

MONTANA WOODY INVASIVE SPECIES



**Statewide
Management Plan
2025**



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Cover Page Photo Credits: Becky Kington, MWCA - uninvaded cottonwoods along slough near Jefferson River

LIST OF ACRONYMS

Acronym	Definition
ACE	Army Corps of Engineers
ARS	Agricultural Research Service
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CABI	CAB International (formerly Centre for Agriculture and Biosciences International)
CD	Conservation District
CEMIST	Central and Eastern Montana Invasive Species Team
CIG	Conservation Innovation Grant
CMP	Crown Managers Partnership
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
DOD	Department of Defense
DOI	Department of Interior
EDRR	Early Detection Rapid Response
FWP	Montana Fish, Wildlife, and Parks
FWS	Fish and Wildlife Service
GBIF	Global Biodiversity Information Facility
GDP	Gross Domestic Product
GYCC	Greater Yellowstone Coordinating Committee
GYE	Greater Yellowstone Ecosystem
IPM	Integrated Pest Management
ISAN	Invasive Species Action Network
MCC	Montana Conservation Corps
MDA	Montana Department of Agriculture
MDT	Montana Department of Transportation
MISC	Montana Invasive Species Council
MNPS	Montana Native Plant Society
MRCDC	Missouri River Conservation Districts Council
MSU	Montana State University
MTNHP	Montana Natural Heritage Program
MWCA	Montana Weed Control Association

Acronym	Definition
NAISMA	North American Invasive Species Management Association
NGO	Non-governmental organization
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRIPC	Northern Rockies Invasive Plants Council
NWTF	Noxious Weed Trust Fund
SAP	Science Advisory Panel
SARE	(Western) Sustainable Agriculture Research and Education
SRM	Society for Range Management
TNC	The Nature Conservancy
UAV	Unmanned Aerial Vehicle
UM	University of Montana
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WHIP	Wildlife Habitat Improvement Program
WWF	World Wildlife Fund
YCWD	Yellowstone County Weed District
YRCDC	Yellowstone River Conservation Districts Council

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EXECUTIVE SUMMARY

Woody invasives—comprising trees and shrubs from both coniferous and deciduous groups—are increasingly recognized as some of the most harmful species worldwide.

Their presence not only disrupts biodiversity but also leads to habitat degradation, impacts on native species, and changes to critical environmental processes. In Montana, riparian areas are particularly vulnerable to these invasions, where they have been shown to increase soil erosion, exacerbate river and stream channelization, reduce water access and biomass production for grazers, damage irrigation infrastructure, and negatively impact recreation, resulting in significant ecological and economic consequences.

The Woody Invasive Statewide Management Plan is a collaborative document designed for landowners and woody invasive managers in Montana, including state, federal, county, and private stakeholders. The purpose of this plan is to identify management priorities, summarize treatment and removal best practices, and outline short- and long-term implementation objectives for three focal species in Montana: common buckthorn (*Rhamnus cathartica*), Russian olive (*Elaeagnus angustifolia*), and the resident saltcedar complex (*Tamarix chinensis*, *T. ramosissima*, and all associated hybrids). This plan addresses the following statewide goals and objectives for woody invasive management in Montana (see *Goals and Objectives* in the Introduction

for more details).

Given the urgency of addressing woody invasive species, stakeholders in Montana must collaborate to accomplish the goals and objectives outlined in this plan. Continued efforts in education, resource allocation, and collaborative planning will be vital in achieving long-term success in woody invasive management. Successful woody invasive management will not only protect Montana's riparian corridors but also sustain the state's diverse agricultural and recreational landscapes for generations to come.

Oversight and Coordination

- Ensure ongoing coordination of the Working Group
- Oversee the implementation strategy set forth within this plan

Funding

- Secure long-term, reliable funding

Mapping and Monitoring

- Compile comprehensive range data for woody invasive species

Outreach and Education

- Focus public outreach on reporting and prevention
- Provide educational resources to landowners and resource managers on best management practices

Long-term Control

- Implement landscape scale management
- Work towards eradication where possible

02

INTRODUCTION

PLAN PURPOSE & NEED

The need for woody invasive species management is far from unique to Montana, the western United States, or North America. In fact, it is a growing issue across the globe.

Woody invasive species pose a unique challenge for natural resource managers, landowners, and producers, often requiring multi-faceted management strategies and diligent follow-up once a species is established. As with other invasive species,

prevention of woody invasion and introduction requires early detection and rapid response measures. This is because cost and effort for woody invasives management is an order of magnitude or more in comparison to herbaceous weed management (Webster et al., 2006). Herein, we provide a strategic document for the state of Montana for common buckthorn (*Rhamnus cathartica*), Russian olive (*Elaeagnus angustifolia*), and the resident saltcedar complex (*Tamarix chinensis*, *T. ramosissima*, and all associated hybrids).

Woody invaders represent trees and shrubs from both coniferous and deciduous classes; their invasions are among the most detrimental and prevalent in the plant world (Richardson and Rejmánek, 2011; Seebens et al., 2023). Empirical evidence of woody invasions across the globe and their impacts have been collected and reported upon extensively (Binggeli, 1996; Webster et al., 2006; Dehnen-Schmutz et al., 2007; Barger et al., 2011; Richardson and Rejmánek, 2011; Rejmánek and Richardson, 2013; Liebhold et al., 2017; Nunez-Mir et al., 2019; Liedtke et al., 2020; Fuentes-Lillo et al., 2023). In their global analyses, Richardson and Rejmánek (2011) found that non-native woody species are often intentionally introduced through horticultural production and

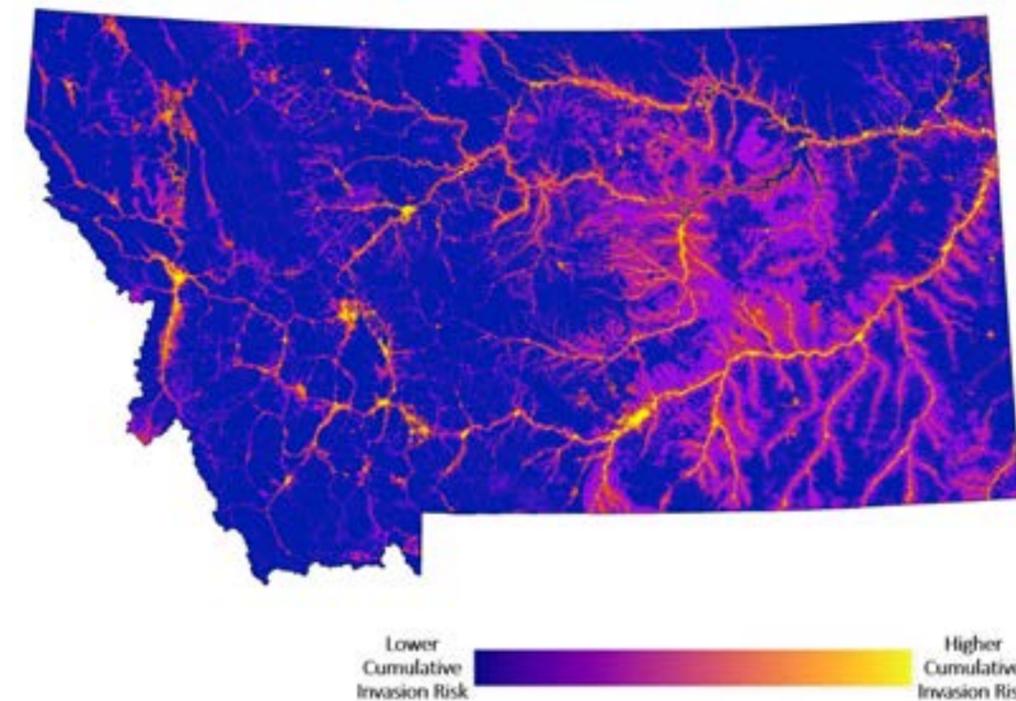


Figure 1. Map representing the cumulative invasion risk for common buckthorn, Russian olive, and the resident saltcedar complex (at current climate scenario), achieved by overlaying Montana Natural Heritage Program's (2025b-d) predicted habitat suitability models for each species/complex.

