

SPECIES: *Elaeagnus angustifolia*

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INTRODUCTORY

SPECIES: *Elaeagnus angustifolia*

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AUTHORSHIP AND CITATION:

Zouhar, Kris. 2005. *Elaeagnus angustifolia*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2007, undefined 24].

FEIS ABBREVIATION:

ELAANG

SYNONYMS:

None

NRCS PLANT CODE [[187](#)]:

ELAN

COMMON NAMES:

Russian-olive

Russian olive

TAXONOMY:

The currently accepted name for Russian-olive is *Elaeagnus angustifolia* L. (Elaeagnaceae) [[46](#),[51](#),[74](#),[87](#),[93](#),[94](#),[98](#),[107](#),[161](#),[194](#),[197](#),[198](#)].

According to Vines [[191](#)] and Weber and Wittman [[197](#)], several varieties of Russian-olive are known in cultivation, and differ primarily in leaf size and shape [[191](#)].

One variety described in the western literature, *E. a. var. orientalis*, is treated as a separate species by Flora USSR (1949, as cited by [[9](#)]). Flora Europaea recognizes no varieties or hybrids of Russian-olive [[178](#)].

LIFE FORM:

Tree
Tree-shrub

FEDERAL LEGAL STATUS:

None

OTHER STATUS:

Russian-olive is classified as a noxious weed in Colorado and New Mexico [[189](#)].

DISTRIBUTION AND OCCURRENCE

SPECIES: *Elaeagnus angustifolia*

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GENERAL DISTRIBUTION:

Russian-olive is native to southern Europe and to central and western Asia [[114](#),[142](#)]. Within this region it occurs primarily on coasts, in riparian areas, and in other relatively moist habitats. It is also a component of several forest types, including mixed tamarisk-olive (*Tamarix-Elaeagnus*) forests, Russian-olive-dominated stands, cottonwood (*Populus* spp.)-Russian olive woodlands, and *Haloxylon* woodlands ([[96](#)] and references therein).

It is unclear when Russian-olive was initially introduced to North America, although its introduction as a horticultural plant was certainly intentional. Russian-olive has been cultivated for shade, hedges, wind- and snowbreaks, soil stabilization, wildlife habitat, landscaping, and to provide pollen for honeybees both in its native range and in North America [[16](#),[94](#),[96](#),[198](#)]. It was introduced to many of the Great Plains and

southwestern states by the early 1900s, and remained a cultivated landscape plant for many decades [41,177]. It was used extensively in windbreaks throughout the Great Plains in the 1930s and 1940s in association with government programs. As recently as the 1980s and 1990s, some state and federal agencies continued to subsidize distribution of Russian-olive seedlings in the U.S. and Canada [96,137].

Russian-olive became prominent outside cultivated areas in the western U.S. about 2 to 5 decades after it was introduced [41]. Most recommendations for planting are from the early 1900s, and escapes (or naturalization) are reported from the 1930s through 60s in Nevada, Arizona, New Mexico, Colorado, Idaho, Texas, and California ([41,67] and references therein).

Russian-olive now occurs throughout most of the U.S. including all western states but excluding most southeastern states. [Plants database](#) provides a state distribution map of Russian-olive. It is most problematic in the Southwest, Intermountain West, and Great Plains regions of the U.S. [52]. Olson and Knopf [138] give detailed Russian-olive distribution information for 17 western states as of 1986. While it is present in much of the central and northeastern U.S., it is generally described as only occasionally or rarely escaping cultivation ([96] and references therein). In Canada, Russian-olive occurs in all of the southern mainland provinces except Saskatchewan and Newfoundland [93]. It is reported to be spreading from cultivation in British Columbia, Alberta, Manitoba, and southern Ontario. Russian-olive was not considered a species of concern in Canada in 1996 (based on a national survey) [78]. There are no documented occurrences of Russian-olive in Mexico; however, suitable sites may exist in parts of the Sierra Madre of Chihuahua and Sonora ([96] and references therein). Russian-olive has also spread from cultivation in semiarid parts of South America [102].

The following lists include vegetation types in which Russian-olive is known or thought to be potentially invasive, based on reported occurrence and biological tolerances to site conditions. Because Russian-olive is most invasive in riparian areas in the western U.S., some upland habitats bordering vulnerable riparian areas are also included. Precise distribution information is limited in some areas, particularly in eastern North America; therefore, these lists may not be exhaustive.

ECOSYSTEMS [69]:

- FRES10 White-red-jack pine
- FRES15 Oak-hickory
- FRES17 Elm-ash-cottonwood
- FRES18 Maple-beech-birch
- FRES19 Aspen-birch
- FRES20 Douglas-fir
- FRES21 Ponderosa pine
- FRES22 Western white pine
- FRES23 Fir-spruce
- FRES28 Western hardwoods
- FRES29 Sagebrush
- FRES30 Desert shrub
- FRES32 Texas savanna
- FRES33 Southwestern shrubsteppe
- FRES34 Chaparral-mountain shrub
- FRES35 Pinyon-juniper
- FRES36 Mountain grasslands
- FRES37 Mountain meadows
- FRES38 Plains grasslands
- FRES39 Prairie
- FRES40 Desert grasslands
- FRES41 Wet grasslands

FRES42 Annual grasslands

STATES/PROVINCES: ([key to state/province abbreviations](#))**UNITED STATES**

AZ	CA	CO	CT	ID	IL	IA	KS	KY	ME
MD	MA	MI	MN	MO	MT	NE	NV	NJ	NM
NY	ND	OH	OK	OR	PA	RI	SD	TN	TX
UT	VA	WA	WI	WY					

CANADA

AB	BC	MB	NB	NS	ON	PQ	SK
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BLM PHYSIOGRAPHIC REGIONS [[14](#)]:

- 1 Northern Pacific Border
- 2 Cascade Mountains
- 3 Southern Pacific Border
- 4 Sierra Mountains
- 5 Columbia Plateau
- 6 Upper Basin and Range
- 7 Lower Basin and Range
- 8 Northern Rocky Mountains
- 9 Middle Rocky Mountains
- 10 Wyoming Basin
- 11 Southern Rocky Mountains
- 12 Colorado Plateau
- 13 Rocky Mountain Piedmont
- 14 Great Plains
- 15 Black Hills Uplift
- 16 Upper Missouri Basin and Broken Lands

KUCHLER [[105](#)] PLANT ASSOCIATIONS:

- K010 Ponderosa shrub forest
- K011 Western ponderosa forest
- K016 Eastern ponderosa forest
- K017 Black Hills pine forest
- K018 Pine-Douglas-fir forest
- K019 Arizona pine forest
- K022 Great Basin pine forest
- K025 Alder-ash forest
- K026 Oregon oakwoods
- K027 Mesquite bosques
- K030 California oakwoods
- K036 Mosaic of K030 and K035
- K045 Ceniza shrub
- K048 California steppe
- K049 Tule marshes
- K050 Fescue-wheatgrass
- K051 Wheatgrass-bluegrass
- K055 Sagebrush steppe
- K056 Wheatgrass-needlegrass shrubsteppe

K063 Foothills prairie
K064 Grama-needlegrass-wheatgrass
K065 Grama-buffalo grass
K066 Wheatgrass-needlegrass
K067 Wheatgrass-bluestem-needlegrass
K068 Wheatgrass-grama-buffalo grass
K069 Bluestem-grama prairie
K070 Sandsage-bluestem prairie
K073 Northern cordgrass prairie
K074 Bluestem prairie
K081 Oak savanna
K082 Mosaic of K074 and K100
K084 Cross Timbers
K085 Mesquite-buffalo grass
K098 Northern floodplain forest
K101 Elm-ash forest

SAF COVER TYPES [[65](#)]:

16 Aspen
20 White pine-northern red oak-red maple
21 Eastern white pine
46 Eastern redcedar
50 Black locust
63 Cottonwood
64 Sassafras-persimmon
68 Mesquite
87 Sweetgum-yellow-poplar
109 Hawthorn
211 White fir
217 Aspen
221 Red alder
222 Black cottonwood-willow
233 Oregon white oak
235 Cottonwood-willow
237 Interior ponderosa pine
241 Western live oak
242 Mesquite
246 California black oak
247 Jeffrey pine
249 Canyon live oak
250 Blue oak-foothills pine
255 California coast live oak

SRM (RANGELAND) COVER TYPES [[159](#)]:

101 Bluebunch wheatgrass
102 Idaho fescue
103 Green fescue
109 Ponderosa pine shrubland
110 Ponderosa pine-grassland
201 Blue oak woodland
202 Coast live oak woodland
203 Riparian woodland

214 Coastal prairie
215 Valley grassland
217 Wetlands
301 Bluebunch wheatgrass-blue grama
302 Bluebunch wheatgrass-Sandberg bluegrass
303 Bluebunch wheatgrass-western wheatgrass
304 Idaho fescue-bluebunch wheatgrass
305 Idaho fescue-Richardson needlegrass
306 Idaho fescue-slender wheatgrass
307 Idaho fescue-threadleaf sedge
309 Idaho fescue-western wheatgrass
310 Needle-and-thread-blue grama
314 Big sagebrush-bluebunch wheatgrass
315 Big sagebrush-Idaho fescue
401 Basin big sagebrush
402 Mountain big sagebrush
403 Wyoming big sagebrush
408 Other sagebrush types
409 Tall forb
411 Aspen woodland
413 Gambel oak
414 Salt desert shrub
418 Bigtooth maple
419 Bittercherry
420 Snowbrush
421 Chokecherry-serviceberry-rose
422 Riparian
601 Bluestem prairie
604 Bluestem-grama prairie
605 Sandsage prairie
606 Wheatgrass-bluestem-needlegrass
607 Wheatgrass-needlegrass
608 Wheatgrass-grama-needlegrass
609 Wheatgrass-grama
610 Wheatgrass
611 Blue grama-buffalo grass
612 Sagebrush-grass
613 Fescue grassland
614 Crested wheatgrass
615 Wheatgrass-saltgrass-grama
704 Blue grama-western wheatgrass
705 Blue grama-galleta
709 Bluestem-grama
710 Bluestem prairie
714 Grama-bluestem
717 Little bluestem-Indiangrass-Texas wintergrass
718 Mesquite-grama
724 Sideoats grama-New Mexico feathergrass-winterfat
731 Cross timbers-Oklahoma
732 Cross timbers-Texas (little bluestem-post oak)
802 Missouri prairie
803 Missouri glades

HABITAT TYPES AND PLANT COMMUNITIES:

The following description of habitat types and plant communities in which Russian-olive occurs is taken from examples found in the literature. The objective is to provide examples of vegetation types in which it occurs, and is not meant to imply that Russian-olive is restricted to these types within these areas. Most examples come from areas where Russian-olive is most widespread and most invasive. In some areas, particularly the eastern U.S., there is little to no information on vegetation types in which Russian-olive occurs.

In the **northwestern**

U.S., Russian-olive was introduced primarily for use in windbreaks and it has established outside of cultivation in several places [87]. In central Washington, where a sagebrush (*Artemisia* spp.) steppe site was transformed into a mitigation wetland, Russian-olive occurs with common cattail (*Typha latifolia*), bulrush (*Scirpus* spp.), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*) [89]. At Hanford in south-central Washington, several species of trees were planted as windbreaks and shade for irrigated farmland. Some of the more commonly occurring tree species include black locust (*Robinia pseudoacacia*), Russian-olive, cottonwood (*Populus* spp.), mulberry (*Morus* spp.), sycamore (*Platanus* spp.), and poplar (*Populus* spp.). Although introduced to this area, these trees now provide habitat for a variety of wildlife, including nest sites, and hiding and thermal cover. Some species (e.g., cottonwood, poplar, and Russian-olive) have established along the Columbia River and are considered by some as "functional components" of these riparian areas [116]. Russian-olive occurred throughout irrigated Kentucky bluegrass (*Poa pratensis*) and orchardgrass (*Dactylis glomerata*) pastures in southeastern Oregon [101].

Russian-olive occurs throughout **California**; however, no information was found describing native plant communities affected by Russian-olive. It occurs primarily in disturbed, sometimes moist places in the San Joaquin Valley, San Francisco Bay Area, eastern Sierra Nevada, Modoc Plateau, and parts of the Mojave Desert near springs [49,52,86]. It was used for mine spoil reclamation at a site supporting Jeffrey pine (*Pinus jeffreyi*), white fir (*Abies concolor*), and mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) dominants [31]. Russian-olive is most common in horticultural settings and interior riparian areas in California [32].

Russian-olive was planted as an ornamental in the **Intermountain** area, and has occasionally escaped onto roadsides and along lower elevation streams [46]. On wetland sites along the Yakima River in south-central Washington, thickets of Russian-olive have replaced stands of black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) and native willows (*Salix* spp.) [59]. Hansen and others [81] describe a Russian-olive community type in Montana. In the Rocky Mountains, foothills, and intermountain valleys, the Russian-olive community type represents seral stages of many different vegetation types including ponderosa pine/red-osier dogwood (*Pinus ponderosa*/*Cornus sericea*) and Rocky Mountain Douglas-fir (*Pseudotsuga menziesii* var. *glauca*)/red-osier dogwood habitat types. Isolated stands are found in western Montana, such as near Dillon, Thompson Falls, and in the Flathead Valley near the National Bison Range [81].

Russian-olive is widespread throughout the **Great Basin** [127] where it occurs in a variety of plant communities on a variety of site types. It is common and widespread throughout most of Nevada, in wet to damp sites of sagebrush deserts [94]. Hall and Hansen [79] describe an incidental Russian-olive community type that typically forms stringer communities on upper floodplain terraces adjacent to streams and rivers at the bottom of deep canyons at low elevations in southern and eastern Idaho. It may also be found in low depressional areas capable of retaining water near the surface for much of the year, especially potholes and abandoned river oxbows. Russian-olive stands in Idaho may be associated with black cottonwood in open communities with widely spaced individuals. The shrub component may be sparse or robust depending on local site factors, and may include willow, Wood's rose (*Rosa woodsii*), hawthorn (*Crataegus* spp.), and currant (*Ribes* spp.). Graminoids, particularly quackgrass (*Elymus repens*), foxtail barley (*Hordeum jubatum*), and Kentucky bluegrass, may dominate the herbaceous understory. The forb component is often poorly represented and includes bulrush and cattail (*Typha* spp.) on wet sites, and Rocky Mountain iris (*Iris missouriensis*) and Eaton's aster (*Symphyotrichum eatonii*) on drier sites. Hall and Hansen [79] report the canopy cover of various native and nonnative plant species recorded in mid- to late-seral stands of the Russian-olive community type in Idaho.

