ELEMENT STEWARDSHIP ABSTRACT

for

Elaeagnus angustifolia L.

Russian olive, oleaster

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Author of this Abstract:
Mandy Tu, The Nature Conservancy's Wildland Invasive Species Team
(530) 754-8891; imtu@tnc.org

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THE NATURE CONSERVANCY
4245 North Fairfax Drive, Arlington, Virginia 22203-1606 (703) 841-5300

SCIENTIFIC NAME

Elaeagnus angustifolia L.
(sometimes mistakenly named *Elaeagnus angustifolius* L.)

SYNONYMS

Elaeagnus iliensis Musheg.
Elaeagnus umbellata Thunb.

COMMON NAMES

Russian olive, oleaster, silverberry

DESCRIPTION AND DIAGNOSTIC CHARACTERISTICS

Elaeagnus angustifolia is a shrub or small tree in the Oleaster family (Elaeagnaceae). It can grow up to 9 meters (30 feet) in height and is often thorny. The leaves of *E. angustifolia* are simple, alternate, lanceolate to oblong, 4-8 cm in length, and are entire (untoothed) along the leaf margins (Hickman 1993). The upper surface of its leaves are light green in color and are covered with silvery star-shaped hairs, and the lower surface of its leaves are silvery white and densely covered with scales (Deiter 2000).

E. angustifolia can flower and set fruit in three years. Flowers of *E. angustifolia* are produced in umbel-like inflorescences from the leaf axils, and are small, light yellow, highly aromatic, and bisexual. In North America, flowers are usually borne early in the growing season (June-July), shortly after leaf emergence. The olive-shaped fruits are dry and mealy, yellow-red in color, and are produced in great quantities (VNPS 2000). These mealy fruits are readily eaten by many species of birds, which works to disperse its seeds (Muzika & Swearingen 1998). Although *E. angustifolia* establishes primarily by seed, vegetative propagation can also occur (Muzika & Swearingen 1998).

E. angustifolia is sometimes confused with the closely related autumn olive (*Elaeagnus umbellata*), which is also an invasive species. *E. angustifolia* can be easily distinguished from *E. umbellata*, because *E. angustifolia* leaves are narrower, longer, and is often more silvery in color, while *E. umbellata* leaves are a bit greener. Branches of *E. angustifolia* are also flexible and usually thorny, whereas *E. umbellata* branches are not, and *E. angustifolia* has distinctive dry mealy yellow fruits (*E. umbellata* fruits are typically red-pink and juicy). It is also possible to confuse *E. angustifolia* with native *Shepherdia* species. *Shepherdia* and *Elaeagnus* are in the same family (Elaeagnaceae) and therefore share several characteristics, but the leaves of *Elaeagnus* are alternately arranged while *Shepherdia* leaves are oppositely arranged.

STEWARDSHIP SUMMARY

E. angustifolia is native to Europe and western Asia. It was originally planted in the United States beginning in the late 1800s as an ornamental shrub or small tree. By the mid-1900s it had escaped cultivation into the central and western U.S., and is now extensively naturalized in 17 western states. It also occurs in southern Canada, from Ontario to British Columbia. Until recently, *E. angustifolia* was still recommended by the U.S. Soil Conservation Service (now called the Natural Resources and Conservation Service) for wildlife and windbreak plantings. In the western U.S., it has become a major problem in riparian woodlands, threatening even large, hardy native trees such as cottonwoods. *E. angustifolia* can form dense, monospecific stands, that can alter vegetation

structure, nutrient cycling, and the hydrology of a system. *E. angustifolia* is especially proficient in displacing native riparian vegetation after disturbances, such as flooding (or with altered flooding regimes). No allelopathic chemicals have been found in *E. angustifolia* (Muzika & Swearingen 1998).

To control *E. angustifolia*, seedlings and sprouts can easily be hand-pulled when the soil is moist. Once it becomes firmly established, the most effective control method is the cut-stump herbicide treatment. This method is both labor-intensive and expensive, but can be highly effective (good kill rate if applied correctly), and is more target-specific than foliar applications of herbicide. Most non-chemical methods for the control of large *E. angustifolia* stands (bulldozing, mowing, brush-cutting) are not effective in the long-term, unless all respouts are continually cut and removed, or otherwise treated, for many consecutive years. Vertebrate herbivores are not known to feed on *E. angustifolia* and few insects seem to utilize or damage it. Canker disease occasionally attacks *E. angustifolia*, but is not effective as a control agent.

