WRITTEN FINDINGS OF THE
WASHINGTON STATE NOXIOUS WEED CONTROL BOARD
DRAFT September 2013

Scientific name: *Elaeagnus angustifolia* L.

Synonyms: *Elaeagnus angustifolia* L. var. *orientalis* (L.) Kuntze

Common name: Russian olive, oleaster, silverberry, wild olive, narrow-leafed oleaster

Family: Elaeagnaceae

Legal Status: Proposed as a Class C Noxious Weed

Images: Left, *Elaeagnus angustifolia* infestation, image credit David J. Moorhead, University of Georgia, Bugwood.org; Center, younger *E. angustifolia* stems with thorns, image Joseph Berger, Bugwood.org; Right, older bark with shredded appearance, image Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

<u>Description and Variation:</u>

<u>Overall Habit</u>:

Elaeagnus angustifolia is a deciduous multi-stem shrub or tree, growing up to 7 meters tall (DiTomaso and Healy 2007). It is a nitrogen-fixing plant with silvery foliage, fragrant yellow flowers and forms olive-like fruit.

<u>Stems:</u>

Stems are smooth to somewhat smooth, dark reddish brown and may or may not have thorns (DiTomaso and Healy 2007). Young stems are slivery gray and densely covered with silvery, shield-shaped (peltate) scales (DiTomaso and Healy 2007). Bark on trunks is reddish in color and sometimes shredding (Katz and Shafroth 2003).

<u>Roots:</u>

Elaeagnus angustifolia has a deep root system with many well developed lateral roots (DiTomaso and Healy 2007). It is an actinhorhizal species, able to participate in a nitrogen-fixing symbiosis with actinomycetes of the genus *Frankia* (Zitzer and Dawson 1992, Johnson 1995 in Katz and Shafroth 2003).

<u>Leaves:</u>

Leaves are alternately arranged, narrowly lanceolate to elliptic in shape and 4-8 cm (1.6-3.1 inches) long (DiTomaso and Healy 2007). Leaves have smooth margins (DiTomaso et al. 2013). The upper leaf surface is gray-green and moderately covered with silvery star-shaped hairs and scales. The petioles and underside of leaf is silvery gray and densely covered with silvery peltate scales (DiTomaso and Healy 2007). As is typical of nitrogen-fixing plants, *Elaeagnus angustifolia* leaves have a high nitrogen content.


Images: Left, Upper and lower side of leaves showing smooth margins and silvery hairs and scales, image © Ben Legler, 2005; Right, *Elaeagnus angustifolia* leaf shape, image © 2008, G. D. Carr.

<u>Flowers:</u>
Flowers are in umbel-like clusters of 1 or more flowers in the leaf axils (DiTomaso et al. 2013, DiTomaso and Healy 2007). The flowers are 5-10 mm long and wide, yellow to yellowish green and highly fragrant (DiTomaso and Healy 2007). The sepals are narrowly bell-shaped, with four acute petal-like lobes (DiTomaso and Healy 2007). Flowers are without petals and have 4 stamens. Flowers bloom May to June and are pollinated by insects (Katz and Shafroth 2003).

Images: Left, *Elaeagnus angustifolia* in flower, image John M. Randall, The Nature Conservancy, Bugwood.org; Right, *E. angustifolia* forming fruit, image Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

<u>Fruits and Seeds:</u>
Fruits are oval-shaped and drupe-like, 1-1.5 cm long. They are covered with silver scales, gray in color and drying to brown (Young and Young 1992 in Katz and Shafroth 2003). Each fruit contains one seed (DiTomaso et al. 2013).

<u>Look-alikes:</u>

Elaeagnus umbellata, autumn olive, is native to parts of Asia and has naturalized in the United States and Canada (USDA ARS 2013). It is listed as a noxious weed or quarantined in Connecticut, Massachusetts, New Hampshire and West Virginia (USDA NRCS 2013). *Elaeagnus umbellata* has scattered locations in Washington, having herbarium collections in Franklin, Skagit and King Counties in Washington and also with collections in Oregon and British Columbia (Consortium of PNW Herbaria 2013). *Elaeagnus umbellata* is a deciduous shrub growing up to 6 meters tall, with stems and leaves having brown and silvery scales. Stems can be thorny. Flowers are yellowish white (not as yellow as *E. angustifolia*) and form fruits up to 8 mm that ripen to a red color. *Elaeagnus angustifolia* fruits are larger and do not turn red.


