Identification and Impacts

Category A—High

African rue (*Peganum harmala*)

Photo credit: NPS

Photo credit: J.M. DiTomaso

Photo Credit: P. Alexander

Key ID Tips

- Bright green, smooth, and fleshy stems and leaves.
- Small, five-petaled white flowers, growing along the leaf axils on the stem
- Acrid taste and unpleasant odor when crushed.

Origin

Native to North Africa and the Mediterranean, from the eastern Iranian region of India to North Africa.

Photo credit: NPS

Description

African rue is a succulent perennial forb with dense branching stems that are smooth and fleshy. The leaves are bright green and divided, with thin linear leaflets. The plant can grow to up to two feet tall. Flowers have five white ovate to lanceolate petals with a yellow center and occur at leaf axils along the stem. Seeds develop in small round capsules that start green and turn brown as they age. They have a deep taproot with shorter, creeping roots.

African rue can reproduce vegetatively and by seed. A single plant can produce as many as 1,000 fruits, that each contain 40—50 seeds. (University of Nevada Cooperative Extension, 2010)

Biology

African rue is extremely drought tolerant and can grow in alkaline and saline soils. Its deep taproot can grow to depths of 20 ft and can quickly spread in disturbed areas, such as roadsides and heavily grazed rangelands. Any remaining plant parts can produce new plants. Its lateral roots allow them to spread to neighboring areas. The plants produce alkaloids that can have toxic effects on people and animals.

Locations

Populations have been found at Navajo Bridge and at business site leases in Western Navajo.

Ecological Threat and Management Concerns

All parts of the African rue are poisonous to livestock and humans. It contains four alkaloids that can cause loss of appetite, trembling, and loss of coordination (USFS 2005). African rue can dominate sites quickly after disturbance. Vehicles, heavy machinery, livestock, and humans can spread the plant to remote sites or locations.

It is adapted to dry climates and a wide range of soil conditions, allowing it to grow quickly and displace valuable native vegetation.

Category A—High

African rue (*Peganum harmala*)

Management Recommendations

Additional safety measures and limitations may apply for each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Grubbing, digging, and hand pulling are the only effective removal methods and must be repeated to address resprouting plants. Tilling, cutting, and mowing are not recommended as underground plant structures will resprout and can cause the plants to spread.

Biological

No biological control organisms are available.

Cultural Control

Grazing is not effective or recommended for African rue, as the plant is toxic cattle, sheep, and horses. Burning is also not recommended as underground plant structures can resprout.

Replanting and cultivating native plants is recommended to prevent plant establishment and expansion.

Chemical

Use of herbicides can be effective. Refer to the product labels for information application rates, timing, and approved application methods.

Recommended herbicides include:

- Imazapyr
- Metsulfuron methyl
- Glyphosate (usually combined with 2,4-D)

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

University of Nevada Cooperative Extension. 2010. Nevada Noxious Weed Field Guide. SP-10-01. 120 pp.

U.S. Forest Service. 2005. Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds. U.S. Forest Service Southwestern Region. 601 pp.

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Identification and Impacts

Category A—High

Blue mustard (*Chorispora tenella*)

Photo credit: EnviroPlan Partners

Photo credit: P. Alexander

Photo Credit: P. Alexander

Key ID Tips

- Basal leaves are dentate while stem leaves are not.
- Tapered silique seed pods
- Flowers pink to purple with four petals in the cross shape. Petals may appear twisted or wavy.
- Plants have a strong, musky odor.

Origin

Native to Europe and Asia, common in Russia and southwest Asia.

Photo credit: S. Dewey, USU

Description

Blue mustard is an annual forb found in agricultural and disturbed sites. They have distinct small pink to purple flowers, with four petals that form a cross shape. The petals may appear twisted, due to slight dentation on the petal margins. The fruits form long linear seed pods, or siliques, that grow along the stems. Basal leaves are dentate, with the leaf margins becoming sinuate higher on the stem. Leaves and stems are covered in sticky, glandular hairs. Plants can grow to about 18-20 inches tall. Plants can grow quickly and produce seeds within a week of flowering, with seed production and flowering occurring simultaneously. Each seed pod produces several small seeds. Individual plants have a large taproot.

Biology

Plants germinate in late fall and overwinter as a rosette, resuming their growth in the spring. Their small growth form and life cycle give them an advantage in the early spring where they can grow quickly before other native plants have started (Lyons et al., 2006).

Locations

Populations have been detected in areas outside of Chinle, AZ.

Ecological Threat and Management Concerns

These plant germinate quickly and easily. Because individual plants can produce hundreds to thousands of seeds, they can spread easily in areas with regular disturbance, such as rangelands, community development areas, and agricultural fields. Their life cycle gives them a competitive advantage in the spring, as they can access nutrients and resources before other native plants or crops have started growing, reducing the growth of more desirable plants (Lyons et al. 2006). Early flowering can also reduce the effectiveness of some control methods, such as herbicides. In rangelands, blue mustards can alter the flavor of milk in dairy cows.

Category A—High

Blue mustard (*Chorispora tenella*)

Management Recommendations

Additional safety measures and limitations may apply for each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Grubbing, digging, and hand pulling are effective removal methods if done before seeds are produced. Tilling can also be effective when plants first start growing in the late fall or early spring. Cutting and mowing are not effective as underground plant parts may remain and resprout.

Biological

No biological control organisms are available.

Cultural Control

Grazing is not effective and could affect some livestock products, such as milk. Other cultural control methods, such as mulching and cover crops can be effective at preventing growth and establishment. Mulch should be several inches thick to prevent germination and plant growth. Burning is also not effective as it can stimulate resprouting.

Chemical

Use of herbicides can be effective, however effectiveness varies by active ingredient. Refer to the product labels for information application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D (least effective)
- Chlorsulfuron methyl
- Glyphosate
- Metsulfuron methyl

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

Lyons, D.J., R.N. Klein, R.G. Wilson. 2006. Blue mustard control. University of Nebraska Cooperative Extension. Publication no. G1272

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Category A—High

Bull Thistle (*Cirsium vulgare*)

Identification and Impacts

Photo credit: Bureau of Indian Affairs

Photo credit: Bureau of Indian Affairs

Photo Credit: S. Dewey, USU

Key ID Tips

- Upright, single, small, bulbous flowers at the end of each stem.
- Spiny wings along the stem.
- Coarse hair on top, and woolly hair on the underside of leaves.
- Seedheads can have woolly hairs when developed.

Origin

Native to Europe

Photo credit: S. Dewey, USU

Description

Bull thistle is a biennial forb. It can grow to 7 feet tall. It starts as a basal rosette before bolting in the spring. In its flowering form, it can have a single stem or multiple branching stems. Leaves are deeply lobed with coarse prickly hairs on top and woolly hairs on the underside. Sharp spines are present on the midrib and tips of the leaves. Bull thistle has a solitary flowers, 1.5 to 2 inches wide, that forms at the end of each stem, which are pink to magenta, with spiny rounded bracts. They are upright and have bulbous spherical ovaries. Stems have spiny wings along the length. Seeds have a feathery pappus , but do not travel large distances.

Biology

Bull thistle is a prolific seeder with individual plants producing between 100 to 300 seeds per seedhead. Seeds germinate in fall or spring, depending on soil moisture. While most seeds die in the first year, deeply buried seeds may survive for 3 or more years (DiTomaso et al. 2013). They are suited to disturbed areas and can occur in foothills, dry meadows, and riparian areas.

Locations

Small populations have been detected on the Navajo Nation along roads and highways.