distributed through landscape nurseries. Nunez-Mir et al. (2019) compared traits of 63 woody species for invasiveness in the United States. Their results indicated that the two greatest factors of a given species and its risk for successful invasion are the ability for vegetative regeneration and long-distance seed dispersal (via bird, water, or mammals); these traits are applicable to our focal species/species complex, common buckthorn, Russian olive, and saltcedar complex (Figure 1).

Across the state of Montana, these plants have contributed to reduced water access and biomass production for grazers, damaged irrigation infrastructure, increased soil erosion, exacerbated river and stream channelization, and negatively impacted recreation. Each of these impacts result in reduced economic benefit and opportunity for Montana. This statewide management plan (hereon referred to as the Plan) outlines management priorities, describes treatment and removal best practices, identifies short- and long-term implementation objectives, and serves as the product of collaboration from dedicated natural resources managers and partners across the state.

NEED FOR COLLABORATION AND STRATEGY

Collaboration and the need for cross-jurisdictional management priorities is a key challenge for invasive species management, globally (Sankaran et al., 2023). In Montana, management of invasive species (particularly in riparian areas) is a shared responsibility among land and water managers, owners, and users. With such a critical resource at stake, it is a common priority for stakeholders across watersheds. There is a need for partnership to improve coordination to control woody invasive species in these systems. Many organizations in Montana have been actively tracking, researching, treating, and advocating for resources to manage woody invasives (Figure 2). However, collaboration is key to ensuring successful management efforts (especially at large scales). Much of the capacity needed to coordinate efforts already exists within the scope of practice of both agency and non-governmental organization (NGO) partners.

By pooling skill sets, data, contacts, time, and resources, these efforts may reach their full potential. The collection, evaluation, and dissemination of spatial data of infestations and detections across jurisdictions will allow for proper prioritization, both for focusing and improving management. The development of best practices improves monitoring and control efforts to ensure that management is effective. Not only can strengthening collaboration and strategy improve efficacy in control efforts, but a lack thereof is often a hurdle in securing funding on a larger, landscape scale.

WORKING GROUP HISTORY

In 2015, the Cumulative Effects Analysis Report for the Yellowstone River Corridor Study (USACE & YRCDC) was published. Woody Invasive Plant Control was identified as one of the report’s recommended actions; each of which were agreed upon by the Yellowstone River Conservation District Council (YRCDC), Montana Department of Natural Resources and Conservation (DNRC), and the Army Corps of Engineers (ACE). After the report was released, greater collaboration toward woody invasives management in Montana was emphasized. In 2017, the Montana Audubon Society hosted a workshop about saltcedar and Russian olive’s invasion along Montana’s waterways. The workshop was attended by 30 scientists, resource managers, conservation groups, and other stakeholders. The collective goal was to develop a more coordinated network for management of healthy riparian systems and control these species. As a product of the workshop, Montana Invasive Species Council (MISC) created a formal subcommittee in November 2017 dedicated to invasive woody species.

Key Events & Documents

Identifying the need for strategic planning

1965

USGS Saltcedar Report

Report outlines expected impacts & spread of saltcedar in the West. Saltcedar’s range is estimated to have had a boom (an 8900% increase) between 1920 & 1961.

Montana’s extent estimated at <1,000 acres.

2009

USGS Saltcedar & Russian Olive Report

Science Assessment dictated by the Saltcedar & Russian Olive Control Demonstration Act of 2006.

Indicates both species are locally dominant in Montana’s watersheds.

2010

CIG Russian Olive & Saltcedar Research Begins

A multi-organizational research effort on ecological impacts after management practices.

Investigated the efficacy & limitations of biomass byproduct as bioenergy fuel source.

2011

Ft. Keogh Russian Olive Removal Begins

A multi-agency research effort on restoration after Russian olive removal occurs.

Located along Yellowstone River at Fort Keogh USDA-ARS site; results to inform best practices in Montana.

2012

USGS Streamflow & Woody Species Report

Data collected between 1992 & 2002 in an effort to understand the relationship between streamflow & woody riparian species.

Of 49 sites in Montana, 14 had Russian olive, 1 had Russian olive & saltcedar. Buckthorn was not included in analysis.

2015

Yellowstone River Cumulative Effects Analysis

Study conducted to understand how human activity cumulatively impacts the Yellowstone River corridor.

Woody invasive plants are identified as a critical threat. Therefore, strategic management is listed as a key recommendation.

2017

Montana Saltcedar Team Deploys

Surveys identified populations of saltcedar between Wolf Point & the confluence of the Missouri & Yellowstone Rivers.

An extensive effort from numerous agencies & organizations successfully treated over 100 river miles, crossing multiple land ownerships.

2017

Montana Audubon Workshop

A primary objective was to identify opportunities to cooperate statewide. Priorities included:

- Pooling resources & knowledge via MISC committee
- Mapping & monitoring
- Public education & communication

Figure 2. A timeline of important documents and events that have shaped the woody invasive species efforts in Montana and the West over the years. These efforts outline (both collectively and individually) the motivation and need for greater collaboration and strategy among stakeholders.

2023

Working Group Trust Fund Grant Awarded

In late 2022, a core group of stakeholders meet to discuss woody invasives management in Billings.

They are awarded a Noxious Weed Trust Fund grant to coordinate woody invasives efforts across the state & develop this management plan.

2023

Passage of HB821

HB821’s passing allows for MDA to receive funding for woody invasive management in Yellowstone, Musselshell, & Stillwater counties.

Grants are then awarded to Musselshell County, Stillwater County, & the City of Billings for management efforts.

Ongoing outreach for the initiative was conducted at weed district meetings, collaborating with the Missouri River Saltcedar Team. A need for dedicated funding seemed a continuous barrier toward greater action. In 2022, MISC hosted a meeting in Billings with the primary objective to find greater understanding for the need for a statewide task force and identify what would be necessary to develop the Plan. This meeting served as the platform for what we now recognize as the Woody Invasives Working Group (hereon referred to as the Working Group). These partners discussed the current capacity, contributions, and scope of practice within their agencies/organizations to carry out this work. The meeting’s discussions identified three ultimate goals: 1) make a comprehensive, united effort for all riparian areas and watersheds across the state; 2) seek larger sources of funding that hadn’t previously been available; and 3) draft the Plan. Several partners (who would later be recognized as the Working Group’s Core Planning Group) submitted a proposal to the Noxious Weed Trust Fund (NWF) in January 2023. This small group, including MISC, YRCDC, Custer County Conservation District, Missouri River Conservation Districts Council (MRCDC), Montana Weed Control Association (MWCA), Yellowstone County Weed District (YCWD), and the Montana Department of Agriculture’s (MDA) Noxious Weed Early Detection Rapid Response program (MT EDRR), then reached out to Invasive Species Action Network (ISAN) to see if they could facilitate the coordination effort as a contracted service.