Images: Left, *Elaeagnus umbellata* leaves, image James H. Miller, USDA Forest Service, Bugwood.org; center, *E. umbellata* in flower, image Leslie J. Mehrhoff, University of Connecticut, Bugwood.org; Right, *E. umbellata* in fruit, image Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.

Elaeagnus commutata, silver berry, is native from British Columbia and Yukon to Quebec, southward in the Rocky Mountain area, from Idaho and Montana to Utah (Hitchcock et al. 1961). In Washington, herbarium specimens have been collection in Okanogan, Adams and Whitman Counties (Consortium of PNW Herbaria 2013). *Elaeagnus commutata* is a spreading to erect shrub growing 1-4 meters tall and is unarmed (Hitchcock et al. 1961), whereas *E. angustifolia* stems may have thorns. Young branches are brownish-scurfy on *E. commutata* while *E. angustifolia*'s young branches are typically silvery. *Elaeagnus commutata* leaf blades are lanceolate to oblanceolate, 2-8 cm long, silvery-scurfy on both surfaces or sometimes brownish-lepidote beneath (Esser 1994, Hitchcock et al. 1961). Flowers are 1-3 per leaf axil or clustered at the base of new twigs (Hitchcock et al. 1961). The fruit is ovate to ellipsoid, 8-10 mm (0.32 to 0.4 inches) long (Esser 1994).




Images: Left, *Elaeagnus commutata* leaves, image D. E. Herman, 1996. North Dakota tree handbook, USDA NRCS ND State Soil Conservation Committee; Center, *Elaeagnus commutata* ripe fruits, image

credit Matt Lavin; Right, *Elaeagnus commutata* growth habit, image D. E. Herman, 1996. North Dakota tree handbook, USDA NRCS ND State Soil Conservation Committee.

Olea europaea, olive, is an evergreen tree with opposite leaves, not alternate and deciduous like *Elaeagnus angustifolia*. *Olea europaea* has white flowers (not yellow), two stamens (not four like *E. angustifolia*) and oily fruits that are green to glossy black (DiTomaso and Healy 2007).

Habitat:

Elaeagnus angustifolia grows in riparian areas, floodplains, grasslands, roadsides, fencerows, seasonally moist pastures, ditches, and other disturbed sites (DiTomaso et al. 2013, Madurapperum et al. 2013). It often inhabits seasonally moist areas and sites near farmlands (DiTomaso et al. 2013). It can grow in a variety of moisture conditions, surviving in arid environments when its deep roots tap into relatively constant supplies of ground water (Katz and Shafroth 2003). It is relatively drought-tolerant and may be able to survive in areas that are typically unsuitable for native, mesic riparian trees and shrubs (Nagler et al. 2011). Survival in these drier environments may be aided by its reflective silvery leaves, a relatively thick leaf cuticle, sunken stomata and it morphological leaf variation (Zhang 1981 and Klich 2000 in Katz and Shafroth 2003). Water availability is a one of the main factors controlling the distribution of *E. angustifolia* in arid and semiarid western U. S., requiring supplemental moisture relative to that available in upland environments (Nagler et al. 2011).

Elaeagnus angustifolia can establish in a broad range of conditions--from full sun to shade, where the water table is shallow or deep, and in flooded or rain-wetted sites (Reynolds and Cooper 2010). It can grow in a variety of soils and is tolerant of high levels of soil alkalinity and is also somewhat tolerant to soil salinity in experimental studies (Katz and Shaforth 2003). It grows best in inland areas with warm summers and cold winters (DiTomaso et al. 2013).

Geographic Distribution:

Native Distribution:

Elaeagnus angustifolia is listed in the GRIN (USDA ARS 2013) database as being native in:

- Asia-temperate: Afghanistan, Iran, Turkey, Armenia, Azerbaijan, Georgia, Russian Federation, Kazakhstan, Tajikistan, Turkmenistan, Uzbekistan, Mongolia and China
- Asia-tropical: India and Pakistan
- Europe: Belarus and Moldova

According to the USDA ARS (2013) GRIN database, *Elaeagnus angustifolia* has naturalized in:

- Europe
- Northern America: Canada, United States

Elaeagnus angustifolia has also been noted as naturalizing from cultivated plants in parts of South America (Klich 2000 in Katz and Shafroth 2003).

