Vol. 1, No. 41 (Rev.). Approved 5/31/2017

VEGETATION MANAGEMENT GUIDELINE

Musk Thistle (*Carduus nutans* L.)

SPECIES CHARACTER

DESCRIPTION

Musk thistle is an erect, tap-rooted forb that has been described as an annual, biennial or short-lived perennial. It is perhaps best described as a monocarpic forb as it dies after it produces seed. Its stems are highly branched and grow to 0.5 - 3 meters (18 inches - 10 feet) tall with one to several stems arising from the base. Growth begins as a basal rosette with elliptical or lance-shaped leaves that are 15 - 70 cm (17 - 27 inches) long and closely appressed to the soil surface. The stem or cauline leaves are alternate and the leaf base extends down the stem forming spiny wings 0.5 – 2.0 cm (1/4 – 3/4 inch) wide. Both rosette and cauline leaves are pinnately divided with triangular-shaped lobes with each lobe being further divided into spine-tipped lobes. Their surfaces may be glabrous to densely pubescent with whitish or purplish margins. The flower heads are terminal, nearly round, 1 - 7 cm (3/8 – 2 ¾ inches) wide, usually nodding and occur singly or in a cluster of a few heads. The bracts of the inflorescence are lance-shaped 9 – 27 mm (3/8 – 1 inch) long, 2 – 10 mm (1/16 - 3/8 inch) wide, whitish to purplish in color, reflexed and spine-tipped. The flowers are tubular, perfect and purplish to white. The achenes are oblong, 3 – 4 mm (3/16 inch) long, glabrous, brown, and have a pappus of several whitish, barbed bristles.

SIMILAR SPECIES

Musk thistle exhibits considerable variation in its physical features which can make positive identification difficult. Positive identification of musk thistle is imperative prior to initiating control efforts because it can resemble a number of native thistles including some that are state or federally listed as threatened or endangered. If identification of musk thistle is in doubt its identity should be verified by consulting a knowledgeable person or appropriate manuals or keys.

DISTRIBUTION

Musk Thistle is native to Scotland, south to western and central Europe, western Siberia, Asia Minor and North Africa. It now occurs in North and South America, Australia and New Zealand. Early reports of it in North America are from Pennsylvania in 1852. By the late 1800's it was reported from several locations along the east coast and began appearing in the Midwest around the turn of the 20th century. By 1940, musk thistle was recognized as a potential problem for all of North America. Today, it occurs in all of the southern provinces of Canada and all the continental U.S. except Florida, Maine, and Vermont. It occurs in several Illinois counties, mostly in the northeast, west-central and southwest portions of the state.

HABITAT

Musk thistle is usually considered an invader of prairies, roadsides, pastures, disturbed areas and waste ground. However, some authors report musk thistle can occupy all habitats except deserts, dense forests, high mountains, coastal areas and newly cultivated fields.

LIFE HISTORY

Musk thistle usually behaves as a winter annual or biennial but it can live for several seasons before producing seeds and dieing. Plants that become established in bare soil or have little competition usually behave as annuals and

Funded Cooperatively by the IDNR & U. S. Fish & Wildlife Service

can produce up to twice as many capitula as plants that must compete with other vegetation. Musk thistle plants that encounter moderate competition may behave as biennials while those growing in dense grass cover may behave as short-lived perennials and experience greater pre-flowering mortality. Musk thistle does not reproduce vegetatively.

Musk thistle can bolt as early as April and blooms from June through October. After the plants bolt, the basal leaves decompose quickly, loosing about 50% of their mass within 15 days. The rapid decomposition may be attributed to high nitrogen content of the leaves. Flowering begins around the perimeter of the flower head on the tallest stems and progresses downward to the lateral shoots in the leaf axils.

Musk thistle pollen is sticky and pollination is via insects. Musk thistle is self-fertile and each plant is capable of producing up to 20,000 seeds, so a stand can rapidly expand from a single plant to a large population in a short period of time. Seed maturation and dispersal can begin as early as 7 days after first bloom and continue for 2 months. Seeds from later developing flowers may not mature until after frost.