Ecological Threat and Management Concerns

While seeds may be short lived, individual plants can produce thousands of them. Bull thistle can regularly invade disturbed sites, and is most problematic in rangelands, burned forest areas, and along roads, ditches, and fences. It is not palatable to livestock and can reduce the value of hay while outcompeting native plants.

Category A—High

Bull thistle (*Cirsium vulgare*)

Management Recommendations

Additional safety measures and limitations may apply for each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Tilling, hoeing, and hand pulling can be effective if done before flowers form. Any methods that cuts the root of the plant below the soil surface is effective to prevent regrowth. Mowing can be effective if done before flowering and usually must be repeated during the growing season to prevent flowering. Once flowered, cutting the flower and seed heads and reduce seeding for future plants.

Biological

No biological control agents are currently approved for use on the Navajo Nation.

Cultural Control

Grazing can be effective if done during the rosette stage. Sheep, goats, and horses will eat young bull thistle. However, goats tend to avoid the plants and prefer the flowers. Grazing can be effective at reducing growth but must be paired with other methods.

Fire is not recommended as it can increase establishment and increase seed dispersal. Burning can be useful for removing dead material, however.

Chemical

Use of herbicides can be effective. Refer to the product labels for information application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Aminopyralid
- Clopyralid
- Picloram*

*Restricted Use by U.S. EPA

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Canada thistle (*Cirsium arvense*)

Photo credit: R. Bartz

Photo credit: Bureau of Indian Affairs

Photo Credit: J.M. DiTomaso

Key ID Tips

- Small clusters of flowers at the end of each stem.
- Grows in thick clumps with several stems
- Rhizomatous root system.
- Has either solely male or female flowers on the plant.

Navajo Name

Azéé hakani yázhí

Photo credit: S. Dewey, USU

Origin

Native to southeastern Europe and the eastern Mediterranean sea.

Description

Canada thistle is a perennial forb that can grow up to 3 to 5 feet tall in patches and clumps. It has an extensive creeping root system that can grow as deep as 15 feet. New shoots and stems form in the spring from the root base. Leaves are spiny, lance-shaped, and lobed, while base leaves are stalkless and clasp the stem. Flowers are small and can be white to purple, with clusters at the end of each branch with a purplish involucre. It is dioecious, meaning male and female plants grow separately.

Biology

Canada thistle can spread through adventitious root buds or by seed. Root fragments as small as 1 cm can resprout to form new plants. A single plant can produce between 1,000 to 5,000 seeds per stem, which are not carried far from the plant, but can if eaten by birds or other animals. It grows in disturbed sites and while it prefers moist soils, it can tolerate a wide range of soils.

Locations

Small populations have been detected on rangelands and along roads near Window Rock and Leupp.

Ecological Threat and Management Concerns

Canada thistle grows aggressively, crowding out native plants. Its deep and extensive root system can also resprout, making eradication difficult. Canada thistle can reduce the productivity of agricultural fields and rangelands. Livestock tend to avoid it and it can cause abrasions and infections when animals rub against the mature plants, which can increase maintenance costs. They are also hosts for numerous agricultural pests.

Category A—High

Canada thistle (*Cirsium arvense*)

Management Recommendations

Additional safety measures and limitations may apply for each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Mowing can reduce root storage and suppress flowering, but must be done every 3 to 4 weeks during the growing season with other control methods. Tilling and grubbing can increase Canada thistle as root fragments can resprout and survive for at least 100 days. Any cultivation should be done every 3 weeks during the growing season.

Biological

Several biological control agents have been studied in the United States. However, none have been approved for use on the Navajo Nation.

Cultural Control

Grazing and fire are not effective for Canada thistle management as both can stimulate resprouting and spread.

Chemical

Use of herbicides can be effective. Refer to the product labels for information application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Aminopyralid
- Clopyralid
- Dichlobenil
- Indaziflam
- Picloram*

*Restricted Use by U.S. EPA

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Common Mediterranean grass (*Schismus barbatus*)

Photo credit: Bureau of Indian Affairs

Photo credit: J.M. DiTomaso

Photo Credit: S. Carnahan

Key ID Tips

- Forms small, low-growing clumps
- Grows in thick clumps with several stems
- Small, fine hairs prominent at the ligule.
- Small, dense spikelets with 3—8 florets.

Origin

Native to southern Europe and possibly parts of southwestern Asia and North Africa

Photo credit: A. Mendoza

Description

Common Mediterranean grass is a cool-season tufted annual grass species. They are low-growing and form individual clumps, reaching close to 8 inches in height, with fine foliage and a dense 2-inch panicle. The ligules have a distinct ring of small hairs. Flower spikelets are small and grow from March to May, with 3 to 8 florets per spikelet.

Biology

Common Mediterranean grass reproduces by seed, with individual plants producing hundreds to thousands. Seeds generally fall near the parent plant and germinate nearby. As an annual, plants grow quickly and die off by late summer and fall, leaving tufts of dead plant material.

Locations

No populations have been reported on the Navajo Nation, but they have common in the Mojave Desert.

Ecological Threat and Management Concerns

As an annual, common Mediterranean grass can leave highly flammable material, that increases fire risk in desert and rangeland areas. Fires fueled by Mediterranean grass can burn with enough intensity to kill nearby shrubs (DiTomaso et al, 2013). This results in a cycle, where common Mediterranean grass and other annual grass species displace native species, convert shrublands to grasslands, and increase soil erosion.

Category A—High

Common Mediterranean grass (*Schismus barbatus*)

Management Recommendations

Additional safety measures and limitations may apply for each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Hand removal or mowing can be impractical due to the small size of individual plants. Soil disturbance may also increase weed establishment. Tilling and plowing can reduce surface density, but can also lead to reinvasions.

Biological

No biological control organisms are available.

Cultural Control

Grazing can be effective for removing biomass, but the resulting soil disturbance can increase germination of it and other annual grasses. Burning is not recommended as it can promote the growth of Mediterranean grass.

Chemical

Use of herbicides can be effective. Refer to the product labels for information application rates, timing, and approved application methods.

Recommended herbicides include:

- Fluazifop-P-butyl
- Glyphosate
- Imazapyr

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Dalmatian toadflax (*Linaria dalmatica*)

Photo credit: M. Licher

Photo credit: S. Dewey, USU

Photo Credit: Bureau of Land Management.

Key ID Tips

- Forms small, low-growing clumps
- Grows in thick clumps with several stems
- Small, fine hairs prominent at the ligule.
- Small, dense spikelets with 3—8 florets.

Origin

Native to Europe and the Mediterranean.

Photo credit: Bureau of Indian Affairs

Description

Dalmatian toadflax is a perennial forb with several branching stems. Stems are rough and woody at the base and become smooth and waxy toward the top. Leaves are waxy and heart-shaped and appear bluish-green with smooth margins. Leaves are alternate and clasp the stem. They have deep taproots with adventitious buds that can form new plants. Flowers resemble snapdragons, with two lips, that can be yellow to orange with a bearded throat and a long spur. Fruits appear as small capsules that hold several small seeds. Individual plants can produce as many as 500,000 seeds a year (DiTomaso et al. 2013).

Biology

Dalmatian toadflax grows in open fields, riparian areas, rangeland, and disturbed sites. It is adapted to a wide range of environments and soils, and often grows in disturbed sites. Toadflax germinates in the spring and fall. It can spread vegetatively or through seed germination. Because of its ability to produce hundreds of thousands of seeds, it increases its chances of germinating and occupying sites. However, because seeds are small, they likely do not survive for more than a few years.

Locations

A few small populations have been documented near roadsides in Western and Fort Defiance Agencies.

Ecological Threat and Management Concerns

Dalmatian toadflax can form dense colonies through its creeping root system and prolific seeding ability, which can outcompete with native grasses and forbs. This can reduce forage and productivity of rangelands and agricultural fields. It also contains quinazoline alkaloids, which can affect livestock if ingested.

