shoes plus socks
PATHWAY® Specialty Herbicide Caution	62719-31	Picloram 5.4% (0.27 lbs. a.i.) 2,4-D 20.9% (1.0 lb. a.i.)	Long-sleeved shirt and long pants Chemical-resistant gloves Shoes plus socks Protective eyewear **Note:** For containers of more than 1 gallon, but less than 5 gallons: Mixer and loaders who do not use a mechanical system (such as probe and pump or spigot) to transfer the contents of this container must wear coveralls or a chemical-resistant apron in addition to other required PPE.	48 hours	Coveralls Chemical-resistant gloves Shoes plus socks Protective eyewear

Product Signal Word	EPA Reg. #	Active Ingredient(s) % and (lbs./gal)	Personal Protective Equipment (PPE)	Restricted Entry Interval	Early Entry PPE
RODEO® Herbicide Caution	62719-324	Glyphosate 53.8% (5.4 lbs. a.i.)	Long-sleeved shirt and long pants Shoes plus socks	4 hours	Coveralls Chemical-resistant, waterproof gloves Shoes plus socks
SPIKE® 20P Specialty Herbicide Caution	62719-121	Tebuthiuron 20.0% (0.2 lbs. a.i./lb. of product)	N/A	N/A	N/A
SPIKE® 80DF Specialty Herbicide Caution	62719-107	Tebuthiuron 80.0% (20 lbs. a.i./25 lb. bag)	Eye protection Long-sleeved shirt and long pants Shoes plus socks Chemical-resistant, waterproof gloves	N/A	N/A
TORDON® 101 MIXTURE Specialty Herbicide Danger	62719-5	Picloram 10.2% (0.54 lbs. a.i.) 2,4-D 39.6% (2.0 lbs. a.i.)	Long-sleeved shirt and long pants Chemical-resistant gloves Shoes plus socks Protective eyewear **Note:** For containers of more than 1 gallon, but less than 5 gallons: Mixers and loaders who do not use a mechanical system (such as probe and pump) to transfer the contents of this container must wear coveralls or a chemical-resistant apron in addition to other required PPE.	48 hours	Coveralls Chemical-resistant gloves Shoes plus socks Protective eyewear
TORDON® K Specialty Herbicide Caution	62719-17	Picloram 24.4% (2.0 lbs. a.i.)	Long-sleeved shirt and long pants Waterproof gloves Shoes plus socks	12 hours	Coveralls Waterproof gloves Shoes plus socks

Product Signal Word	EPA Reg. #	Active Ingredient(s) % and (lbs./gal)	Personal Protective Equipment (PPE)	Restricted Entry Interval	Early Entry PPE
TRANSLINE® Specialty Herbicide Caution	62719-259	Clopyralid 40.9% (3.0 lbs. a.i.)	Long-sleeved shirt and long pants Chemical-resistant, waterproof gloves Shoes plus socks	12 hours	Coveralls Chemical-resistant, waterproof gloves Shoes plus socks
VISTA® Specialty Herbicide Warning	62719-308	Fluroxypyr 26.2% (1.5 lbs. a.i.)	Long-sleeved shirt and long pants Chemical-resistant gloves Shoes plus socks Protective eyewear	12 hours	Coveralls Chemical-resistant gloves Shoes plus socks Protective eyewear

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Tordon 101M and Tordon K are federally Restricted Use Pesticides.
Always read and follow label directions.

DAVMVEGM8041

V30-137-024 (9/08)
010-50277

Appendix D: Brochures and Other Public Education Material Examples

Slemmons, Caleb. 2007. Invasive Plants Take Root in Alaska Curriculum. Homer Soil and Water Conservation District, Alaska Association of Conservation Districts and USDA Forest Service. http://www.homerswcd.org/invedu/.

Fraser Basin Council Publications:
http://www.fraserbasin.bc.ca/publications/invasive_plants.html

Included as Adobe files:

Don't Plant a Pest brochure, UAF-Cooperative Extension Service
CES-UAF_don't_plant_a_problem.pdf

Fraser Basin education kit extensions:
FBC_IP_Kit_Extension_WEB.pdf

Homer Soil and Water Conservation District's Pocket Guide to Responsible Landscaping in Southcentral Alaska:
May07Alternativespocketguide.pdf

King County Noxious Weed Control Program Alert brochure:
KC_Purple_loosestrife_factsheet.pdf

Manitoba Preventing the Spread Purple Loosestrife brochure:
Canada-Preventing the Spread.pdf

Reducing the Spread of Non-Native Invasive Plants in Alaska: Voluntary Codes of Conduct for the Gardening Public, UAF-Cooperative Extension Service:
Gardening_Public_Codes_CES.pdf

Reducing the Spread of Non-Native Invasive Plants in Alaska: Voluntary Codes of Conduct for Nursery Professionals, UAF-Cooperative Extension Service:
NursProf_Codes_CES.pdf

Warren character coloring page:
Warren_digging_coloring_page.pdf

Invasive Garden Species:

FGV-00146

Don't Plant a Problem

Sometimes garden plants jump the fence and invade natural areas. Plants become invasive when they threaten wild areas by displacing native vegetation and destroying wildlife habitat. Many of the major problems caused by invasives in other states have not yet been experienced in Alaska. By not planting known invasive species, gardeners can help stop them from spreading in Alaska.

To help guide gardeners in making decisions about what to grow in the garden, the Cooperative Extension Service has developed the following "DON'T Plant in Alaska" list. Plants have been put on the list for a number of reasons. Some have escaped in other states and are known to grow well in parts of Alaska. Some are classified as noxious weeds. Some have a reputation for being aggressive in the garden. Others may belong to a genus of notoriously problematic plants.

Some plants are weedy but don't survive outside of cultivation. An invasive plant goes beyond aggressiveness in the garden. These plants have the ability to strong-arm other species into surrendering their place in the wild. The term 'noxious' can be used to describe some of these species, but noxious is also a legal term. States have noxious weed laws, to protect agriculture and the public interest. Alaska has 12 species on its noxious weed list and another eight that are considered restricted noxious weeds.

Because of Alaska's broad climatological differences, plants that are invasive in one part of the state may not be troublesome elsewhere. In addition to those species that Extension suggests not planting in Alaska, an additional five have been added to the "DON'T Plant in Southeast Alaska" list. As our understanding of invasives grows, this list may change.

DON'T Plant in Alaska

Rampion bellflower (Chimney bells), *Campanula rapunculoides*

Becoming so extremely aggressive wherever it is planted, rampion bellflower is known by some gardeners as the "purple monster." It produces a large number of seeds and also spreads by creeping rootstocks. It escapes into lawns and can persist with frequent mowing. Removal by digging is usually not successful because plants resprout from any small pieces left in the ground.

There are many non-invasive species of *Campanula* which can be planted as alternatives. *Campanula persicifolia*, the peach-leaved bellflower and *C. lactiflora*, the milky bellflower are two which don't spread to unwanted locations. The milky bellflower is not as winter hardy as peach-leaved bellflower. *Campanula rapunculoides* should not be confused with *Adenophera,* although both are often called ladybells.

Creeping Charlie (Ground ivy), *Glechoma hederacea*

In many parts of the United States, creeping Charlie is considered a weed and is not offered for sale by nurseries. In Alaska, it is most commonly sold in hanging baskets because of its long, trailing stems. As a groundcover, creeping Charlie roots at every node and quickly takes over. It has escaped or naturalized in 46 states including Alaska where it can be found spreading in wooded areas in Southcentral.

It is difficult to suggest an alternative groundcover to creeping Charlie because all groundcovers spread and could potentially get out of hand. A couple of less invasive ideas include bugleweed, *Ajuga reptans*, which is not always hardy in Southcentral and yellow archangel, *Lamiastrum galeobdolon* 'Hermann's Pride.'

Orange hawkweed, *Hieracium aurantiacum*

A small clump of orange hawkweed quickly becomes a large, solid mat of hairy leaves crowding out other plants. Don't be tempted by its bright, orange flowers. This species is not garden worthy. Areas near Homer and other parts of the state are covered in orange hawkweed and chemical eradication programs have been undertaken in the Kodiak National Wildlife Refuge. Orange varieties of dwarf strawflower, *Helichrysum bracteatum*, can provide the same bright color as orange hawkweed in the garden. For more detailed information, contact Cooperative Extension for a copy of the "Orange Hawkweed" brochure published by the U.S. Forest Service. Don't be responsible for spreading this plant in your neighborhood or into the wild.