When musk thistle seeds are mature, the receptacle recedes dislodging the seeds from the head. The seeds can be dispersed by wind, water, wildlife, livestock, humans, and equipment. Long distance dispersal usually occurs via water, livestock, wildlife or machinery. Long range wind dispersal is not common because only about 5% of the seed remain attached to the pappus after it separates from the seedhead. These seeds usually travel less than 50 m (162 feet) from the parent plant. In heads attacked by *Rhinocyllus conius* (seed weevils), the affected portions of the receptacle do not recede leaving many seeds tightly attached to the receptacle allowing for dense stands of seedlings after the seedheads fall from the parent plant. When musk thistle seed comes in contact with moisture, the seedcoat thickens and secretes a sticky substance that adheres the seed to the soil surface and other objects.

Left undisturbed the seed can persist in the soil for ten years or more, but apparently persists for only a few years if the soil is disturbed. The seeds do not have a dormancy period and can germinate within 14 – 21 days after dispersal given contact with the soil surface, adequate moisture (continuously moist substrate for three to five days) and warm temperature. Germination is best on bare soil and can occur over a period of several months from fall to late spring. Some studies report that musk thistle seeds that germinate in early fall experience lower mortality, attain larger vegetative size and produce more seeds than those that germinate in late fall or spring. However, late summer droughts can increase seedling mortality up to nearly 77%. Studies indicate certain microhabitats may play an important role in seed germination and seedling survival. The optimal seedbed for musk thistle establishment seems to be one that retains the seed near the soil surface, but provides cracks, small (1 cm or 3/8 inch) diameter clods, or irregular surfaces that inhibit evaporation.

After the seeds germinate, rosettes with numerous small roots develop in late summer or fall. Seedling survival is highly influenced by competition from neighboring plants, including other musk thistle seedlings, and light intensity. Musk thistle seedlings that receive 2, 8 or 14% of full sun experience a 97, 68, and 35% reduction in growth rate, respectively. This is important because several studies have found that rosette size rather than age is an important indicator of seed production and plants with larger rosettes produce the most seeds. In spring, the surviving seedlings produce a large, fleshy taproot that is hollow near the soil surface. The root crown has apical buds that are normally dormant, but can produce sprouts if the plant is damaged.

EFFECTS UPON NATURAL AREAS

In heavily infested areas, musk thistle density in excess of 20,000 plants per acre has been reported. These dense stands can out-compete native vegetation and reduce native diversity. Some studies report that musk thistle may possess allelopathic properties. Leachates from musk thistle plant material may inhibit germination of some pasture species and stimulate growth of musk thistle seedlings.

CURRENT STATUS

Musk thistle has been declared a noxious weed in 24 states including Illinois.

CONTROL RECOMMENDATIONS

Musk thistle's tolerance of most herbicides seems to be between the period of initial bolt and full flower stage.

RECOMMENDED PRACTICES IN HIGH QUALITY NATURAL COMMUNITIES

Initial effort in areas of light infestation

Clipping of the seedheads when the plants are in peak flower can dramatically reduce or prevent seed production. The clipped seedheads should be bagged, removed from the site and burned. The stems may also be cut at ground level and treated with a 2.0–3.0% active ingredient solution of glyphosate which is available under a variety of trade names. Care should be taken to avoid contacting non-target plants, since glyphosate is a nonselective herbicide. The herbicide should be applied while backing away from the area to avoid walking through wet herbicide. By law, herbicides may only be applied as per label instructions and by licensed herbicide applicators or operators when working on public properties.

Hand grubbing or cutting of the root below the root crown is an effective control for small infestations. Hand grubbing is very labor intensive and if the entire root crown is not removed the lateral buds may be stimulated resulting in a multi-stemmed plant. Grubbing also increases soil disturbance and can create areas that are ideal for musk thistle seedling establishment.