HABITAT & RANGE

E. angustifolia occurs in a variety of soil and moisture conditions (such as on bare mineral substrates or in nitrogen-poor areas), but prefers sandy floodplains and is often associated with open, moist riparian habitats. Mature *E. angustifolia* trees are tolerant of floods, droughts, and to close shearing or burning in the dormant season, but does not tolerate acidic conditions (pH<6.0). Seedlings and young saplings of *E. angustifolia* are shade tolerant.

E. angustifolia is native to Europe and western Asia. As a North American invader, *E. angustifolia* occurs primarily in the central and western U.S., but can also occur in the eastern U.S. (Virginia to Pennsylvania), sometimes in association with autumn-olive (*E. umbellata*). In the west, *E. angustifolia* is common in the Great Basin at 240-600 m (800-2000 feet) elevation, and is abundant in riparian zones of the Great Plains; e.g., the Platte River in Nebraska. It is especially plentiful in some intermountain basins in the Rockies, such as the Big Horn Basin and in the Uintah Basin.

E. angustifolia has been reported growing outside cultivation in the following states: Arizona, California, Colorado, Connecticut, Idaho, Illinois, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, and Wyoming (USDA-NRCS 2001). *E. angustifolia* has been declared a state noxious weed in Colorado and in New Mexico.

Despite its invasive properties, *E. angustifolia* is still being recommended and sold to landowners for horticulture, wildlife habitats, and as windbreaks. As recently as 1984, several governmental agencies (primarily extension forestry and state forestry services) were still subsidizing the distribution of *E. angustifolia* seedlings to private landowners in 16 of 17 western states for wildlife plantings (Olson & Knopf 1986). This has likely contributed to the current widespread occurrence of *E. angustifolia* in the U.S.

IMPACTS AND THREATS POSED BY *ELAEAGNUS ANGUSTIFOLIA*

E. angustifolia can invade both open upland and riparian bottomland (marshland and other wetland) communities, alter the course of plant succession, and ultimately result in lowered levels of native plant and animal diversity. It negatively impacts natural areas by creating dense, monotypic stands that outcompete native vegetation, modifying vegetation structure, and displacing native wildlife.

E. angustifolia can also alter nutrient cycling and system hydrology by spreading throughout woodlands, connecting lowland riparian forests with more open, upland areas. This contributes to the stabilization of riverbanks against future flooding, increasing overbank deposition, and limiting the number of suitable sites for native cottonwood regeneration (Howe & Knopf 1991). Further, *E. angustifolia* trees have high rates of evapotranspiration, utilizing more water resources than native species (Carman & Brotherson 1982), and can eventually change riparian sites into relatively dry uplands with *E. angustifolia* as the climax species (Currier 1982, *in* Olson & Knopf 1986). Dense thickets of *E. angustifolia* can also increase fuel loads that may cause catastrophic wildfire (Caplan 2002).

Once *E. angustifolia* is established in a watershed, it will likely remain a significant component of riparian communities along both unregulated and regulated stretches within that watershed. This is because *E. angustifolia* is able to germinate and survive in the shaded understory of native trees, such as under cottonwoods. When those native cottonwood trees die (from old age, windthrow, or beaver), *E. angustifolia* quickly becomes the dominant shrub or tree community, and can perpetuate itself through both sexual reproduction and/or by vegetative growth. The shaded *E. angustifolia* understory then becomes unfavorable for the (re-)establishment of most other native plant species (Shafroth et al. 1995).

E. angustifolia has been touted for enhancing wildlife habitat by providing shelter and plentiful edible fruits, but in fact, communities dominated by *E. angustifolia* can be detrimental to many native animal species in the long-term, since it provides inferior wildlife habitat to that of native riparian vegetation. Knopf and Olson (1984) and Brown (1990) both documented greater bird species richness in riparian areas dominated by native vegetation rather than in *E. angustifolia* infestations in the Rocky Mountains and along the Snake River in Idaho, respectively, especially for cavity-nesting and insectivorous birds. Brown (1990) speculated that this could be due in part to the reduced numbers of insects in *E. angustifolia* trees. Ducks also tend to avoid wetlands rimmed by dense stands of *E. angustifolia* (Knopf & Olson 1984).