Next, requests for input, assistance, and collaboration were sent to a wide breadth of stakeholders. Many agencies, organizations, and county weed districts were asked to provide data, letters of support, and/or fill out grant cooperator interest forms. This widespread interest successfully demonstrated the need for strategic efforts to mitigate woody invasives at a large scale and the group’s proposal to the Noxious Weed Trust Fund was ultimately successful in securing funds. The collaboration exhibited in the proposal process ensured that the effort would be well informed and was set for long-term and impactful success in protecting our state’s natural resources.

PLAN DEVELOPMENT Funding

NWTF Grant

The Core Planning Group’s grant proposal was submitted to the NWTF in 2023 for \$75,000.00 and awarded at \$65,000.00. The proposal outlined a plan to support statewide efforts for woody invasives management through resource sharing and stakeholder expertise. The stakeholders (Working Group) and coordinating contractor would develop education and outreach materials, gather conclusions from current and emerging research, discuss strategy with managers, identify gaps and challenges, and compose this Plan. An additional goal of identifying and, ideally, securing long-term funding was established. Using a collaborative approach, the proposal was set to effectively improve coordination and communication between all stakeholders. A no-cost extension for the NWTF was submitted in fall 2024 for expiration on October 31, 2025.

Science Advisory Panel Funding

An additional contract for the planning and coordination of two Science Advisory Panels (SAP) was fully executed between ISAN and DNRC/MISC on September 7, 2023 for a total of \$10,000.00. SAP meetings are intended to gain insight from experts to address gaps and challenges that Montana’s managers have faced and will face.

Working Group

ISAN submitted a bid for coordination of the Plan and Working Group in late May 2023. The contract was awarded and fully executed on June 28, 2023. In which, ISAN agreed to provide the following services:

- i. Act as the hub and point of contact for Working Group communication and materials organization.
- ii. Coordinate and facilitate three Working Group Meetings.

- iii. Develop and facilitate two formal SAP meetings (in partnership with MISC).
- iv. Compile and format a Statewide Management Plan draft for public input (in partnership with Working Group members).
- v. Support development of education and mixed media outreach material by providing input and organizing feedback from other Working Group members.
- vi. Attend and/or support educational or outreach events within Montana to deliver messaging to target audience.
- vii. Seek funding for additional Working Group support from diverse sources with priority given to funding opportunities with greater longevity.

A detailed account of Working Group meetings, Land Manager Survey results, and SAP meetings may be found in Appendix A.

Review Process

The Management Plan and Working Group efforts were largely driven by the Core Planning Group. Members of the Core Planning Group provided critical feedback and recommendations throughout the coordination and writing processes (presented below in alphabetical order by last name).

Additionally, significant contribution from technical experts was required to produce the management guides (Appendices B through D). Key Working Group members provided substantial guidance during their development and are presented on the next page with their affiliations.

Previous drafts were sent to additional reviewers (outside the Core Planning Group) for edits and suggestions. For instance, relevant sections were sent to Science Advisory Panelists. Other stakeholders volunteered to review draft sections and provided helpful feedback throughout the process. Those reviewers who returned edits and suggestions are listed alphabetically by last name on Page 12.

Core Planning Group

Erin Bjorklund	Invasive Species Action Network
Rebecca Boslough-King	Montana Association of Conservation Districts
Jasmine Chaffee	Montana Department of Agriculture
Russ Hartzell	Montana Invasive Species Council
Liz Lodman	Montana Invasive Species Council
Molly Masters	Missouri River Conservation Districts Council
Kelsey Miller	Montana Weed Control Association
Sara Ricklefs	Invasive Species Action Network
Jennifer Riddle	Invasive Species Action Network
Dan Rostad	Yellowstone River Conservation Districts Council
Amy Seaman	Montana Watershed Coordination Council
Brent Smith	Central and Eastern Montana Invasive Species Team
Josh Wagoner	Montana Department of Agriculture
Steve Wanderaas	Missouri River Conservation Districts Council/ Montana Invasive Species Council/Central and Eastern Montana Invasive Species Team/private landowner

GOALS AND OBJECTIVES

The primary objective for the Plan is to provide evidence-backed information, tools, and frameworks to guide landowners and resource managers through best management practices for these focal species.

The Plan has been developed to prioritize and implement ecologically based, integrated pest management (IPM) programs to protect and enhance Montana's natural resources, such as fish, wildlife, agriculture, and native plant communities. Overall, aiming to increase both capacity and expertise in managing woody invasive species in Montana. The following individual goals are not presented in rank order. They are regarded as equivalent in need and should be considered as such for funding purposes:

Oversight and Coordination

Ongoing coordination of the Working Group and oversight of the implementation strategy set forth within the Plan will be required. Assurance of best practices, on-the-ground support, and technical assistance ensures that control restores the desired ecological, economic, and cultural values where management occurs. Oversight will require great attention to prioritization initiatives, including updated priorities based on evolving information about infestations and management efforts.

Funding

Long-term, secure funding will be required to properly implement management priorities and achieve success on a cross-jurisdictional level. Overall project cost is greatly impacted by labor costs, which are difficult to meet for many small organizations, landowners, or districts where funding availability is lower due to smaller property tax pools.

Mapping and Monitoring

Comprehensive range data is lacking, particularly for common buckthorn. This is imperative for improving modelling efforts and properly identifying priority management areas. Initial efforts should be focused on locations within floodplains. Secondary efforts may target specific project objectives (e.g., mapping Russian olive in upland areas for biocontrol efforts when agent receives full approval). Response to new detections and follow-up monitoring on management efforts will remain a goal in the long term.

Outreach and Education

Outreach and education are key to increasing awareness, gaining support, and improving coordination. Public outreach focused on reporting and prevention will be essential for mapping and monitoring efforts. Additional education and outreach efforts on best management practices and demonstrations will be key for landowners and resource managers. Outreach efforts should include information about applicable regulations and impacts from woody invasive species.

Long-term Control

Goals of long-term control of woody invasive species should be targeted and prioritized. Efforts toward landscape scale management should be implemented. Where possible, eradication should be the ultimate goal. Successful management will require dedicated collaboration among agencies, NGOs, landowners, and other stakeholders.