Butter and eggs (Toadflax), *Linaria vulgaris*

Butter and eggs looks non-threatening with its dainty, snapdragon-like flowers. It has been planted by unsuspecting gardeners, but if you've ever tried to eliminate butter and eggs from an area, you know how tenacious it can be. Plants can be seen growing from cracks in Anchorage parking lots and along the railroad tracks in Willow. There are other species of annual and perennial *Linaria*, some more aggressive than others, but in Alaska none have spread to areas outside the garden like *Linaria vulgaris*. A close relative, dalmation toadflax is also a weed and should not be planted. Annual snapdragons can be used as an alternative to butter and eggs.

Purple loosestrife, *Lythrum salicaria, L. virgatum*

Nationwide, purple loosestrife is considered extremely invasive, especially in wet areas where the plant completely displaces other species and destroys wildlife habitat. Sale of the plant has been banned in 13 states and many nurseries refuse to sell the plant even if it isn't banned in their location.

In Alaska, purple loosestrife was first documented as escaping into the wild in October 2005. Numerous plants were pulled from an island in Chester Creek near Westchester Lagoon in Anchorage. The flower color of purple loosestrife is similar to fireweed which blooms earlier in the season. One plant that could be used as a substitute for purple loosestrife is *Liatris spicata*, commonly known as blazing star or prairie gayfeather. Its stiff spikes of purple or white flowers open from the top down. Plants grow 1 1/2 to 3 feet tall depending on cultivar and are hardy in Southcentral Alaska. Other alternatives include blue or violet *Salvia*, *Delphinium* and native lupines.

Ornamental ribbongrass, *Phalaris arundinaceae* 'Picta'

Non-variegated *Phalaris arundinaceae* is more commonly known as reed canarygrass, an aggressive, mat-forming grass nearly impossible to eliminate once it becomes established. Reed canarygrass has escaped and/or naturalized in 43 states, including Alaska, and in many Canadian provinces. According to "Selected Invasive Plants of Alaska" it is found along roadsides, ditches, wetlands, riparian areas, beaches and growing into lakes.

Variegated ribbongrass, *Phalaris arundinaceae* 'Picta,' is likewise invasive and, as many gardeners can attest, is difficult to control. A better behaved grass to use as an alternative is *Miscanthus sinensis* 'Variegatus,' Japanese silver grass. Although websites and catalogs list it as a Zone 5 perennial, a nice clump labeled *Miscanthus* has been growing at the Palmer Visitor's Center (Zone 3) for many years and the cultivar 'Purple Flame' proved hardy at the Alaska Botanical Garden in Anchorage until it was removed.

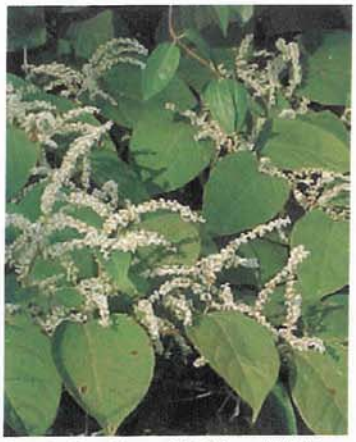


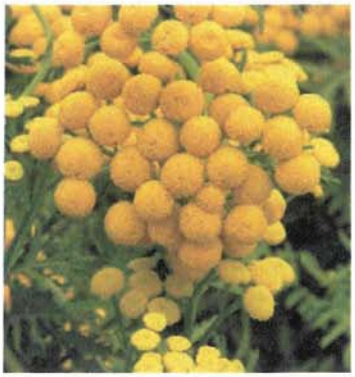
Photo by Britt Slattery, U.S. Fish and Wildlife Service, www.forestryimages.org

Japanese knotweed, *Polygonum cuspidatum (Reynoutria japonica, Fallopia japonica),* **Bohemian knotweed,** *(Polygonum* x *bohemicum)*

Problematic in the Pacific Northwest, Japanese knotweed, and its cousins giant knotweed (*P. sachalinense*), and a hybrid between the two, Bohemian knotweed, are troublesome in Alaska. Local names for these plants include Chinese or Japanese bamboo because of the plant's hollow stems. Many countries have been involved in research to try and eradicate this species where it has taken over. A brochure on "Japanese Knotweed" published by the U.S. Forest Service in Alaska describes the impacts it has on native vegetation and wildlife. Rutgers Cooperative Extension claims Japanese knotweed is one of the most difficult to control species in the home landscape. In Southeast Alaska, large stands exist where plants have escaped cultivation. Plants can also be propagated inadvertently, when pieces of roots or stems are disposed of improperly. To find out more about this invasive species, contact Cooperative Extension for a copy of the U.S. Forest Service brochure and for information on how to control existing stands.

Common tansy, *Tanacetum vulgare*

This species can be found planted in both flower gardens and herb gardens. Gardeners try to control its spread by digging out unwanted rhizomes. Unfortunately, common tansy also spreads by seed and can be found growing in vacant lots and along the edges of woods and trails in Anchorage parks. Plants have also been found growing along roads in the Kenai mountains. Common tansy is winter hardy and spreads aggressively in Fairbanks. Perhaps it's still possible to prevent our roadsides from becoming covered with tansy by not planting this species in gardens. The plant can be a skin irritant and gloves should be worn when removing tansy from the garden or from places to which it has escaped.



Common mullein, *Verbascum thapsus*

The *Verbascums* are a group of very popular garden flowers because of their unusual, tall spikes of flowers. *Verbascum thapsus* is a common roadside weed in other parts of the country. Unfortunately, Alaskan gardeners, excited about this genus, are starting to plant common mullein. This biennial has been recorded as growing in open areas in Southcentral Alaska. The flowers of *Verbascum thapsus* are not showy like many of its cousins. The wooly leaved *Verbascum bombyciferum* is much more ornamental. Like common mullein, it is a biennial. *Verbascum chaxii* is a reliably winter hardy perennial in Southcentral Alaska. Although not as tall or large-flowered as *V. bomyciferum*, it has many flowering stems per plant. Other yellow flowered mulleins may be winter hardy depending on which part of the state you are located.

Ornamental Jewelweed, *Impatiens glandulifera*

The most commonly used local name for this species is Washington orchid. This plant may have been passed along to Alaska by gardeners from Washington, but this quick growing annual certainly isn't an orchid. The plant is huge, often growing to eight feet tall. It seeds prolifically and has been documented growing in a large area along the beach in Haines. Ornamental jewelweed is known to thrive in riparian areas and can easily send seeds downstream. Its quick growth and ability to form dense stands allows it to out-compete other vegetation. As with other members of this genus, ripe seed pods explode when touched, ejecting seeds for many feet. *Impatiens glandulifera* may also be found listed as policeman's helmet and Himalayan balsam. *Impatiens noli-tangere* is a much shorter, yellow-flowered Alaska wildflower.

DON'T Plant in Southeast Alaska

In addition to the above flowers those listed, below should not be planted in Southeast Alaska. Sweet rocket, St. John's wort and creeping buttercup should also be watched in other parts of the state because of their potential to cause problems.

Scotch broom, *Cytisus scoparius*

Scotch broom is a woody member of the pea family which has become widespread on southern Vancouver Island and in many parts of the United States. It is considered a noxious weed in California, Hawaii, Idaho, Oregon and Washington. Scotch broom is already quite common in Ketchikan and has been planted in Sitka, Hoonah and Petersburg. Because it has overrun large areas in other parts of the country, there is concern that it may do the same in Southeast Alaska. Scotch broom requires 150 frost-free days to produce seed.

Photo by Eric Coombs, Oregon Department of Agriculture, www.invasive.org

Foxglove, *Digitalis purpurea*

Although many gardeners are disappointed that this biennial does not usually survive the winter in Southcentral and Interior Alaska, foxglove has escaped cultivation in Southeast. It is very common in Sitka gardens. Gardeners in Juneau have reported its escape in their community. The flower is usually seen growing in ditches and it can form dense areas in disturbed sites. It is possible this species could threaten native plant communities. There are many other species of *Digitalis* that don't have the reputation of escaping into the wild.