Knopf and Olson [103] describe a Russian-olive-dominated site along the Snake River where riparian vegetation is mostly dominated by black cottonwood, willow, and Wood's rose; and upland vegetation is dominated by big sagebrush (*A. tridentata*). The Russian-olive site consisted of mature Russian-olive, about 30 feet (10 m) tall, with canopy cover exceeding 80%. Cheatgrass (*Bromus tectorum*) and a few scattered shrubs such as black greasewood (*Sarcobatus vermiculatus*) and Wood's rose occurred in canopy openings and in the understory. A shallow wetland with cattails and bulrushes bordered the north side of the stand [103]. Along the middle Snake River, from Swan Falls Dam to the Idaho/Oregon border, Russian-olive and tamarisk make up approximately two-thirds of the tree species present. In this area Russian-olive occurs primarily with sandbar willow (*Salix exigua*), peachleaf willow (*S. amygdaloides*), and tamarisk in the zone 3 to 5 feet (0.8-1.4 m) above mean river level [55].

Russian-olive has escaped cultivation and established along drainages and in moist meadows over vast areas of Utah [198]. Christensen [41] describes it as a conspicuous part of the vegetation in pastures, along fences and ditch banks, and in moist lowlands in the valleys of central and northern Utah. A riparian site along the Uinta River in northeastern Utah supported a Russian-olive stand with about 50% canopy cover comprised of individuals mostly 16 to 20 feet (5-6 m) tall, with several mature trees up to 33 feet (10 m) tall. The understory was dominated by cheatgrass and forbs, especially mustards (*Brassica* spp.), and occasional alfalfa (*Medicago sativa*) plants. A native riparian site in the area was dominated by cottonwood associated with willows, scattered Russian-olive and occasional saltcedar (*Tamarix ramosissima* and/or *T. chinensis*). Upland vegetation in the area was dominated by big sagebrush, green rabbitbrush (*Chrysothamnus viscidiflorus*), cheatgrass, Indian ricegrass (*Achnatherum hymenoides*), and several forbs, especially desert princesplume (*Stanleya pinnata*) and lupine (*Lupinus* spp.) [103]. At Utah Lake, a comparison of infested and uninfested sites revealed that sites infested with Russian-olive also supported plant species typical of mesic meadows, especially perennial grasses. A variety of understory communities was associated with Russian-olive. Plant species consistently associated with Russian-olive include bearded wheatgrass (*Elymus trachycaulus* ssp. *subsecundus*), redtop (*Agrostis gigantea*), common ragweed (*Ambrosia artemisiifolia*), and tansyleaf aster (*Machaeranthera tanacetifolia*) [36]. In the Escalante River Basin in southern Utah, Russian-olive occurs with tamarisk, Fremont cottonwood (*Populus fremontii*), and willow [15].

Russian-olive is common throughout the **Southwest**, especially along rivers on the Colorado Plateau and other high elevation sites, including the Rio Grande and San Juan rivers [188]. It is well established and continues to spread in the Four Corners region [20]. Habitat and plant community information comes primarily from these areas, although individual or scattered occurrences are also indicated in other areas such as in critical desert tortoise habitat in the Mojave and Colorado deserts [21].

Dick-Peddie [50] describes a "successional-disturbance riparian" vegetation type in **New Mexico**, with 2 series. The Russian-olive series is most common in the northern part of the state, and the saltcedar series is more common in the southern part [50]. In a 130-mile (210 km) stretch along the Rio Grande River, in north-central New Mexico from Espanola to Bernardo, Russian-olive occurs within one of the most extensive gallery forests of Rio Grande cottonwood (*Populus deltoides* ssp. *wislizenii*) remaining in the Southwest, where Rio Grande cottonwood comprises over 93% of the canopy trees, and peachleaf willow and Goodding willow (*Salix gooddingii*) comprise the remainder of the canopy trees. Sandbar willow, Russian-olive, saltcedar, Great Plains false willow (*Baccharis salicina*), desert false indigo (*Amorpha fruticosa*), and New Mexico olive (*Forestiera pubescens* var. *pubescens*) are dominant understory shrubs. Desert grasslands, shrubland, residential areas, agricultural fields, and levee roads surround the woodland boundaries [91]. Along a more southerly stretch of the Rio Grande River, between Albuquerque and El Paso, Russian-olive is rare south of San Antonio, New Mexico. It occurs in communities dominated by cottonwood with Goodding willow and tamarisk as codominants; and in communities with a dense overstory of cottonwood and a separate stratum of Russian-olive and Goodding willow, with tamarisk present on adjacent, disturbed sites. Other plant species in these communities include desert false indigo, yerba mansa (*Anemopsis californica*) and sweetclover (*Melilotus* spp.), with no grasses [33].

Muldavin and others [128] describe a Russian-olive alliance that occurs in lowland regions of the Rocky

Mountains with detailed descriptions of its occurrence in New Mexico. In New Mexico, the alliance is widely distributed in the middle Rio Grande, Pecos, and San Juan river basins. Russian-olive stands are often represented by densely forested thickets, often with greater than 90% total canopy cover, and some scattered mature Rio Grande cottonwood in the canopy. The authors describe 4 provisional community types within the alliance (3 on the Middle Rio Grande, and 1 on the San Juan River) where Russian-olive is the dominant indicator species, and suggest that additional information is needed on the composition and ecology of these community types throughout the West. The Russian-olive/alkali sacaton (*Sporobolus airoides*) community type is an open-canopied woodland that often takes on a shrubland appearance due to mowing. Other common native wetland trees and shrubs in this type include Goodding willow, sandbar willow, and Great Plains false willow. Herbaceous cover is grassy and dominated by alkali sacaton and occasionally codominated by saltgrass (*Distichlis spicata*) and alkali muhly (*Muhlenbergia asperifolia*). Smooth horsetail (*Equisetum laevigatum*) is a common wetland forb in this community. The Russian-olive/sandbar willow community type has a dense canopy of Russian-olive with sandbar willow in the understory. Understory herbaceous species are variable, and often dominated by mesic forbs and grasses. In the Russian-olive/sparse community type, Russian-olive forms nearly impenetrable stands with scattered sandbar willow and saltcedar in the shrub layer and sparse undergrowth. Herbs are mostly represented by scattered bunches of grasses that may include purple threeawn (*Aristida purpurea*), saltgrass, Baltic rush (*Juncus balticus*), and alkali sacaton. These stands form as narrow strips ranging from 30 to 100 feet (10-30 m) wide along lowland riverbanks. Flood control structures such as jetty jacks are also present and may have influenced the establishment and maintenance of the community. The Russian-olive/redtop community type and is found on lowland river bars on the San Juan River in northwestern New Mexico. Shrubs are usually poorly represented in this community type, and may include sandbar willow or saltcedar. The herbaceous layer is dominated by the nonnative invasive grass redtop, with a wide variety of other mesic forbs and grasses. Wetland indicators in this type include field horsetail (*Equisetum arvense*), reed canarygrass (*Phalaris arundinacea*), common reed, common threesquare (*Schoenoplectus pungens* var. *pungens*), owlfruit sedge (*Carex stipata*), common cattail, and wild mint (*Mentha arvensis*) [128].

Russian-olive also codominates with Rio Grande cottonwood in several New Mexico riparian community types. On some sites, where absence of flooding may contribute to Russian-olive invasion, it forms a sprawling subcanopy under a dense, closed canopy of Rio Grande cottonwood. In the Rio Grande cottonwood-Russian-olive/New Mexico olive community type, Russian-olive reproduces under the dense canopy and may be replacing New Mexico olive on some sites. The Rio Grande cottonwood-Russian-olive/tamarisk community type is widespread in the middle Rio Grande and San Juan river basins, and is characterized by a mixed-tree canopy with Rio Grande cottonwood dominating the overstory and Russian-olive in the understory. Saltcedar is well represented to abundant, and dominates the shrub layer. Overall species diversity is poor in this community type [128]. Russian-olive also occurs in the subcanopy of the Rio Grande cottonwood/big sagebrush community type in the San Juan River Basin in northwestern New Mexico and probably adjacent Utah and Arizona. It may also reproduce and become invasive in the understory of Rio Grande cottonwood/Goodding willow communities in the Pecos and Rio Grande basins [128].

Similarly, in a cottonwood-Russian-olive type described by Hink and Ohmart (1984, as cited by [67]), Russian-olive formed a monotypic understory with herbaceous plants being sparse to absent. In the northern reaches of the Middle Rio Grande, a cottonwood/juniper (*Juniperus* spp.) type was characterized by an understory of juniper mixed with Russian-olive, New Mexico olive, threadleaf snakeweed (*Gutierrezia microcephala*), and rubber rabbitbrush (*Chrysothamnus nauseosus*). They also recognized a Russian-olive community type dominated by young to intermediate-aged Russian-olives interspersed among patches of young sandbar willow, cottonwood, saltcedar, and seepwillow (*Baccharis salicifolia*) with a dense herbaceous layer of mixed grasses and forbs (Hink and Ohmart 1984, as cited by [67]). A survey conducted by Mount and others [126] in 1995 indicates an increase in cover, height, and density of Russian-olive in the Middle Rio Grande over the 11 years since Hink and Ohmart's study. In the Gila River Valley in southern New Mexico, Russian-olive occurs both as isolated understory trees within riparian patches composed of Fremont cottonwood, Goodding willow, Arizona sycamore (*Platanus wrightii*), boxelder (*Acer negundo*), Arizona walnut (*Juglans major*), velvet ash (*Fraxinus velutina*), Great Plains false willow, and Arizona alder (*Alnus oblongifolia*); and in small

monotypic stands on the periphery of patches [168].

Russian-olive occurs throughout the **Great Plains**, but is most common in the western half of the region. Originally planted in shelterbelts, it is one of the hardiest species of trees introduced to the Great Plains and has persisted and spread in many areas, especially in the understory along rivers and streams [172,197]. Deserted homesteads in the Great Plains and the western slope of the Rocky Mountains are often recognizable by persisting windrows of Russian-olive trees [197].

Hansen and others [81] describe an Russian-olive riparian plant community type as an incidental type at low elevations on floodplains of the major rivers and streams in central and eastern **Montana**. Relatively large stands of this community type are found along the Yellowstone River and its major tributaries, along the Musselshell River near Roundup, in irrigated valleys around the Bowdoin National Wildlife Refuge near Malta, along the Milk River from Glacier National Park to Glasgow, along the Missouri and Sun rivers near Great Falls, and on the Charles M. Russell National Wildlife Refuge north of Lewistown [81]. About 500 Russian-olive saplings and seedlings were introduced directly to the Milk River in Montana and Alberta floodplain in 1950. Secondary growth has since formed thickets so dense that other riparian species have been excluded. Downstream from the point of introduction, Russian-olive and plains cottonwood (*Populus deltoides* ssp. *monilifera*) are scattered on the floodplain and commonly associated with Wood's rose, peachleaf and sandbar willow, buffaloberry (*Shepherdia* spp.), smooth brome (*Bromus inermis*), and Canada thistle (*Cirsium arvense*); while silver sagebrush (*Artemisia cana*), western wheatgrass (*Pascopyrum smithii*), and needle-and-thread grass (*Hesperostipa comata*) occupy the most elevated and driest sites on alluvial fans between the floodplain and valley slopes [140].

On many sites Russian-olive forms thickets such that it excludes most other species. Dense stands of Russian-olive tend to limit access by livestock. However, severe grazing can cause the understory to be dominated by nonnative herbaceous species such as Kentucky bluegrass and timothy (*Phleum pratense*). In stands that are somewhat open, associated species may include widely scattered plains cottonwood, green ash (*F. pennsylvanica*), boxelder, peachleaf willow, narrowleaf cottonwood (*Populus angustifolia*), and/or an assortment of grasses and forbs [81]. Adjacent upland or drier sites may be dominated by the silver sagebrush/western wheatgrass habitat type and a variety of upland species. Wetter sites may be dominated by common cattail, bulrushes, spikerushes (*Eleocharis* spp.), or common reed habitat types, or by peachleaf willow or sandbar willow community types [81,113]. Cottonwood forests may be hundreds of meters wide in meandering reaches of the rivers [113]. Russian-olive also occurs in riparian plant communities dominated by green ash, chokecherry, plains cottonwood, red-osier dogwood, western snowberry (*Symphoricarpos occidentalis*), and Wood's rose in Montana. In the northern Great Plains, the Russian-olive community type may represent a seral stage of the green ash/chokecherry (*Prunus virginiana*) habitat type or the boxelder/chokecherry habitat type [81].

At the confluence of the Knife and Missouri rivers in north-central **North Dakota**, native forest sites are composed of plains cottonwood (73.9% of the density), and peachleaf willow (24.2%), with 1.9% Russian-olive, which occasionally invades openings within these forests [42]. At Nature Conservancy preserves in **Minnesota**, Russian-olive occurs in tallgrass prairie sites (especially those that are grazed or otherwise disturbed), riparian areas, and savannas. Here it may affect threatened species such as western prairie fringed orchid (*Platanthera praeclara*), grape fern (*Botrychium* spp.), small white lady's slipper (*Cypripedium candidum*), Hill's thistle (*Cirsium hillii*), greater prairie-chicken, dakota skipper, and upland sandpiper [148].

Russian-olive cuttings planted on surface-mined reclamation areas in **Wyoming** had good survival in plant communities dominated by western wheatgrass, bluebunch wheatgrass (*Pseudoroegneria spicata*), needle-and-thread grass, blue grama (*Bouteloua gracilis*), Sandberg bluegrass (*Poa secunda*), big sagebrush, Saskatoon serviceberry (*Amelanchier alnifolia*), Gambel oak (*Quercus gambelii*), quaking aspen (*Populus tremuloides*), snowberry (*Symphoricarpos* spp.), chokecherry, and mountain brome (*Bromus marginatus*). Sites with poor Russian-olive survival (0 to 40%) were dominated by more xeric species, such as bottlebrush squirreltail (*Elymus elymoides*), rabbitbrush (*Chrysothamnus* spp.), basin wildrye (*Leymus cinereus*), shadscale

(*Atriplex confertifolia*), Gardner's saltbush (*A. gardneri*), and winterfat (*Krascheninnikovia lanata*) [90].

Russian-olive occurs mostly on low ground along streams or valleys and scattered in agricultural areas of **Colorado**, probably originating from cultivated plants [83]. On a study site northwest of Milliken, Russian-olive occurs in a stand with canopy cover of about 40% and trees 16 to 26 feet (5-8 m) tall. Cheatgrass, Canada thistle, and stinging nettle (*Urtica dioica*) dominate the understory, and a few small Siberian elm (*Ulmus pumila*) are also present. Along the south side of the Big Thompson River, on a site characterized by an overstory of plains cottonwood and an understory primarily of grasses, with common cattail, bulrushes, and willows present in small numbers, scattered Russian-olive occurs infrequently on drier microsites away from the main river channel [103].