	Category A—High	Dalmatian toadflax (*Linaria dalmatica*)
Management Recommendations		Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information. ### Mechanical/Manual Removal Hand removal can be effective for seedings before plants are established. Mowing can prevent plants from going to seed, but can also stimulate root growth. Tilling can be effective but must be done weekly during the growing season and repeated over several years to reduce resprouting root fragments. ### Biological Seven different biological control agents have been approved for use on the Navajo Nation. Seed and flower feeding insects can reduce seed set. The stem mining weevil is also effective at damaging foliage and flower production. ### Cultural Control Grazing is not an effective control method as it can create disturbance that encourages plant growth and its alkaloids are considered moderately toxic for livestock. Fire is also not effective since it does not damage the underground roots. Maintaining healthy plant cover is good at preventing establishment and reseeding with native grasses is effective at preventing spread and reducing survival. ### Chemical Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods. Recommended herbicides include: • Chlorsulfuron methyl • Fluazifop-P-butyl • Imazapic • Indaziflam • Picloram* *Restricted Use by U.S. EPA ### References DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp. USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Fountaingrass (*Pennisetum setaceum*)

Photo credit: J.M. DiTomaso

Photo credit: J.M. Randall

Photo Credit: Starr Environmental

Key ID Tips

- Smooth leaves with hairs on the ligule and collar margins.
- Long, feathery, spikelike florets that appear purple to red.
- Grows in tall clumps up to 4 feet in height

Origin

Native to northeastern Africa and west Asia

Photo credit: E. Guinter

Description

Initially planted as a perennial ornamental grass, fountaingrass grows in dense clumps with erect stems that can reach a height of 4 feet. Florets grow in feathery, spikelike clusters that appear red to purple and are 6-15 inches long. Leaves are narrow and 8 to 13 inches in length and appear folded or flat and can be smooth or with short sparse hairs. The ligules, however, have a fringe of white hairs and the collar margins are ciliate with long white hairs.

Biology

Fountaingrass is fire-adapted for warm climates and can grow in disturbed sites, roadsides, and in shrublands and canyons. It is tolerant of drought, light shade, and most soil types, but does not survive prolonged freezing periods. It can grow in crevices, but is not tolerant of saline conditions. Seeds disperse In late spring through wind and by clinging to fur and clothing. Seeds have been known to survive for about six years and individual plants can live for up to 20 years or more (DiTomaso et al. 2013).

Locations

No known populations have been documented on the Navajo Nation, but some have been noted in neighboring parts of Arizona and New Mexico.

Ecological Threat and Management Concerns

Fountaingrass has been noted in the conversion of shrublands to grasslands. Its prolific and hardy seeds allow it to establish quickly and recur over time. As a fire-adapted species, fountaingrass can alter fire regimes in areas, especially in remote canyons and rangelands, where they can quickly replace native vegetation following disturbance. Seeds can also travel long distance through animal migration, wind, or water transport (USFS 2005).

Category A—High

Fountaingrass (*Pennisetum setaceum*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Hand removal can be effective by uprooting plants. Large tools, such as picks, shovels, or mattocks are recommended to uproot large plants over 6 inches in diameter. When removing, inflorescence should be cut and bagged to prevent seeds from spreading. Manual treatments should be repeated over 1 to 2 month. Mowing and tilling are not effective control methods.

Biological

No biological control organisms are available.

Cultural Control

While animals may eat fountaingrass, grazing has not been shown to effectively control it. Fire is not recommended as fountaingrass can recover quickly and spread after a burn.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- Fluazifop-P-butyl
- Glyphosate
- Imazapyr

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

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Identification and Impacts

Category A—High

Leafy spurge (*Euphorbia esula*)

Photo credit: L.L. Berry

Photo credit: J.M. Randall

Photo Credit: L.J. Mehrhoff

Key ID Tips

- Flowers have large showy greenish-yellow bracts while flowers have no petals or sepals.
- Extensive root system with adventitious buds but no taproot.
- Grows in clumps with erect stems.

Navajo Name

Chi'il abcĺ tsoh

Photo credit: E. Guinter

Origin

Native to southern Europe

Description

Leafy spurge is an erect perennial forb that grows in clumps from an extensive root system that uses adventitious buds to form new stems. Stems and leaves are glaborous with numerous alternate thin leaves and stems that ooze a milky sap. The sap contains a toxic compound, ingenol, which can cause severe diarrhea and skin irritation in livestock. Leafy spurge flowers have showy large greenish-yellow bracts and small flowers without petals or sepals. Flowers have a three -chambered seed capsules .

Biology

Leafy spurge can reproduce either through seed dispersal or from adventitious buds and root fragments. Seeds begin germination in early spring, but can germinate throughout the growing season. Seeds can also survive for 8 or more years in the field. Mature seeds are released when the seed capsules explode, projecting seeds up to 15 feet from the parent plant. They form large clonal colonies, displacing native vegetation. Leafy spurge can grow in a wide range of soils and habitats

Locations

No known populations have been documented on the Navajo Nation, but some populations have been found near Mormon Lake in Flagstaff, AZ

Ecological Threat and Management Concerns

Leafy spurge can establish quickly either through root fragments or from seeds, and grows in dense clumps with an extensive root network. These clumps can quickly displace native vegetation above and below ground. The milky sap is irritating and harmful to livestock if consumed. It can cause severe diarrhea and weakness in cattle and horses as well as blistering and irritation in humans and other animals.

Category A—High

Leafy spurge (*Euphorbia esula*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Hand pulling, hoeing, and grubbing can be used on small patches before seeds form but must be repeated over 2 to 3 weeks and gloves should be worn to reduce irritation. Mowing is not effective due to resprouting but can help herbicide applications and should be done every 2 to 4 weeks. Tilling can be helpful at a depth of 4 inches and repeated for 2 to 3 years. Cultivation should be done every 2 to 3 weeks in the late summer and fall.

Biological

Six biological control organisms are available for use on the Navajo Nation. All are variations of the flea beetle (*Aphthona* spp.) which deposits its eggs at the base of the plant so the larvae can feed on the roots.

Cultural Control

Goats and sheep are less sensitive to spurge sap but should graze in the early spring when it first emerges. Grazing will not eradicate spurge, but can reduce seed production and allow native plants to grow. Fire is not effective at controlling leafy spurge and can stimulate regrowth.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Dichlobenil
- Glyphosate
- Imazapic
- Picloram*

*Restricted Use by U.S. EPA

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St. John, L., D. Tilley. 2014. Plant guide for leafy spurge (*Euphorbia esula*). USDA Natural Resources Conservation Service, Plant Materials Center. Aberdeen, Idaho 83210. 4 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

Identification and Impacts

Category A—High

Musk thistle (*Carduus nutans*)

Photo credit: Bureau of Indian Affairs

Photo credit: Bureau of Indian Affairs

Photo Credit: B. Ackley

Key ID Tips

- Leaf edges deeply lobed and spiny
- Single flowers at the end of each stem about 3 inches wide.
- Flowers are nodding and hemispherical.

Navajo Name

Azee'okani'whooshi

Azee'okani'deniní

Origin

Native to Europe and the Mediterranean region.

Photo credit: Bureau of Indian Affairs

Description

Musk thistle is a winter annual or biennial with prickly leaves and wings along the stem. Individual plants can grow up to 5 feet tall. They have deep taproots and start as a rosette before bolting in the spring. Flowers are pink to purple with a single flower at the end of each stem. Flowers are round and hemispherical and are nodding on long stalks. Flowers also have distinct triangular bracts with a spine at the end that can be green, straw-colored, or purple .