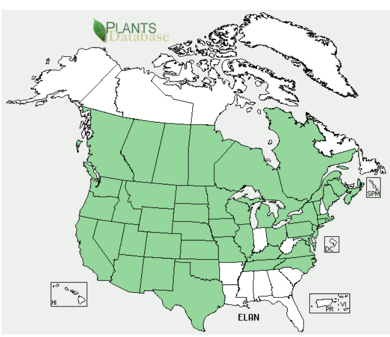
Distribution in North America:

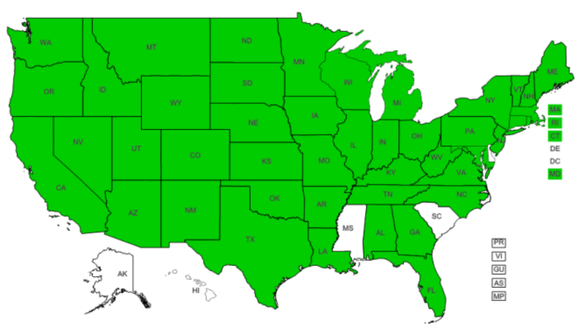
Elaeagnus angustifolia is listed in the GRIN (USDA ARS 2013) database as being naturalized in Canada and the United States. The PLANTS database (USDA NRCS 2013) reports it is present in most all of the continental U.S. except in the southeast and in Canada it is reported in all southern provinces. EDDMapS (2013) documents *E. angustifolia* in additional states from the PLANTS database, including Indiana, West Virginia, New Hampshire, Arkansas, Louisiana, Alabama, Georgia and Florida (see maps). The southern boundary of *E. angustifolia* in North America is through southern California, Arizona, New Mexico and

Texas (Guilbault et al. 2012). This southern limit is associated with winter low temperatures (Guilbault et al. 2012). Planted *E. angustifolia* extends further south than that of naturally occurring *E. angustifolia* (Guilbault et al. 2012).

Elaeagnus angustifolia is reported to have been initially brought to the United States by Russian Mennonites to use in hedgerows and for shade (Hansen 1901 in Nagler et al. 2011). Since then, *E. angustifolia* has been planted through the Great Plains as windbreaks and in landscape plantings, encouraged in part by state and Federal subsidies (Olson and Knopf 1986 and Haber 1999 in Nagler et al. 2011). It was promoted as a source for nectar, wildlife habitat and erosion control (Hayes 1976 and Borell 1962 in Katz and Shafroth 2003). Anthropogenic processes, such as clearing of riparian forest, have promoted *E. angustifolia* invasion and proliferation (Friedman et al. 2005 in Madurapperuma et al. 2013).

In the United States, *Elaeagnus angustifolia* is most problematic in the Southwest, Intermountain West and the Great Plains regions (DiTomaso and Healy 2007). Various publications (cited in Katz and Shafroth 2003) indicate that *Elaeagnus angustifolia* has become naturalized along most of the major river systems in the Great Plains and in mid-elevation rivers in all the southwestern states (Nagler et al. 2011). In a study documenting the abundance of 44 riparian woody plants in 17 western states, Friedman et al. (2005) found *E. angustifolia* to be the fourth most frequently occurring woody riparian plant and the fifth most abundant. Although *E. angustifolia* occurs east of the Mississippi river, it is generally not regarded as a pest in those states (Nagler et al. 2011). In 2006, Congress passed public law 109-320, the 'Salt Cedar and Russian Olive Control Demonstration Act'. The purpose of this act is to assess the extent of the infestation by salt cedar and Russian olive trees in the western United States; to demonstrate strategic solutions for the long-term management of salt cedar and Russian olive trees and the reestablishment of native vegetation; and to assess economic means to dispose of biomass created as a result of salt cedar and Russian olive trees.





Maps: Left, *Elaeagnus angustifolia* distribution map, image credit USDA NRCS 2013; Right, *Elaeagnus angustifolia* EDDMapS distribution map, green indicates presence, image credit EDDMapS 2013.