Russian-olive is considered a dominant indicator species on the Platte River in **Nebraska** [47]. Here its average canopy cover is 12.3% to 24.5% and it typically codominates with plains cottonwood. In Russian-olive/plains cottonwood vegetation types, important understory species include common ragweed, sedges (*Carex* spp.), saltgrass, and Kentucky bluegrass. Plains cottonwood/Russian-olive vegetation types tend to occur on drier somewhat upland sites, and are characterized by an overstory of large plains cottonwood and an dense understory of Russian-olive, green ash, and Missouri River willow (*Salix eriocephala*). Understory shrubs are infrequent, but in a few locations roughleaf dogwood (*Cornus drummondii*) is an important component. Russian-olive occurs, with an average of 6.2% cover, in plains cottonwood/eastern redcedar (*J. virginiana*) communities associated with riverbank grape (*Vitis riparia*), Wood's rose, green ash, and desert false indigo with Kentucky bluegrass and poison-ivy (*Toxicodendron radicans*) as major herbaceous species. It occurs in cottonwood shrub communities with 2.2% cover. In some areas along the Platte River, Russian-olive forms dense, nearly monospecific stands [47].

Along the Arkansas river in western **Kansas**, Russian-olive occurred with skunkbush sumac (*Rhus trilobata*), desert false indigo, and green ash on some sites [73].

There is very little information on Russian-olive's occurrence in the **eastern** U.S. Russian-olive is grown as an ornamental in the northeast [16]; however, reports of its occurrence in natural communities are rare. On Hempstead Plains in Uniondale, New York, Russian-olive occurs with other woody species such as eastern white pine (*Pinus strobus*), black cherry (*Prunus serotina*), and shining sumac (*Rhus copallina*) among small pockets of native plant communities dominated by bluestems (*Schizachyrium scoparium*, *Andropogon virginicus*, and *A. gerardii*), switchgrass (*Panicum virgatum*), indiagrass (*Sorghastrum nutans*), yellow sedge (*Carex pensylvanica*), and staggerbush (*Lyonia mariana*) [131]. In Virginia, Russian-olive occurs in mesic environments, in sun or part shade, on coastal plain, piedmont, and mountain sites [192].

In **Canada**, Russian-olive is often planted as an ornamental in Nova Scotia [150], and is "frequently planted and fairly hardy" in all but northern parts of Ontario [161], but there is no information available regarding its distribution in native plant communities.

Russian-olive community types are described in the following publications:

Montana [81]

southern and eastern Idaho [79]

New Mexico [128]

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: *Elaeagnus angustifolia*

- [GENERAL BOTANICAL CHARACTERISTICS](#)

- [RAUNKIAER LIFE FORM](#)
- [REGENERATION PROCESSES](#)
- [SITE CHARACTERISTICS](#)
- [SUCCESSIONAL STATUS](#)
- [SEASONAL DEVELOPMENT](#)

GENERAL BOTANICAL CHARACTERISTICS:

This description provides characteristics that may be relevant to fire ecology, and is not meant for identification. It is based on descriptions from syntheses, literature reviews ([[16,49,96,172](#)]), and floras ([[46,74,86,94,115,161,196,198](#)]). Keys for identification are available (e.g. [[46,74,87,94,98,198](#)]).

Russian-olive can resemble some willow species with light green foliage, particularly sandbar willow.

However, unlike Russian-olive, willows have inconspicuous flowers on erect stalks and small, wind-dispersed seeds [[52](#)]. It is important to be certain of identification before control measures are begun. In the eastern United States, Russian-olive may be confused with another nonnative invasive tree, autumn-olive (*Elaeagnus umbellata*). Mehrhoff and others [[119](#)] provide a descriptive comparison to distinguish these species.

Russian-olive is a perennial, tree or large multi-stemmed shrub. It has dark, smooth and sometimes shredding bark. Its branches are flexible and often armed with coarse thorns. Russian-olive is described as between 16 and 40 feet (5-12 m) tall, with trunks 4 to 20 inches (10-50 cm) thick. Borell [[16](#)] describes unpruned Russian-olive trees with 5 to 6 main stems starting near the ground and growing 12 to 20 feet (4-6 m). He suggests that if pruned to 1 stem, Russian-olive on good soil with plenty of water can grow to 40 feet (12 m) tall [[16](#)]. Field observations of naturalized Russian-olive in Montana indicate that it frequently branches at ground level, about 4 to 8 inches (10-20 cm) above the root crown in moist, unshaded sites; and branches further above ground level in drier, shaded habitats [[112](#)].

Russian-olive is deciduous, with alternate, petiolate leaves in small lateral clusters on twigs of the current year. Shape and vesture of Russian-olive leaves varies among individuals and within the canopy of single trees [[102,196](#)]. Descriptions of Russian-olive leaf size range from 0.8 to 4 inches (2-10 cm) long and 0.4 to 1.6 inches (1-4 cm) wide, and leaf shape is generally described as lanceolate to oblong and sometimes elliptic. Russian-olive produces fragrant flowers, 3-12 mm long, in small axillary clusters on the twigs of the current year. Fruits are drupe- or berry-like, oval-shaped, 0.4 to 0.8 inch (1-2 cm) long. A single, relatively large, 6-13 mm, oblong achene is enclosed in the fleshy fruit.

Roots:

There are few descriptions of Russian-olive's root system in the literature. It is generally described as extensive [[172](#)] or deep, with many well-developed laterals. In deep soil with a calcareous clayey subsoil and water table below 15 feet (5 m), a 25-year-old, 26-foot-tall (8 m) Russian-olive had roots as long as 39 feet (12 m). A measure of root distribution by depth indicated that 23.4% of roots were in the 1st foot of soil, 26.5% in the 2nd foot, 31.6% in the 3rd foot, 18.3% in the 4th foot, and roots were rare below 4 feet (1.2 m) [[203](#)].

Depending on location and site conditions, Russian-olive roots sometimes associate with nitrogen-fixing bacteria (*Frankia* spp.) [[117,149,179,206](#)]. Cross-inoculation assays of *Frankia* isolates indicate that *Frankia* strains that infect Russian-olive may also infect plant species in the Rhamnaceae and Betulaceae families [[17,40](#)]. Because Russian-olive has been a common nursery plant, the scientific literature is rich with information on *Frankia* symbiosis and nitrogen fixation in Russian-olive, but this topic is beyond the scope of this review.

Growth habit/stand structure:

Russian-olive's growth habits (e.g. stem and foliage density, canopy cover) seem to vary between plant communities in which it occurs, and depend on size and age of associated species, as well as history of disturbance of the site. In many sites Russian-olive grows in dense thickets with close spacing [[16,47,59,81,140,168](#)], sometimes with scattered mature cottonwood in the canopy [[128](#)]. On some southwestern riparian sites, dense, nearly monotypic stands of tamarisk and/or Russian-olive form a nearly

continuous, closed canopy with no distinct overstory layer. Canopy height generally averages 16 to 33 feet (5-10 m), with canopy density uniformly high. The lower 6.5 feet (2 m) of vegetation often contains a tangle of dense, often dead, branches. Live foliage density may be relatively low from 0 to 6.5 feet (2 m) above ground, but increases higher in the canopy ([188] and references therein). Russian-olive may also grow as scattered individuals or groups under a canopy of mature riparian vegetation (e.g., [47,100,128,168]) or in mixed stands of varying canopy height and density (e.g., [100,128]).

Katz and Shafroth [96] present the following table describing density and cover of several established Russian-olive populations in western North America:

River or Location	Density (plants/ha)	Cover (%)	Source
Rio Grande, NM	52-357 ^a	N/A	Freehling 1982
Rio Grande, NM	0-566 ^b	0-43.3	Hink and Ohmart 1984
Rio Grande, NM	N/A	11.1-34.8	[91]
Chinle Wash, AZ	430-1150 ^c	25-78	[20]
Duchesne R., UT	N/A	50	
Milliken, CO	N/A	40	[103]
Arikaree R., CO	0.7-225.2	N/A	
S. Fk. Republican R., CO	4.3-314.3	N/A	[97]
Platte R., NE	N/A	2.2-24.5	[47]
Marias R., MT	20-760 (avg. 186)	N/A	
Yellowstone R., MT	20-5,120 (avg. 676)	N/A	[112]
Snake R., ID	N/A	80	[103]
Snake R., ID	940	81.2	[25]
Snake R., ID	0-55	N/A	[55]

a Only individuals >8cm diameter at breast height and >2 m tall sampled

b All individuals sampled

c Estimated from figure

RAUNKIAER [146] LIFE FORM:

[Phanerophyte](#)

[Geophyte](#)

REGENERATION PROCESSES:

Russian-olive reproduces by seed and postinjury sprouting.

Breeding system: Flowers are [perfect](#), or some are staminate [46,86,172,198].

Pollination: Fragrant yellow flowers are produced in spring and are insect pollinated [52,96].

Seed production:

It is generally stated that Russian-olive produces a large amount of seed, but nothing quantitative was found in the literature. According to Borell [16], the age at which Russian-olive produces its 1st seed crop varies with latitude, but seedlings typically produce fruit about 3 to 5 years after transplanting. Lesica and Miles [112] recorded the ages of fruit-bearing Russian-olive on the Marias and Yellowstone rivers in Montana. None of the Russian-olive trees sampled on the Marias River under age 5 produced fruit, while all trees over age 14 fruited. On the Yellowstone River only 1 of 38 plants \leq 6 years old fruited in 1998. Fruiting generally began at 7 to 10 years of age, and 89% of Russian-olive over 10 years old produced fruit. These results suggest the average age

of 1st reproduction for Russian-olive on both rivers is around 10 years [112].

Seed dispersal:

Most Russian-olive fruits remain on trees until distributed by animals, especially birds, mostly during the fall and winter. Seed may also be dispersed by water or ice.

Several bird species consume Russian-olive fruit [16,47,138], and at least some are known to defecate viable seed [101]. For example, European starlings are effective dispersers of Russian-olive in southeastern Oregon and may have contributed substantially to its spread there. Kindschy [101] observed large flocks of European starling foraging throughout the winter on Russian-olive fruit in irrigated grass meadows in southeastern Oregon. The starlings then roosted in larger trees such as black cottonwood and Siberian elm, dispersing Russian-olive seed below. When tested, there was no significant loss of viability ($P < 0.05$) in seeds that passed through the digestive tract of starlings [101].

Fruit loosened by wind or feeding birds may also fall to the ground [16] where other vertebrates consume and cache Russian-olive fruit (personal observations cited by [96,113,138]), sometimes up to 500 feet (150 m) from the original sources (F. Johnson personal communication, as cited by [138]). While DiTomaso and Healy [52] indicate that Russian-olive seeds survive ingestion by animals, the only experimental evidence of this is from Kindschy's study [101] of European starlings. Lesica and Miles [113] observed raccoons eating Russian-olive fruits and dispersing seed in their feces, although viability of these seeds was unknown.

Russian-olive seed may also be dispersed by fluvial transport [20,96,113,140]. Lesica and Miles [113] indicate that ripe fruits will float for up to 48 hours. Additionally, observations and evidence presented by Pearce and Smith [140] suggest seed dispersal by water and ice transport, although this was not tested directly and is not documented elsewhere in the literature.

Seed banking: Russian-olive seed stored under "ordinary" conditions remains viable for up to 3 years [136], but seed longevity in the field is undocumented [52]. Russian-olive seeds are dispersed during the late fall and winter in a dormant state and require a period of after-ripening to break dormancy [80,88]. Several researchers have studied Russian-olive seed dormancy (see [Germination](#)); however, exact mechanisms of dormancy are unknown.

If seeds retain viability for a long period, Russian-olive may be able to exploit suitable germination conditions over a relatively long time compared to native taxa with which it commonly associates. Success of Russian-olive may be due, in part, to its ability to germinate whenever conditions at a particular site become suitable [156]. More research is needed to determine longevity of Russian-olive seed banks.

Germination:

Russian-olive seeds are hard and dormant at maturity and require a period of cool, moist stratification, or possibly scarification, for germination.

Laboratory tests indicate that a period of 2 to 3 months at around 41 °F (5 °C) under moist conditions is required to break Russian-olive seed dormancy [88,176,200]. Dormancy appears to be related to inhibitors found in all parts of Russian-olive seeds [80,88,92]. Activity of the inhibiting substance was not reduced by low temperatures; however, an uncharacterized substance that may reverse inhibition was produced after exposure to low temperatures. Activity of the inhibiting substance was also reversed by gibberellic acid and kinetin [80]. Jinks and Ciccarese [92] found that 6 days of washing before prechilling, or warm, moist stratification for 4 weeks (without prechilling) improved germination, suggesting that the inhibitor is somewhat water-soluble [92].

It has been suggested that scarification may improve germination rates of hard-coated Russian-olive seeds [20,52]. Laboratory tests indicate that dormancy is broken by soaking in sulfuric acid [200], (Heit 1967, as cited by [92]). The dormancy period was reduced in cleaned seed compared to that of dry fruits [136], suggesting that digestion of fruits may also break dormancy.

Some reviews indicate that Russian-olive seeds germinate in many soil types and over a variable period of time, depending on site conditions [52,103], and that Russian-olive seeds germinate under a broader range of conditions than seeds of native willow and cottonwood associates [52]. In greenhouse experiments, Shafroth and others [156] found that Russian-olive seeds germinate under a wide variety of moisture conditions at different times of the growing season, and that seed germination varies under different treatment combinations of light and elevation above groundwater. Russian-olive seedlings suffered little to no mortality following germination [156].

Seedling establishment/growth:

Observational and experimental evidence indicates that Russian-olive seedlings can establish on disturbed sites in full sun (e.g. [2,112]), in shade, or within intact groundcover. These nonspecific establishment requirements confer an advantage on Russian-olive over associated native species that require full sun and disturbance for establishment [52,96] (see [Successional Status](#)).

Older stands of Russian-olive in Montana generally have plants of many ages, indicating that infrequent disturbance events are not required for recruitment [112]. Katz and others [95] found that seedlings of Russian-olive established within dense, undisturbed herbaceous vegetation on experimental plots, while those of cottonwood did not. Kindschy [101] observed Russian-olive growing throughout irrigated Kentucky bluegrass and orchardgrass pastures in southeastern Oregon. The author suggests that the large seed of Russian-olive contains sufficient food resources to enable sprouting roots to penetrate sod to mineral soil and thus establish in these areas [101].

DiTomaso and Healy [52] indicate that Russian-olive seedlings can survive under a canopy of mature willows and cottonwoods and then grow quickly when the loss of a tree creates an opening in the canopy, although the source of this information is not given. Conversely, willow and cottonwood seedlings seldom survive under a canopy of Russian-olive trees. Shafroth and others [156] found that artificial shade decreased growth of plains cottonwood seedlings more than Russian-olive seedlings in experimental planters but that there was no effect on seedling survival of either species. Russian-olive's ability to establish in the shade may vary with latitude [16,72] (see [Site Characteristics](#)).

Russian-olive growth may be independent of many environmental variables. Lesica and Miles [112] measured Russian-olive recruitment and growth rates in 46 stands on the Marias and Yellowstone rivers in Montana. Russian-olive recruitment rate per mature tree in 46 stands varied from 0 to 4.07 recruits/year, with a mean of 0.69 recruits/year. There was no difference in recruitment rate between the Marias and Yellowstone rivers. There was no significant relationship between recruitment rate and tall-tree canopy cover ($r^2=0.006$, $P=0.61$). There was also no relationship between Russian-olive recruitment rate and associated understory vegetation; nor between recruitment rate and elevation above September river levels for either the Marias or Yellowstone rivers [112].