Biology

Musk thistle germinates in the winter to early spring and start as a rosette before bolting in the summer when flower development starts. They only spread by seed, which can fall near the parent plant or disperse by the wind to greater distances. Seeds can persist for a few years in the soil. Musk thistle prefers disturbed sites and can tolerate a wide range of soils.

Locations

Found throughout the Navajo Nation along roadsides, farm fields, and rangelands.

Ecological Threat and Management Concerns

A single plant can produce 100,000 seeds, which can invade an area within a few years. While short lived, their prolific seeding can create dense clusters that crowd out native vegetation. Their prominent spines also discourage animals from grazing or entering invaded areas.

	Category A—High	Musk thistle (*Carduus nutans*)
Management Recommendations		Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information. **Mechanical/Manual Removal** Manual removal is feasible for small populations . When cutting thistles, the top of the root crown should be removed, while grubbing should cut plants 2 to 4 inches below the soil surface to prevent resprouting. Mowing can reduce seed production and must be repeated every 1 to 2 months when blooming as plants bloom at different times. Mowing is most effective when plants are about to flower. Cutting the first flowers can also reduce seed production. **Biological** No biological control organisms are available for use on the Navajo Nation. **Cultural Control** While animals will avoid musk thistle, horses, cattle, goats may eat the flowerheads and sheep will eat the rosettes. Flaming can be used to kill individual plants but broadcast burning may not be hot enough to kill the root crown and reduce resprouting. Maintaining native plant cover is effective at reducing establishment of musk thistle. **Chemical** Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods. Recommended herbicides include: • 2,4-D • Aminopyralid • Clopyralid • Dichlobenil • Imazapic • Indaziflam • Picloram* *Restricted Use by U.S. EPA **References** DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp. USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Perennial pepperweed (*Lepedium latifolium*)

Photo credit: S. Dewey, USU

Photo credit: J.M. DiTomaso

Photo Credit: L.J. Mehrhoff

Key ID Tips

- Small clusters of white flowers.
- Branching, deep, and woody roots.
- Serrate, ovate leaves that are hairless and greyish green.
- Seed pods are covered in short, fine hairs.

Navajo Name

Os si tsóh

Origin

Native to Eurasia

Photo credit: L.J. Mehrhoff

Description

Perennial pepperweed is a perennial forb that can grow to 6 feet tall, although most are 2 to 4 feet tall. It prefers moist or seasonally wet sites, growing near riparian areas and wetlands. The crown and stems are slightly woody. Leaves are larger at the base, serrated, ovate, and lack hairs. They appear greyish green and are alternate. Flowers are in clusters of small white flowers. Flowers have four petals and produce small pods with tiny reddish-brown seeds that are covered in short, fine hairs. Seed pods are flat and circular. Pepperweed has deep, thick roots that creep vigorously , but are unable to retain soils (DiTomaso et al. 2013). Aboveground material dies off in the late fall and winter, leaving dead stems and leaves that can persist for several years.

Biology

Pepperweeds can tolerate saline and alkaline soils. It spreads mostly vegetatively, while being a prolific seeder. Small root fragments can resprout into new plants and can be moved by flooding, erosion, and human and animal activity. Plants can easily germinate in a range of temperatures and soil moisture conditions. However, seeds do not live for long in soils, making vegetative reproduction the main way for new plants to generate.

Locations

Perennial pepperweed has been found in Marble Canyon and on NAPI-NIIP lands on the Navajo Nation.

Ecological Threat and Management Concerns

Perennial pepperweed resprouts vigorously from root fragments, making it hard to control. It can form dense thickets that crowd out native vegetation. Seeds can stick to animals, shoes, and tires, allowing them to disperse great distances.

Perennial pepperweed (*Lepidium latifolium*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Hand pulling and tilling can be effective on new populations, but are ineffective on established plants as they can quickly resprout. Tilling and grubbing established populations can increase the size of populations. Cleaning equipment is important to prevent spread to new areas. Mowing is not effective and can produce new growth, but it can be used to remove dead thatch and prevent shading of other plants.

Biological

No biological control organisms are available for use on the Navajo Nation.

Cultural Control

Cattle, sheep, and goats can graze on pepperweed in the early spring, when in the rosette stage. Sheep and goats are most tolerant of pepperweed, but must remain in the affected pasture permanently to provide effective control. Burning is not effective at controlling pepperweed but can be used to remove accumulated thatch and is best done in the spring or winter before growth is initiated in the spring. Maintaining native plant cover is most effective at suppressing and preventing pepperweed.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Chlorsulfuron methyl
- Dichlobenil
- Glyphosate
- Imazapic
- Metsulfuron methyl

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Ravenna grass (*Saccharum ravennae*)

Photo credit: J.M. DiTomaso

Photo credit: J.M. DiTomaso

Photo Credit: L.J. Mehrhoff

Key ID Tips

- Base of the leaf blades are covered in dense, long hairs that hide the ligule.
- Inflorescence are large feathery plumes 2 ft in length.
- Stems and leaves can be 12 feet tall.

Photo credit: Daderot

Origin

Native to Eurasia

Description

Ravennagrass is a large tufted perennial bunchgrass, that can produce flowering stems up to 12 feet tall. Leaves are similar to pampasgrass, but are covered in dense hairs at the base, effectively hiding the ligule. Inflorescence are in large feathery panicles that can be 2 feet long and can appear purplish-brown to silvery-gray. Seeds are tiny and numerous. Roots form rhizomes that facilitate vegetative spread.

Biology

Ravenna grass was originally planted as an ornamental and is still sold in some nurseries. It can grow quickly, and prefers wet sites in riparian habitats and wetlands and disturbed sites. It forms dense tufts that expand quickly over time and crowd out native vegetation. Seeds can be transported by wind or water, allowing them to establish in downstream sites.

Locations

Ravenna grass has been detected on the Hopi Reservation and in Grand Canyon National Park.

Ecological Threat and Management Concerns

Ravenna grass forms dense stands quickly, crowding out native vegetation. It can alter riparian habitat and is a concern for several sensitive plant and animal species. Established stands can also increase fire risk in riparian soils and prevent erosion, which can increase incisions along river channels (PDCNR 2013).

	Category A—High	Ravenna grass (*Saccharum ravennae*)
Management Recommendations		Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information. **Mechanical/Manual Removal** Manual removal should remove all root and root fragments. They are most effective when plants are young. For larger plants, tilling or using a mattock or hoe can remove clumps. The top section of the roots needs to be removed to prevent resprouting. Collect and incinerate all removed plant parts to prevent seed dispersal from removed material, especially inflorescence. **Biological** No biological control organisms are available for use on the Navajo Nation. **Cultural Control** Because of their proximity to open water, grazing is not recommended. Burning is also not recommended or effective as it can stimulate resprouting and does not remove underground structures. **Chemical** Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods. Recommended herbicides include: • Glyphosate **References** DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp. Pennsylvania Department of Conservation and Natural Resources (PDCNR). 2013. Invasive Plants of Pennsylvania: Ravenna Grass. 2 pages. USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Sahara mustard (*Brassica tournefortii*)

Photo credit: P. Alexander

Photo credit: Bureau of Land Management

Photo Credit: P. Alexander

Key ID Tips

- Deeply pinnately lobed leaves (more so than most mustards)
- Small yellow four-petaled flowers along a raceme
- Linear seed pods that open from the base.

Navajo Name

Oostsé

Photo credit: Michael Lewis, UCR

Origin

Native to the Mediterranean region.