Sweet rocket (Dame's rocket), *Hesperis matronalis*

Often a component of non-native wildflower mixes, sweet rocket has also been planted by gardeners for its fragrance. Unfortunately, plants have escaped in 40 states, including Alaska where it is common in downtown Juneau, Kodiak and Sitka. Plants reproduce by seed and although usually listed as a biennial, can also be perennial.

DON'T Plant in Southeast Alaska (continued)

St. John's wort, *Hypericum perforatum*

St. John's wort is planted because of its pharmaceutical properties, although for this use it would be much safer to purchase from health food stores. Known as an extremely aggressive weed in the Pacific Northwest, St. John's wort has escaped and/or naturalized in 44 states. It is a perennial that reproduces both by seed and vegetatively. Plants have been found growing in Hoonah, Sitka and Prince of Wales Island. Do not plant St. John's wort in Southeast Alaska and monitor it carefully in Southcentral.

Creeping buttercup, *Ranunculus repens*

Gardeners are well aware of creeping buttercup's aggressive tendencies. The species has escaped in 41 states and in many Alaska locations including Denali National Park, Girdwood, Seward, Homer, Juneau and Kodiak where gardeners wage war against it on an annual basis. Plants can withstand low mowing when mixed in a lawn. When growing among taller species creeping buttercup grows to two feet. It thrives in moist locations but plants are not fussy. Gardeners in Southeast Alaska should not plant this species and gardeners in other parts of the state should think twice before planting what could become a problem.

Invasive Garden Species to Watch

Not all species that are aggressive in the garden will escape into Alaska's wildlands and become problematic. The following compilation of species are garden flowers, trees and shrubs that should be watched to keep them from spreading. As we learn more about how these species behave in Alaska, the list of invasive garden species not to plant will likely change.

Oxeye daisy

Oxeye daisy, *Leucanthemum vulgare,* is often used in non-native wildflower seed mixes and has been planted along roadsides. It is a gangly white daisy, that spreads from areas where it was originally planted in Southcentral Alaska. It is also hardy in the Interior. There are many cultivars of the more ornamental Shasta daisy, *Leucanthemum X supurbum,* which can be grown. They are not as winter hardy as the oxeye daisy but much better behaved. Another alternative is the native arctic daisy, *Dendranthema arcticum.*

Another aggressive speader is **sneezeweed,** a relative of yarrow. Its scientific name is *Achillea ptarmica.* On the Kenai peninsula it is known as Russian daisy. In the garden, this white flower spreads readily by seed. It has escaped and/or become naturalized in 18 states, including Alaska.

Two commonly used groundcovers that have reputations as being weedy Outside include **bishop's goutweed,** *Aegopodium podagraria* and **spotted deadnettle,** *Lamium maculatum*. Many Alaskan gardeners are raising a red flag about bishop's goutweed too. It spreads from flower gardens into the lawn and is difficult to eradicate once you decide you don't want it. Spotted dead nettle is more often called by its genus name, *Lamium*. Many new cultivars have been developed in recent years, even though it is a spreader. Both of these species should be watched to make sure they don't escape cultivation.


Bishop's goutweed

Growing tight to the ground, **creeping Veronica,** *Veronica repens*, can show up in places where it is not wanted. This species of *Veronica* was once banned from beds at the Alaska Botanical Garden but can still be found growing in the lower perennial garden. If it gets into your lawn, you'll be sorry. Another *Veronica*, *V. grandiflora*, the **Aleutian speedwell,** is an Alaskan native, but taken from the Aleutian Islands and brought into the garden, this little *Veronica* can really spread.


Bigleaf lupine

Garden flowers that spread themselves around by seed include **maiden pink,** *Dianthus deltoides*, and the non-native **forget-me-nots.** Spreading outside the garden, maiden pink has escaped and/or become naturalized in at least 23 states. Forget-me-nots are commonly planted because gardeners think they are planting the Alaska state flower. Our native forget-me-not is *Myosotis alpestris* subspecies *asiatica*. It doesn't have the tendency to spread like the non-native species. Often times, seed packets don't even mention the species of *Myosotis* they contain. Other times they are mislabeled.

The **bigleaf lupine,** *Lupinus polyphyllus*, is a non-native species that has been documented growing in Denali National Park, Seward and along roadsides in other parts of the Kenai Peninsula. There are concerns that this lupine is hybridizing with our native species. There are really no advantages to growing bigleaf lupine over our native *Lupinus arcticus* and *L. nootkatensis* which have fewer than ten leaflets compared to *L. polyphyllus*. In addition to spreading by seed, bigleaf lupine can also develop large clones through spreading rhizomes. The 'Russell Hybrid' lupines grown by gardeners are available in a wide range of colors, and to date have not been shown to be invasive in Southcentral Alaska.

Many *Anemones* are indigenous to Alaska. The **snowdrop windflower,** *Anemone sylvestris* is not and should be watched because of its strong tendency to spread by rhizomes. The large yellow flag iris, *Iris psuedacorus*, grows more prolifically in wet locations than typical garden soil. Gardeners should keep an eye on it, especially in Southeast.

While *Campanula rapunculoides* has the reputation of being the most invasive *Campanula*, there are others that should be watched. The **clustered bellflower,** *Campanula glomerata,* has escaped and/or naturalized in 12 states including Alaska. **Korean bellflower,** *Campanula takesimana,* has also proven to be a strong spreader in Southcentral Alaska and gardeners should take care to see that it does not escape. Suggested alternatives for these species are listed under *Campanula rapunculoides* on page 1.

The genus *Centaurea* includes many bad weeds so it makes sense that related garden flowers should be suspect. The annual **bachelor's buttons** or cornflower has escaped in 48 states and is often included in non-native wildflower seed mixes


Globe centaurea

in Alaska. **Globe centaurea,** *Centaurea macrocephala,* is designated as a "Class A Noxious Weed" in Oregon and Washington. **Perennial bachelor's buttons** have escaped and/or naturalized in other states and is known to spread itself around in Alaska gardens.


Mayday tree in the understory along Chester Creek, Anchorage

In addition to St. John's wort, which should not be planted in Southeast, there are a number of herbs which should be watched. **Chives,** *Allium schoenoprasum,* seed prolifically if spent flowers are not removed. While many varieties of **mint,** *Mentha* sp., are not winter hardy in Southcentral Alaska and areas that are colder, some species are known to be very invasive. **Catnip,** *Nepeta cataria,* is a weed in many parts of the country. Gardeners growing it should make sure to pull out unwanted seedlings. **Comfrey,** *Symphytum officinale,* has been banned from more than one garden because of its aggressive tendencies.

Not all garden species to keep an eye on are herbaceous. There are trees and shrubs which have started spreading beyond the home/commercial landscape. **Mayday tree,** also known as European birdcherry, *Prunus padus,* has become established along riparian areas in Anchorage parks and along the Chena River in Fairbanks. At this point, the Amur chokecherry, *Prunus mackii,* has not been noticed escaping into wild areas. **Siberian peashrub,** *Caragana arborescens,* seedlings have also been noted spreading out from original plantings in Mat-Su. **Tatarian honeysuckle,** *Lonicera tatarica,* has completely degraded woodland composition in parts of the Midwest and should be watched to make sure that it does not become established in the wild in Alaska. **European mountain ash,** *Sorbus aucuparia,* has escaped cultivation in Anchorage and Southeast Alaska where native species of mountain ash exist.

As gardeners, what can you do?

- Don't plant flowers, trees and shrubs which are known to be invasive.
- Watch species that have the potential to become troublesome and help share information.
- Order from reputable nurseries that are not likely to mislabel plants or sell weedy seed mixes.
- Don't share potential problems with other gardeners.
- When you purchase new plants, watch to make sure you don't introduce weeds hitchhiking in pots or root balls.
- Make sure you don't introduce problems by planting non-native wildflower seed mixes which contain invasive species or weed seeds.

Human actions are the primary means of invasive species introductions. Gardeners can be a part of the solution. Don't plant invasive species intentionally.


Alaska wild iris

For more information

Contact the University of Alaska Fairbanks Cooperative Extension Service for help in identifying invasive garden species and weeds. You can also check with Extension for specific control recommendations.