Cutting the root below the root crown after the plants have bolted is an effective control that is easier, faster, and causes less disturbance than grubbing. A shovel or spade with a notch ground in the cutting edge works well. The notch prevents the blade from slipping off the side of the root when pressure is applied to the shovel or spade. Once cut, the stem of the plant should be pulled to ensure the stem and root crown have been completely severed. Where practical, the cut plants should be bagged and removed from the site to reduce the risk of seeds maturing on the site.

A solution of 2.0 % active ingredient glyphosate combined with a nonionic surfactant at 0.25 % was an effective control for musk thistle in Tennessee. The application was made using a backpack sprayer when the rosettes were 15 cm (6 inches) or larger in diameter (April 4 in Tennessee) and prior to bolting. The control rate was 88% after five weeks and 93% after eight weeks. Care should be taken to avoid contacting nontarget plants. **Do not spray so heavily that herbicide drips off the target species.** The herbicide should be applied while backing away from the area to avoid walking through wet herbicide. By law, herbicides only may be applied as per label instructions and by licensed herbicide applicators or operators when working on public properties. Biotypes of nodding thistle have developed in New Zealand that require over six times the normal rate of some herbicides to control them.

Initial effort in areas of heavy infestation

Triclopyr (Garlon 3A, Tahoe 3A) is a selective post-emergent herbicide for control of broadleaf weeds including thistles. Use a 1.2% active ingredient solution with a nonionic surfactant at a 0.25% volume/volume rate is required for Garlon 3A and Tahoe 3A. Applications may be made using a backpack sprayer or ATV-mounted boom sprayer.

For larger infestations or dense stands, 2,4-D is a selective herbicide that kills broadleaf

weeds but not grasses and is one of the most commonly used herbicides on the market. Because there is no longer a patent governing the manufacture and sale of 2,4-D, any company is free to produce it. It is inexpensive and available under a variety of trade names including Barrage HF, Platoon, Savage CA, Weedone 638, and Weedar 64. Barrage HF should be applied as a 0.6% active ingredient (a.i.) solution, Platoon as a 0.5% a.i. solution, Savage as a 0.4% a.i. solution, Weedone 638 as a 0.2% a.i. solution and Weedar 64 as a 0.8% a.i. solution. 2, 4-D herbicides are available in many different formulations and concentrations. Always read and follow the label for the specific product that is being used.

Other herbicides that combine 2, 4-D with other triclopyr (tradename Crossbow) or clopyralid (tradename Curtail) may also be effective for control of musk thistle. Applications may be made using handheld, backpack or ATV-mounted boom sprayers. For Crossbow, use a 0.5% active ingredient solution. For Curtail in handheld or backpack sprayers, use a 0.3% active ingredient solution. For boom sprayers, mix 960 ml (32 ounces) Curtail with enough water to make 10 gallons of solution for each acre to be treated. For best results, apply when plants are in the rosette stage and actively growing.

Maintenance control

Maintaining high quality areas and restoring lower quality areas can assist with musk thistle control. Sites dominated by robust stands of grasses seem to be less susceptible to musk thistle invasion than sites that are grazed, have soil disturbance, or are dominated by forbs. High quality areas with good canopy cover may have less available light at ground level making them less susceptible to musk thistle invasion. Reduced light availability may also reduce musk thistle seedling competitiveness.

Prescribed burning

The response of musk thistle to prescribed burning is determined by the intensity of the fire, pre-fire abundance of musk thistle, and the response of surrounding vegetation. Spring burning has been used to effectively control musk thistle at sites with vigorous stands of prairie grasses. Intense fires will destroy seeds that have not germinated or remain in the seedhead. Burning will also reduce litter and duff accumulations making herbicide treatments more effective. On lower quality sites or sites where the vigor of prairie grasses has been diminished because of grazing or other factors, prescribed burning may favor musk thistle. Patchy burns may also favor musk thistle recruitment because they may lack the intensity to destroy musk thistle seed and create areas of bare soil that provide ideal conditions for musk thistle establishment.