Elaeagnus angustifolia has the following noxious weed and/or quarantine listings in the United States:

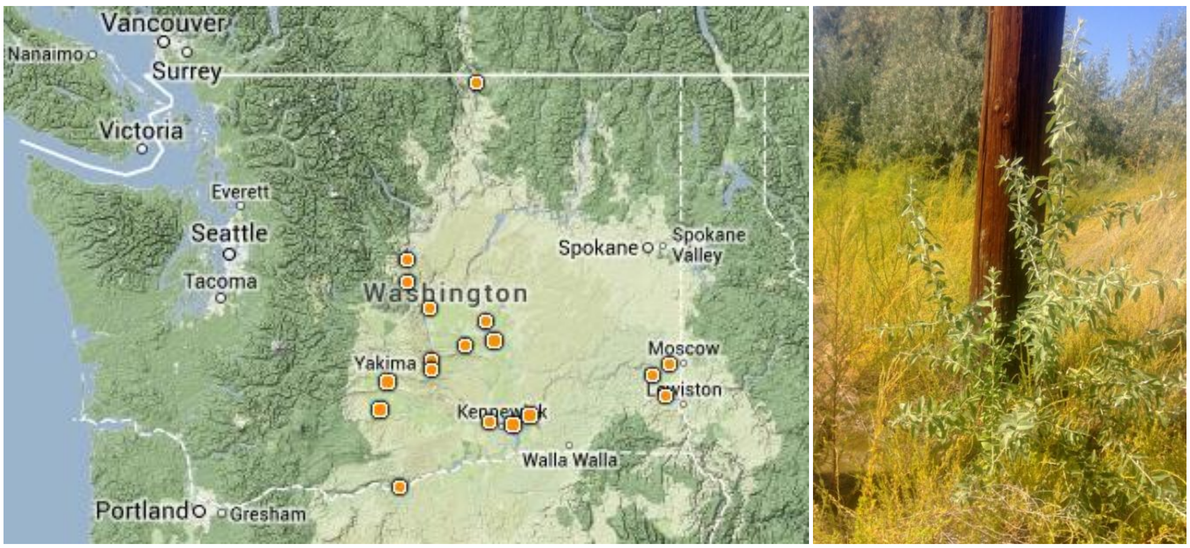
- Colorado: Class B noxious weed
- Connecticut: invasive plant on prohibited plant list—prohibits anyone from importing, moving, selling, buying, cultivating, distributing, or transplanting
- Montana: priority 3 regulated plant--may not be intentionally spread or sold
- New Mexico: Class C noxious weed
- Washington: Class C noxious weed in Grant County Weed District #3 only
- Wisconsin: cannot legally transport, transfer or introduce

- Wyoming: prohibited noxious weed

(National Plant Board 2013).

History and Distribution in Washington:

The first herbarium record of *Elaeagnus angustifolia* in Washington State is from 1923, collected in Whitman County (WS 46675, Consortium of PNW Herbaria 2013). Further herbarium records were not collected of *E. angustifolia* until 1972, after which records have been collected in many eastern Washington counties (Consortium of PNW Herbaria 2013). There are not any herbarium records from Western Washington though E. angustifolia has been known to be used in ornamental plantings west of the Cascades (Wendy DesCamp pers. obser., Ray Larson pers. comm.).



Images: Left, herbarium specimen collections of *Elaeagnus angustifolia* in Washington (Consortium of PNW Herbaria 2013); Right, *E. angustifolia* growing along a road in Grant County Weed District #3, image WSNWCB.

Biology:

Growth and Development:

Elaeagnus angustifolia can germinate and establish in open and shaded areas. It does not require bare fluvial surfaces, like some native riparian species, that are commonly created by flood-related processes to germinate and establish. Water flow regulation (for example, dams) typically provides fewer new bare fluvial surfaces and could provide more suitable sites for the more shade-tolerant *E. angustifolia* than for species native species like cottonwood and willow (Shafroth et al. 1995, Reynolds and Cooper 2010 in Nagler et al. 2011).

At three to five years of age *Elaeagnus angustifolia* generally begin to flower and fruit, though it may take longer depending on the location (Muzika and Swearingen 2005, Zouhar 2005). *Elaeagnus angustifolia* has been noted to have both a slow and fast growth rates. Its growth habits (e.g. stem and foliage density, canopy cover) vary between plant communities and depend on the size and age of associated species and the history of disturbance of the site (Zouhar 2005). The oldest *E. angustifolia* plants recorded were 36 and 40 years old on the Marias and Yellowstone rivers, respectively (Zouhar 2005). Mean age of *E. angustifolia* stands was 15.3 years on the Marias and 18.6 years on the Yellowstone (Zouhar 2005). A study in Colorado measured the growth rate of *E. angustifolia* as an ornamental tree and found it to have an average DGH increase of 0.40 inches per year and an average DBH increase of 6.4 inches per 16-year period (Wood 2010).