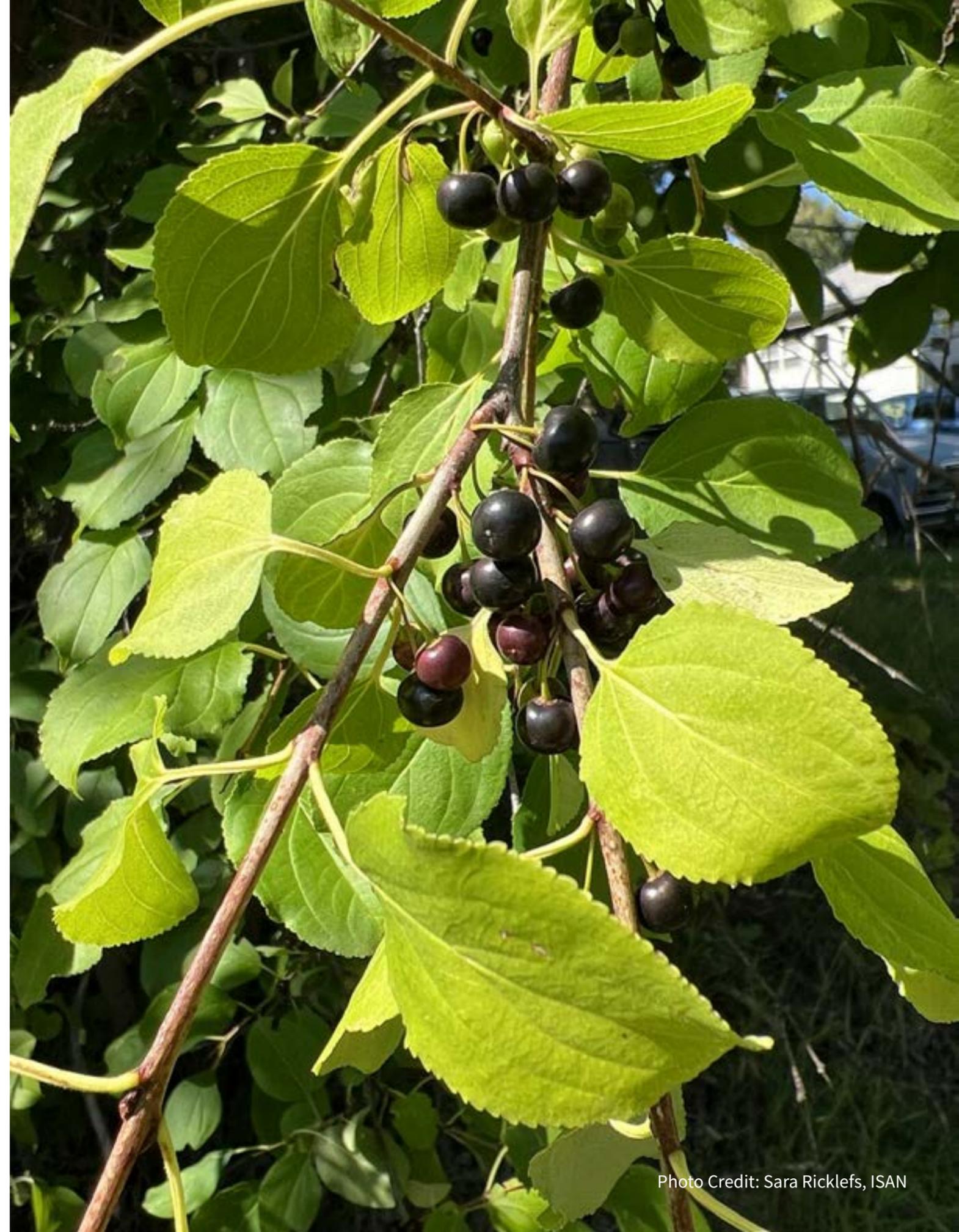


Photo Credit: Sara Ricklefs, ISAN

03

FOCAL SPECIES OVERVIEW

COMMON BUCKTHORN (RHAMNUS CATHARTICA)

Species Overview

Rhamnus cathartica is widely known as common buckthorn (previously referred to as European buckthorn). Common buckthorn can be identified by its long-lasting oval, glossy, dark green leaves (about 1-2.5 in. in length), typically in sub-opposite pairs, with 3-5 pairs of veins curving toward the tip from the mid-vein (Figure 3), and branch tips with small, sharp thorns (Figure 4) (Davis and Mangold, 2018; Missoula County, 2024). In the spring, buckthorn produces small yellowish-green flowers with four petals (Figure 5) and round green fruits that mature into purple-black berries in the fall (Figure 6); however, buckthorn has separate male and female plants, meaning not all plants bear fruit (Davis and Mangold, 2018; Missoula County, 2024).

Common buckthorn's adaptations allow for its rapid growth, high germination success (estimated 85%), sun and shade tolerance, and ability to thrive in disturbed areas (Knight et al., 2007). However, common buckthorn's growth and/or establishment may be limited by climate, soil moisture, and soil alkalinity (Kurylo et al., 2007). The selection and genetics of common buckthorn plants in North America may be more tolerant of wet conditions, potentially from specimens in England where it does occupy wetter habitats (Kurylo et al., 2007). While some of its life history traits have gained it notoriety as a difficult invasive species, Schuster et al. (2023) suggests that seedbank longevity may be much shorter than previously thought with more than 97% depleted within two years.



Figure 3. Common buckthorn leaves. Photo credit: Josh Wagoner, Montana Department of Agriculture.

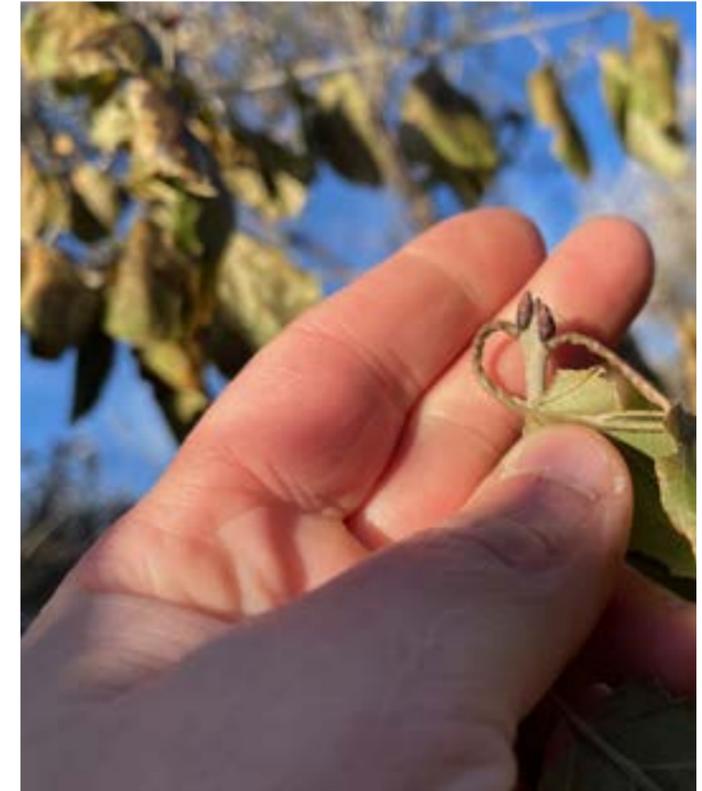


Figure 4. Common buckthorn thorn. Photo credit: Josh Wagoner, Montana Department of Agriculture.



Figure 5. Common buckthorn flowers. Photo credit: Robert Vidéki, Doronicum Kft., Bugwood.org.



Figure 6. Common buckthorn's purple-black berries in the fall. Photo credit: Matt Lavin, Montana State University (Davis and Mangold, 2018).