Growth: Russian-olive is said to have a slow [81] to rapid [16] growth rate. There is little experimental evidence to support these observations; however, growth rate probably varies with site conditions such as temperature, moisture, and light availability, as well as plant age.

In warm areas, Russian-olive seed planted in spring will produce bushy plants 2 to 3 feet (0.6-0.9 m) tall in the 1st season. Under "good" conditions, nursery transplants may reach 4 to 5 feet (1.2-1.5 m) in the 1st year, and 8 to 12 feet (2-4 m) in the 2nd year [16]. Borell [16] suggests that under dry land conditions in the Great Plains, Russian-olive's growth rate is probably half that. Under "prevailing climatic conditions" in the northern Great Plains, planted Russian-olive averaged 12.8 feet (4 m) tall after 10 years with 96% survival, and averaged 16 feet (5 m) tall after 44 years, with 51% survival [72]. On abandoned farm land in Michigan, planted Russian-olive was 17 feet (5 m) tall, with 83% survival after 16 to 18 years [77]. Growth rate was negatively associated with height above the September river level for both the Marias ($r^2=0.20$, $P=0.028$) and Yellowstone ($r^2=0.18$, $P=0.012$) rivers in Montana. There was no relationship between growth rate of Russian-olive and composition of understory vegetation, although there was a significant negative relationship between

Russian-olive growth rate and cottonwood canopy cover ($r^2=0.06$, $P=0.002$, $n=153$) [112].

Lesica and Miles [112] found that growth rate (measured by height) of Russian-olive increased with age over all age classes on riparian sites on 2 rivers in Montana. Growth rate varied between 0.1 and 2.7 cm/year with a mean of 0.8 cm/year, and was not different between the 2 rivers when corrected for age. Recruitment and growth were not affected by stand age as reflected by understory vegetation; however, growth, but not recruitment, was greater on lower sites closer to alluvial groundwater [112]. Rankings for biomass production, short- and long-term revegetation potential, and erosion control potential provided by Hansen and others [81] also suggest that Russian-olive's growth rate increases with age. They also suggest that Russian-olive produces a relatively high yield of dry plant material and is relatively persistent.

Asexual regeneration: It has been suggested that Russian-olive spreads by "underground rootstalks" [18]; however, there is no evidence in the literature that indicates that Russian-olive spreads by asexual reproduction under field conditions, except following injury or top-kill. According to Williams and Hanks [200] Russian-olive can establish by layering, and it is propagated by stem and root cuttings and by grafting for horticultural purposes [200]. Brock [20] observed Russian-olive branches that were covered with sediments had numerous adventitious roots on buried stem portions. The occurrence of Russian-olive establishment from stem or root pieces in the field is unclear.

Several workers report that Russian-olive sprouts from the trunk, root crown, and/or roots after top-kill or damage [34,49,52,59,112,140,148,172], and some report sprouting from roots and root crown following fire [35,201]. There is no information in the literature specifically addressing asexual regeneration in Russian-olive after fire.

SITE CHARACTERISTICS:

Russian-olive is native to temperate areas of Eurasia, and is adapted to the general climatic conditions that characterize much of interior western North America. Within this region Russian-olive is most invasive in semiarid riparian habitats, moist and/or irrigated pastures and meadows [41,103], and other wet or disturbed microsites such as old fields and road ditches [148]. Russian-olive's success on riparian sites may be due to its ability to tolerate a broad range of soil alkalinity, salinity, and moisture availability, and to its relative lack of specialization with respect to fluvial processes compared to native riparian species [96].

General climate: Russian-olive's primary distribution is throughout the western US, from the Pacific coast as far east as Minnesota and Kansas, and from Canada to Mexico. In this area it withstands temperatures ranging from -50 °F to 115 °F (-45 to 46 °C). Although untested, George [72] reports considerable variability in winter hardiness, depending on fall soil moisture conditions, for Russian-olive in the northern Great Plains. Large Russian-olive trunks are sometimes broken by gusty winds or drifted snow [72]. On rivers in the northern Great Plains, Russian-olive may be killed by winter ice flows [140]. According to DiTomaso and Healy [52], Russian-olive grows best in inland areas with warm summers and cold winters

In providing guidelines for growing Russian-olive, Borell [16] suggests that in areas with less than 15 inches (380 mm) mean annual precipitation (MAP), irrigation will help growth, but that Russian-olive will grow in areas with as little as 12 inches (305 mm) of precipitation. Russian-olive cuttings planted on reclaimed surface-mined sites in Wyoming had good survival rates where mean annual precipitation (MAP) ranged from 12 to 16 inches (295-402 mm). Sites with poor Russian-olive survival rates had similar site characteristics; however, MAP was 9 to 11 inches (235-271 mm) [90].

Russian-olive's ability to thrive under climatic conditions in the eastern US is less clear. According to Borell in 1971 [16], Russian-olive is grown as an ornamental in the northeast, but has not been successful in windbreak or wildlife plantings in that region, and it has been used little in the southeast. However, the USDA, Forest Service, Eastern Region ranks Russian-olive as "highly invasive", based on information from lists, botanists, and ecologists from 15 of the 20 states in that region [183]. Additionally, the Forest Service, Southern Region [184] and the Virginia Department of Conservation and Recreation [192] include Russian-olive on their lists of

potentially invasive species (see [Impacts](#)).

Landscape type/land use:

Russian-olive is often found in wildlands and natural areas where there are nearby or adjacent wildlife tree plantings or shelter belts that have Russian-olive in them. Sites supporting escaped Russian-olive are typically seasonally moist pastures, wetland margins, floodplains, riverbanks, shores, irrigation ditches, overflow channels, roadsides, fencerows and other disturbed sites [[52,56,57,82,115,148,194](#)]. On the Platte River in Nebraska, Russian-olive establishment is generally associated with intensively grazed wetland meadows characterized by intermittent flooding and sandy loam and silty clay soils [[47](#)]. In north-central New Mexico Russian-olive is highly invasive in lowland valley floodplains, and is typically found on streambanks and bars of rivers with highly altered hydrological regimes [[128](#)]. Russian-olive sometimes also dominates in late-successional, declining cottonwood forests on regulated rivers in New Mexico [[33,91,128](#)], Montana [[2,112,140](#)], and other western states [[103](#)].

Russian-olive also occurs along free-flowing rivers, such as the narrow bedrock canyons of the Escalante River Basin in southern Utah [[15](#)], unregulated reaches of the Yellowstone [[112](#)], the Milk, and other rivers [[140](#)] in Montana. Interestingly, Russian-olive does not always occur at the expense of native species on these unregulated rivers. Both native and nonnative species are well-represented, and native species are dominant on many sites in the Escalante Basin [[15](#)]. Similarly, where Russian-olive occurs on the upper reaches of the Yellowstone River, flooding and new channel development continuously create new cottonwood habitat [[112](#)].

Elevation/Latitude: Borell [[16](#)] reports that Russian-olive occurs from sea level to at least 8,000 feet (2,400 m) in the western U.S. Other elevations of occurrence reported by area are as follows:

Location	Elevation	References
AZ	up to 5,500 feet (1,680 m)	[98]
CA	generally < 5,000 feet (1,500 m)	[86]
CO	4,500 to 6,500 feet (1,370-1,980 m)	[83]
ID	3,000 to 4,420 feet (909-1,340 m)	[79]
MT	2,100 to 3,400 feet (640 to 1,036 m)	[81]
NV	2,600 to 6,000 feet (790-1,830 m)	[94]
NM	4,775 to 5,450 feet (1,460-1,660 m)	[128]
WY	4,500 to 7,500 feet (1,370-2,290 m)	[90]
Grand Canyon region	1,850 to 3,100 feet (560-950 m)	[165]

Shade tolerance, reproduction, growth, and recruitment rates for Russian-olive may vary with latitude, making it less invasive, or slower to invade at the upper and lower latitudinal limits of its North American range. While Russian-olive is frequently planted and "fairly hardy" in all but northern parts of Ontario [[161](#)], it may not be invasive at that latitude. Lesica and Miles [[112](#)] found that most Russian-olive invasions in eastern Montana occur over a period of several decades and suggest that Russian-olive may be more invasive in warmer parts of semiarid western North America. Similarly, George [[72](#)] suggests that Russian-olive does not thrive in shade in the northern Great Plains, and Borell [[16](#)] states that Russian-olive requires full sun for fruit production in "the north", but can produce fruit in the shade of large cottonwood trees in the southwest. In the Southwest, Russian-olive is most invasive in north-central New Mexico, northern Arizona, Colorado, and Utah [[16](#)]. It is not widely established in the hot deserts south of the Mogollon rim in Arizona [[20](#)], and occurs only as scattered plants along the edge of the Rio Grande River south of San Antonio, New Mexico [[33](#)].

Soils:

Russian-olive thrives on a wide range of soil types and textures. Soils supporting Russian-olive are commonly Mollisols or Entisols, with textures ranging from clay loam to sand, with varying amounts of coarse fragments (e.g. [[79,128](#)]).

Soil moisture: Several reports indicate that Russian-olive favors sites with moderate to high soil moisture [36,37,47,147], and does poorly on dry sites [37,112,147]. Russian-olive was the only woodland type found on poorly drained soils on the Platte River in Nebraska [47]. Conversely, drought tolerance is part of the horticultural appeal of Russian-olive in some areas ([96], and references therein). In a central Illinois study, for example, Russian-olive survived and grew better on an upland site compared to a bottomland site [48].

Other reports indicate Russian-olive occurrence on seasonally wet sites, on a wider or intermediate range of soil moisture conditions, or at an intermediate elevation above mean river level [33,52,55,79,103,128]. For example, Russian-olive did not occur in alluvial bar sample plots on the Marias River in Montana, and was found at low density on only 2 alluvial bar plots on the Yellowstone River [112]. On young, moist terraces on these rivers, Russian-olive occurred with and without a cottonwood canopy; however, it did not occur outside a cottonwood canopy on the upper, dry terraces. The authors suggest that occurrence of Russian-olive only in riparian forests on upper terraces may be due to facilitation by the cottonwood canopy making a cooler, more humid microclimate, and/or cottonwood acting as a hydraulic pump, bringing water from the water table to the upper rooting zone ([112] and references therein). Once Russian-olive is present on these high terraces, it appears to persist after overstory cottonwoods die. In the absence of Russian-olive, many such sites would be dominated by sagebrush steppe following cottonwood senescence [112].

In New Mexico and Montana Russian-olive is classified as a facultative wetland plant - one that usually occurs in wetlands but is occasionally found in nonwetlands [81,128]. As a facultative phreatophyte, Russian-olive avoids drought stress by tapping into ground water ([96] and references therein). Russian-olive is generally reported to occur on sites where the water table is 2 to 6 feet (0.6-1.8 m) below the surface for at least part of the growing season [16,79,128]. Shafroth and others [156] found that the lowest numbers of both Russian-olive and cottonwood seedlings survived when groundwater levels were farthest from the soil surface. Compared to many native riparian trees in western North America, Russian-olive may have more drought adaptations that compensate for its relatively small root mass, including reflective silvery foliage, a relatively thick cuticle, and sunken stomata ([96], and references therein). Additionally, Klich [102] argued that morphological and anatomical leaf variation within individual Russian-olive canopies constitutes an adaptive advantage in semiarid riparian habitats characterized by strong variations in solar radiation, air temperature, and humidity.

Soil chemistry:

Discriminate analysis of Russian-olive infested and uninfested sites at Utah Lake, Utah, indicated that magnesium concentration, clay content, and pH were significantly ($P \leq 0.05$) higher where Russian-olive occurred, and phosphorus content was significantly lower, although Russian-olive did occur on some sites with high levels (70 ppm) of phosphorus [36]. According to Borell [16] Russian-olive does not thrive in acid soils, and a pH of 6 may be the lowest limit. This has not, however, been tested and is not supported by the relative success of Russian-olive planted on acid mine spoils with pH ranging from 4.3 in California [31] to a lower limit of 5.5 on coal mine spoils throughout the eastern U.S. [193]. Conversely, Russian-olive did not survive on acid surface-mine spoil reclamation sites in Kentucky, where pH was below 4.5 and available phosphorus was generally less than 7 ppm [144].

Russian-olive is said to be better adapted than many other tree species to alkaline or saline soils [16,23,147,182]. In a laboratory study, seeds and recently germinated seedlings of Russian-olive rated as the most **alkali** tolerant of 20 common shelterbelt species tested for tolerance of sodium sulphate and sodium carbonate [167]. Field observations are consistent with this result, as Russian-olive is reported to be well-established on some alkaline sites ([96], and references therein).

Russian-olive seems also to be moderately to highly tolerant of **salinity** in experimental studies [99,124,125], and generally more tolerant of salinity than associated native species such as Fremont cottonwood [157] and plains cottonwood ([96], and references therein). A study at Utah Lake reported average soluble soil salt concentrations of 2.0g/L (range 0.1-3.5g/L) on sites supporting a noncultivated Russian-olive population, compared to an average of 5.2 g/L (range 0.7-15.0 g/L) on adjacent sites supporting saltcedar [36]. Conversely,

Monk and Wiebe [124] rank Russian-olive as saline tolerant as tamarisk, and Kefu and Harris [99] cite data from Zhou (1987) indicating that Russian-olive can grow in soils with salinities of 10 to 15 g/L. However, Russian-olive seedlings planted in a highly saline (electrical conductivity (EC) 9.2 dS/m) and sodic (SAR 33.1) bentonite soil in Wyoming died within 2 weeks (Uresk and Yamamoto 1994, as cited by [96]), and Russian-olives were dead in saline meadows along the Bighorn River, Wyoming, where soils had an EC of 27.5 dS/m [2].

Number and size of nitrogen-fixing nodules on Russian-olive roots decreased with increasing concentration of sodium chloride, being significantly ($P < 0.05$) reduced at 5 g/L NaCl. Still, symbiotic nitrogen fixation in Russian-olive shows a high tolerance of salinity and is likely to make a substantial contribution to the nitrogen requirements of Russian-olive plants even at 10 g/L NaCl [99].

Disturbance:

In some cases Russian-olive invades areas where disturbance results in microsites with favorable conditions, such as road and railroad ditches, and irrigated and/or heavily grazed pastures (e.g. [47,148]). Along the Milk River in Montana and Alberta, the highest densities of Russian-olive were along the reach that had more livestock grazing and beaver harvesting, as both beaver and livestock prefer cottonwood over Russian-olive [140]. Similar observations were made by Lesica and Miles along other Montana rivers [112,113].