Reproduction:
Plants primarily reproduce from seed (DiTomaso et al. 2013). Seed dispersal occurs during the fall and winter, primarily by birds, other vertebrates and possibly water and ice (Van-Dersal 1939, Borell 1962, Olson and Knopf 1986b, Kindschy 1998, G. Katz person observation, Brock 1998 and Pearce and Smith 2001 in Katz and Shafroth 2003). Seeds survive ingestion by animals (DiTomaso et al. 2013). For example, European starlings are effective dispersers of *E. angustifolia* in southeastern Oregon and may have contributed substantially to its spread there (Zouhar 2005). Seeds are dormant at maturity and require a cool moist stratification period of about 2 to 3 months. Guilbault et al. (2012) found no effect on germination from seed scarification. Stored seeds remain viable for one to three years in the laboratory but longevity in the field is undocumented (Young and Young 1992 in Katz and Shafroth 2003). Stratification has a positive effect on the proportion of seeds that germinate, with longer stratifications having higher germination rates (Guilbault et al. 2012).

The timing of seed germination varied widely, depending on when site conditions are suitable (Shafroth et al. 1995 in Katz and Shafroth 2003), though this is beneficial only on substrates that are older and stable enough to contain seeds from previous years. *Elaeagnus angustifolia* reproduction is not linked to flood disturbance, having an advantage over disturbance-dependant native and non-native taxa (Katz and Shafroth 2003). *Elaeagnus angustifolia* seedlings are relatively shade tolerant, able to establish under cottonwoods and willows, unlike most other co-occurring riparian trees and shrubs (Shafroth et al. 1995 in DeCant 2008).

Cut trees can readily resprout from the crown and roots (DiTomaso et al 2013).

Control:
When controlling *Elaeagnus angustifolia*, it is important to consider site-specific conditions, particularly in stream channels characterized by dynamic morphology (Jaeger and Wohl 2011). Plant removal methods, stream bank composition, channel morphology and stream flows are factors to take into consideration when restoring a riparian plant community (Jaeger and Wohl 2011). It is also important to consider the potential for increased erosion when planning control of *E. angustifolia* in riparian areas. Large scale control of dominant species can lead to unintended erosion (Vincent et al. 2009). For example, a helicopter herbicide application in New Mexico targeting tamarix species that dominated a floodplain, also killed native willow (*Salix exigua*). A flood 3 years later caused erosion of the area where the control took place and widened the channel by 84% (Vincent et al. 2009).

Mortenson and Weisberg (2010) discuss how the dominance of non-native, invasive species complicates process-based restoration strategies as invasive species may be well suited to certain natural water flow regimes. They note that once an invasive species has established along a waterway, returning to natural flow conditions alone will not ensure the success of native plant species and that restoration plans must be designed from an ecosystem perspective that encompasses diverse plant species.

It is also important to replant the area with desirable plants, such as native willow and cottonwood species, to restore riparian wildlife habitat (Fischer et al. 2012).

Remember to wear protective clothing when controlling *Elaeagnus angustifolia* to avoid injury from the thorns.

Mechanical Methods:
When possible, manually remove seedlings and saplings, including roots, before they mature (DiTomaso et al. 2013). Pulling or digging out larger plants is both labor-intensive and generally not recommended, since it can leave behind root fragments that can resprout (DiTomaso et al. 2013). Trees with a diameter of 3.5 inches or smaller can be pulled out with a weed wrench when soils are moist.

In some situations larger trees can be removed using a bulldozer or tractor with an attached chain, with remaining exposed roots cut off below ground level and buried (DiTomaso et al. 2013). Jaeger and Wohl (2011) removed entire plants from a stream bank with backhoes, causing the channels to widen significantly but the general channel morphology remained entrenched. Other observations have found substantial channel morphology changes when plants were removed, but these streams had different channel characteristics. It is important to consider local factors and the methods of plant removal likely to influence the channel response to invasive plant removal. While whole plant removal does provide complete removal of *E. angustifolia*, it is costly, labor-intensive, and provides little to no increased benefit to native vegetation establishment over a cut-stump method (Reynolds and Cooper 2011).

Girdling and cutting trees can suppress growth but will not kill the plant if used alone as plants will resprout from the roots and crown or below the girdle or cut area (DiTomaso et al. 2013). Cutting trees in mid-summer, followed by mowing the resprouts in late summer, provides some control but it is labor intensive and costly (DiTomaso et al. 2013). Cutting trees before fruits mature can be combined with either burning the stumps or applying an herbicide in a cut stump treatment to give effective control.