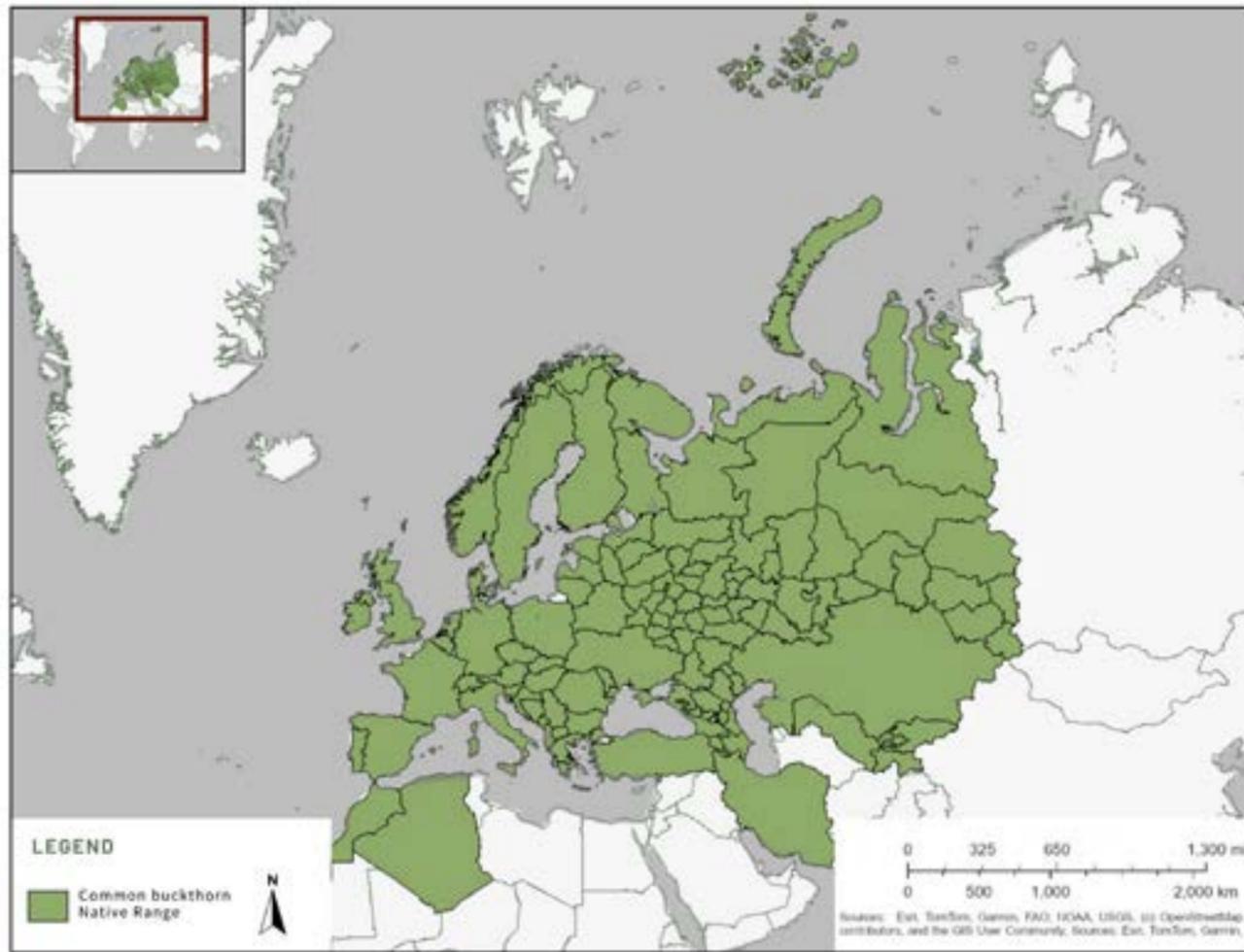


Figure 7. Common buckthorn's native range developed from World Flora Online (2025b) database. Range within Russia is provided at the Republic scale to better represent geographic scope.

Extent of Range/Habitat Suitability Index

Native Range

Common buckthorn's native range (Figure 7) spans Europe, western Asia, Russia, and northern Africa (Godwin, 1943). Common buckthorn has been found in a variety of ecosystems, ranging from low peatlands and valleys to upland forests and mountain tops (Godwin, 1943; Browics, 1984; Kurylo et al., 2007; Mascaro and Schnitzer, 2007; Klionsky et al., 2011). Although, it often thrives in open areas or in forest edge habitats (Gassmann, 2005; Kurylo et al., 2007). Common buckthorn does occur at both high latitudes (> 80° N) and high elevations (Godwin, 1943). Particularly in the southern portion of its range, hybridization with other *Rhamnus* species occurs (Kurylo et al., 2007). Literature suggests that

common buckthorn is tolerant of wide-ranging soil characteristics, such as diverse moisture, alkalinity, and acidity levels, which may attribute to its overall invasiveness in North America (Kurylo et al., 2007).

Invasive Range

Common buckthorn was introduced to North America as an ornamental plant, heavily regarded for its use in hedge plantings (Kurylo and Endress, 2012). It was first introduced in the 1800s (Knight et al., 2007; Kurylo and Endress, 2012; Kurtz, 2013); specific timing within that century has been a topic of ongoing debate (Kurylo and Endress, 2012). Since its initial North American introduction, it has spread throughout the Midwest, New England, and some western states, as well as eastern Canadian provinces (Figure 8). This introduced range occurs within similar latitudes to common buckthorn's native range.