Publications

- **Invasive Plants of Alaska,** 2005. AKEPIC–Alaska Exotic Plants Information Clearinghouse, Alaska Association of Conservation Districts Publication, Anchorage, Alaska
- **Voluntary Codes of Conduct for the Gardening Public,** published jointly by UAF Extension and USDA Forest Service, Publication No. FGV-00142, 2004
- **Voluntary Codes of Conduct for Nursery Professionals,** published jointly by UAF Extension and USDA Forest Service, Publication No. FGV-00147, 2005
- **Selected Invasive Plants of Alaska,** USDA Forest Service R10-TP-130B, 2004
- **Orange Hawkweed,** USDA Forest Service Leaflet R10-TP-129, June 2004
- **Japanese Knotweed,** USDA Forest Service Leaflet R10-TP-119, July 2003

Websites

- U.S. Forest Service, Forest Health Protection, Alaska Region website, where many of the above publications can be found: http://www.fs.fed.us/r10/spf/fhp/
- UAA Natural Heritage Program, Plant Invasiveness Ranking Project: http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm

Written by

Julie Riley, Extension Horticulture Agent, Anchorage
Jamie Snyder, Extension Invasive Plants Program Instructor, Anchorage

Photo credits

All photos by Julie Riley unless otherwise noted.

Reviewed by

Peter Bierman, Extension Land Resources Agent, Palmer
Michele Hébert, former Extension Land Resources Chair, Fairbanks
Sue Lincoln, formerly with Extension, Anchorage
Janice Chumley, Extension Program Aide, Soldotna
Michael Shephard, Vegetation Ecologist, USDA Forest Service, Anchorage
Jeff Heys, Exotic Plant Management Team Liaison, National Park Service, Anchorage

Graphic design by

Susan Bybee, Extension Administrative Assistant, Anchorage

COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF ALASKA FAIRBANKS

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Kit Extension Activities

The purpose of this document is to provide weed committee coordinators and education centres with an outline for a teaching kit that they can build to enhance the educational program *Nab the Bully Plant: Become a Bully Plant Special Agent* (see www.fraserbasin.bc.ca). Ideally this kit will be used by the coordinators, or lent out to youth clubs or teachers. For activities with an associated website link, the descriptions and instructions outlined are brief since full details of each program can be found on the website. The full instructions for each activity can be printed and included in the kit.

1) CSI Robin's Farm(Reader's Theatre) Enhancement

Objective: To identify threats that invasive plants pose to our ecosystem and economy.

Overview: Enhance the reader's theatre by adding props and costumes.

Supplies required:

- detective coat and hat for leader reading
- hats (bands around head with plants sticking up) for Betty Balsamroot, Willy Wheatgrass, Cathy Cattail, Nathan Knapweed, Lucy Loosestrife and Spunk Spurge
- helmet for motorbike rider
- cowboy hat for Robin
- other supplies listed under "Activity #1: CSI - Robin's Farm" in main program

2) Pressed Plant Collection

Objective: To identify invasive plant species using pressed samples.

Overview: Enhance the "Prime Suspects" activity (if it is played indoors) by using pressed plants rather than photos. Leader mounts pressed plants on cardstock with glue. Laminate the plant. On each card, add a label on the front that can be covered, or add a label on the back.

Supplies required:

- set of Prime Suspects bully plants pressed and laminated
- other supplies listed under "Activity #3: Prime Suspects" in main program

3) Tagging the Prime Suspects

Objective: To reinforce the Prime Suspects activity (invasive plant identification) using live samples.

Overview: See http://www.weedcenter.org/education/lessons/taggingrace3-5.pdf

Supplies required:

- sets of clothespins with flagging tape and names of plants

4) Witness Descriptions—Invasive Plant Riddles

Objective: To review invasive plant identification and Prime Suspects in your area.

Overview: Develop a series of 10 riddles based on the Prime Suspect Profiles, each riddle describing a bully plant. Read them as if they are witness descriptions at a bully plant crime scene. "The witness is sure she saw a bully plant with yellow flowers, and the leaves were clinging to the stems..." Students can be divided into teams or pairs, and can ring bells or put up their hands if they know the answer.

Supplies required:
- set of 10 "witness description" riddles
- bells or other noisemakers (optional)

5) Mystery Bags

Objective: To develop observational skills and to review invasive plant species.

Overview: Good observational skills involve the senses. What something feels like may be an important clue. Fill a series of bags or boxes with different invasive plant parts (seeds, leaves, entire plants, stems, etc.). Each youth feels inside the bag without looking. Can they guess what is inside?

Supplies required:
- bags or boxes
- invasive plant parts

6) Bully Plant Puzzles

Objective: To identify invasive plant parts (leaves, stem, flowers, etc.) using puzzle pieces.

Overview: Enhance plant identification through this puzzle game. Tell the students that "solving a crime is like doing a jigsaw puzzle—if you put all the pieces together you get the whole picture." Use large black and white drawings of the Prime Suspects in your area that are all in a similar style (e.g., from *Guide to Weeds in British Columbia* which can be found at www.weedsbc.ca). Cut them all up into the same shapes (so a puzzle piece from one plant will fit the puzzle of another). Groups of kids have to put the puzzles together based on the features of the plant (they can look at Prime Suspect Profiles for help if necessary).

Supplies required:
- large drawings of Prime Suspect bully plants laminated and cut up
- Prime Suspect Profiles (optional)

7) Bully Plant Fingerprints

Objective: To create artwork using invasive plants and to identify their leaf prints.

Overview: Youth select a Prime Suspect plant that they wish to "fingerprint" for their detective file. They can select a piece of a plant from the outdoors or use a sample brought in by the group leader. (Be careful not to select toxic plants.) Students paint an entire plant or part of a plant (e.g., leaf) and then press it onto paper. When they peel off the plant, the image remains. They can label their plant with its name and include the date of fingerprinting. Have other students guess which Prime Suspect was fingerprinted by looking at the artwork (label covered).

Supplies required:
- paper
- paint
- plant samples
- newspaper to catch paint drips on table and floor

8) Seed SI

Objective: To identify seeds from invasive plants and investigate how they spread.

Overview: Bully plants spread their seeds in many ways. Enhance the "Getaway Vehicles" activity by showing a variety of seeds from bully plants. Fill jars or sandwich bags with seeds from each bully plant species. Some good examples:
- Canada thistle: small seeds each with parachute-like pappas similar to dandelion; carried mainly by wind; also dispersed by birds and in mud caught in tire or boot treads
- toadflax or cinquefoil: small, hard seeds, winged in the case of toadflax; carried by birds, ungulates or other animals, and possibly short distances by wind; also dispersed in mud caught in tire or boot treads
- hound's tongue: clinging, barbed nutlets; hitchhike on humans, wildlife or livestock

Supplies required:
- jars or sandwich bags
- collections of seeds

9) Seeds on the Move

Objective: To illustrate how the seeds of invasive plants spread.

Overview: Youth create their own "seeds" using craft materials provided. They then demonstrate to the rest of the group how their seeds disperse.

Supplies required:
- pipe cleaners
- straws
- tape or glue
- cardstock
- tissue paper
- Velcro
- Ping-Pong balls
- colour markers
- scissors
- recycled materials (bottle caps, paper clips, etc.)

10) Pin the Seed on the Bully Plant

Objective: To match "seeds" with three species of invasive plants.

Overview: A fun game to help familiarize youth with seeds that bully plants use to reproduce. Play a version of pin the tail on the donkey in which youth have to pin the seed on the bully plant. Have three bully plants made out of fabric on a fabric backdrop. Have three seeds (made of felt with Velcro) that match each weed (e.g., see "Seeds on the Move," above). A player is blindfolded and turned around, and then has to try to pin the seed on the bully plant. Whoever gets their seed on the correct plant and closest to the correct place (flower head) wins.

Supplies required:

- fabric backdrop with three fabric bully plants attached
- fabric seeds with Velcro
- blindfold
- tape or other means of hanging backdrop

11) Seeing Purple: A Population Explosion

Objective: To demonstrate how invasive plant populations can explode by the number of seeds they produce; to demonstrate the concept of sampling.

Overview: See http://www.iisgcp.org/edk-12/escape/SeeingPurple_copy.pdf

Supplies required:

- bag of purple confetti
- poster board (for each group)
- fan or hair dryer (and extension cord if necessary)
- string
- tape
- colour markers

12) Population Explosion Relay

Credit: Jon Detka Return of the Natives Restoration Education Project, Watershed Institute, CSU Monterey Bay, Seaside, California (see website below)

Objective: To demonstrate the concepts of seed dispersal, germination rate, exponential population growth, and predation by engaging in a "weeds vs. natives" relay race.