Fire may kill small *Elaeagnus angustifolia* seedlings, but burning alone will not adequately control larger individual plants as they will vigorously resprout following the fire (Katz and Shafroth 2003). Stump burning of *E. angustifolia* has been successful but it is time-consuming compared to other techniques (DiTomaso et al. 2013). Prescribed burning can be used as a pretreatment for other control methods, particularly subsequent herbicide treatments to the resprouts or a basal bark treatment.

A combination of treatments will likely be the best approach to *Elaeagnus angustifolia* control. Dieter (1996 in Katz and Shafroth 2003) recommends pulling out small individual plants with a weed wrench when the soil is moist and then cutting larger individual plants at ground level and immediately applying a small amount of herbicide to the cut stems. Typically any initial control method will require at least some ongoing suppression of stem and roots sprouts and of new recruitment from seed (Edelen and Crowder 1997 in Katz and Shafroth 2003). The Yakama Nation has been controlling *E. angustifolia* for many years using a combination of treatments including late summer foliar sprays, winter dormant basal-bark applications, ripping out and grinding up plants and monitoring with follow-up treatments where necessary (Jason Newquist pers. comm.).

Biological Control:
There are currently no approved biological controls for *Elaeagnus angustifolia* (DiTomaso et al. 2013). The early stages of research to find a biological control agent for *E. angustifolia* are currently underway through CABI (Center for Agriculture and Biosciences International) (CABI 2013).

Chemical methods:
The Pacific Northwest Weed Management Handbook provides the following herbicide recommendations for *Elaeagnus angustifolia* as of 2013:

- 2,4-D LV ester: apply at a rate of 2 lb ae/acre when leaves are fully developed. It may take two to three annual re-treatments for complete control of plants.

- 2,4-D ester + triclopyr ester (Crossbow): apply at a 1.5% spray solution during active growth, after full leaf expansion and when moisture and temperature are favorable. This treatment can also be used in dormant stem and conventional basal applications. Retreatment may be necessary.

- Glyphosate: apply 2 cc (ml) per inch of trunk diameter, undiluted to frill cuts or a 5% solution applied to foliage after plants have fully leafed out, wetting foliage but not to the point of runoff.

- Imazapyr (Habitat/Arsenal): apply 2 cc (ml) per inch of trunk diameter, undiluted to frill cuts or a 0.75% solution of the 2 lb ai/gallon applied to foliage after plants have fully leafed out, wetting foliage but not allow spray to run off foliage.

In addition, DiTomaso et al. (2013) also recommend:

- Triclopyr: apply 1 to 2 qt product/acre (1 to 2 lb a.e./acre); addition of 7 oz product/acre of Milestone (aminopyralid) can improve control. Low volume foliar treatment of a 5% v/v solution of triclopyr and water plus 0.5% surfactant v/v to thoroughly wet all leaves.
    - Foliar treatment of resprouts: 25% Garlon 4 Ultra ((triclopyr ester) for the following two years. The best time to apply the herbicide is when plants are growing rapidly from May through September.
    - Basal cut stump treatment: 25 to 50% Garlon 4 Ultra in 50 to 75% oil carrier. Cut stems horizontally at or near ground level and apply herbicide solution immediately, covering the outer 20% of the cut face. Suckering from the roots typically occurs after cutting but the treatment should control most resprouts.
    - Cut stump treatments: undiluted Garlon 3A (triclopyr or triclopyr amine) or 50% Garlon 3A in water.
    - Basal bark treatment: 25% Garlon 4 Ultra in 75% oil carrier, or Pathfinder II (triclopyr ester, but only 0.75 lbs/gal formulation already mixed with oil) as a ready to use formulation. Spray the lower trunk, including the roots collar, to a height of 12 to 15 inches from the ground; the spray should thoroughly wet the lower stem but not to the point of runoff.
- Timing: Cut stump, basal cut stump and basal bark treatments can be applied as long as the ground is not frozen, but they are best applied in late summer or early fall, before leaf drop.

The Missouri River Watershed Coalition and the Center for Invasive Species Management are conducting herbicide trials that included Garlon 4 Ultra foliar application to young trees and basal cut stump or basal bark treatment depending on tree size. The study is also monitoring cover of native and non-native species and other invasive species that may colonize the site after treatment (Duncan 2013). They are also are researching into the feasibility of converting *E. angustifolia* to a biofuel (Duncan 2013). They are converting cut trees into fuels such as wood pellets. So far results show the ash content is too high to make residential wood pellets but there is potential to supply facility-scale heating boilers with biomass (Duncan 2013). To make this cost effective though, a processing facility is needed within 100 miles of the removal site.