Description

Sahara mustard is a winter annual forb, that can grow up to 4 feet tall. It starts as a basal rosette until forming its flowering stems. Leaves are deeply pinnately lobed and lower stems have dense stiff white hairs. Flowers are small and pale yellow with four petals arranged in a raceme. Fruits are long linear siliques, or seed pods, that are strongly constricted around the seeds to appear beaded. Seeds open from the base to release the seeds. Seeds become slightly sticky when wet.

Biology

Sahara mustard seed is adapted to arid climates and sandy soils. They spread readily along roads, washes, and desert shrublands. Plants reproduce through seed, which germinate close to the parent plants and can persist in soils for years.

Locations

Sahara mustard has not been found yet on the Navajo Nation but has been detected in southern parts of Arizona and New Mexico.

Ecological Threat and Management Concerns

Individual plants can produce a large amount of biomass, which increases fuel loads and fire risk. It has been connected with increased fire frequency and plant community conversions, especially in arid environments (DiTomaso et al. 2013). It can also harbor diseases that affect agricultural crops. The foliage and roots are high in glucosinolates, which can irritate the digestive tract and cause thyroid issues. Cattle can exhibit toxicity issues after ingesting large quantities of seeds, especially when confined in heavily infested areas. These impacts can all result in significant increases in management costs.

	Category A—High	Sahara mustard (*Brassica tournefortii*)
Management Recommendations		Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information. Mechanical/Manual Removal Manual removal is effective for small young populations, and should be done after stems form but before seed production. Hula hoes can be effective when still in the rosette stage. Grading can also control plants, but should be done before seed development. Biological No biological control organisms are available for use on the Navajo Nation. Cultural Control While some livestock species will graze on Sahara mustard, it is not recommended as it can lead to toxicity issues. Burning is not recommended as plants grow in arid environments, which complicates timing issues. Plants need to develop enough biomass to fuel the fire, which is typically after seed production, which can contribute to post fire germination. Chemical Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods. Recommended herbicides include: • 2,4-D • Aminopyralid • Clopyralid • Metsulfuron methyl • Triclopyr References DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp. USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA
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Identification and Impacts

Category A—High

Scotch thistle (*Onopordum acanthium*)

Photo credit: EnviroPlan Partners

Photo credit: Bureau of Land Management

Photo Credit: J.M. DiTomaso

Key ID Tips

- Leaves are covered in cottony hairs along with stems, appearing bluish green.
- Large purple to pink flowers in clusters.
- Flat bracts with green to orange spines

Navajo Name

Zéé hókaníił béí

Whosh waa'

Origin

Native to Eurasia

Photo credit: J.M. DiTomaso

Description

Scotch thistle is an erect biennial forb, with long, green spiny leaves, covered in fine cottony hairs. They start as a rosette, 1 to 2 feet in diameter before bolting to 4 to 6 feet tall. Flower heads are large, which can be in clusters of 2 to 7 at the end of each stem. Flowers are spherical to hemispherical and have numerous spiny green to orange bracts while the disk flowers are showy purple to pink compound flowers. Spines are present on the leaves and stems, which also have a broad vertical rib.

Biology

Scotch thistle reproduces solely by seed. However, seeds contain a water-soluble germination inhibitor that can keep 80% of seeds dormant for several years. Germination occurs in the spring and fall when soil moisture is highest. Seeds are dispersed by wind or by animals or humans. Scotch thistle grows in a variety of disturbed sites and is associated with degraded annual plant communities.

Locations

Found throughout the Navajo Nation along roadsides and riparian washes and farms.

Ecological Threat and Management Concerns

Because Scotch thistle can produce numerous seeds with the ability to delay germination, eradication is difficult and can continue for several years. Populations can expand rapidly during wet years due to increased germination. The sharp spines can injure wildlife and livestock and create natural barriers that prevent movement.

Scotch thistle (*Onopordum acanthium*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Small infestations can be removed by digging plants and severing the root below the surface. Mowing during bud development can prevent seed development. However, if done too early, it can delay flower development and can still lead to viable seed set. Mowing should be done repeatedly during the growing season. Cutting flowers can also prevent expansion. Tilling can control emerged plants but can also increase germination.

Biological

No biological control organisms are available for use on the Navajo Nation.

Cultural Control

Sheep, goats, and horses can reduce thistles for small populations and when young. Sheep prefer the small rosettes, while goats will eat the flowerheads and seed heads, preventing seed production. Grazing with cattle is not recommended. Overgrazing can promote growth. Fire is not effective as it can stimulate growth. Maintaining perennial native plant cover and prevent establishment.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Aminopyralid
- Clopyralid
- Dichlobenil
- Imazapic
- Picloram*

*Restricted Use by U.S. EPA

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Category A—High

Spotted knapweed (*Centurea maculosa*)

Identification and Impacts

Photo credit: Bureau of Indian Affairs

Photo credit: P. Alexander

Photo Credit: P. Alexander

Key ID Tips

- Deep, woody taproots
- Phyllaries are darker and combed at the tips, making the flowers appear spotted.
- Leaves have resin ducts and short gray hairs.

Navajo Name

Ch'it bilat'a dootłizhigí

Origin

Native to Europe and Asia minor

Photo credit: National Park Service

Description

Spotted knapweed is a bushy biennial to short-live perennial that can grow to 3 feet tall with a long, sturdy taproot. Plants form a basal rosette in the winter and early spring, which can persist for years, before developing erect branching flowering stems in the late spring and summer. Leaves are alternate, pinnately lobed and dotted with resin ducts on the underside. They may also have short interwoven gray hairs. Flowers are in clusters and appear white, pink, or purple, with phyllaries that are combed at the tips and dark colored, giving the flowers a "spotted" appearance. When flowerheads mature, they dry out and pop, ejecting the seeds near the parent plant. Seeds have a short bristly pappus on top.

Biology

Spotted knapweed reproduces by seeds and lateral root growth. Seeds can remain dormant for 8 years and vary in germination frequency based on light exposure. It can also hybridize with diffuse knapweed. It prefers disturbed and exposed sites, with limited growth in shaded areas.

Locations

Common along roads and near the Shonto Boarding School.

Ecological Threat and Management Concerns

Spotted knapweed can form dense stands that reduce native plant growth and cover. Its long-lived seeds with varying light exposure needs for germination can make it difficult to eradicate without long-term monitoring and repeated treatments.

Category A—High

Spotted knapweed (*Centaurea maculosa*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Manual removal is feasible for small and scattered populations and should be repeated over the growing season for a few years. Manual removal should remove as at least 2 to 4 inches of the taproot below the soil surface, if not the entire taproot. Manual removal should occur before seed production.

Biological

Five biological control organisms are available for use on the Navajo Nation. There are four different seedhead feeding weevils and a root feeding weevil that can weaken plant growth and reduce seed production.

Cultural Control

Sheep, goats, and horses can reduce thistles for small populations and when young. Sheep prefer the small rosettes, while goats will eat the flowerheads and prevent seed production. Grazing with cattle is not recommended. Overgrazing can promote growth. Fire is not effective as it can stimulate regrowth. Maintaining and restoring perennial native plant cover can prevent establishment.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Aminopyralid
- Clopyralid
- Dichlobenil
- Fluroxypyr
- Picloram*

*Restricted Use by U.S. EPA

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Category A—High

Squarrose knapweed (*Centurea virgata*)

Identification and Impacts

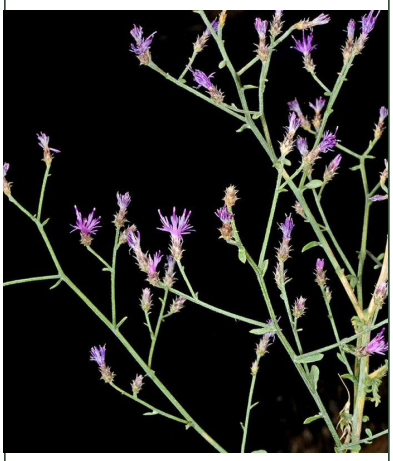

Photo credit: G. Carr

Photo credit: J.M. DiTomaso

Photo Credit: C. Roche

Key ID Tips

- Bracts have a spiny tip that points down.
- Thin, pinnately lobed leaves covered in short hairs.
- Perennial knapweed with a deep taproot.