Overview: See http://watershed.csumb.edu/ron/roncor/cor/prelay.htm

Supplies required:

- two very different types of dried beans (500 g bag of each)
- three large bowls
- masking tape
- marker
- large sketch pad or copies of Weeds vs. Natives Score Sheet from website
- hula hoop or piece of rope tied to make a circle

13) Outwit–Outplant–Outlast

Objective: To demonstrate what plants need to survive, and how bully plants can take over an area from native plants.

Overview: See http://www.dnr.state.wi.us/org/caer/ce/eek/teacher/invasivesguide/Outwit%20Outplant%20Outlast.pdf

Supplies required:
- chalk or paper plates
- tape measure
- 100 poker chips of each of two colours (200 total)
- bell or noisemaker

14) Bully Plant Treasure Hunt

Objective: To reinforce various bully plant facts including ecosystem impacts, economic impacts and methods of spread.

Overview: Photocopy and laminate facts about bully plants. Hide them throughout the room before the youth come in. Kids find as many as they can. Meet in the centre of the room and redistribute cards if some participants don't have as many. Have each youth read out their bully plant fact.

Supplies required:
- invasive plant facts written out on small pieces of paper and laminated

15) Bully Plant Board Game

Objective: To review how bully plants spread and what individuals can do.

Overview: Youth play a board game that simulates bully plant invasions and management. For examples, see the Weed Warrior Activity Book developed by the Regional District of Okanagan–Similkameen or http://www.weedbusterweek.info.au/docs/Weedbuster_Game.pdf.

Supplies required:
- game board
- playing tokens
- dice

16) Bully Plant Jeopardy

Objective: To review information on invasive plants.

Overview: Youth play a Jeopardy-like game in which they are given an answer within a category and they have to identify the question. Ideas for categories include:

- bully plant impacts
- prime Suspects
- getaway vehicles
- control methods
- what can you do?

Supplies required:

- five topic headings
- five answers per category with the question written on the back (or a cheat sheet for the leader)
- masking tape to put up all the answers under each category
- pen and paper for recording scores

17) Bully Plant Bingo

Objective: To review information on invasive plants.

Overview: Youth play a bingo-like game in which they need to identify answers or drawings based on something called out. For example, if "spotted knapweed" is called, they need to put their tokens on the spotted knapweed drawings or photos on their playing card.

Supplies required:

- bingo sets (boards and tokens)
- small drawings or words to modify bingo cards
- invasive plant names or facts on small pieces of paper to be drawn from a hat
- hat

Additional Resources To Include In Kit:

- posters
- activity books
- weed warrior tattoos
- weed guidebooks
- weed samples made from silk

Print the first page and then turn paper over to print page two on the back.
Cut out the pocket guide and fold where indicated.
Stick it in your wallet and refer to it when choosing landscaping plants.

Purple Loosestrife *Lythrum salicaria*
An aggressive invader of wetlands, purple loosestrife forms dense monocultures and outcompetes native grasses, sedges and other wetland plants. This species poses a serious threat to salmon streams in Alaska.

Butter and Eggs *Linaria vulgaris*
AKA: common toadflax, yellow toadflax, wild snapdragon
A problematic ornamental plant that can spread to displace native species, livestock forage and wildlife habitat. A single plant can produce up to 30,000 seeds annually. It is also reported to be mildly toxic to cattle and is generally avoided by browsers.

fold

Common Tansy *Tanacetum vulgare*
AKA: tansy, garden tansy, golden buttons, bitter buttons, hind-head, parsley-fern, ginger-plant
Tansy was introduced from Europe as a medicinal and ornamental plant but it has the potential to be toxic to both wildlife and humans. It is listed by Washington, Colorado, Wyoming and Montana as a noxious weed.

Japanese Knotweed *Polygonum cuspidatum*
AKA: crimson beauty, bamboo, Mexican bamboo, Japanese fleeceflower.
This plant spreads quickly along roads and streams. It will outcompete native flora readily and has already become a serious concern in Southeast Alaska. Also avoid Giant and hybrid Bohemian knotweed which are also very troublesome and difficult to remove once established.

fold

Ornamental Jewelweed *Impatiens glandulifera*
AKA: Himalayan balsam, policeman's helmet, touch-me-not, Indian jewelweed, Washington orchid
Listed as a noxious weed in several Western states, jewel weed reproduces vigorously with prolific seed production. It is known to damage native plant communities, wildlife habitat and even alter water flow at high densities.

Orange Hawkweed *Hieracium auranticum*
AKA: devil's paintbrush, king-devil
This plant is a tenacious invasive weed. It has become a serious problem in Southcentral Alaska and is spreading rapidly in other areas of the state. It will overtake lawns, gardens and mountain meadows alike.

fold

For information about invasive plants and how to control them, visit the Homer Soil and Water Conservation District website: **www.homerswcd.org** and the statewide Committee for Noxious and Invasive Plant Management (CNIPM) website: **www.cnipm.org**

For plants not covered in this guide - search the US Dept of Agriculture's Plants Database (http://plants.usda.gov) for additional info about listed noxious weeds.

Pocket Guide to RESPONSIBLE LANDSCAPING *in Southcentral Alaska*

May 2007

GREEN

Preferred alternatives to invasive ornamental plants. These hardy species do not have invasive tendencies and can be safely utilized for landscaping in Alaska. Help protect our diverse native flora and wildlife by choosing these non-invasive alternatives.

Pot Marigold *Calendula*
This is a stout annual with showy orange or yellow flowers growing up to 2 feet tall. Pot marigold is easy to propagate and does well in partially shaded and well-drained areas.

Blazing Star *Liatris*
A great low-maintenance alternative to loosestrife that forms showy, purple floral "spikes" from 1 1/2 to 3 feet tall. This perennial ornamental is also known as prairie gayfeather and makes an excellent cut flower for indoor arrangements.

Asiatic Lily *Lilium*
These lilies are hardy, brightly colored perennial flowers available in red, orange and yellow varieties. Grows to 3 feet or taller and makes a great border or accent to ground covers. Does well in full sun and will grow in a variety of Alaskan climates. If you are looking for a fuller flower consider using peonies that also come in a diverse collection of colors.

PLANT KEY

This pocket guide will help you select alternatives to some of Alaska's most invasive ornamental plants.

- ALTERNATIVES
- CAUTION
- INVASIVE
- NOXIOUS

Supported by
Homer Soil and Water Conservation District, the Alaska Association of Conservation Districts and US Forest Service- State and Private Forestry

fold

GREEN (con't)

Shasta or Alaska Daisy *Leucanthemum maximum or Leucanthemum x superbum*
This is an attractive daisy with the classic white petals and yellow centers. Ideal for landscaping and garden edges, it grows 1-3 feet tall and does very well in dry sites. Make sure you are not getting the invasive Oxeye Daisy,[N] as package labels are sometimes unclear or incorrect. There is also a native arctic daisy *Denddranthema arcticum* that is a suitable alternative.

fold

Bride's Feathers or Goat's Beard *Aruncus*
This is a nice substitute for knotweed with similar plumes of cream-colored flowers. It grows best in moist areas with partial to full sun. It is clump-forming and will grow from 4 to 8 feet tall depending on the variety and site conditions.

Lupine *Lupinus including 'Russell Hybrids'*
A striking variety of colors make lupines a wonderful perennial to add to your landscaping. However, lupines grow best in drier sites. Two native species *L. nootkatensis and L. arcticus* can also be successfully propagated but avoid the "Bigleaf" lupine that may hybridize with native lupines.

Alternative shrubs and trees

fold

Some shrubs and trees that have been reported to be invasive include: Scotchbroom,[N] Siberian Peashrub, European Bird Cherry ("mayday tree") and European Mountain Ash. Consider some of the following options.

Shrubby Cinquefoil or Buttercup Shrub
Potentilla fruticosa
Potentilla is an eye-catching, low maintenance shrub with attractive flowers that are available in a variety of colors. They will grow from 1 to 6 feet tall in areas of full and partial sun. Avoid Sulfur Cinquefoil (*Potentilla recta*)[N] which is a known noxious weed.

Peking Cotoneaster *Cotoneaster acutifolius*
fold
A fast-growing, Alaska hardy shrub with pinkish white flowers. The foliage is dark green and turns a brilliant orange and red in the fall, it will add a splash of color to your landscape and can be trimmed into hedges. Does best in moist but well-drained soils and can grow to 6 feet tall. Watch for and avoid planting other Cotoneasters, as some are invasive.