BIOLOGY AND ECOLOGY

Light, soil conditions, and temperature

E. angustifolia is a hardy, long-lived shrub or small tree that can survive and prosper in a variety of soil and moisture conditions. This adaptability has led *E. angustifolia* to be widely planted in shelterbelts throughout the prairie states, for wildlife habitat plantings, for erosion control, and for highway beautification.

E. angustifolia is commonly found invading floodplains, riverbanks, stream courses, marshes, and irrigation ditches in the West, occurring from sea level to at least 2,438 m (8,000 ft). *E. angustifolia* can grow at a rate of up to 1.8 m (6 ft) per year. It is somewhat shade tolerant and can withstand competition from other shrubs and trees. This tolerance of shaded conditions allows *E. angustifolia* to establish and survive in native cottonwood understories for prolonged periods, and then become dominant once the native vegetation senesces.

E. angustifolia thrives under a wide range of soil textures from sand to heavy clay, and can withstand prolonged flooding and silting. It grows best in deep sandy or loamy soils with only slight salt (100-3,500 p/m) and alkali content. The soil pH must range between 6 and 9. *E. angustifolia* can also survive considerable drought, and is therefore adapted to ephemeral riparian areas in arid regions. *E. angustifolia* requires a minimum of 20 cm (ca 12 inches) of precipitation

per year, and has a high rate of evapotranspiration, which robs water from native species. *E. angustifolia* can withstand temperatures ranging from -45° to 46° C (-50° to 115° F) (Carman & Brotherson 1982).

Reproduction

E. angustifolia can reproduce either sexually or vegetatively. Numerous root suckers are produced at the root crown after disturbance or damage to the above-ground tree from fire, cutting, or girdling.

Seed production and dispersal enables *E. angustifolia* to rapidly colonize new areas. Trees begin bearing fruits at 3 to 5 years. The fruits are then eaten and widely dispersed by birds. The outer layer of the seed is impermeable to digestive juices. The large seeds can remain viable for up to 3 years and are capable of germinating over a broad range of conditions (Shafroth et al. 1995). Germination rates can be enhanced by stratification in moist sand for 90 days at 5° C (41° F). The seeds of *E. angustifolia* can germinate anytime from fall-to-spring, and this gives it a considerable advantage over native riparian species, since *E. angustifolia* is able to exploit suitable germination conditions over a longer time interval (Howe & Knopf 1991). Furthermore, the seeds can germinate on undisturbed soils, so the species can establish itself in environments immediately without having to wait for rare events like floods or fires, unlike many native riparian species (Lesica & Miles 1999).

Seedlings of *E. angustifolia* are tolerant of shade, allowing seedlings to survive under the dense shade of a native canopy, then rapidly grow and dominate once the upper canopy is removed. Spring moisture and slightly alkaline soils tend to favor seedling growth.

Disturbance

E. angustifolia is an early colonizer of disturbed floodplains and streambanks. It is relatively shade tolerant, and once established, can persist throughout seral stages and become the climax dominant species. In disturbed or modified environments (e.g. fire, droughts, and decreased flood intensities because of dams), the colonization of *E. angustifolia* is favored over native woody species (Lesica & Miles 1999). Beaver can also promote the growth of *E. angustifolia*, as they preferentially damage native cottonwood trees. Lesica and Miles (1999) determined that beaver suppress cottonwood maturation, which allows quantities of *E. angustifolia* to increase. Eventually, the shade of *E. angustifolia* prevents cottonwood recruitment, and *E. angustifolia* eventually becomes the dominant climax species.

ECONOMIC USES

E. angustifolia has been widely planted as an ornamental plant, for windbreasks, and for erosion control. The wood is not commercially or economically important. *E. angustifolia* has also been often planted for wildlife habitat purposes. Mourning dove and northern mockingbird nest in it, and other wildlife uses it for shelter. More than 50 species of birds and mammals eat the sweet, mealy fruit, and the foliage is browsed by deer and livestock. It is sometimes valued as a plant for honeybees, and beaver often use the branches of *E. angustifolia* for dam-building material.