Origin

Native to Asia

Photo credit: J.M. DiTomaso

Description

Squarrose knapweed is a bushy perennial that grows to about 3 ft tall and has a deep taproot. Leaves are alternate, thin, pinnately lobed, and covered in short woven gray hairs. They start as a basal rosette in the fall and winter and bolt to flowering stems in late spring and summer. Flowers are in clusters of four to ten, with small pink to purple compound flower at the top. The base of each flower is narrow and covered in comb-like bracts with a spine at the tip that curves out.

Biology

Squarrose knapweed reproduces solely by seed, which fall close to the parent plants. While seeds do not remain viable in the soil for more than 2 to 5 years, some varieties have been known to survive for longer. Squarrose knapweed prefers disturbed sites and is adapted to drought and cold temperatures. It prefers exposed and sunny sites and does not grow for long in shaded areas.

Locations

No known populations have been detected on the Navajo Nation.

Ecological Threat and Management Concerns

Squarrose knapweed can form dense clumps, replacing native plant cover. Plants can spread when flowers cling to animals or humans, transporting them to new sites. They favor open disturbed sites, including rangelands and roadsides. While it does not spread vegetatively, carbohydrate stores in its taproot can stimulate regrowth, making control difficult.

Category A—High

Squarrose knapweed (*Centaurea virgata*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Manual removal is feasible for small and scattered populations and should be repeated over the growing season for a few years. Manual removal should remove as at least 2 to 4 inches of the taproot below the soil surface, if not the entire taproot. Manual removal should occur before seed production. Mowing is not effective at any stage, but can remove dead material before herbicide applications.

Biological

No biological control organisms are available for use on the Navajo Nation.

Cultural Control

Grazing is not recommended or effective as it can promote regrowth and germination. Fire is not effective as it can stimulate regrowth. Maintaining and restoring perennial native plant cover can prevent establishment and reduce populations

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Aminopyralid
- Clopyralid
- Dichlobenil
- Fluroxypyr
- Picloram*

*Restricted Use by U.S. EPA

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

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Identification and Impacts

Category A—High

Sulphur cinquefoil (*Potentilla recta L.*)

Photo credit: R. Flogaus-Faust

Photo credit: S. Dewey, USU

Photo Credit: J.M. DiTomaso

Key ID Tips

- Palmate leaves with serrate margins and thin leaflets.
- Stiff hairs under the leaves and along the stem.
- Pale yellow flowers with 5 heart-shaped petals.

Navajo Name

Azee tsoxíí

Chil di tsoxíí

Origin

Native to the Mediterranean region and Eurasia

Photo credit: USDA ARS

Description

Suphur cinquefoil is a perennial forb that grows to 3 feet tall. It has pale yellow flowers with heart-shaped petals and 5 enclosed sepals. Leaves are palmate with narrow oblong to lanceolate leaflets and serrate margins. Lower leaves have longer petioles, while upper leaves have short or no petiole and become less dense. The stems and undersides of the leaves have long stiff hairs. Plants have a woody taproot that rots at its core as the plant develops new shoots around the root perimeter. It starts as a rosette before flowering stems develop.

Biology

Sulphur cinquefoil can reproduce by seed or from the formation of new root shoots. A single plant can produce 1,500 seeds, which disperse near the parent plant. Seed longevity varies, with seeds remaining viable for 2 to 4 years in soil. While young plants do have a taproot, its root shoots allow the plant to spread vegetatively. However, they do not form rhizomes. It prefers disturbed sites but can occur where healthy plant cover is present. It is mainly found in pastures, rangeland, and wildlands.

Locations

No known populations have been detected on the Navajo Nation.

Ecological Threat and Management Concerns

Sulphur cinquefoil is a prolific seeder and is not grazed by livestock as it has a high concentration of tannins (DiTomaso et al. 2013). It is also able to germinate and expand in areas where healthy native plant cover already exists. It can reduce forage and grazing capacity on rangelands and wildlife habitat.

Category A—High

Sulphur cinquefoil (*Potentilla rect. L*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Manual removal is feasible for small and scattered populations. Treatments should remove the entire root crown to prevent resprouting. Mowing is not effective as it can stimulate lateral root branching and regrowth. Plowing and tilling are not recommended as it can stimulate regrowth.

Biological

No biological control organisms are available for use on the Navajo Nation.

Cultural Control

Grazing is not recommended as most livestock do not find it palatable. There is also limited information on its response to fire and prescribed burning. Isolated studies indicate burning may not increase mortality and may increase regrowth. Since sulphur cinquefoil is not shade tolerant, restoration of overstory native plant communities can prevent establishment and reduce some populations.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Aminopyralid
- Picloram*

*Restricted Use by U.S. EPA

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

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Identification and Impacts

Category A—High

Tall whitetop (*Cardaria draba*)

Photo credit: J.M. DiTomaso

Photo credit: S. Dewey, USU

Photo Credit: J.M. DiTomaso

Key ID Tips

- Heart-shaped seed pods.
- Clasping leaves along the stem and short stems near the base.
- Short hairs on the leaves.

Navajo Name

Os si tsóh

Origin

Native to the Russia and Eurasia

Photo credit: USDA ARS

Description

Tall whitetop, or hoary cress, is a deep-rooted perennial that grows up to 2 feet tall above ground and 12 to 30 feet deep. Leaves are alternate, grey-green in color, and arrowhead shaped. The leaves are covered in short hairs. Lower leaves have a short stalk, while leaves along the stem are clasping. It has numerous small, white, four-petaled flowers. Flowers grow in clusters at the stem ends and form an umbel shape. Seeds are in a round pod, called a silicle, that are heart-shaped to oval. They are prolific seed producers.

Biology

Tall white top grows in disturbed open sites, along roadsides, riparian areas, and agricultural fields. It prefers moist, alkaline to saline soils, but can grow in a wide range of site conditions. They can reproduce either through seeds or vegetatively as they produce numerous vertical and horizontal roots. Seeds germinate in the fall, after the first rain fall, and can begin producing root buds within three weeks. Their extensive roots store carbohydrate reserves that accumulate throughout the growing season and keep the plants alive during prolonged drought and freezing periods.

Locations

Tall whitetop has been detected along roadsides and washes in the eastern Chuska Mountains on the Navajo Nation.

Ecological Threat and Management Concerns

Tall white grows aggressively and can displace native vegetation to form monocultures. They are difficult to control due to their extensive root system and prolific seeding rate. They are toxic to cattle as they produce high levels of glucosinolates. When they decompose, they also produce allelopathic chemicals that inhibit the growth of other plants (USFS 2014).