Mugo or Dwarf Mountain Pine *Pinus mugo*
A great landscaping tree, with shrubby varieties growing from 4 to 6 feet tall. Taller varieties are also available. It has dark green needles and is great for shrubby edges. Very tolerant of a variety of soil types and will grow in full sun.

[N] Currently listed as a noxious weed by one or more states in the US.

YELLOW

Species are known to be problematic elsewhere and should generally be avoided. These are known to have invasive characteristics and may be considered noxious weeds in some states. Consider an alternative.

Cornflower or Bachelors Buttons
Centaurea spp.
Several of the most troublesome weeds in the Western US are within this genus including Spotted and Diffuse Knapweed[N], and Yellow Starthistle[N]. Several related ornamental plants are sold as "bachelors buttons" or "mountain corn flower". The annual bachelors button is less hardy but still considered invasive by some sources. Consider an alternative.

The Pearl *Achillea ptarmica*
This plant, also called sneezeweed or Russian daisy, is widely planted but has become a pest in a hayfield on the lower Kenai Peninsula and has become naturalized in over 18 states.

Purple Foxglove *Digitalis purpurea*
Has spread outside cultivation in Southeast Alaska and become a naturalized plant elsewhere. Plants are very poisonous and though poisonings are rare, should generally should be avoided.

Variegated Ribbongrass *Phalaris arundinaceae*
An ornamental variety of Reed Canary Grass[N] which has been responsible for the destruction of countless acreage of lost wetland habitat. This variety is reported to have similar habits and is virtually impossible to remove once established.

Honeysuckle *Lonicera spp.*
Some honeysuckle plants, such as Tatarian honeysuckle,[N] are a serious problem elsewhere where they overtake forest edges and road right of ways. Seeds may be carried into remote areas by birds .

RED

These are known invasive or noxious ornamental plants. They quickly spread to invade natural areas, cause declines in biodiversity and damage native habitats and agricultural production. Don't propagate or spread these aggressive weeds

[N] Oxeye Daisy *Leucanthemum vulgare*
Commonly planted as an ornamental or as a component in "wildflower" seed mixes, Oxeye daisy is an invasive perennial that can alter nutrient cycles and poses a serious threat to forage crop production. This plant can be very difficult to remove and seeds remain viable for over six years.

fold

KING COUNTY NOXIOUS WEED CONTROL PROGRAM WEED ALERT

Purple Loosestrife

Lythrum salicaria Loosestrife Family

Class B Noxious Weed: Control Required

Identification Tips

- Tall, showy, magenta flower spikes
- Flowers small and numerous with 5-7 petals
- Develops woody tap root, fibrous root and rhizomes
- Forms substantial root wads with many stems
- Stiff, four-sided stems, often growing 6 to 10 feet tall
- Leaves simple, smooth edged and opposite or whorled
- Usually associated with moist or marshy areas

Impact: purple loosestrife can take over wetlands, displacing native plants and wildlife.

Biology

- Rhizomatous perennial; reproduces by seed, roots and vegetative growth
- Forms up to 2.5 million, pepper-size seeds per plant
- Seed banks build unnoticed for years, then under the right conditions a widespread infestation may suddenly emerge
- Seeds float on water and stick to animals
- Mature stands of purple loosestrife can live up to 20 years
- Flowers July to September

This weed features long flower spikes.

Impacts

- Alters wetland ecosystems by replacing native and beneficial plants
- Dense infestations can impede water flow
- Displaces nesting habitat for waterfowl, fur-bearing animals and birds
- Agriculture is impacted by a loss of wild meadows, hay meadows and wetland pastures

Purple loosestrife quickly invades shorelines.

Distribution

- Occurs in freshwater and brackish wetlands
- Found on lakes and waterways throughout King County
- Sometimes cultivated as a garden ornamental

Questions?

King County Noxious Weed Control Program Line: **206-296-0290**
www.kingcounty.gov/weeds

King County

What You Can Do

Do your part by checking regularly for purple loosestrife on your property and along public waterways and wetlands. If a new infestation on public lands is spotted, please contact the King County Noxious Weed Control program.

Control Methods

Most control methods need to be applied over several years to be successful. Often, a combination of methods will be more effective than one by itself.

Prevention: Beware of varieties sold as ornamentals. If boating in areas with purple loosestrife, check boat hulls, motors and other equipment for plant fragments that can be transported to new waterways.

Manual: Small infestations can be dug, bagged and disposed of, taking care not to disperse seeds. Mature flowering stems can be cut *at base* in late summer or early fall to prevent seed production. Brush off boots and clothes before leaving the infested area.

It may look pretty, but purple loosestrife is a dangerous invader.

Mechanical: Cutting or mowing by itself is not an effective control option for purple loosestrife. Shoots and adventitious roots will develop. Black plastic covering is an interim option for dense seedling infestations. It does not kill mature plants, but it does slow down growth and seed production.

Chemical: Chemical control options may differ for private, commercial and government agency users. **Follow all label directions and local regulations regarding herbicide use in sensitive areas.** Certain herbicides cannot be used in aquatic areas or their buffers. If herbicides are used, make sure that their label specifies your type of site. All aquatic herbicides are restricted-use herbicides. Purchase and application of these herbicides can only be done by licensed aquatic herbicide applicators. Permits are required before applying aquatic herbicides. For site specific herbicide recommendations, please contact the King County Noxious Weed Control Program.

Left to right: purple loosestrife, native spiraea, native fireweed.

The look-alikes: purple loosestrife is sometimes confused with the native plants spiraea and fireweed. Spiraea or hardhack (*spiraea douglasii*) is a shrub with round stems and toothed leaf tips. Flowers are tiny and lighter pink, appearing in dense clusters at the top of the plant. Fireweed (*Epilobium angustifolium*) has round stems and longer leaves with a distinctive mid-vein. Flowers are on stalks and have four petals. Long capsules split open to release fluffy white seeds.

Revised June 2007

King County
Department of Natural Resources and Parks
Water and Land Resources Division
Noxious Weed Control Program
206-296-0290 TTY Relay: 711

Assiniboine River, Winnipeg

Alternative Plant Choices

The gardening industry has been quick to respond to the purple loosestrife challenge. Many environmentally-friendly perennial plant choices are now available. The following is a sample of plants recommended for growing in western Canada. See your local nursery or garden centre for more details.

Spiked Gayfeather, Blazing Star

This 1.5 m (5 ft.) native of eastern Canada has pink, purple and white blossoms from mid-summer to early fall. It requires full sunlight to partial shade.

Little Princess

This compact 38 cm (15 in.) native mallow has soft frilly flowers and blooms in July and August. It requires full sun to partial shade.

Additional Information

For more information visit our Web site at:

www.purpleloosestrife.org

or contact the Manitoba Purple Loosestrife Project

204-467-3269

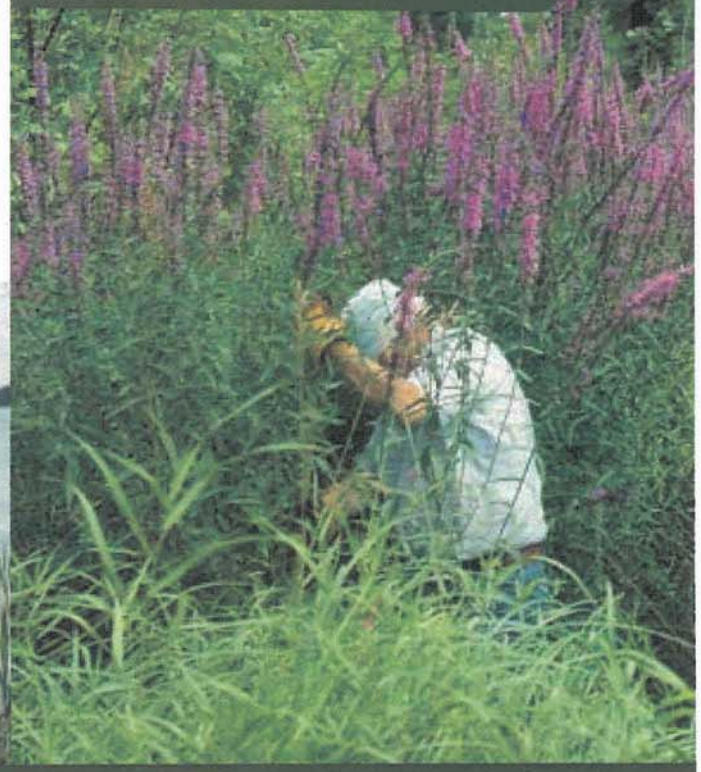
The Manitoba Purple Loosestrife Project is a partnership of the following organizations:

- Environment Canada – Canadian Wildlife Service
- Manitoba Conservation
- City of Winnipeg
- Ducks Unlimited Canada
- Delta Waterfowl Foundation
- Manitoba Naturalists Society
- Manitoba Weed Supervisors Association
- T & T Seeds

Crescent Lake, Portage la Prairie

Purple Loosestrife

Preventing the Spread in Western Canada



Protecting & Managing *our Future*

Manitoba
Building for the Future

Netley-Libau Marsh

The wetlands of western Canada are facing a serious threat – damage caused by the spread of an invasive plant, purple loosestrife. In the wild, purple loosestrife (also called *Lythrum*) invades and destroys habitat along rivers, streams, lakes, ditches and wetlands. It creates a dense purple landscape that chokes out native plants and deters wildlife.

Purple loosestrife is not native to Canada. In fact, it was introduced from Europe. Purple loosestrife planted in gardens and yards produce seeds that invade the wetland areas. To help stop this noxious weed, you are encouraged to remove and destroy existing *Lythrum* plants. Common garden varieties of *Lythrum* include Dropmore Purple, Morden Pink, Morden Gleam and Morden Rose. The sale of *Lythrum* varieties is prohibited in some provinces, including Manitoba.

Identifying Purple Loosestrife

Look for a plant one or two metres tall. It has smooth-edged leaves on a four-sided square stalk. There are several stalks per plant. The flowers bloom from June to September on long, pink/purple spikes.

Removing Purple Loosestrife in Wetland Areas

Large purple loosestrife infestations in wetlands areas are not easy to remove. Herbicides cannot be used in or near wetland areas. Digging up these infestations is very labour intensive and increases the risk of spreading the seeds. Therefore, a different approach must be taken.

In Canada and the United States, specialized leaf-eating beetles from Europe are controlling purple loosestrife. These beetles do not eat any other plants and are a safe alternative to using chemicals. This is an example of biological control. The beetle has successfully controlled large areas of purple loosestrife allowing for the return of native plants such as sedges and cattail.

Biological control beetle *Galerucella calmariensis*

Removing Purple Loosestrife from Gardens

In gardens, your purple loosestrife should be removed by mid-summer, before the flowers go to seed. Make sure the entire root mass, and all pieces, are removed. Remember, roots can extend 30 cm (12 in.) or deeper into the soil.

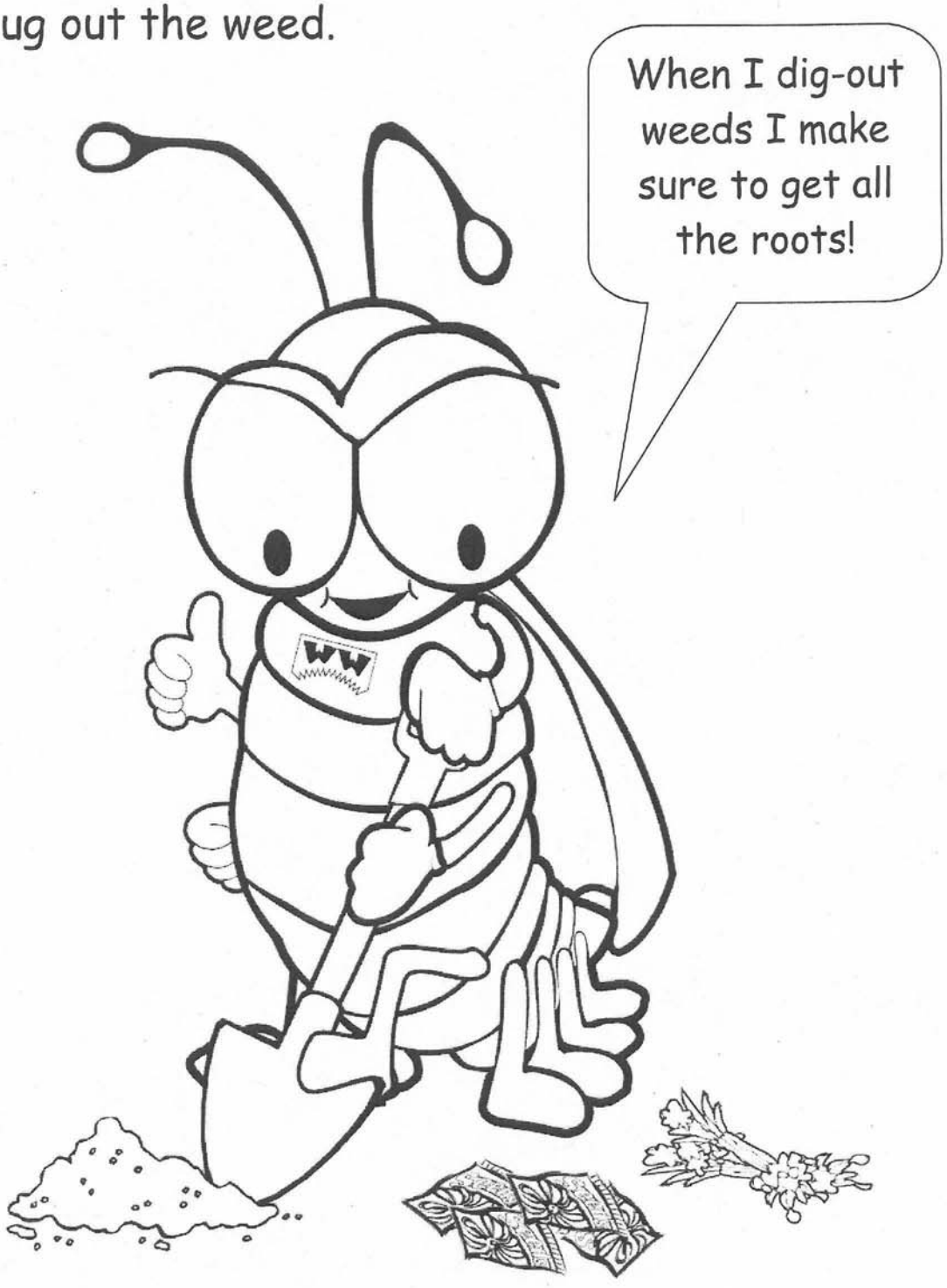
Place all plant material in a carton to dry completely. Protect it from wind, water, human or animal activity. Once completely dried and dead, it can be burned or bagged for disposal. If burning, ensure that all plant matter is destroyed. If bagging, double-bagging is recommended. Wrap plant securely in two dark plastic bags or a container to avoid contamination at landfill sites.

Purple loosestrife can easily re-establish from small pieces of root, stalk or seeds. Make certain that no trace of the plant remains in the soi. Frequently re-inspect the site for new shoots that may grow. Once cleared, the site can be replanted with grass or other perennial flowers.

Netley-Libau Marsh – Before biocontrol

After biocontrol

Draw a native plant in the empty space where Warren dug out the weed.