Tordon can also be used as a foliar spray in some situations, keeping away from water and sensitive crops.

Please refer to the PNW Weed Management Handbook, available online at http://weeds.ippc.orst.edu/pnw/weeds for specific herbicide instructions, as herbicide recommendations may have changed since the time of this writing.

Economic Importance:

Detrimental:

Elaeagnus angustifolia invades riparian areas, forming monotypic stands or becoming a co-dominant species (Katx and Shafroth 2003). Riparian areas support diverse habitat types and contribute to a region's biodiversity (Naiman et al. 1993 and Naiman, Decamps 1997 and Sabo et al. 2005 in Reynolds and Cooper 2010). The abundance of *E. angustifolia* in riparian habitats leads to the replacement of native *Populus* (cottonwood) and *Salix* (willow) trees (Lesica and Miles 1999 in Madurapperuma et al. 2013).

Its broad tolerance of environmental conditions can allow *Elaeagnus angustifolia* to establish in conditions not suitable for native plant establishment. *Elaeagnus angustifoli*a can establish beneath the canopy of native riparian trees and form self-replacing stands. Reynolds and Cooper (2010) found *E. angustifolia* survival to be significantly higher in dense shade and low moisture conditions than native cottonwood and also tamarisk (another invasive species). *Elaeagnus angustifolia* can germinate and have seedlings survive in shade and in areas where flooding does not occur, allowing it to spread and invade further than its current distribution (Reynolds and Cooper 2010). Reynolds and Cooper (2010) found *E. angustifolia* establishing up to 8 meters above the stream channel in riparian zones where flooding cannot occur and soils only received precipitation.

Elaeagnus angustifolia may alter successional dynamics of riparian forests (Katz and Shafroth 2003). Much of the interior native riparian forests were dominated by native, pioneer species--primarily cottonwood and willow species—that rely on physical disturbance to create bare, moist patches for seedling establishment. These pioneer species are generally intolerant of shade and will not germinate or establish within shade. *Elaeagnus angustifolia* seeds can germinate and survive in shade and are also viable longer than *Populus* and *Salix* species (Reynolds and Cooper 2010, Katz and Shafroth 2003). In the absence of physical disturbance, riparian forests eventually succeed to non-forested communities such as prairie or sage brush steppe.

Riparian ecosystems exercise strong controls over flows of materials, energy and organisms between upland and stream ecosystems and invasive plant species are a key stressor to these systems (Ringold et al. 2008). *Elaeagnus angustifolia* may have important effects on ecosystem nutrient dynamics (DeCant 2008). Riparian areas of the interior western United States historically included native nitrogen-fixing plants, but *E. angustifolia* is now more common in these riparian habitats than the other native woody riparian nitrogen fixers (Friedman et al. 2005 in Shah et al. 2010). Along with being more common, *E. angustifolia* also has a higher nitrogen fixation capacity to all these other native woody riparian fixers except red alder (*Alnus rubra*) (Shah et al. 2010). A shift in *E. angustifolia* abundance leads to large increases in nitrogen inputs to riparian soils, though is unclear to what extent these inputs alter the riparian nitrogen budget—neighboring plants could take up the extra nitrogen or it could fertilize riparian soils (Shah et al. 2010). While neighboring plants might benefit from this increase in nitrogen, fertilization effects may limit the ability of riparian corridors to effectively buffer adjacent waterways from elevated nutrient loads (Shah et al. 2010). Increased soil nitrogen may augment nitrogen flux rates, which in turn may degrade water quality by increasing soluble NO_3-N (Shah et al. 2010).

Alterations in riparian vegetation could be the driver of major ecological change in arid streams, potentially shifting these ecosystems to an alternative stable state (e.g. Heffernan 2008, Ball et al. 2010 in Mineau et al. 2012). Riparian systems are often limited in nitrogen and the proliferation of nitrogen fixing plants like *Elaeagnus angustifolia* may have effects on community structure, productivity, and ecohydrology (Vitousek et al. 1987 and Yelenik et al. 2004 in Hultine and Bush 2011). Mineau et al. (2011) studied nutrient dynamics in streams and determined that the nitrogen fixation by *E. angustifolia* alters in-stream nutrient processing. Stream reaches invaded by *E. angustifolia* had higher organic nitrogen concentrations and exhibited reduced nitrogen limitation of biofilms. In another study, Mineau et al. (2012) found that stream riparian areas invaded with *E. angustifolia* increased allochthonous (leaf and plant parts) litter nearly 25-fold from un-invaded areas. This litter decayed more slowly than native willow, but there were no associated changes in stream ecosystem respiration or organic matter export. They calculated stream ecosystem efficiency (ration of ecosystem respiration to organic matter input) and found it decreased by 14%, but it is unknown if the system will persist in this state or if the aquatic community will eventually adapt to the new source of organic matter input from *E. angustifolia*.