MANAGEMENT

Potential for Restoration of Invaded Sites

Large mature stands of *E. angustifolia* are nearly impossible to eradicate throughout an entire watershed once it becomes well-established, so the early detection and rapid response to treat newly

detected populations of *E. angustifolia* is important. Small patches of *E. angustifolia*, however, can be adequately controlled using a variety of control methods. All control techniques used to manage *E. angustifolia* are labor-intensive and expensive, especially in the first year of large-scale *E. angustifolia* removal. Mowing, cutting, burning, excavation, spraying, girdling, and bulldozing have all been used for *E. angustifolia* control, and they all work to reduce aboveground biomass, sometimes to varying degrees of success. Successful long-term control of *E. angustifolia* requires that all control sites to be continually monitored and follow-up treatments vigilantly applied for several years, since *E. angustifolia* frequently resprouts or develops root suckers from the root crown.

Along regulated-rivers, once *E. angustifolia* trees have been killed and/or removed, the ensuing restoration of native trees and shrubs can be improved by simulating historic flood regimes and rates of water drawdown at the time of cottonwood seed dispersal (Friedman 1993, *in* Shafroth et al. 1995). In some situations, the planting of poles or nursery stock of native trees and shrubs can assist in the re-establishment of native riparian communities (Shafroth et al. 1995).

Manual and Mechanical Control

E. angustifolia seedlings and sprouts can be hand-pulled or weed wrenched out when soil is moist (Deiter 2000). Saplings with a trunk diameter less than 3.5 inches can be pulled sufficiently with a weed wrench (Deiter 2000). Pulling or digging out larger plants is both extremely labor-intensive and not recommended, since it can leave behind root fragments that can resprout. Seedlings can also be continually mowed for good control, but larger plants respond to cutting or girdling by vigorously resprouting, resulting in thicker, denser growth, unless herbicide is immediately applied to cut surfaces after cutting.

Prescribed Burning

Small seedlings of *E. angustifolia* may be susceptible to fire, but burning alone does not adequately control larger individuals of *E. angustifolia*, since it can vigorously re-sprout following fire (similar to cutting or mowing). Prescribed burning, however, can be used as either a pretreatment to, or used in combination with another control method, called integrated pest management (IPM).

Chemical Control

Seedlings, saplings, and mature *E. angustifolia* trees can all be effectively killed by the careful, judicious, and targeted application of herbicide. Foliar and basal bark applications can be effective, especially for young individuals or for resprouts, but there may be off-target effects (from overspray or drift) if applied as a foliar spray to large stands. The most specific herbicide application technique for large mature trees is the cut-stump application method. First cut the stem/trunk as close to the ground as possible, then immediately (within a few minutes) brush-on or squirt herbicide onto the cambium layer of that cut-stump. Hacking and frilling ("hack and squirt"), girdling plus herbicide, or injection of herbicide, are also all effective at killing mature trees.

Glyphosate (e.g. RoundUp®) and triclopyr ester (e.g. Garlon 4®) have both been reported to be effective in killing mature *E. angustifolia* trees (Parker & Williamson 1996). Caplan (2002) reported excellent kill rates using a 50% solution of Garlon 4® in a cut-stump treatment (herbicide applied within 5 minutes of cutting) on trees with trunks less than 4 inches (10 cm) in diameter in New Mexico. This may not be effective on trees with trunks larger than 8 inches in diameter (Caplan 2002). Caplan (2002) then followed-up the cutting treatments with foliar sprays on root sprouts for the following two years (25% solution of Garlon 4®), and reports that instead of large

dense stands of *E. angustifolia*, he now finds on average, less than 3 sprouts per acre. He adds that continued vigilance, monitoring, and follow-up treatments are necessary for long-term success.

Edelen and Crowder (1997) eliminated *E angustifolia* trees in Washington State by cutting them in mid-summer, and then mowing the re-sprouts once in late summer the following year. While effective, this non-herbicidal method was labor intensive and costly. They decided that their next efforts would include using herbicide to first kill the trees before removal. They used imazapyr (e.g. Contain® or Arsenal®) at different concentrations, and found that Contain® (used in a 4% solution; 14% active ingredient) damaged about 75% of the trees. Large trees showed damage in the upper half of canopy, while younger trees and sprouts were strongly affected throughout their entire canopy. When Garlon 4® (triclopyr) was applied as an aerial spray (no concentrations given), they reported a 90% kill rate (W. Crowder, pers. comm.).