Russian-olive is also invasive on sites at later successional stages, due to its shade tolerance and ability to establish in intact ground cover [95,156]. Russian-olive is better adapted to the artificial flow regimes and reduced flood disturbance of regulated rivers than associated native species [50,111,112,140,156,188]. Where a dynamic disturbance regime maintains most of the active floodplain in early-successional vegetation (i.e. young to middle-aged cottonwoods and willows), only a small proportion of the riparian zone will remain undisturbed long enough to become fully stocked with Russian-olive. Russian-olive is more likely to become dominant in reaches where the riparian zone is less dynamic or where the stream is more entrenched or has been artificially channelized [96,112,148] (see [Successional Status](#)).

SUCCESSIONAL STATUS:

Russian-olive can establish at early successional stages, on bare, nutrient poor soils, and at later successional stages, under a well-developed canopy. It can persist into later stages of succession and change successional trajectories in the native communities that it invades. For example, it grows equally well beneath a dense cottonwood overstory, in almost pure stands of tamarisk, and in open areas along the Rio Grande River in New Mexico [33,91]. Knopf and Olson [103] observed naturalized Russian-olive individuals growing both within cottonwood floodplain forest and colonizing open wet meadows in several western states. It also occurs (as seedlings, saplings, and mature trees) in cottonwood forests of all ages, from the relatively open canopies of young (5- to 29-year-old) stands to very old (>80-year-old) stands along the Bighorn River in Montana [2].

Early succession: As a nitrogen-fixing, actinorrhizal plant, Russian-olive is likely to be an early-successional, pioneer species, able to colonize nitrogen-poor soils such as sandy, eroded mineral soils and wetlands [40]. As such, Russian-olive has often been used for reforestation and mine reclamation [24,31,90,144,193].

Russian-olive can establish in the postflood environment, but does not tend to dominate on sites with frequent flood disturbance [112].

There is no information in the literature regarding postfire succession in Russian-olive; however, observations by several workers indicate that Russian-olive sprouts from roots and root crown following aboveground damage [34,35,59,163,201], and is therefore likely to colonize on-site in the initial postfire community. If Russian-olive has a persistent seed bank and heat resistant or heat scarified seed, Russian-olive seedlings may also establish in the early postfire environment. More research is needed in this area of Russian-olive's reproductive ecology.

Late succession:

The large seed size of Russian-olive provides resources to help seedlings establish under mature canopies. This allows Russian-olive regeneration in riparian areas to be decoupled from flood disturbance, unlike associated

native species that depend on seasonal flooding for seedling establishment. Russian-olive is especially able to take advantage of the reduced levels of physical disturbance that characterize riparian habitats downstream from dams [23,96,156] (see [Impacts](#)).

Field observations indicate that Russian-olive is relatively tolerant of interference from established native vegetation, invading beneath woody overstories or within herbaceous vegetation [2,16,47,91,101,103,188]. Russian-olive has been recorded growing and reproducing in the understory of mature riparian forests along the Platte River in Nebraska [47], the Rio Grande River in New Mexico [33,60,66,91], and several rivers in Montana [2,111,112]. In fact, along the Marias and Yellowstone rivers in Montana, invasion of riparian communities often depends on proximity to established, mature trees [112].

Understory invasion in mid- and late-successional communities may alter the fuel structure of those communities (see [Fire Ecology](#)).

Shade tolerance:

Russian-olive grows in either full sunlight or shade, but seems to prefer full sunlight (Cote and others 1988, as cited by [20]). It can establish and persist both in the shade of a mature overstory, in partial shade in margins and gaps, and in the open under full sunlight (see above). Shade tolerance may vary with latitude, although these limits are unclear. It has been suggested that Russian-olive does not thrive in shade in the northern Great Plains [72] or produce fruit in shade in "the north" [16]. Shade tolerance at northern latitudes may be related to age of Russian-olive and to moisture availability.

In eastern Montana, Akashi [2] observed Russian-olive seedlings at all overstory ages along the Bighorn River, though individuals seemed to persist in margins and gaps. On the Marias and Yellowstone rivers, Russian-olive was restricted to the cottonwood understory on dry high terraces but occurred with and without a cottonwood canopy on moist, lower-elevation terraces. Lower terraces along open and little-shaded channels, ditches and other relatively wet sites also provide habitat conducive to Russian-olive establishment and invasion [112].

Succession on Russian-olive-infested sites: Invasion of Russian-olive may alter the successional dynamics of riparian forests in several ways. In much of interior western North America, native riparian forests are dominated by pioneer species (primarily cottonwood and willow species) that are generally intolerant of shade [156] and do not establish within intact vegetation [95]. Russian-olive invades these communities by establishing beneath the canopy of native riparian trees and forming self-replacing stands. Russian-olive also establishes on flood-disturbed sites that are optimal for cottonwood recruitment.

On many western rivers, the absence of fluvial disturbance and lack of recruitment of native riparian trees allows Russian-olive to establish and eventually dominate on many sites at various successional stages [91,96,97,111,112,156]. Invasion of a cottonwood-dominated riparian forest by Russian-olive might proceed as follows on a river system with reduced flood magnitude and frequency: 1) Russian-olive seedlings establish under, or in margins or gaps of the canopy of an existing stand of cottonwoods; 2) as cottonwoods die, Russian-olive becomes the dominant overstory species; and 3) recruitment of Russian-olive seedlings continues in the shade of the new canopy, but cottonwood recruitment is restricted to the narrow, frequently-disturbed margins of the active stream channel, where annual high flows may bury or scour seedlings [156]. In addition to flow regulation, livestock grazing and trampling and selective harvesting by beaver limit recruitment of cottonwood on river floodplains in the northern Great Plains [111,113,140]. Shafroth and others [156] predict that Russian-olive will likely become a more prominent component of western landscapes as the cottonwood canopy of existing stands along regulated rivers is replaced by Russian-olive now present in the understory.

A review by Lesica and Miles [112] describes natural succession on the Marias and Yellowstone rivers in eastern Montana as follows: Cottonwood and willow establish from wind-borne seed on fresh, moist alluvium deposited by floods or channel meandering. Terraces with an understory of willow and a ground layer of hydrophytic plants are dominated by relatively young cottonwoods. As stands became older, periodic deposition raises the ground level higher above the water table. These older stands support an understory dominated by

less hydric shrubs and grasses. After 100 to 200 years, cottonwoods die and are replaced by sagebrush or shade-tolerant green ash. Russian-olive may affect this riparian successional sequence by persisting and continuing to reproduce on these upper terraces and dominating the plant community after overstory cottonwoods die. Russian-olive was common along both rivers in stands with plants of many ages, suggesting that Russian-olive, but not cottonwood, recruitment continues to occur under established Russian-olive trees. Conversely, cottonwood establishment and dominance is not precluded on sites where flooding and new channel development continuously create new cottonwood habitat [15,112].

Concentrations of Russian-olive have been observed and mapped on most eastward flowing rivers in Montana, including unregulated rivers. Along the unregulated stretch of Milk River in Montana and Alberta, for example, Russian-olive outnumbers plains cottonwood on many sites between the Alberta/Montana border and the Fresno reservoir [140]. Cottonwood seed dispersal and germination do not appear to be a problem on unregulated reaches, as there were twice as many cottonwood as Russian-olive seedlings; however, successful cottonwood recruitment occurs only once in 5 to 10 years on the Milk River (Bradley and Smith 1986, as cited by [140]). In their study reach, Pearce and Smith [140] estimated attrition from seedling to sapling at 73% for cottonwood and 12% for Russian-olive. Based on present recruitment rates, it appears that Russian-olive will outnumber cottonwood in all size classes along the Milk River study reach within 10 years [140].

In the eastern Great Plains, cottonwood and willow are early successional species and are replaced by a self-sustaining, diverse hardwood forest as natural succession proceeds. In the western Great Plains, forest diversity decreases westward until only the early-successional tree species, cottonwood and willow, remain. Thus, in much of the western Great Plains, the climax native bottomland community is not forest, but shrubland or grassland. Therefore, maintenance of riparian forest in this area is dependent on regular physical disturbance. Since the 1800s, fire suppression and decreases in flow variability caused by water development have allowed Russian-olive and trees from the eastern Plains, especially green ash and eastern redcedar, to establish and persist in western bottomlands where shade-tolerant trees were formerly absent ([68], and references therein). Currier [47] provides an illustration and discussion of successional patterns on the Platte River in Nebraska. In some areas cottonwood dominates the forest canopy while Russian-olive establishes in the understory. Without cottonwood regeneration, Russian-olive, juniper, or mixed hardwood species eventually dominate the forest vegetation. Where Russian-olive establishes in grasslands in this area, sites become progressively elevated and drier over time as a result of overbank deposition, degradation of the river channel, and declines in river stage levels. The oldest Russian-olive stands were found on deep, well-drained soils, on which Russian-olive is apparently no longer able to establish [47].

Along the Rio Grande River in New Mexico, introduction of tamarisk and Russian-olive has changed the successional stages and ultimate dominants in many communities. Russian-olive replaces screwbean mesquite (*Prosopis pubescens*) in the understory of large Rio Grande cottonwood in phreatophyte communities along the Rio Grande south of Socorro [33], and may be replacing New Mexico olive on more northerly sites [128]. For more information on the effects of Russian-olive on succession in southwestern riparian areas see [Habitat Types and Plant Communities](#).

Longevity:

Along the Marias and Yellowstone rivers in eastern Montana, Russian-olive occurred in all size classes along both rivers, and most stands were multiple-aged. The oldest Russian-olives recorded were 36 and 40 years old on the Marias and Yellowstone rivers, respectively. Mean age of Russian-olive stands was 15.3 years on the Marias and 18.6 years on the Yellowstone. The oldest Russian-olive tree was as old or older than the oldest cottonwood in 39% and 14% of the stands on the Marias and Yellowstone rivers, respectively. In many cases these were stands where cottonwoods appeared to have established in fresh alluvium deposited on existing terraces with established Russian-olive [112].

Russian-olive has a low recruitment rate on eastern Montana rivers, and requires about 10 years to reach reproductive maturity; thus, invasion should proceed slowly compared to other aggressive herbaceous or shrubby weeds. Russian-olive has been present on both of the rivers studied for 36 to 40 years, but density in

many stands is low [112].

SEASONAL DEVELOPMENT:

Russian-olive branches elongate each year by growth from a lateral bud near the terminus of the previous year's growth [112]. There are no reports in the literature on when spring growth begins in different regions. Dates of flowering and fruit maturation are reported by area as follows:

Area	Flowering date	Fruit maturation	Refs
CA		May-June	[130]
Illinois	May-June		[122]
Nevada	April-June		[94]
New Mexico	May-June		[115]
TX	June	August-October	[191]
central plains	May-June	September	[164]
Great Plains	May-June		[172]
Intermountain area	May-July		[46]
northeastern US	June-July		[74]
western North America	May-June	September-November	[52]

Russian-olive seed dispersal occurs throughout fall and winter, with ripe fruits remaining on trees throughout the winter or until consumed by animals [16,200]. Fruits are borne from 4 to 20 feet (1-6 m) or more above ground and are thus available to animals above deep snow [16].

FIRE ECOLOGY

SPECIES: *Elaeagnus angustifolia*

- [FIRE ECOLOGY OR ADAPTATIONS](#)
- [POSTFIRE REGENERATION STRATEGY](#)

FIRE ECOLOGY OR ADAPTATIONS:

Fire adaptations:

There is no information in the literature specifically addressing fire adaptations in Russian-olive. Several workers report that Russian-olive sprouts from the trunk, root crown, and/or roots after top-kill or damage [34,49,52,59,112,140,148,172], and some report sprouting from roots and root crown following fire [35,201].

The hard-coated seed of Russian-olive may require scarification for germination (see [Germination](#)), suggesting the possibility of fire scarification. However, this has not been reported in the literature.

The growth habit (i.e. fuel arrangement) of Russian-olive varies among plant communities in which it occurs, depending on site characteristics, size and age of Russian-olive and associated species. Russian-olive stands are sometimes dense thickets of varying size, with scattered mature cottonwood in the canopy [128]. Sometimes stands are so dense that other riparian species are excluded entirely [47,59,81,128,140,168]. On some sites, especially where absence of flooding contributes to Russian-olive invasion, Russian-olive forms a sprawling to dense subcanopy under an overstory canopy of cottonwood [47,128,168]. In some cases, dense growth of Russian-olive may be more fire-prone than native communities that it invades, although this has not been studied or reported in the literature (Also see [Growth habit/stand structure](#)).

Fire regimes:

Information on fire regimes in which Russian-olive evolved is lacking. Similarly, there is little quantitative information on prehistoric frequency, seasonality, severity and spatial extent of fire in North American riparian ecosystems, where Russian-olive is commonly invasive. Fire frequency in these ecosystems probably varied with drought cycles, prevalence of lightning strikes, prevalence of burning by Native Americans, and frequency of fires in surrounding uplands. Fire was probably more frequent along rivers in grassland and savanna biomes than in deserts, chaparral shrublands, and conifer forests (see Fire Regime table, below) [188].

Fires in low- to mid-elevation southwestern riparian plant communities dominated by cottonwood, willow and/or mesquite (*Prosopis* spp.) are thought to have been infrequent [29]. Evidence used to support this supposition includes the high water content of most riparian forests; low fire frequency in much of the surrounding uplands (Sonoran and Mojave deserts, and drier portions of Chihuahuan Desert and Great Basin desert scrub); and suggestions that the dominant trees in these communities, notably Fremont and Rio Grande cottonwood, are not well-adapted to fire [28,61,188]. There remains, however, considerable uncertainty as to the effects of fire on cottonwood [60], with limited and mixed experimental evidence (e.g. [1,13,60,173]). The role of fire in these ecosystems as a whole is not well understood [60,174].

Increases in fire size or frequency have been reported in riparian areas along some southwestern [27,173,174,181] and California [23] rivers in recent decades [188]. These increases are attributed to a number of factors including an increase in ignition sources [23,174,181], increased fire frequency in surrounding uplands (e.g., [22]), increased abundance of fuels [29,60,61,135], and changes in fuel characteristics brought about by invasion of nonnative plant species (also see [tamarisk](#) in FEIS).

Several interrelated factors have contributed to increased fuel loads and changes in fuel characteristics in many riparian communities. Disturbance regimes in many southwestern riparian communities have been altered by factors including dams and diversions, groundwater pumping, agriculture, and urban development, all of which have contributed to reduced base flows, lowered water tables, less frequent inundation, and changes in the frequency, timing and severity of flooding [5,64]. The result is a drier floodplain environment where much of the native broad-leaved vegetation becomes senescent or dies, and is replaced by more drought-tolerant vegetation such as tamarisk [5,64,160] and Russian-olive [33,156]. Natural flood regimes that once served to clear away live and dead vegetation and redistribute it in a patchy nature on the floodplain are suppressed, leading to increased build-up and continuity of fuels [29,60,61,135]. Typical stand conditions on the Middle Rio Grande, for example, are now characterized by mature and over-mature Rio Grande cottonwood trees, with accumulations of dead wood and litter on the forest floor [174]. The organic matter that has accumulated on the floor of riparian forests along the middle Rio Grande now averages over 50,000 kg/ha in some areas [123].