DeCant (2008) conducted soil comparisons between cottonwoods with *E. angustifolia* as an undercanopy and cottonwoods without an undercanpy of *E. angustifolia*. Soils under *E. angustifolia* subcanopy are higher in nitrogen resources than soils that are not influenced by its presence. But while *E. angustifolia* does contribute soil nitrogen, it did not appear to augment the amount of foliar nitrogen in the mature cottonwoods, thus suggesting *E. angustifolia* is unlikely to promote mature cottonwood tree growth, and it may in fact compete with native cottonwoods for resources. Additional research needs to be done on how *E. angustifolia* may impact riparian and stream ecosystems.

Elaeagnus angustifolia infestations appear to reduce habitat for wildlife. Its fruits provide some food for wildlife but they are used to a lesser degree than native vegetation (DiTomaso and Healy 2007). Katz and Shafroth (2003) report on Brown's (1990) study comparing bird use of *Salix* and *E. angustifolia* habitats of similar structure along the Snake River in Idaho. In the winter season they found more foraging guilds in *Salix* than in *E. angustifolia* stands, but no other differences existed. In the breeding season, they found species richness, abundance and density were significantly greater in *Salix* than in *E. angustifolia* habitats and all foraging guilds avoided *E. angustifolia* (Brown 1990 in Katz and Shafroth 2003). In contrast, Fischer et al. (2012) conducted bird surveys along the Snake and Columbia Rivers in southeastern Washington that indicated riparian habitats dominated by *E. angustifolia* can support diverse and abundant bird communities, though this study did not compare plots with *E. angustifolia* to plots that were dominated by native vegetation. Cavity nesting species were noticeably sparse in *E. angustifolia* with only two woodpecker species detected during the breeding season and the only cavity nester with greater than 10 detections was the non-native European starling. In another study, *Elaeagnus angustifolia* and other non-native species removal in riparian habitat resulted in an increase in abundance for two native species of lizard and no significant decrease in four other native lizard species (Bateman et al. 2008). Additionally, native beaver rarely harvest *E. angustifolia* trees, and the severity of beaver damage was low compared to the mortality and damage inflicted to native cottonwood on the Marias, lower Yellowstone, Bighorn, and Milk rivers in Montana (Lesica and Miles 1999, Lesica and Miles 2004, Pearce and Smith 2001 in Zouher 2005).

Elaeagnus angustifolia may also alter fire regimes. It is noted that the presence of *E. angustifolia* in the understory creates a 'fuel ladder' for fire to reach the forest canopy (Ellis et al. 2002 in Shah et al. 2010).

Elaeagnus angustifolia can also invade into gameland and negatively impact agriculture by growing along edges of fields, damaging equipment and injuring people with their thorny stems (Tony Stadelman pers. comm.). Its stems can also make treating other noxious weeds a challenge. In Grant County Weed District #3 *Lepidium latifolium* (perennial pepperweed) grows under *E. angustifolia*, making this class B noxious weed hard to access (Tony Stadelman pers. comm.).

Image: Ornamental planting of *Elaeagnus angustifolia*, image Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Beneficial:
Elaeagnus angustifolia has been cultivated as a landscape tree and has been used in wind breaks (DiTomaso and Healy 2007). It has also been historically planted to prevent erosion of soils. Plants for our Future (2013) lists *E. angustifolia*'s medicinal uses as a fever reducer (febrifuge), as a food to reduce the incidence of cancer and reversing the growth of cancer, and as an electuary in the treatment of catarrh and bronchial affections.

Rationale for Listing:
Elaeagnus angustifolia is a nonnative, invasive species that appears to be an increasing problem in irrigation waterways, right-of-ways and around lakes in Grant County and possibly other eastern Washington counties. Currently, control is only required in Grant County Weed District #3. Listing it as a Class C noxious weed on the state list will increase awareness about the invasiveness of this species as well as provide education on best management practices. Adding it to the state noxious weed list would also give county weed boards the option to require control where it is a growing problem.

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