	Category A—High	Tall whitetop (*Cardaria draba*)
Management Recommendation		Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information. **Mechanical/Manual Removal** Hand pulling is not recommended as its extensive root system can remain for a year after removal. Hand hoeing can be effective if repeated every 4 weeks for 2 years. Mowing is only effective if paired with replanting efforts. Tilling and grubbing are not recommended as it can disperse root fragments and increase infestations, unless done every two weeks for 2 to 4 years. **Biological** No biological control organisms are available for use on the Navajo Nation. **Cultural Control** Sheep and goats will eat young whitetop but cattle should not be used as it can form toxic compounds in the cattle and taint the milk supply. Burning is not effective and can stimulate resprouting. Agricultural practices, such as reducing irrigation, removing outlying plants, and reducing disturbance are helpful when paired with rigorous native plant restoration. **Chemical** Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods. Recommended herbicides include: • Aminopyralid • Chlorsulfuron methyl • Glyphosate • Imazapic • Imazapyr • Metsulfuron methyl **References** DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp. U.S. Forest Service (USFS). 2014. Field guide for managing whitetop in the southwest. USDA Forest Service Southwestern Region, Forest Health. Technical Guide TP-R3-16-20. USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA

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Identification and Impacts

Category A—High

Tamarisk hybrids (*Tamarix spp.*)

Photo credit: J.M. DiTomaso

Photo credit: The Nature Conservancy

Photo Credit: EnviroPlan Partners

Key ID Tips

- Scale-like deciduous leaves.
- Raceme of small white to pink flowers.
- Shrub-like appearance with multiple stems.

Navajo Name

K'eiłichii'its'óóz

Photo credit: S. Dewey, USU

Origin

Native to the Eurasia and Africa

Description

This description applies to tamarisk species and includes *T. chinensis* , *T. parviflora*, and hybrids. These species are less common in the region. They are tall woody shrubs to shrub-like trees with scaly leaves, similar to junipers or cedars. However, their leaves are deciduous, turning yellow to brown in the fall before falling off. They also produce flowering racemes with small pink to white flowers. All Tamarisk species are phreatophytes with deep taproots that can reach the water table.

Biology

Tamarisk species prefer saline soils and can grow in arid conditions due to their deep taproots. They often appear along riparian corridors. Their root systems are able to extract water from unsaturated soil layers, which gives them a competitive advantage over native phreatophyte species (Zouhar K. 2003). They also accumulate salt in glands in their leaves that they excrete from the leaf surface, which then accumulate on surface soils. They can tolerate a range of environmental conditions and are able to outcompete native vegetation to form dense monocultures.

Locations

Tamarisk stands that are not *T. ramossisima* have been found in isolated populations on the Navajo Nation.

Ecological Threat and Management Concerns

Tamarisk can increase erosion and stream incision, which affects floodplain dynamics. Their deep roots and salt excretions can make it difficult for native plants to survive and can alter soil salinity. They also affect wildlife habitat for several avian species, such as the endangered Southwestern willow flycatcher. Hybridization can increase the spread of these species and their ecological impacts.

Tamarisk hybrids (*Tamarix spp.*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Most mechanical and manual cutting methods are only good at suppressing growth and are not intended for eradication. Hand pulling of small seedlings is feasible for small populations. Grubbing and bulldozing to remove the entire plant are the most effective, but often expensive. Mechanical removal or felling trees is most effective when paired with herbicide treatments to prevent resprouting.

Biological

No biological control organisms are available for use on the Navajo Nation. While the tamarisk leaf beetle is present (*Diorhaba carinulata),* it is not a USDA-approved biological control organism.

Cultural Control

Cattle and goats will graze on young tamarisk or resprouts, but they have little nutritional value. Burning is not recommended for eradicating or controlling tamarisk as it can resprout from its adventitious roots. Burning is recommended for disposing of removed material. Once removed, restoration of native plant communities is highly recommended to prevent reestablishment.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- Imazapyr

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA.

Zouhar, K. 2004. Tamarix spp. In: Fire Effectives Information System [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available at https://www.fs.usda.gov/database/feis/plants/tree/tamspp/all.html.

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Category A—High

Tree of heaven (*Ailanthus altissima*)

Identification and Impacts

Photo credit: R. Gardner

Photo credit: R. Gardner

Photo Credit: R. Gardner

Key ID Tips

- Gland located at the base of each leaflet near the petiole.
- Skunky smell to leaves and flowers.
- Smooth, thin bark and a straight bole.

Navajo Name

T'iis Nattói

Photo credit: R. Kleinman

Origin

Native to China

Description

Tree of Heaven is a deciduous tree that can grow to nearly 70 feet tall. It has large, pinnately compound leaves. The leaves give a skunk-like odor when crushed. It looks similar to native smooth sumac and hickory but is distinguished by the small notched gland at the base of each leaflet near the petiole. Its flowers are dioecious (either male or female) and grow in a long panicle with small white to pink flowers that also have a strong smell (Fryer 2010). The tree produces seeds in a samara that appear reddish brown in the fall. Young trees develop a taproot that diminishes with age as a network of long, lateral roots develop, making adults shallowly rooted. Bark is smooth and thin, and branches break easily and the bole of the tree is straight.

Biology

Tree of heaven prefers disturbed sites in riparian areas, grasslands, and woodlands. It tolerates shade, pollution, and a wide range of soil conditions including acidic and mining wastes. It is a prolific seeder and can reproduce by seed and vegetatively through its root suckers. Its root sprouts can sprout up to 50 feet from the parent tree. Individual trees can live between 30 to 50 years.

Locations

Populations have been documented in Shiprock.

Ecological Threat and Management Concerns

Tree of heaven's extensive and woody root network can damage underground structures and buildings. Its weak branches can also increase property damage and hazard branch risks. It grows rapidly, creating dense stands that limit native plant growth and grazing. Chemicals excreted from its leaves, bark, roots, and seeds may inhibit the growth of other plants. While not toxic, the foliage can cause contact dermatitis and allergies in some individuals.

	Category A—High	Tree of heaven (*Ailanthus altissima*)
Management Recommendations		Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information. **Mechanical/Manual Removal** Hand pulling can remove seedings, but must remove the underground roots to be effective. Removal of the entire root is needed and removal is best when soil is wet. **Biological** No biological control organisms are available for use on the Navajo Nation. **Cultural Control** Grazing and fire are not recommended for controlling tree of heaven as both can cause resprouting. Leaves are also high in various bitter compounds that make them unpalatable to livestock. (Fryer 2010). Maintaining shade is key to reduce establishment of resprouting trees and seedlings. **Chemical** Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods. Recommended herbicides include: • Glyphosate • Imazapyr • Triclopyr **References** DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp. Fryer, J. 2010. Ailanthus altissima. In: Fire Effects Information System, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available at: https://www.fs.usda.gov/database/feis/plants/tree/ailalt/all.html. USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA.

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Identification and Impacts

Category A—High

Uruguayan pampas grass (*Cortaderia selloana*)

Photo credit: J.M. DiTomaso

Photo credit: J. Ruter

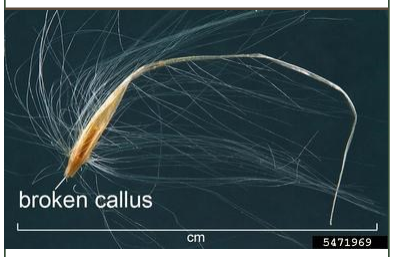

Photo Credit: D. Walters and C. Southwick.

Key ID Tips

- Dense, feathery inflorescence.
- Leaves are long and smooth except for the dense hairs at the ligule.
- Seeds have hairs and long calluses.

Origin

Native to South American in low elevation subtropical grasslands.

Photo credit: J. Ruter

Description

Uruguayan pampas grass is a fast growing bunch grass with densely tufted branches and long basal leaves. Leaves can be bluish-green in color with a smooth upper surface at the base and hairs on the lower surface near the collar. Leaf tips are bristled and curled and margins can be rough, stiff, and sharp. Flowers are in a dense, showy, and feathery panicle and can appear purple, to brown, to white. Seeds are covered in hairs with a long callus tip. They develop lateral roots that facilitate vegetative expansion of the plants.