The structure of stands supporting nonnative invasive species may carry fire better than that of native vegetation. Saltcedar and Russian-olive can contribute to increased vertical canopy density, creating volatile fuel ladders, thereby increasing the likelihood and impacts of wildfire [174]. The spread of highly flammable, nonnative vegetation such as tamarisk, giant reed (*Arundo donax*), red brome (*Bromus madritensis*), and cheatgrass in these communities, "is due partly to the same changes in flow regimes that render riparian areas more flammable, making it difficult to disentangle the effects of the nonnative species from the effects of the management factors that have enhanced their spread" [188].

In summary, the likelihood of fire in southwestern riparian ecosystems is greatest with the combination of flood suppression, water stress, and presence of nonnative species. Additionally, in the absence of flooding, regeneration of native trees is impeded and organic matter accumulates, thus increasing chances for future fires that may further alter the species composition and structure of southwestern riparian forests and promote the spread of fire-tolerant nonnative species [60,61]. Fires have replaced floods as the primary disturbance factor in many southwestern riparian ecosystems. With its ability to sprout following top-kill, and more persistent seed bank, Russian-olive may be better adapted to persist in an environment of frequent fires than native riparian trees. More research is needed to understand Russian-olive's response to fire and its ability to establish and/or persist in the postfire environment.

The following list provides fire return intervals for plant communities and ecosystems where Russian-olive may be important. It may not be all-inclusive. If you are interested in plant communities or ecosystems that are not listed, see the complete [FEIS Fire Regime Table](#).

Community or Ecosystem	Dominant Species	Fire Return Interval Range (years)
maple-beech-birch	<i>Acer-Fagus-Betula</i>	> 1,000
silver maple-American elm	<i>Acer saccharinum-Ulmus americana</i>	< 35 to 200 [195]
bluestem prairie	<i>Andropogon gerardii</i> var. <i>gerardii</i> - <i>Schizachyrium scoparium</i>	< 10 [104,139]
silver sagebrush steppe	<i>Artemisia cana</i>	5-45 [85,145,202]
sagebrush steppe	<i>A. tridentata/Pseudoroegneria spicata</i>	20-70 [139]
basin big sagebrush	<i>A. tridentata</i> var. <i>tridentata</i>	12-43 [154]
mountain big sagebrush	<i>A. tridentata</i> var. <i>vaseyana</i>	15-40 [8,26,121]
Wyoming big sagebrush	<i>A. tridentata</i> var. <i>wyomingensis</i>	10-70 (40**) [190,205]
coastal sagebrush	<i>A. californica</i>	< 35 to < 100
saltbush-greasewood	<i>Atriplex confertifolia-Sarcobatus vermiculatus</i>	< 35 to < 100
desert grasslands	<i>Bouteloua eriopoda</i> and/or <i>Pleuraphis mutica</i>	5-100 [139]
plains grasslands	<i>Bouteloua</i> spp.	< 35 [139,202]
blue grama-needle-and-thread grass-western wheatgrass	<i>Bouteloua gracilis-Hesperostipa comata-Pascopyrum smithii</i>	< 35 [139,152,202]
grama-galleta steppe	<i>Bouteloua gracilis-Pleuraphis jamesii</i>	< 35 to < 100 [139]
cheatgrass	<i>Bromus tectorum</i>	< 10 [141,199]
sugarberry-America elm-green ash	<i>Celtis laevigata-Ulmus americana-Fraxinus pennsylvanica</i>	< 35 to 200 [195]
northern cordgrass prairie	<i>Distichlis spicata-Spartina</i> spp.	1-3 [139]
California steppe	<i>Festuca-Danthonia</i> spp.	< 35 [139,169]
western juniper	<i>Juniperus occidentalis</i>	20-70
Rocky Mountain juniper	<i>Juniperus scopulorum</i>	< 35
Ceniza shrub	<i>Larrea tridentata-Leucophyllum frutescens-Prosopis glandulosa</i>	< 35 [139]
wheatgrass plains grasslands	<i>Pascopyrum smithii</i>	< 5-47+ [139,145,202]
interior ponderosa pine*	<i>Pinus ponderosa</i> var. <i>scopulorum</i>	2-30 [7,12,109]
Arizona pine	<i>P. ponderosa</i> var. <i>arizonica</i>	2-15 [12,44,155]
eastern cottonwood	<i>Populus deltoides</i>	< 35 to 200 [139]
aspen-birch	<i>P. tremuloides-Betula papyrifera</i>	35-200 [58,195]
quaking aspen (west of the Great Plains)	<i>P. tremuloides</i>	7-120 [7,76,120]

mesquite	<i>Prosopis glandulosa</i>	< 35 to < 100 [118,139]
mesquite-buffalo grass	<i>P. glandulosa-Buchloe dactyloides</i>	< 35
Texas savanna	<i>P. glandulosa</i> var. <i>glandulosa</i>	< 10 [139]
black cherry-sugar maple	<i>Prunus serotina-Acer saccharum</i>	> 1,000 [195]
mountain grasslands	<i>Pseudoroegneria spicata</i>	3-40 (10**) [6,7]
California oakwoods	<i>Quercus</i> spp.	< 35 [7]
oak-hickory	<i>Q.-Carya</i> spp.	< 35 [195]
oak-juniper woodland (Southwest)	<i>Q.-Juniperus</i> spp.	< 35 to < 200 [139]
canyon live oak	<i>Q. chrysolepis</i>	<35 to 200
blue oak-foothills pine	<i>Q. douglasii-P. sabiniana</i>	<35
Oregon white oak	<i>Q. garryana</i>	< 35 [7]
California black oak	<i>Q. kelloggii</i>	5-30 [139]
oak savanna	<i>Q. macrocarpa/Andropogon gerardii-Schizachyrium scoparium</i>	2-14 [139,195]
little bluestem-grama prairie	<i>Schizachyrium scoparium-Bouteloua</i> spp.	< 35 [139]
elm-ash-cottonwood	<i>Ulmus-Fraxinus-Populus</i> spp.	< 35 to 200 [58,195]

*fire return interval varies widely; trends in variation are noted in the species review

**mean

POSTFIRE REGENERATION STRATEGY [166]:

Tree with adventitious bud/root crown/soboliferous species root sucker

Tall shrub, adventitious bud/root crown

Small shrub, adventitious bud/root crown

Geophyte, growing points deep in soil

Ground residual colonizer (on-site, initial community)

Secondary colonizer (on-site or off-site seed sources)

FIRE EFFECTS

SPECIES: *Elaeagnus angustifolia*

- [IMMEDIATE FIRE EFFECT ON PLANT](#)
- [DISCUSSION AND QUALIFICATION OF FIRE EFFECT](#)
- [PLANT RESPONSE TO FIRE](#)
- [DISCUSSION AND QUALIFICATION OF PLANT RESPONSE](#)
- [FIRE MANAGEMENT CONSIDERATIONS](#)

IMMEDIATE FIRE EFFECT ON PLANT:

There is no experimental evidence regarding the flammability of Russian-olive vegetation or the effects of fire on Russian-olive plants or seeds. Observational evidence indicates that Russian-olive is top-killed by prescribed fire in tallgrass prairie [201] and by wildfire in riparian communities on the Rio Grande River [35]. Fire in tallgrass prairie sites generally does not top-kill trees greater than 2-inch (5cm) DBH [148,201].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:

No additional information is available on this topic.

PLANT RESPONSE TO FIRE:

There is no information in the literature specifically addressing the response of Russian-olive to fire. Several workers report that Russian-olive sprouts from the trunk, root crown, and/or roots after top-kill or damage [34,49,52,59,112,140,148,172], and some report sprouting from roots and root crown following fire [20,35,201].

Observations by Caplan [34,35] suggest that mixed species stands along the Rio Grande often become monospecific stands of Russian-olive due to vigorous root sprouting following fire. Mount and others [126] surveyed vegetation in an area along the Middle Rio Grande from Albuquerque to Belen and found evidence of 31 fires in the study area between 1984 and 1995. On burned polygons, the 1st woody species to establish or sprout was sandbar willow, followed by saltcedar, Russian-olive, and, finally, Rio Grande cottonwood [126].

The hard-coated seed of Russian-olive may require scarification for germination (see [Germination](#)), suggesting the possibility of fire scarification. However, this has not been reported in the literature.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:

No additional information is available on this topic.

FIRE MANAGEMENT CONSIDERATIONS:

Fire as a control method:

Russian-olive sprouts after burning, but is kept at brush height with regular burning in tallgrass prairie sites in Minnesota [148,201]. According to Deiter [49], stump burning may successfully control sprouting in Russian-olive, but it is time-consuming compared to other control techniques.

Postfire colonization and spread: Observations by Caplan [34,35] suggest that mixed-species stands along the Rio Grande often become monospecific stands of Russian-olive due to vigorous root sprouting following fire. Therefore managers should be prepared to manage sprouts of Russian-olive following fire in areas where Russian-olive is present.

Preventing postfire establishment and spread: The USDA Forest Service's "Guide to Noxious Weed Prevention Practices" [185] provides several fire management considerations for weed prevention in general that may apply to Russian-olive.

Preventing invasive plants from establishing in weed-free burned areas is the most effective and least costly control method. This can be accomplished through careful monitoring, early detection and eradication, and limiting invasive plant seed dispersal into burned areas by [75,185]:

- re-establishing vegetation on bare ground as soon after fire as possible
- using only certified weed-free seed mixes when revegetation is necessary
- cleaning equipment and vehicles prior to entering burned areas
- regulating or preventing human and livestock entry into burned areas until desirable site vegetation has recovered sufficiently to resist invasion by undesirable vegetation
- detecting weeds early and eradicating before vegetative spread and/or seed dispersal
- eradicating small patches and containing or controlling large infestations within or adjacent to the burned area

In general, early detection is critical for preventing establishment of large populations of invasive plants. Monitoring in spring, summer, and fall is imperative. Managers should eradicate established Russian-olive plants and small patches adjacent to burned areas to prevent or limit postfire dispersal and/or spread into the site [75,185].

The need for revegetation after fire can be based on the degree of desirable vegetation displaced by invasive plants prior to burning, and on postfire survival of desirable vegetation. Revegetation necessity can also be related to invasive plant survival as viable seeds, root crowns, or root fragments capable of reproduction [75].

Managers can enhance the success of revegetation (natural or artificial) by excluding livestock until vegetation is well established (at least 2 growing seasons) [75]. See [Integrated Noxious Weed Management after Wildfires](#) for more information.

When planning a prescribed burn, managers should preinventory the project area and evaluate cover and phenology of any Russian-olive and other invasive plants present on or adjacent to the site, and avoid ignition and burning in areas at high risk for Russian-olive establishment or spread due to fire effects. Managers should also avoid creating soil conditions that promote weed germination and establishment. Weed status and risks must be discussed in burn rehabilitation plans. Also, wildfire managers might consider including weed prevention education and providing weed identification aids during fire training; avoiding known weed infestations when locating fire lines; monitoring camps, staging areas, helibases, etc., to be sure they are kept weed free; taking care that equipment is weed free; incorporating weed prevention into fire rehabilitation plans; and acquiring restoration funding. Additional guidelines and specific recommendations and requirements are available [185].

MANAGEMENT CONSIDERATIONS

SPECIES: *Elaeagnus angustifolia*

- [IMPORTANCE TO LIVESTOCK AND WILDLIFE](#)
- [OTHER USES](#)
- [IMPACTS AND CONTROL](#)



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IMPORTANCE TO LIVESTOCK AND WILDLIFE:

Domestic livestock browse young Russian-olive trees [16], (Katz personal observation as cited by [96]), but adult Russian-olives deter browsers with sharp thorns and defense compounds in the leaves (Seastedt personal communication as cited by [96]). Rabbits may eat the bark of small trees. Poultry (chickens, turkeys, ducks, pigeons) may eat the leaves from newly planted trees [16].

Russian-olive has been promoted for plantings to benefit wildlife because it produces abundant, edible fruit, and

several native birds and mammals have been reported to use Russian-olive for food, nesting, and cover [10,16,43,77,106,108,140,143,172,175]. Borell [16] reports that more than 50 kinds of birds and mammals eat the fruit of Russian-olive. Of these, 12 are game birds, including ring-necked pheasant, grouse, mallard, quail, wild turkey, and mourning dove. Most birds swallow the fruit whole, while some peck the pulp from the seed. Seeds sprouting on the ground in spring are also readily eaten. Other wildlife known to eat Russian-olive fruit include cottontail, fox squirrel, ground squirrel, elk, and deer [16]. Squirrels also eat Russian-olive bark and young branches [172]. Pocket gophers occasionally feed so heavily on the roots of young trees that the trees die. Rodents seldom damage the bark or roots of mature trees [16]. Granivory by generalist mammals (primarily house mice and deer mice) completely prevented germination of Russian-olive seeds outside of small mammal exclosures in study plots in Colorado [95]. Lists of species observed using Russian-olive native riparian and upland sites are provided by Knopf and Olson [103].

While Russian-olive is said to provide nectar for bees (Hayes 1976, as cited by [96]), reviews suggest that insects are found only at low densities on Russian-olive [16,96,177], and that the fruit is not consumed by insects [191]. Dix and others [54] suggest that grasshoppers sometimes consume leaves of young trees as well as the fleshy part of the fruit.

It has been suggested that while Russian-olive can enhance wildlife habitat for some species, it is used to a lesser degree than native vegetation [52]. This may have greater impacts on species such as cavity-nesting and insectivorous birds on sites where Russian-olive replaces formerly dominant cottonwood and willow (see [Impacts](#) and [Succession](#)). Additionally, native beaver rarely harvest Russian-olive trees, and the severity of beaver damage was low compared to the mortality and damage inflicted to native plains cottonwood on the Marias [111], lower Yellowstone, Bighorn [113], and Milk rivers [140] in Montana.

Palatability/nutritional value: Hansen and others [81] rank palatability of Russian-olive as poor for cattle, domestic sheep, and horses; with moderate energy and protein values. They rank food value or degree of use as fair for elk, white-tailed deer, and pronghorn; poor for mule deer; and good for upland game birds, waterfowl, small nongame birds, and small mammals [81].

Russian-olive's palatability to livestock and wildlife species in several western states has been rated by Dittberner and Olson [53] as follows:

	CO	MT	ND	UT	WY
Cattle	Poor	Fair	Fair	Poor	Poor
Sheep	Fair	Fair	Good	Fair	Fair
Horses	Poor	Poor	Poor	Poor	Poor
Pronghorn	----	Fair	----	Fair	Poor
Elk	----	----	----	Good	Fair
Mule deer	----	Poor	Poor	Good	Good
White-tailed deer	Good	Fair	----	----	Poor
Small mammals	Good	----	----	Good	Good
Small nongame birds	Good	Good	Fair	Good	Good
Upland game birds	----	Good	Good	Good	Good
Waterfowl	----	----	----	Fair	Good

A study of the nutritional energetic requirements of sharp-tailed grouse recommends Russian-olive fruit as good winter food [62]. Another report says that Russian-olive helps provide grouse with a winter diet sufficient to survive winter conditions in the northern Great Plains ([63] and references therein).