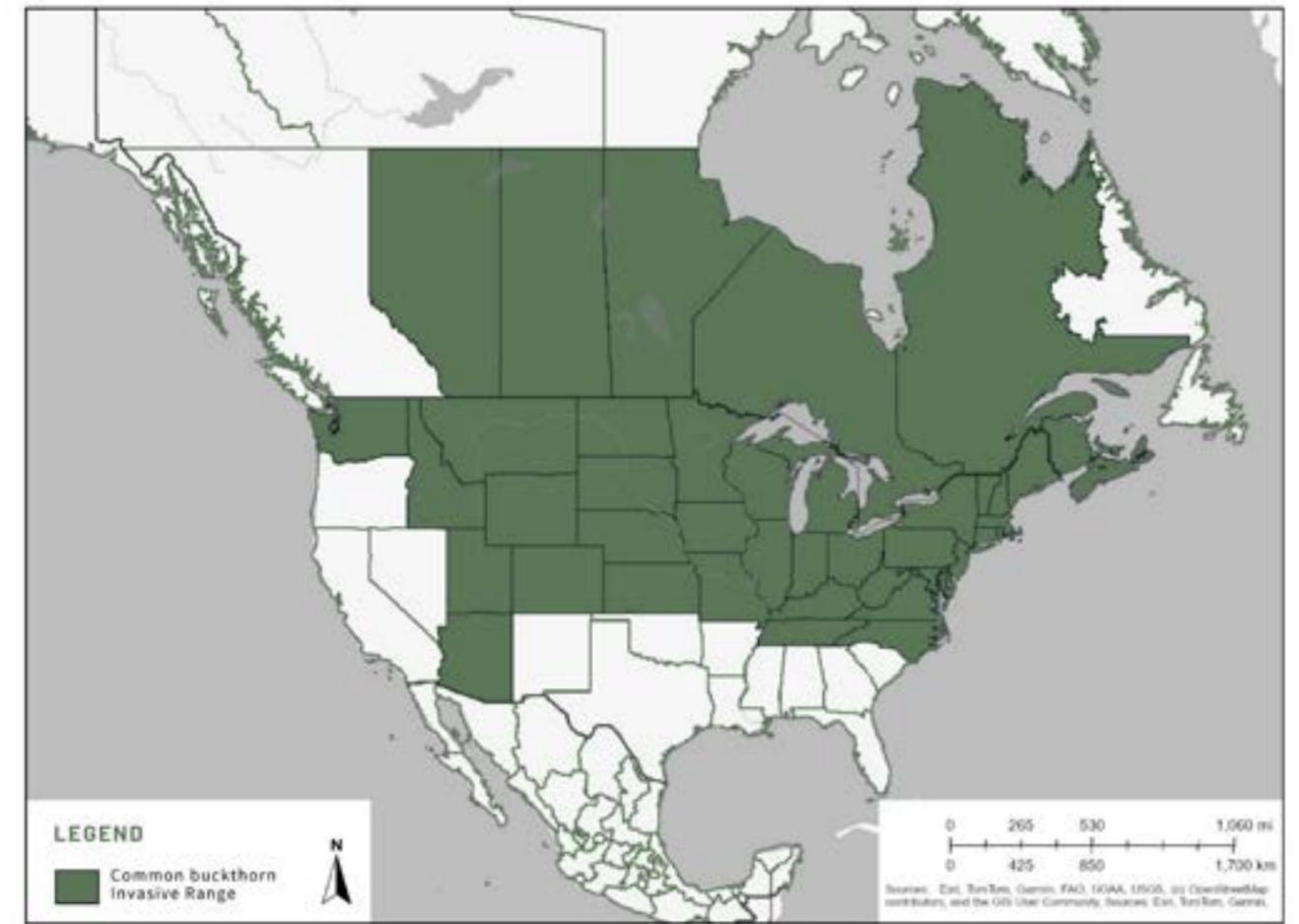


Figure 8. Common buckthorn's invasive range developed from records in the World Flora Online (2025b) and Global Biodiversity Information Facility (2025b) databases. Due to lack of confirmation for common buckthorn establishment in Argentina, it is not represented here.

Likely causes of spread include additional planting by settlers and some dispersal via wildlife (Kurylo and Endress, 2012). Genetic analyses have indicated that North American populations of common buckthorn exhibit low levels of genetic variation in comparison to native populations, perhaps revealing the impacts of one or more recent bottlenecks (Wafer et al., 2020). Bottlenecks are characterized by low genetic diversity due to severe reductions in population or varieties, often caused by disease, pests, natural disasters, or other critical impacts. In the case of common buckthorn, these results are likely indicative of influence from its horticultural background (e.g., cultivar plantings). This lack of genetic diversity among North American plants has seemingly not prohibited this species' adaptability (i.e., invasiveness or invasion success). However,

further research is likely necessary to confirm such a claim (Wafer et al., 2020). Today, common buckthorn is pervasive in North American understories where it occurs; it is a particularly dominant invader across the upper Midwest (Mascaro and Schnitzer, 2007).

Range within Montana

In Montana, common buckthorn is found in scattered populations (Figure 9); it largely occurs in disturbed urban or suburban riparian areas (Ortega et al., 2019), including along the Yellowstone River corridor (Kellogg, 2016). These scattered populations were likely introduced via ornamental plantings (Ortega et al., 2019). Common buckthorn populations are spreading in the state, causing significant negative impact on native riparian vegetation where it occurs (Pearson et al., 2016; Ortega et al., 2019).

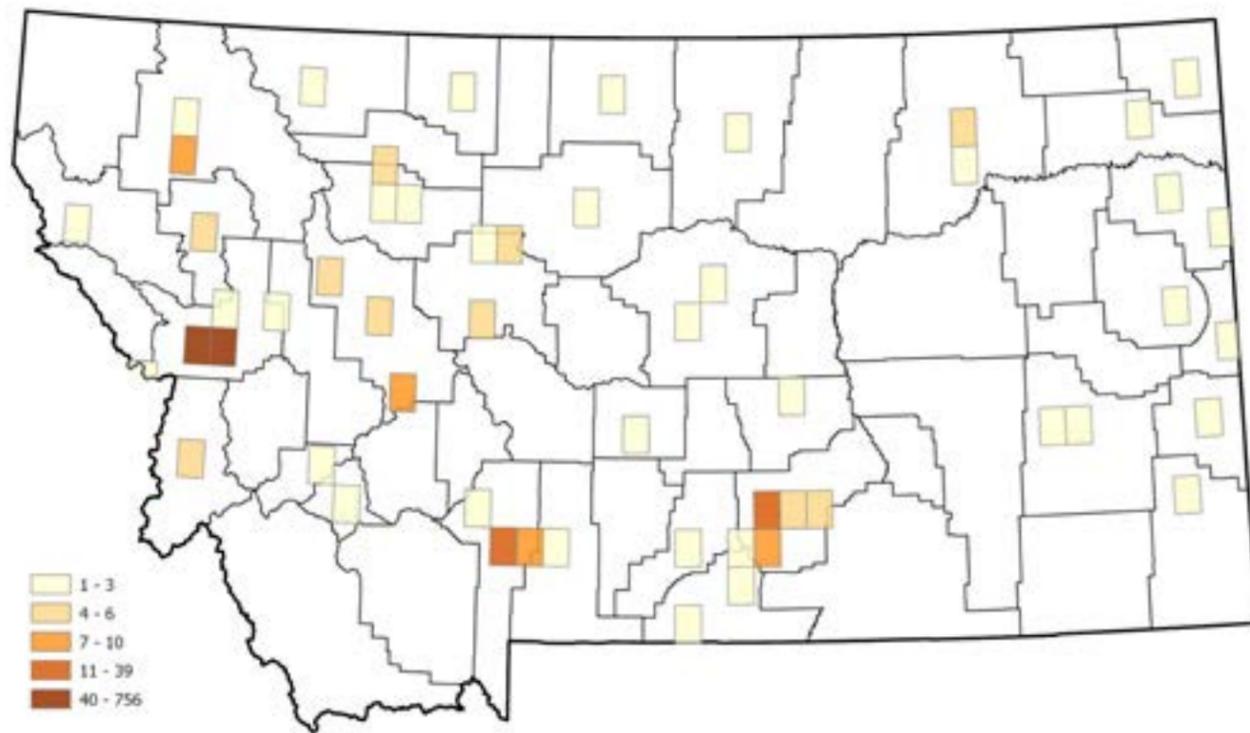


Figure 9. Map of common buckthorn generated from Montana Natural Heritage Program Generalized Observations (2025e).

These results helped justify a statewide noxious weed listing, which currently stands at Priority 2A (Ortega et al., 2019). This classification indicates that common buckthorn is common in isolated areas, which requires eradication or containment in areas of lower abundance (MDA, 2019). Common buckthorn’s current range has likely not been fully documented based on communication with the Working Group and results from the Land Manager Survey (Appendices A and E). Therefore, education and outreach to encourage monitoring and reporting for this species has been an ongoing objective of the Working Group.

In 2018, common buckthorn had been reported in 27 Montana counties (Davis and Mangold, 2018). Now, common buckthorn has been confirmed in 34 of Montana’s 56 counties (MTNHP, 2025e). There is a fair amount of suitable habitat for common buckthorn in Montana, especially in the western side of the state. Figure 10, created by MTNHP, shows the suitability of habitat for common buckthorn in Montana. Although the Natural Heritage models can be helpful

in predicting where common buckthorn might grow in Montana, they are based on statewide biotic and abiotic variables and are not representative of where common buckthorn is currently present. Additionally, the model outputs are not appropriate for spatial scales smaller than shown in Figure 10, which can be challenging for making management decisions and survey planning. Model outputs should not be used in place of on-the-ground surveys for common buckthorn, rather model outputs should be used in conjunction with habitat evaluations to determine the need for on-the-ground surveys.