Biology

Pampas grass prefers disturbed areas, roads, and grasslands. They form dense, tall bunches that outcompete native vegetation and are abundant seed producers, with a single plant able to produce up to 100,000 seeds, which can travel long distances by wind. Seeds, however, only survive for 6 months in the field, with germination in the fall after the first rainfall. It is drought and frost tolerant and grows well in intense sunlight. Its vigorous root system allows it to spread vegetatively.

Locations

No populations have been documented on the Navajo Nation.

Ecological Threat and Management Concerns

Pampas grass can grow vigorously, quickly crowding out native vegetation and reducing habitat and rangeland quality. Its dense, fibrous lateral roots allow them to outcompete native grasses. Its sharp leaf margins can cut wildlife, livestock, and humans. It can also make it difficult to remove. Its tolerance of a wide range of habitat conditions contribute to their invasiveness.

Uruguayan pampas grass (*Cortaderia selloana*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Hand pulling can prevent the spread of pampas grass. Removal of the entire crown and top section of the roots is needed to prevent resprouting. Removed plants should be disposed of immediately as they can take root and reestablish in moist soil. Mechanical removal with excavators and backhoes can also be effective for large infestations. Any manual treatments should use gloves, helmets, and other protective gear as leaves can cause injuries.

Biological

No biological control organisms are available for use on the Navajo Nation.

Cultural Control

Grazing and fire are not recommended and are not effective for controlling pampas grass. Mulching bare sites and restoring native plant communities is effective at reducing seedling emergency and spread.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- Imazapyr

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA.

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Identification and Impacts

Category A—High

Yellow nutsedge (*Cyperus esculentus*)

Photo credit: J.M. DiTomaso

Photo credit: J.M. DiTomaso

Photo Credit: P. Alexander

Key ID Tips

- Flowers form at the end of the stem in clusters.
- Three leaf-like bracts below the flowers.
- Tubers form in the roots.
- Seeds are brown and ellipsoidal.

Origin

Tłoh'gaí

Origin

Native to Europe

Photo credit: D. Doohan, OSU

Description

Yellow nutsedge is a perennial sedge with stiff, thick leaves that are arranged in sets of three at the base. Stems are triangular and appear bright green to yellow-green. Flowers form at the end of the stem and have three leaf-like bracts at the base. Flower are a clustered spikelet that appear yellow to brown. Seeds are brown and ellipsoidal. Below ground they develop small round tubers that allow for vegetative spread.

Biology

Yellow nutsedge is perennial sedge that grows in moist soils but can tolerate drought, making them long-lived. They can also grow in cultivated areas. Their tubers increase their rooting depth and allow it form new plants. They also grow as part of a network or thin rhizomes, which can make removal difficult. Plants die back in the fall and re-emerge in the spring. Their fast growth and upright growing habit allow them to overtop native plants and grasses.

Locations

No populations have been documented on the Navajo Nation.

Ecological Threat and Management Concerns

Yellow nutsedge is most problematic in riparian areas, irrigation agricultural fields, and wetlands as they can replace native species. It can grow quickly and their tubers allow then to resprout and develop new clusters, especially in disturbed sites. Once established, they are difficult to control.

Category A—High

Yellow nutsedge (*Cyperus esculentus*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Hand pulling seedlings and small plants can reduce establishment for small populations. Plants should be removed before they have 5 to 6 leaves to limit tuber production and resprouting. Repeat treatments are needed for established populations as tubers can resprout more than 3 times before being depleted. Hoeing, digging, and tilling must be at a depth of at least 8 to 14 inches. However, tilling can spread infestations by moving tubers to new locations.

Biological

No biological control organisms are available for use on the Navajo Nation.

Cultural Control

Grazing is not recommended or effective for controlling nutsedge as it will not address the tubers. It is unknown whether fire is an effective control method and thus is not recommended. . Mulching, reducing irrigation, and blocking fabrics can be effective at limiting and reducing nutsedge growth.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- Glyphosate

References

USDA, NRCS. 2023. PLANTS Database. Available at https://plants.sc.egov.usda.gov/. National Plant Data Team, Greensboro, NC 27401-4901 USA.

Wilen, C.A., M.E. McGiffen, C.L. Elmore. 2010. Pest Notes: Nutsedge. University of California Statewide Integrated Pest Management Program: Agriculture and Natural Resources. Publication No. 7432.

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Identification and Impacts

Category A—High

Yellow starthistle (*Centurea solsitialis*)

Photo credit: USDA ARS

Photo credit: C. Roche

Photo Credit: M.E. Harte

Photo credit: S. Dewey, USU

Navajo Name

C'it bilat'a dootłizhigí

Origin

Native to Asia

Description

Yellow starthistle is a bushy winter annual with spiny yellow flowers and stiff, wiry stems. Plants form a basal rosette in the early spring, before bolting into flowering stems in mid-spring. Stems leaves are alternate and appear blue to greyish-green. They are densely covered in cottony hairs. Their compound flowers grow singly at the end of each stem and have long spines at the tips of the phyllaries or bracts and narrow yellow petals. They have a deep taproot that can grow at least 3 feet deep.

Biology

Yellow starthistle prefers open disturbed sites and can grow in variety of settings from grasslands to open wastes. They do not tolerate shade or low light, however. They grow quickly and form dense stands and reproduce only by seed. However, their deep taproots allow them to resprout after removal. Germination typically follows precipitation events in the fall, winter, and early spring. Seeds can survive for up to 10 years in soils with ideal weather conditions.

Locations

Yellow starthistle has been detected along BIA Route 27 north of Ganado Lake and along I-40 outside of Window Rock.

Ecological Threat and Management Concerns

Yellow starthistle seeds can contaminate hay and agricultural seeds, lowering their quality and production. They form dense colonies that crowd out native vegetation and create barriers to wildlife and livestock. Yellow starthistle also produces an unknown compound that causes nigropallidal encephalomania, or chewing disease , which prevents horses from swallowing and is fatal.

Key ID Tips

- Long terminal spines on the phyllaries/ bracts
- Thin, pinnately lobed leaves covered in short hairs.
- Perennial knapweed with a deep taproot.

Category A—High

Yellow starthistle (*Centaurea solstitialis*)

Management Recommendations

Additional safety measures and limitations may apply to each method. Refer to the Navajo Nation Integrated Weed Management Plan for more information.

Mechanical/Manual Removal

Manual removal, mowing, and tilling can be used to prevent seed production when done for 2 or more years. Manual removal is most effective for small patches and areas where plants occur sporadically. It is most effective shortly after plants have bolted and before seed production and should remove all above ground material to limit resprouting. Mowing is most effective when seedheads just start to form and should cut plants below the lowest branch. Mowing requires multiple years of retreatments. Tilling is most effective in agricultural fields and along roadsides. It is not recommended in rangelands or wildlands as it can create conditions that lead to rapid recolonization. Tilling is most effective before seed set and after rainfall/germination events.

Biological

Four biological control organisms are available for use on the Navajo Nation. They include the starthistle hairy weevil, bud weevil, peacock fly, and gall fly.

Cultural Control

High intensity grazing over a short period with sheep, goats, or cattle can be effective at reducing seed production if done just after plants have bolted. Burning can also be effective when plants begin flowering and should be repeated for at least 3 years.

Chemical

Use of herbicides can be effective. Refer to the product labels for application rates, timing, and approved application methods.

Recommended herbicides include:

- 2,4-D
- Aminopyralid
- Clopyralid
- Glyphosate
- Imazapyr
- Indaziflam
- Metsulfuron methyl
- Picloram*
- Triclopyr

*Restricted Use by U.S. EPA

References

DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States.* Weed Research and Information Center. University of California. 544 pp.

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