RECOMMENDED PRACTICES ON BUFFER AND SEVERELY DISTURBED SITES

Same as above with additional recommendations as noted below.

BIOLOGICAL CONTROL

The flowerhead-feeding weevil, *Rhinocyllis conicus*, was introduced into North America in July 1968 to control non-native thistles, particularly musk thistle. The weevils overwinter as adults, emerge in late spring, and lay eggs in conspicuous egg cases on thistle flower heads. After the larvae emerge, they feed for 14 – 30 days, consuming the receptacle, florets, and seeds within the flower head. They then enter a pupal stage for 14 – 21 days then a quiescent period of 7 – 14 days within the flower head. New adults emerge and disperse to overwintering sites.

Initially, prospects for controlling musk thistle with *R. conius* appeared to be good. However, later studies have shown *R. conius* to be only marginally effective in reducing musk

thistle seed production. Some studies report only a 30 – 45% reduction in seed produced by terminal flowers and little or no reduction in seed production in lateral flowers.

R. concius will also attack over 30% of the native *Cirsium* species in North America including wavy-leaved thistle (*C. undulatum*) and the federally threatened Platte thistle (*C. canescens*). In early studies damage to native thistle populations seemed to be most severe when native thistles were growing among or in close proximity to musk thistles. These earlier studies reported that wavy-leaved thistles that were 30 – 50 meters way from musk thistle populations were less likely to suffer damage than those growing among musk thistle plants.

More recent studies indicate *R. conicus* may inflict severe damage to native thistles even in areas that lack significant musk thistle populations. *R. conicus* weevils were released in Nebraska in 1969 – 1972. By 1993, the weevils had invaded prairies in the Sand Hills of central Nebraska that had populations of the Platte thistle, but did not have the targeted non-native thistles. Weevils began attacked the flower heads of Platte thistle and the number of weevils increased over the next three years. The weevil numbers remained high for several years and decreased Platte thistle seed production by 86% while Platte thistle density decreased by 80 to 95% between 1993 and 2003.

There is also concern that *R. conicus* may pose a threat to the federally listed *Cirsium pitcheri* (Pitcher's thistle). Pitcher's thistle is closely related to Platte thistle and, in the U.S., is known to occur only in the intermittent sand dune systems along the shores of Lake Michigan in Indiana, Michigan, Wisconsin and Illinois. While *R. conicus* has not been reported from these habitats, it has been reported from locations north and south of the pitcher's thistle populations.

Trichosirocaulis horridus, a weevil that attacks the crown of musk thistle rosettes has also been used as a biological control agent in the US. During a Tennessee study conducted from spring 2004 through summer 2005 adult crown weevils were observed feeding on the foliage of three species of native thistles – *Cirsium altissimum, C. discolor,* and *C. carolinianum*.

Prairie vole (*Microtus ochrogaster*) reportedly feed on the taproots of musk and bull thistle (*Cirsium vulgare*) in mixed grass prairies in Kansas. In some instances, the feeding was severe enough to kill the leaves of the plants. Further observations revealed that voles had constructed runways that led directly to musk and bull thistle plants and voles had excavated soil surrounding the taproots to a depth of 10 cm to allow greater access to the taproot. Voles did sample taproots of other thistle species, but apparently did not feed heavily upon them. Searches in other portions of the same prairie could not establish a positive association between prairie vole foraging and invasive thistles.

FAILED OR INEFFECTIVE PRACTICES

- Grazing is not an effective control measure because musk thistle is unpalatable to most livestock and grazing reduces competition between musk thistle and native grasses.
- *Puccinia carduorum* is a fungus that was released in the US to reduce rosette vigor. The fungus helps assist with control, but is known to attack five other species of *Carduus* and eight species of *Cirsium*.

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