Parker and Williamson (1996) report that basal bark applications (spraying herbicide directly onto the bottom 60 cm [2 feet] of each stem) with triclopyr (e.g. Garlon 4®or Remedy®) appeared to give effective control. They added that with these basal applications, top-kill is excellent, and this method minimizes soil disturbance and maintains other desirable vegetation. Parker and Williamson (1995) also stressed that it is important that applications completely wet the entire circumference of all stems or clumps of stems, but not to the point of run-off. The basal bark method is effective with small trees with smooth bark. For larger trees, the sprayed area must extend upward to include some smooth bark. Treatment of larger trees with thick, rough bark using this method may provide only about 50% control. The best time to apply herbicide is when the plants are actively growing from May through September. Parker and Williamson (1996) recommend that burning is effective in large stands for first reducing biomass, and then basal applications should be used on resprouts.

Biological Control
There are no reported biocontrol agents for the control of *E. angustifolia*.

EXAMPLES OF *ELAEAGNUS ANGUSTIFOLIA* MANAGEMENT ON TNC PRESERVES
Brian Winter of TNC's Northern Tallgrass Prairie Ecoregion in Minnesota and the eastern Dakotas reports that *E. angustifolia* tends to occur in old agricultural fields, ditches, and where it was planted for wildlife habitat. He notes that if *E. angustifolia* is allowed to reach maturity and produce seeds, it becomes particularly pernicious because it can then form dense thickets that shade-out the natives, change overall vegetation structure, and becomes even more widespread as the seeds are dispersed by wind and birds. Brian has tried controlling *E. angustifolia* by cutting and by burning, but has found that in both cases, re-sprouts will occur. He recommends using a herbicide formulation of picloram and 2,4-D (e.g. Pathway®) to control *E. angustifolia*. He applies 100% concentrate Pathway® on cut-stumps where it kills the roots and prevents re-sprouting, and as a foliar spray at label concentrations to kill small seedlings. Brian believes that the potential to control *E. angustifolia* is high if new plantings are eliminated, and if preserves work with all local landowners and other stakeholders to cut-stump treat and kill all mature trees.

In Idaho's Thousand Springs Preserve, Chris O'Brien reported that pulling seedlings was effective when the soil is moist, but required a great deal of labor. In Utah, Sue Bellagamba adds that pulling is effective for small trees. The most effective method for controlling *E. angustifolia*, however, is to cut-down the trees and then apply herbicide to the cut-stumps.

MONITORING

Following control treatments, further control efforts and monitoring is needed (at least) annually for several years to determine results from your management activities. Viability of seeds in the seed bank may also determine how long monitoring at a particular site needs to be maintained.

Permanent plots, or permanent transects through experimental and control plots, where visual estimates of vegetation cover, are usually appropriate to determine the effects of management treatments, if enough plots are sampled.

The chosen monitoring method should depend on the objectives and goals of the restoration project. For example, if information is sought regarding the treatment response of individual native species, a more detail-oriented sampling method may be needed. Trained botanists may be required to determine which species are native and which are potentially problematic exotic species. Analyzing monitoring data regularly will determine whether management objectives are being met and if modifications to the control treatments are needed.

CONTACTS:

Sue Bellagamba or Joel Peterson
P.O. Box 1329
Moab, UT 84532
Phone: (435) 259-4629
E-mail: sbellabamba@tnc.org

Brian Winter
The Nature Conservancy
Northern Tallgrass Prairie Ecoregion Office
RR 2 Box 240
Glyndon, MN 56547
Phone: (218) 498-2679
E-mail: bwinter@tnc.org

RESEARCH NEEDS

The following research topics need attention:
1) Continue and expand on studies examining the invasiveness and impacts of *E. angustifolia* on natural systems (nutrient cycling, native plant regeneration and survival, etc.).
2) Conduct further research into identifying which native species are good competitors and how best to introduce those species into restoration projects.
3) Continue projects to find native alternatives to *E. angustifolia* for wildlife habitats, windbreaks, highway shoulders, and other non-agricultural areas.
4) Continue research on the best control methods for *E. angustifolia*, and on possible biological control agents.

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AUTHORED BY:

Mandy Tu, The Nature Conservancy's Wildland Invasive Species Team

July 2003

EDITED BY:

Barry Rice & John M. Randall, The Nature Conservancy's Wildland Invasive Species Team
(530) 754-8891