It’s important to note that the majority of research on common buckthorn in the U.S. has occurred in the midwestern and eastern regions (e.g., Schmidt and Whelan, 1999; Heneghan et al., 2006; Mascaro and Schnitzer, 2007; Grunzweig et al., 2015; Anfang et al., 2019). It’s difficult to predict how common buckthorn will behave across Montana. In the upper Midwest, it commonly invades forest and shrublands, but urban and developed areas are most susceptible (Renz, 2024). Montana likely has heavy environmental

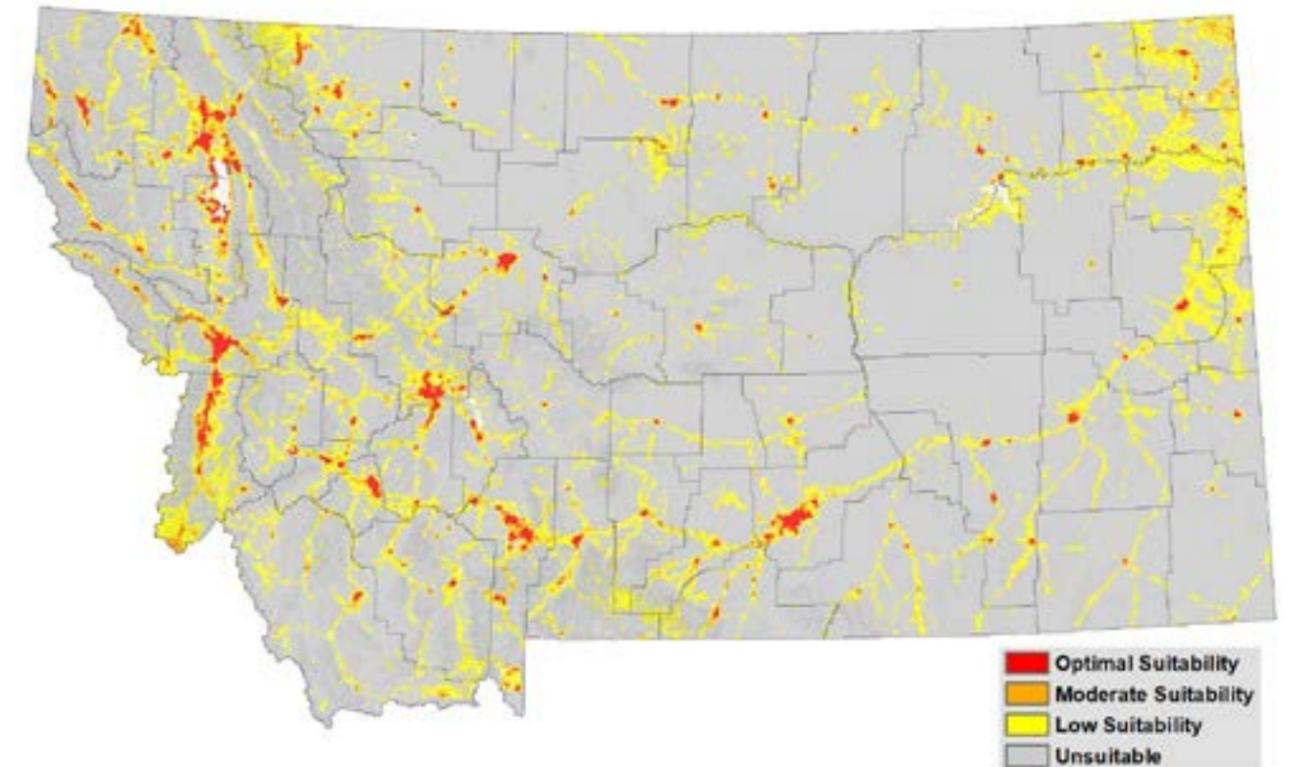


Figure 10. Montana Natural Heritage Program’s (2025b) Suitability Map for common buckthorn. Suitability ranges from low (yellow) to moderate (orange) to optimal (red). Low suitability classification likely represents areas where common buckthorn may occur in scattered or patchy distributions (MTNHP, 2025c). Whereas, moderate to optimal classified areas are more likely to have continuous habitat for common buckthorn (MTNHP, 2025c).

constraints in comparison to midwestern ranges (Renz, 2024). Managers in Montana should be prepared and expect existing populations to continue to grow and spread. However, some substantial knowledge gaps exist, including the complete range of common buckthorn in Montana and its patterns of spread. Specifically, there is a lack of understanding about what is constraining buckthorn’s spread in Montana (Renz, 2024). It would be useful to research what is currently constraining the spread of common buckthorn in the state.

Pathways of Introduction

Common buckthorn was introduced to North America in the late 1700s or early 1800s as an ornamental shrub and for the medicinal use of its berries (Knight et al., 2007; Kurylo and Endress, 2012; Boettcher et al., 2021). In the late 19th century, common buckthorn became a popular hedge plant (Figure 11) in the northeastern U.S. due to its tolerance to many

different climates, soil conditions, and resistance to animal and insect attacks (Boettcher et al., 2021).

Buckthorn spread from human planted locations into the surrounding countryside through natural vectors (Kurylo and Endress, 2012). Common buckthorn reproduces exclusively by seeds (Davis and Mangold, 2018), so birds are likely to be the main vector of non-anthropogenic seed dispersal, especially in long-distance dispersal of seeds (Knight et al., 2007). This ultimately contributes to buckthorn’s ability to establish new populations in sites far from established populations (Knight et al., 2007). However, common buckthorn seed dispersal by vertebrates, particularly small mammals, also occurs frequently (Knight et al., 2007). For example, rodents can disperse buckthorn seeds (Godwin, 1936; Godwin, 1943). Mouse predation of buckthorn seeds may hinder seedling recruitment. However, buried stores of seeds forgotten by rodents will germinate (Godwin, 1936).



Figure 11. Common buckthorn hedge in a residential area of Montana. Photo credit: Josh Wagoner, Montana Department of Agriculture.

Impacts

Common buckthorn is known to have numerous negative impacts when it invades, including impacts to native species, nutrient cycling, crop diseases/pests, and recreation and industry. In Montana, buckthorn appears to suppress native woody overstory and understory species in riparian habitats (Ortega et al., 2019). These impacts are likely exacerbated in disturbed areas, such as urban or urban-adjacent stands (Grunzweig et al., 2015). For example, the invasion of common buckthorn rendered an urban forest (Tiff Nature Preserve in Buffalo, New York) unsuitable habitat for herbivorous insects and their larvae, particularly butterflies and moths (Grunzweig et al., 2015). This could result in negative cascading effects for higher trophic levels, most immediately in the avian community (Grunzweig et al., 2015).

Impacts to Native Species

One impact of common buckthorn invasion is that invading buckthorn frequently outcompetes native species. Common buckthorn effectively competes for light, nutrients, and water, thus outgrowing many plants that attempt to establish beneath it (Boettcher et al., 2021; Davis and Mangold, 2018). Additionally, common buckthorn uses chemical defenses to outcompete native species (Knight et al., 2007). Thus, leading to the reduction and exclusion of native plant species. The presence of buckthorn is often associated with other invasive species, creating a negative feedback loop (Alsum, 2003; Knight et al., 2007). The reduction of native plant species in turn reduces quality habitat and forage for local wildlife (Knight et al., 2007). Transforming riparian habitats from native cottonwoods and shrubs to buckthorn could have dramatic impacts on these highly productive systems with important ramifications for a range of wildlife species. Additionally, common buckthorn fruit is not the preferred food source for native birds and the positive effects of buckthorn as a food source may be offset by its negative effects (Knight et al., 2007). For example, many avian species

experience reduced nesting success due to increased predation in buckthorn stands (Schmidt and Whelan, 1999; Knight et al., 2007). Lastly, common buckthorn potentially facilitates earthworm invasions, creating a positive feedback loop between buckthorn invasion and invasive earthworms (Knight et al., 2007).