Seasonal proximate composition and cell wall constituents (%) of Russian-olive leaves harvested in northern Pakistan are given as follows [11]:

Season	dry matter	crude protein	neutral detergent fiber	acid detergent fiber	hemicellulose	acid detergent lignin	ash
Spring	65.6	14.9	37.5	21.0	16.5	2.5	7.1
Winter	46.7	13.9	31.0	20.8	10.2	5.8	11.8

Cover value: According to Borell [16], Russian-olive has spreading, thorny branches and thicket-forming growth that make excellent wildlife cover. Mourning doves, mockingbirds, roadrunners, and several other kinds of birds are said to use Russian-olive for nesting [16]. According to Stubbendieck and others [172], Russian-olive provides winter roosting cover for ring-necked pheasants and nesting sites for mourning doves and songbirds in the Great Plains. Some Southwestern willow flycatcher nesting sites are found in riparian habitats dominated by nearly monotypic stands of tamarisk and Russian-olive in the Southwest [188].

Hansen and others [81] rank thermal or feeding cover value of Russian-olive as fair (moderately used for cover when available) for elk and mule deer, and good (readily utilized for cover when available) for white-tailed deer in Montana. They rank thermal or feeding cover value as good for upland game birds and small nongame birds, and fair for waterfowl and small mammals [81].

OTHER USES:

Russian-olive has been promoted for many uses including, for example, windbreaks and erosion control [41,71,72,84]; snow traps [158]; gully and streambank plantings; hedgerows and living fences; attracting wildlife [38,41,77,84]; ornamental and landscape plantings [39]; and nectar for bees (Hayes 1976, as cited by [96]). It has been used as a nurse crop for black walnut (*Juglans nigra*) because of its nitrogen fixing ability [48]. Russian-olive has been planted on reclaimed mine spoils in central and eastern U.S. [24,144,193], Wyoming [90], and California [31]. It is planted in coastal areas because of its ability to withstand ocean salt spray and deposition of windblown sand (Morehart et al 1980, as cited by [96]). Russian-olive was used as part of an introduced seed mixture in a study of revegetation techniques in a northwestern Colorado disturbed big sagebrush community in 1976 [132]. Russian-olive has since been declared a noxious weed in Colorado [189].

Public and private agencies have continued to advocate planting Russian-olive for windbreaks and other horticultural purposes. As recently as the 1980s and 1990s, many state and federal agencies were subsidizing the distribution of Russian-olive seedlings in the western US and Canada [78,137]. Additionally, planting recommendations and suppliers of seedlings such as those given by Borell [16] are often found in the literature. Russian-olive was among the most popular tree species offered by nurseries throughout the United States from 1980 to 1986, and was especially popular in the north-central and western regions. Its popularity decreased significantly (chi-square test, alpha=0.05) in the north-central region between 1980 and 1986. Reasons for decreased popularity are not given or speculated upon [133].

Continued horticultural interest in Russian-olive is evidenced by recent research addressing such topics as chemically regulating the growth of Russian-olive in nurseries to maintain a compact form, herbicide resistance of Russian-olive seedlings, treatments that facilitate rooting in Russian-olive cuttings, and methods of propagating Russian-olive from leaf segments and shoot segments ([96] and references therein).

Russian-olive leaves were found to be an accurate biomonitor for lead, cadmium, and zinc in heavy metal-contaminated soils in Turkey; heavy metal concentrations in leaves correlated well with heavy metal concentrations in surface soils [3].

A literature search indicates several references suggesting medicinal properties of Russian-olive; however, that topic is beyond the scope of this review.

Wood Products: Russian-olive wood makes good fuel and fair fenceposts [16].

IMPACTS AND CONTROL:

Impacts:

There is varied and somewhat limited empirical evidence available demonstrating Russian-olive's impacts upon native ecosystems in North America; however, some evidence suggests that Russian-olive replaces native vegetation, altering vegetation structure and reducing wildlife habitat for some species. Additionally, some authors have suggested that Russian-olive can alter stream hydrology and nutrient cycling [180], although this has not been tested in natural settings.

Russian-olive is often invasive in riparian areas, which are often impacted by a plethora of human-induced disturbances. "Riparian ecosystem functions have been altered, reduced, or lost among the cascading effects of river management actions on many western rivers. Because ecosystems are complex and replete with interconnected, confounding factors, it can be difficult to quantify losses and function, and to sort out causes and effects. Riparian nonnative invasives appear to be a single symptom or facet of a complex, systemic resource allocation problem" [171].

Rankings:

Several agencies and organizations rank Russian-olive as invasive to varying degrees. The USDA, Forest Service, Eastern Region ranks Russian-olive as "highly invasive" (nonnative plants that invade natural habitats and replace native species), based on information from lists, botanists, and ecologists from 15 of the 20 states in that region [183]. Conversely, Russian-olive is ranked as an "occasionally invasive species" (plants that generally do not affect ecosystem processes but may alter plant community composition by outcompeting one or more native plant species) by the Virginia Department of Conservation and Recreation. These are plants that often establish in areas severely disturbed by events such as ice storms, windthrow, or road construction, and spread slowly or not at all from disturbed sites [192]. Russian-olive is ranked as a "Category 2 species" (nonnative plant species that are suspected to be invasive or are known to be invasive in limited areas of the Southern Region) by the Southern Region of the US Forest Service, as reported by the [Southeast Exotic Pest Plant Council](#). Category 2 species will typically persist in the environment for long periods once established and may become invasive under favorable conditions, thus posing a potential risk to the integrity of natural plant communities in parts of the region [184]. The California Invasive Plant Council ([Cal-IPC](#)) lists Russian-olive among the most invasive wildland pest plants in California. These are "documented as aggressive invaders that displace natives and disrupt natural habitats" [32]. However, there is no information in the literature specifically describing distributions and impacts of Russian-olive in California. At a given site, Russian-olive may be present as scattered individuals, within multi-species canopies, or in monotypic stands [96]. Russian-olive is said to displace and/or have the potential to displace native climax species in many parts of the western US such as the Platte River drainage of Nebraska [47] and other prairie river floodplains [140]; marshlands in South Dakota [137]; the Rio Grande Basin in New Mexico [33,91,123,128], and other river drainages in the Southwest [128].

Several characteristics give Russian-olive an advantage in the communities it invades, including high seed production and viability, seed longevity, seed dispersal by birds and mammals, vegetative reproduction following injury, drought and salt tolerance, and the ability to establish in the absence of disturbance in late successional communities (see [Botanical And Ecological Characteristics](#)). These characteristics allow Russian-olive to replace some dominant, native riparian species that can no longer germinate, establish, and persist under conditions imposed by river impoundment (e.g. increased salinity, reduced flooding, and water table declines) and other impacts of human development [4,19,45,64,81,91,111,112,113,123]. Native riparian trees tend to be pioneers, dependent on physical disturbance for recruitment [23,96,156]. Flow regulation resulting in reduced flood peaks and point bar accretion rate, in addition to land clearing, livestock grazing, beaver cutting, ice damage, and fire, along with nonnative species invasions, are all implicated in the decline of native woody vegetation in riparian ecosystems in the western US [30,61,67,134,160,171,174]. These same site conditions and processes that lead to the decline of native species concurrently provide ideal site conditions for Russian-olive establishment and eventual dominance [50,111,112,140,156,188]. Russian-olive is both a partial cause and a symptom of native species declines [91].

Once established, Russian-olive may further hinder recruitment of native cottonwood and willow on some sites [47,112]. For example, where Russian-olive occurs as a major understory component along the Rio Grande River, from Espanola to south of Belen, New Mexico, it will continue to spread through the woodland, contributing to stabilization of the riverbanks against future flooding, and thus further limit opportunities for cottonwood regeneration [91]. Similarly, in a comparison of the free-flowing Yellowstone River and the flow-regulated Marias River in eastern Montana, Lesica and Miles [111,112,113] found cottonwood establishment and dominance was not precluded by Russian-olive on the upper reaches of the Yellowstone River where flooding and new channel development continuously create new habitat for cottonwood establishment. However, cottonwood may eventually be replaced by Russian-olive on the Marias River as old cottonwoods die on upper terraces and young cottonwoods on low terraces are removed by beaver or livestock or shaded by less palatable species [111,112,113].

Russian-olive dominance may further lead to reduced species diversity. Russian-olive stands tend to be less diverse both structurally and compositionally than surrounding communities [91,128]. In Montana, for example, undisturbed colonizing and established cottonwood communities support as many as 114 and 58 plant species, respectively, compared to only 29 species in Russian-olive stands [81,140]. Altered structural and compositional plant diversity may lead to lower wildlife diversity.

Wildlife:

The impact of Russian-olive invasions upon wildlife species is variable, site specific, and often debated. Also see the [Importance to Livestock and Wildlife](#) section of this report. Anecdotal evidence and observations by managers suggest that several species may be affected by Russian-olive invasion, although in some cases it is unclear whether impacts are caused by Russian-olive itself, or by changes in the ecosystem as a whole. Although Russian-olive has been promoted for use in wildlife habitat plantings, there has been relatively little research on its use by native animals [96].

Knopf and Olson [103] suggest that naturalization of Russian-olive on floodplains in the Rocky Mountains has provided additional wildlife habitat between riparian cottonwood forests and adjacent grass-dominated uplands. In some cases Russian-olive may provide important structural habitat for wildlife species by forming an intermediate-height canopy layer that is lacking in some native riparian forest communities. It may also increase the spatial extent of woody habitat by establishing on the outer edge of native riparian forests, providing additional habitats, especially for those avian species that are associated with tall shrub vegetation. Bird species richness and alpha diversity in monotypic Russian-olive stands were intermediate to those of native riparian and native upland vegetation types in Colorado, Idaho and Utah [103]. However, in some cases Russian-olive forms dense, monotypic stands that replace native communities on floodplains (see above), thus altering and potentially reducing habitat options for wildlife [91,137,140]. Some authors suggest that the displacement of native floodplain forest by Russian-olive can result in loss of habitat for species such as cavity-nesting and insectivorous birds [25,103,112,137,168].

Some researchers have examined Russian-olive's relative usefulness to wildlife as compared with native plant species it replaces, with mixed results. Several studies indicate that Russian-olive is utilized to varying degrees, and with varying degrees of success, by many avian species along the Rio Grande River [110,204], the Gila River [168], the Columbia River (Hudson 2000, as cited by [168]), and the Snake River [25]. However, results and related inference from several studies indicate avoidance of Russian-olive and/or a preference for native plant species by, for example, primary and secondary cavity nesters [168], neotropical migrants (Hudson 2000, as cited by [168]), greater prairie-chicken ([McCarthy et al 1997] and references therein), ducks [70], and foreign guilds in winter [25]. Additionally, Brown [25] found that species richness, abundance and density were greater in willow than in Russian-olive habitats, and all foraging guilds avoided Russian-olive in the breeding season along the Snake River in Idaho.

Other studies and reports indicate less certainty about the role and/or impacts of Russian-olive for native wildlife species. The threatened southwestern willow flycatcher, for example, nests in native vegetation where available but also nests in thickets dominated by Russian-olive and saltcedar, and individuals of both species are

used as nesting substrates ([188] and references therein). High-elevation (>6,200 feet (1,900 m)) breeding sites are typically dominated by native trees and shrubs, although Russian-olive is a major habitat component at some high-elevation breeding sites in New Mexico. From the standpoint of flycatcher productivity and survivorship, the suitability of nonnative-dominated habitats is unknown. Flycatcher productivity is lower in nonnative dominated sites compared with native-dominated sites in some locations, and higher in others. It is unclear whether factors such as patch size may have greater effects on flycatcher productivity at those sites. Details are given in the southwestern willow flycatcher recovery plan [188]. Results presented by Kelly and others [100] and Gazda and others [70] also do not seem to support the conjecture that nonnative shrubs in riparian areas provide lower-quality habitat for birds, and Russian-olive does provide a food source for many birds. The role of Russian-olive in native wildlife habitat is unclear for many species [168,204].

For small mammals, species richness was greater in Russian-olive stands than in the native riparian and upland vegetation types (low species richness, intermediate diversity) in Colorado, Idaho and Utah [103]. Native beavers primarily use cottonwood trees while rarely using Russian-olive or tamarisk along several rivers in eastern Montana [111,112,113]. Thus, beavers create areas of lower competitive stress for Russian-olive by felling dominant cottonwoods. Most beaver damaged cottonwoods were cut off at the base, while damage to Russian-olive was usually confined to 1 or 2 basal limbs. Growth rates of both Russian-olive and tamarisk were substantially higher where beavers had reduced the cottonwood canopy cover. Managers wishing to reintroduce beavers should consider the potential effect on invasive plants; it may be best to control invasives before reintroducing beavers [113].

Hydrogeology/Nutrient cycling/Other:

Some authors have suggested that Russian-olive influences hydrogeomorphic processes, for example by increasing floodplain roughness in habitats where woody vegetation would otherwise not occur (Tickner et al 2001, as cited by [96]), and contributing to stabilization of riverbanks against flooding [91]. There is not, however, literature available that addresses this issue.

As a nitrogen-fixing plant species, Russian-olive has high leaf nitrogen content [153], and leaves and leaf litter of Russian-olive tend to have higher nitrogen content than native species in the communities it invades. Thus, Russian-olive may contribute substantial amounts of additional nitrogen to invaded ecosystems ([96] and references therein). Nodular nitrogenase activity in Russian-olive varies with season and site conditions [206], thus the impacts of an Russian-olive as a novel N-fixing plant in some communities probably also vary. Royer and others [153] found slow processing rates of Russian-olive leaves (compared to natives) in some Idaho streams, and suggested that slowed litter processing might alter local and downstream aquatic communities. However, studies of degradation rates of Russian-olive leaf litter have been inconclusive regarding system nitrogen inputs. So, while invasion by Russian-olive may affect ecosystem nutrient levels, no studies have yet demonstrated this in invaded communities [96].

There is little quantitative information on the historic and present-day spread of Russian-olive, ecological factors that may limit the geographical range of Russian-olive, or its potential for range expansion in western North America. Lesica and Miles [112] approximate a 10-year lag before newly established Russian-olive individuals become reproductively mature in eastern Montana, and Katz and Shafroth [96] suggest inherently slow rates of spatial spread for species such as Russian-olive that possess relatively large, primarily vertebrate-dispersed seed. There is also no published information on competition or facilitation between Russian-olive and co-occurring species. More research is needed on these topics to better understand the potential impacts of Russian-olive in particular plant communities under specific site conditions [96].