Regional District Okanagan-Similkameen Publication
November 2007

Appendix E: Useful Links and Other Resources

Alaska Botanical Garden
http://www.alaskabg.org/

Alaska Department of Fish and Game Invasive Species
http://www.adfg.state.ak.us/special/invasive/invasive.php

Alaska Exotic Plant Information Clearinghouse
http://akweeds.uaa.alaska.edu/

Alaska Invasive Species Working Group (AISWG)
http://www.uaf.edu/ces/aiswg/

Alaska Master Gardener Association, Anchorage Chapter
http://www.alaskamastergardeners.org/

Alaska Natural Heritage Program
http://aknhp.uaa.alaska.edu/

Alaska Native Plant Society
http://www.aknps.org/

Committee for Noxious and Invasive Species in Alaska (CNIPM)
http://www.uaf.edu/ces/cnipm/

Homer Soil and Water Conservation District, Invasives Program
http://www.homerswcd.org/invasives/invasivepg.htm

Municipality of Anchorage Parks and Recreation Department
http://www.muni.org/parks/

The Nature Conservancy
Global Invasive Species Team
http://tncinvasives.ucdavis.edu/

Appendix F: Five Year Plan of Action

Example Five Year Plan Table of Action for Options 1 and 2

	Month and Year of Action					
Option	**May-09**	**Jun-09**	**Jul-09**	**Aug-09**	**Sep-09**	**Oct-09**
Option 1 - Hand Pulling	Review report. Prepare brochure on purple loosestrife in Alaska. Start with a strong message. Prepare a PSA.	Begin to assemble volunteer team for scouting and hand-pulling. Prepare identification materials for training. Train internal staff on identification and hand pulling techniques. Start airing PSA on the radio.	Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems in order to assess program success over time. Continue to train staff and contact volunteers.	Monitor for stems and flowering. Schedule hand pulling events. Advertise for volunteers. Contact existing volunteers and interested stakeholders about upcoming hand pulling event.	Perform hand pulling of all stems.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.
Option 2 - Hand Pulling with Spot Application of Glyphosate	Review report. Prepare brochure on purple loosestrife in Alaska. Focus on time, space, and severity aspects of pesticide use. Start with a strong message. Prepare a PSA.	Contact organizations and agencies that may have concerns about pesticide use. Begin to assemble volunteer team for scouting and hand-pulling. Prepare identification materials for training. Start airing PSA on the radio.	Hold a public meeting for all interested organizations concerned with pesticide use to answer questions and educate stakeholders. Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems in order to assess program success over time.	Monitor for stems and flowering. Schedule hand pulling events. Advertise for volunteers. Contact existing volunteers and interested stakeholders about upcoming hand pulling event. Assess need for spot application of glyphosate.	Perform hand pulling of all stems. If spot application is required, schedule application event with contractor. Contact potential contractors to apply pesticide. Compare rates and ability to apply glyphosate using the cut stem method.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.

	Month and Year of Action					
Option	**Nov-10**	**Dec-10**	**Jan-11**	**Feb-11**	**Mar-11**	**Apr-11**
Option 1 - Hand Pulling	Check site one last time as the ground is freezing for any remaining stems.	Take time to assess success. Create location maps that track stem numbers over time. Review how many stems were present each year. If the program shows low or no success, consider using pesticides.	Continue winter activities highlighted in 2009-2010 winter season to maintain contacts and prepare to keep public interest high.			Prepare for 2011 field season. Should we reprint the brochure? What do we expect this year? What kind of volunteer or staff needs will we have?
Option 2 - Hand Pulling with Spot Application of Glyphosate	Check site one last time as the ground is freezing for any remaining stems.	Take time to assess success. Create location maps that track stem numbers over time. Review how many stems were present each year. If the program shows low or no success, consider revising the hand pulling and spot application approach.	Continue winter activities highlighted in 2009-2010 winter season to maintain contacts and prepare to keep public interest high.			Prepare for 2011 field season. Will pesticides be necessary? Can we switch to hand pulling only? What kind of success did we have?

Option	Month and Year of Action					
	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11
Option 1 - Hand Pulling	Prepare brochures, PSAs, or other materials with the idea of EDRR in mind. Focus on successes of the program, and the need to continuously monitor for this species over the long term.	Hold a staff refresher on identification.	Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems.	Schedule hand pulling, if needed.	Perform hand pulling of all stems.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.
Option 2 - Hand Pulling with Spot Application of Glyphosate	Prepare brochures, PSAs, or other materials with the idea of EDRR in mind. Focus on successes of the program, and the need to continuously monitor for this species over the long term.	Hold a staff refresher on identification. Check in with concerned groups if pesticides are to be used and are still a concern.	Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems.	Schedule hand pulling, if needed. Schedule spot application of glyphosate, as needed.	Perform hand pulling of all stems. If spot application is required, schedule application event with contractor.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.

	Month and Year of Action					
Option	**Nov-11**	**Dec-11**	**Jan-12**	**Feb-12**	**Mar-12**	**Apr-12**
Option 1 - Hand Pulling	Check site one last time as the ground is freezing for any remaining stems.	Re-assess program success. Is the treatment working? Are we happy with the results? Are we going to achieve our goal of eradiation?	Continue winter outreach activities with politicians, stakeholders, other agencies, and the public.			Prepare for 2012 field season. What do we expect this year? If we have achieved eradication, we still need to monitor.
Option 2 - Hand Pulling with Spot Application of Glyphosate	Check site one last time as the ground is freezing for any remaining stems.	Re-assess program success. Is the treatment working? Are we happy with the results? Are we going to achieve our goal of eradiation?	Continue winter outreach activities with politicians, stakeholders, other agencies, and the public.			Prepare for 2012 field season. What do we expect this year? If we have achieved eradication, we still need to monitor.

Option	Month and Year of Action					
	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12
Option 1 - Hand Pulling	Focus any public education material on EDRR. Highlight eradication success, if possible.	Prepare for monitoring and/or control efforts as appropriate.	Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems.	Schedule hand pulling, if needed. Coordinate volunteers and staff as needed.	Perform hand pulling of all stems.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.
Option 2 - Hand Pulling with Spot Application of Glyphosate	Focus any public education material on EDRR. Highlight eradication success, if possible. Feature the safe, effective use of pesticides to facilities any and all future efforts.	Prepare for monitoring and/or control efforts as appropriate.	Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems.	Schedule hand pulling, if needed. Schedule spot application of glyphosate, as needed. Coordinate volunteers and staff as needed.	Perform hand pulling of all stems. If spot application is required, schedule application event with contractor.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.

	Month and Year of Action					
Option	**Nov-12**	**Dec-12**	**Jan-13**	**Feb-13**	**Mar-13**	**Apr-13**
Option 1 - Hand Pulling	Check site one last time as the ground is freezing for any remaining stems.	Re-assess program success. Is the population eradicated? Is it maintained? Have other populations been reported in the state?	Continue winter outreach activities with politicians, stakeholders, other agencies, and the public.			Prepare for 2012 field season monitoring.
Option 2 - Hand Pulling with Spot Application of Glyphosate	Check site one last time as the ground is freezing for any remaining stems.	Re-assess program success. Is the population eradicated? Is it maintained? Have other populations been reported in the state?	Continue winter outreach activities with politicians, stakeholders, other agencies, and the public.			Prepare for 2012 field season monitoring.

	Month and Year of Action					
Option	**May-13**	**Jun-13**	**Jul-13**	**Aug-13**	**Sep-13**	**Oct-13**
Option 1 - Hand Pulling	Focus any public education material on EDRR. Highlight eradication success, if possible.	Prepare for monitoring and/or control efforts as appropriate.	Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems.	Schedule hand pulling, if needed. Coordinate volunteers and staff as needed.	Perform hand pulling of all stems.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.
Option 2 - Hand Pulling with Spot Application of Glyphosate	Focus any public education material on EDRR. Highlight eradication success, if possible.	Prepare for monitoring and/or control efforts as appropriate.	Monitor for appearance of purple loosestrife stems. Inventory (using past year's techniques) all stems.	Schedule hand pulling, if needed. Schedule spot application of glyphosate, as needed. Coordinate volunteers and staff as needed.	Perform hand pulling of all stems. If spot application is required, schedule application event with contractor.	Revisit site to see if there are more stems. If yes, perform more hand pulling. If necessary, schedule another pulling event with volunteers and staff.

	Month and Year of Action					
Option	**Nov-13**	**Dec-13**	**Jan-14**	**Feb-14**	**Mar-14**	**Apr-14**
Option 1 - Hand Pulling	Check site one last time as the ground is freezing for any remaining stems.	Final program assessment. After five years. The population should be eradicated. If not, revise the plan.	If eradication is achieved, focus on EDRR efforts around the state. Use this program as an example for other species and other locations.	If a plan revision is necessary, start work on it.		Continue promoting EDRR efforts. Continue a monitoring program.
Option 2 - Hand Pulling with Spot Application of Glyphosate	Check site one last time as the ground is freezing for any remaining stems.	Final program assessment. After five years. The population should be eradicated. If not, revise the plan.	If eradication is achieved, focus on EDRR efforts around the state. Use this program as an example for other species and other locations.	If a plan revision is necessary, start work on it.		Continue promoting EDRR efforts. Continue a monitoring program.