Control:

Detailed control prescriptions are beyond the scope of this review; however, an understanding of what kills or damages Russian-olive may provide insight into how Russian-olive responds to injury, and therefore its potential response to fire. For more detailed management techniques and prescriptions, refer to cited references, the [Russian-olive ESA](#), or the [Weed Control Methods Handbook](#).

There is limited published research addressing effective techniques to control or remove Russian-olive from invaded sites. Caplan [34] and Edelen and Crowder [59] present case studies of effective Russian-olive control in New Mexico and Washington, respectively. Tu [180] discusses a variety of control approaches for Russian-olive and provides examples of Russian-olive management on Nature Conservancy preserves. Stannard and others [163] and Deiter [49] assess a variety of suppression methods, including mechanical and chemical approaches. Important considerations for Russian-olive management include age of Russian-olive individuals, timing relative to population establishment and seed set, size of Russian-olive populations, and site conditions, including land use.

Awareness and prevention are probably the most effective tools for managing against Russian-olive invasion. In Montana, for example, invasion by Russian-olive is relatively recent and ongoing, receiving important impetus from domestic plantings [111]. Land managers should be aware of Russian-olive in the area surrounding their management unit. If Russian-olive is present, monitoring for Russian-olive seedling establishment is an important prevention practice. Discourage adjacent landowners from planting Russian-olive if possible. When Russian-olive is already established in an area, it is important to employ control measures where they will be most effective (e.g., where the native vegetation has some chance of recovering).

Control of Russian-olive is difficult once trees are mature, so early detection and rapid response are important [49,180]. Similarly, large, well-established stands of Russian-olive are nearly impossible to eradicate throughout an entire watershed, whereas small patches of Russian-olive can be adequately controlled using a variety of control methods [180]. Additionally, removal of Russian-olive should be undertaken before seeds are fully developed to prevent further spread of seeds [49]. Stevens and Ayers [165] report that heightened awareness, modest field efforts, and early detection have resulted in the control of Russian-olive and other nonnative species in the Grand Canyon.

When planning Russian-olive control, integrating several approaches will likely be necessary, depending on the size, age, and extent of the population. Mowing, cutting, burning, excavation, spraying, girdling, and bulldozing have all been used to reduce aboveground Russian-olive biomass, with varying degrees of success. Russian-olive removal can be labor-intensive and expensive, especially in the 1st year of large-scale removal [180]. Most published accounts of effective Russian-olive suppression employ chemical treatment, either alone or combined with mechanical techniques [49]. Cultural control, in the sense of managing for natives, is an important consideration.

Russian-olive control approaches and successes may differ between riparian areas on free-flowing rivers and streams, where native species have a better chance of re-establishment, and more heavily managed areas along regulated rivers. Where a dynamic disturbance regime maintains most of the active floodplain in early-successional vegetation, only a small proportion of the riparian zone will remain undisturbed long enough to become fully stocked with Russian-olive. Russian-olive is more likely to become dominant in reaches where the riparian zone is less dynamic or where the stream is more entrenched or has been artificially channelized. Consequently, the latter are the places where control measures may have a more long-term benefit [112].

Successful long-term control of Russian-olive requires that all control sites be continually monitored and follow-up treatments applied for several years, since Russian-olive sprouts following injury [180]. Lesica and Miles [112] suggest that, because most Russian-olive invasions in eastern Montana occur over a period of several decades, eradication of mature trees every 10 years or of all plants every 30 years may be effective strategies for controlling Russian-olive in those areas. Rate of spread of Russian-olive probably varies among regions, so this approach may not be effective in some areas.

Prevention:

Once established, Russian-olive is difficult to control and nearly impossible to eradicate. Therefore planting of Russian-olive should be eliminated due to its tendency to persist and spread in some areas, and the inevitable costs associated with long-term control [79,81]. Prevention involves awareness and education, working with adjacent landowners and managers to remove Russian-olive from plantings and prevent additional plantings,

providing alternative species for planting in areas where Russian-olive is commonly used, managing livestock grazing to minimize damage to native species, maintaining natural disturbance regimes (i.e. seasonal flooding) in riparian areas, and minimizing other human induced disturbances.

According to the USDA, NRCS [186], seed or plants of Russian-olive are available through several suppliers throughout the US, and Russian-olive is not identified as an invasive species on their list. Similarly, Carty [39] recommends 10 drought resistant trees, Russian-olive among them, for planting. While he does mention that Russian-olive is nonnative, considered invasive, and displaces native species across much of the Southwest, he also says, "as long as it's not allowed to spread, it can fill a variety of drought resistant niches." This is the type of misinformation that land managers must contend with when discouraging individuals and organizations from planting "horticulturally desirable" species such as Russian-olive [39]. As long as this type of information and these plant products are available, prevention of new introductions is difficult.

Choosing noninvasive landscape ornamentals to plant at sites near natural areas can help prevent the spread of Russian-olive [52]. In the Southern Region, Russian-olive is classified as a "Category 2" species. Therefore planting is prohibited in areas where ecological conditions would favor invasiveness and is discouraged elsewhere. They suggest consulting the forest botanist, plant ecologist, or forest noxious weed coordinator for alternative native and/or noninvasive species [184]. Stannard and others [163] provide a list of native, woody species that could be planted instead of Russian-olive in the northern Great Plains.

The potential benefits of Russian-olive to landowners for windbreaks, soil stabilization and ornamental plantings must be weighed against potential negative impacts to native communities [140]. Winter [148] recommends working with landowners and managers to remove Russian-olive from shelter belts and tree plantings, and to recommend desirable, native species for future plantings in Minnesota.

Lack of natural regeneration of native species in western riparian areas may be due, in part, to cattle grazing in the Great Plains and cattle and elk grazing in the Southwest [134]. When browsing among the multispecies patches of seedlings that germinate on bare sediments after floods, livestock feed upon the more palatable cottonwoods and willows, thus favoring dominance of tamarisk and Russian-olive. Additionally, mature Russian-olive exhibits several traits that allow it to thrive in grazed habitats, including sharp thorns, which increase in density if the tree is cut back, and large seeds that may enhance the survival of seedlings following browsing. These adaptations may contribute to spread of Russian-olive into heavily-grazed meadows and pastures ([188] and references therein). Initial Russian-olive seedling establishment may be prevented in an area with targeted grazing, granivory (using animals that would eat Russian-olive seedlings and/or seeds), or temporary inundation [96].

Water diversion, groundwater pumping [91,170], and sand and gravel mining also impact native species regeneration in the Southwest [134,170]. Hydrologic alterations have been implicated in the widespread decline of some riparian forest types and in facilitating invasions by opportunistic nonnative species ([96] and references therein). Indeed, it is likely that reduced levels of fluvial disturbance downstream from dams favor invasion of Russian-olive [95,111,112,156]. Current interest in changing river-flow management strategies to restore native fish [151] and/or native riparian forest [123] provides hope for the possible control of invasive riparian plant species via restoration of ecosystem processes (also see FEIS review on [tamarisk](#)). At present, it is unclear how prescribed flows might influence the spread or abundance of Russian-olive. Ideally, river flow regimes designed to improve regeneration and survival of native riparian forest species will also limit the success of nonnative invaders [96].

Integrated management:

Integrated management includes considerations of not only killing the target weed, but also of establishing desirable species and maintaining weed-free systems over the long-term. Factors to be addressed before a management decision is made include inventory and assessment to identify the target weed and determine the size of the infestation(s); assessment of nontarget vegetation, soil types, climatic conditions, and important water resources; and an evaluation of the benefits and limitations of control methods [129].

On Hempstead Plains in Uniondale, New York, where Russian-olive and other nonnative trees and shrubs are present, restoration has been attempted to re-establish the prairie matrix. Controlled burns, mowing, herbicides and reintroduction of native species have all been used, but no results were given [131].

Deiter [49] reports that the most effective means of Russian-olive control employs a combination of pulling out small individuals from moist soil using a weed wrench, and cutting larger individuals at ground level and then immediately applying a small amount of herbicide to the cut stumps. Similarly, Caplan [34] describes controlling small (<4 inches (10 cm) diameter) Russian-olive stems with a mulching tractor and controlling large stems with cutting and immediate application of triclopyr. Several annual follow-up applications of herbicide to the foliage of root sprouts were also required [34] (see [Chemical](#) control for more detail). In general, any initial control method requires at least some ongoing suppression of stem and root sprouts and of new recruitment from seed [59,96,163].

Physical/mechanical:

Physical control techniques alone may be suitable for removal of Russian-olive seedlings and saplings, whereas control of larger individuals usually requires application of herbicide or removal of the stump by burning, since cut trees typically sprout from the roots and root crown [52].

Manually removing seedlings and saplings (<4 inches (10 cm) diameter) and their roots is an effective control method. It is most effective when soil is moist. Any remaining exposed roots should be cut off below ground level and buried [49,52,148,180].

Control is difficult once Russian-olive trees mature and populations are well-established. The most effective control method is the cut-stump herbicide treatment [34,49,148,180] (see [Chemical](#) control). Girdling and cutting are not effective controls by themselves, as trees are likely to sprout below the girdled or cut areas or along roots [49].

Techniques such as mowing, cutting, girdling, chaining, and bulldozing can suppress Russian-olive on invaded sites, although the disadvantages to such approaches can be substantial, including the necessity for frequent treatment repetition, the indiscriminate removal of other species, and severe soil disturbance [163]. Additionally, these approaches are not effective without long-term monitoring and follow-up removal of sprouts [180]. Regular cutting in Minnesota tallgrass prairie sites does not kill Russian-olive, but keeps it at "brush height" [148].

Fire: See the [Fire Management Considerations](#) section of this summary.

Biological: Research on biological control agents has not been undertaken for Russian-olive [49].

Herbivory does not seem to limit Russian-olive invasion in western North America to any great extent. Reviews indicate that few insects are found on Russian-olive [96,177]. Grasshoppers sometimes consume leaves of young trees as well as the fleshy part of the fruit, but rarely do serious damage [54].

Although domestic livestock browse Russian-olive, the observation that Russian-olive commonly invades grazed meadows and pastures suggests that herbivory does not prevent its survival or limit its spread. Additionally, Russian-olive seedling survival may be enhanced by large seed size, and Russian-olive adults possess several adaptations to deter grazers, including sharp thorns and leaves containing abundant defense compounds ([95] and references therein). On the other hand, granivory by generalist mammals (primarily house mice and deer mice) completely prevented germination of Russian-olive seeds outside of small mammal exclosures in study plots in Colorado [95].

There is a fair amount of literature on the susceptibility and/or immunity of Russian-olive to various diseases (e.g. [54,162]), although none have been proposed as a potential biological control agents.

Chemical:

Herbicides may be effective in gaining initial control of a new invasion or a severe infestation, but are rarely a complete or long-term solution to weed management. Use of herbicides may be limited in natural areas, and it is suggested that native species large enough to provide "good structure" be present to fill the niche left by removed Russian-olives [148]. See the [Weed Control Methods Handbook](#) for considerations on the use of herbicides in natural areas and detailed information on specific chemicals and techniques. Herbicides that have been reported as effective at controlling Russian-olive to varying degrees include glyphosate, imazapyr, triclopyr, picloram, and 2,4-D.

Foliar spraying of herbicide has provided "successful control" of Russian-olive in some cases, although long-term response is unclear. This approach may be neither feasible nor desirable in many riparian settings ([96] and references therein) due to potential effects on nontarget species, and potential for overspray or drift when applied to large stands [180]. Small seedlings can also be killed with foliar applications of a mixture of picloram and 2,4-D [148]

Cut-stump herbicide treatments can be effective if the cut surface is treated with herbicide immediately after cutting. Cuts should be made as close to the ground as possible [49,52,148,180]. In an 80-acre (32 ha) cottonwood gallery forest on the Middle Rio Grande in New Mexico, Russian-olive is the codominant tree in mixed stands. From November 1998 through February 1999, Russian-olive less than 4 inches (10 cm) in diameter were mowed, using mulching tractors, larger trees were cut with chainsaws, and triclopyr ester was applied to the cut stump within 5 minutes of cutting. A second pass was made with mulching tractors to pulverize the remaining tree waste. By summer, 1999, Russian-olive root sprouts occurred throughout the site. Numerous root sprouts were found within close proximity of larger, sprayed stumps, suggesting that the rate of triclopyr used was not effective on stumps exceeding 8 inches (20 cm) in diameter. Triclopyr was applied to leaves of Russian-olive root sprouts each year for 3 subsequent summers. Each follow-up treatment required fewer people and less time. Continued monitoring and spot treatments keeps Russian-olive under control at the site [34].

For trees that do not have to be removed or immediately taken down, exposing more than 50% of the cambium by cutting into the bark with a saw or ax close to ground level and introducing herbicides into the exposed areas is also effective [49]. Deiter [49] reports that injecting herbicide capsules around base of trunk has also been successful for controlling Russian-olive. When injecting herbicides into the cambium of a standing tree, monitoring should occur during the same year to ensure that the entire tree is affected [49].

Conversely, Edelen and Crowder [59] propose killing the top-growth with herbicide (imazapyr), followed by mechanical control of resprouts as an effective alternative to cutting and then mowing resprouts. A project to test this control approach was begun in August 1996 in south-central Washington [59], and resulted in a 90% kill rate (personal communication from Crowder as cited by [180]).

Monitoring for sprouting from cut stumps and/or roots, or seedling establishment should be done for several years following treatment [34,148,163].

Cultural:

In all cases of Russian-olive control, it is important that desirable plant species be planted or otherwise cultivated to discourage re-establishment of Russian-olive. Additionally, promotion of natural processes (e.g. natural flooding regimes) may be important to manage for desirable native species. In areas where natural disturbance processes still function, removal of Russian-olive may facilitate recovery of native species. On regulated rivers and areas with intensive livestock grazing, removal or suppression of Russian-olive is likely to be only temporary, unless measures are taken to promote establishment and persistence of native species. Stannard and others [163] and Brock [20] provide lists of species useful for replacement of Russian-olive and rehabilitation of Russian-olive-infested sites.

In southwestern riparian ecosystems, managing for native species may be more successful than managing

against nonnative species [171]. Elimination of the stresses, such as high salinity and reduced stream flows, that favor nonnative plants over native plants may be necessary if native plant communities are to be sustained ([188] and references therein). Stromberg and Chew [171] provide some constructive options for restoring functionality to southwestern desert riparian ecosystems. They also indicate that it is unlikely that nonnative species will be eradicated from southwestern riparian systems, but that it is also unlikely that simply removing nonnatives would allow natives to thrive where conditions no longer favor them [171]. Along these lines, Stromberg [170] discusses the ecology, threats and recovery potential of cottonwood and willow in southwestern riparian systems. See the FEIS review on [tamarisk](#) for more information on this subject.

Obedzinski and others [134] suggest that in the case of dams and diversions, we may need to accept that a return to natural, sustainable conditions may not be possible, and that we may need to design management techniques, such as timed interval flooding and artificial seedbeds, to maintain riparian function. We may also need to learn the silvics of nonnative species and utilize them according to where they best fit into riparian systems [134].

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