Impacts to Nutrient Cycling

The establishment of common buckthorn also has several impacts that affect nutrient cycling and soil health. Common buckthorn leaves have high concentrations of nitrogen (N), more so than other non-N-fixing trees (Knight et al., 2007). High nitrogen inputs from leaf litter can cause a doubling of nitrogen in the soil (inorganic versus organic forms are dependent on density) (Heneghan et al., 2006). Additionally, these high-N leaves decompose quickly, eliminate leaf litter, and expose bare soil (Kollmann and Grubb, 1999; Knight et al., 2007). Rapid decomposition diminishes food sources earlier in the year, ultimately, harming soil arthropods and the mammals and birds which they support (Knight et al., 2007). Not only does common buckthorn increase soil N with its high-N leaves, but it also impacts carbon sequestration (C pools) and soil pH (Knight et al., 2007). Evidence suggests that alterations in soil properties may persist even after buckthorn is

removed (Knight et al., 2007). Additional studies have found that after the removal of common buckthorn, carbon storage is not significantly reduced; however, further research may be needed (Larkin et al., 2014).

Impacts to Crop Diseases

Common buckthorn is also a host for several deleterious insects and diseases that can lead to significant changes in crop production. Common buckthorn is an alternate host of the fungus that causes crown rust of oats and other grasses, which negatively affects yield and quality of oat crops (Bragonier, 1954; Davis and Mangold, 2018). Oat crown rust (*Puccinia coronata* f. sp. *avenae*) can reduce grain yields by 30% (Bragonier, 1954). In addition to oat crown rust, common buckthorn is also a host to soybean aphids (Davis and Mangold, 2018; Lagos-Kutz and Hartman, 2021). Large populations of soybean aphids can reduce soybean yields by up to 40% (Lagos-Kutz and Hartman, 2021). In general, soybeans are an irrigated crop near riparian areas where common buckthorn would be able to thrive. However, studies in the Midwest indicate that preexisting natural predators are effective in



Figure 12. Common buckthorn thicket along a recreational trail. Photo credit: Josh Wagoner, Montana Department of Agriculture.

suppressing soybean aphids (Miksanek and Heimpel, 2019; Miksanek and Heimpel, 2020). Research may be needed to determine if natural predators could suppress aphids in Montana and if that suppression will continue to be effective with further climatic change. In summary, the spread and establishment of common buckthorn would increase the likelihood of deleterious insects and diseases, which, depending on the severity, could lead to small- or large-scale changes in agricultural economics.

Impacts to Recreation and Tourism

The negative impacts of common buckthorn can have serious implications for the recreation and tourism industries. Common buckthorn forms dense and impenetrable thickets (Figure 12) that can reduce accessibility for and satisfaction with recreational activities (e.g., hunting, bird watching, hiking, and foraging) (Davis and Mangold, 2018). In 2023, the outdoor recreation economy contributed to 4.6% of Montana's gross domestic product (GDP), the third highest in the country (Lawson, 2024). The outdoor recreation industry produced 30,920 jobs and \$1.64 billion in wages in Montana in 2023 (Lawson, 2024). A change in Montana's recreational tourism, whether caused by buckthorn invasion or another reason, could have catastrophic effects on the state's economy and workforce. Lastly, dense thickets of common buckthorn can also inhibit timber production, again posing potential threats to Montana's economy. Managers in Montana should expect existing populations to continue to spread and prepare to manage common buckthorn's negative impacts.

Management Strategies

As common buckthorn continues to invade Montana, it is important that managers understand the various management strategies available to them (Appendix B). Early detection and rapid response to eradicate or contain common buckthorn infestations is highly recommended (Davis and Mangold, 2018). Some common buckthorn management methods include

hand pulling, goat grazing, herbicide application, and prescribed fire. Common buckthorn management needs to be implemented with multiple methods and always followed up with monitoring (Schuster, 2024a; Schuster, 2024b). Additionally, managers should plan for repeat treatments and revegetation as follow-up is the key to success (Schuster, 2024a; Schuster, 2024b).

Hand Pulling and Mowing

Common buckthorn infestations with low density and small (< 3/8 in. or < 9.5 mm stem diameter) plants can be removed by hand or with a hand tool (Bernhardt et al., 2022). Typically, the best time to remove and treat common buckthorn is in the late fall; however, hand pulling may be easiest in the spring due to moist soils (Bernhardt et al., 2022). It is best to time removal before plants go to seed. Although mowing has become a common management practice due to common buckthorn's invasion of understories (Anfang et al., 2019), it is not a recommended treatment. It was previously thought that mulch, created as a mowing byproduct, inhibited the regeneration of common buckthorn seedlings (Anfang et al., 2019). However, mowing has ultimately been found to increase light availability (even with mulch byproduct creation), stimulating germination success and growth rate of buckthorn regeneration, potentially at even higher rates than prior to mowing treatment (Anfang et al., 2019). Consider following up any manual or mechanical removal practices with spot herbicide treatments for better success.

Goat Grazing

Common buckthorn patches in hard-to-reach areas are sometimes managed by goat grazing (Bernhardt et al., 2022). However, the use of goat grazing and its effectiveness is still not completely understood as a means of common buckthorn management (Bernhardt et al., 2022). One study found that only 2% of buckthorn seeds remained intact after passing through goat digestive tracts and of the 2%, only 11% remained viable (Marchetto et al., 2020). The study also found that larger seeds (> 3/20 in. or > 4 mm in length) were less likely to pass the gut intact (Marchetto et

al., 2020). However, managers using goat grazing as a common buckthorn management method should keep in mind that goats don't selectively eat only buckthorn (Bernhardt et al., 2022). Another study on periodic browsing by goats over a 3-year period found that after 5 browsing periods, 66% of common buckthorn stems had at least partial bark stripped and some of intermediate-sized (0.8–2.3 in. or 20–60 mm) buckthorn were top-killed, presumably from bark stripping (Mundahl and Walsh, 2021). This study also found that buckthorn densities were reduced by 90% mostly from browsing on small (< 0.8 in. or < 20 mm diameter) buckthorn and more than 90% of second-year buckthorn plants were browsed (Mundahl and Walsh, 2021). Therefore, goat grazing may be an effective management strategy for stands of young buckthorn if there is repeated periodic browsing over multiple years (Mundahl and Walsh, 2021; Bernhardt et al., 2022). Sheep grazing may have similar outcomes to goat grazing. However, more research on sheep grazing as a common buckthorn management strategy is needed (Bernhardt et al., 2022). Although goat grazing may be effective for smaller buckthorn stands, herbicide treatment is likely necessary to manage large, reproductive stands of common buckthorn (Mundahl and Walsh, 2021).

Herbicide Application

Aside from hand pulling, herbicide application is one of the most common and effective management tools for common buckthorn. Foliar herbicide application (including but not limited to aminopyralid, glyphosate, triclopyr, or triclopyr plus 2,4-D) is likely to offer the most reliable control over dense patches of small common buckthorn plants (Davis and Mangold, 2018; Anfang et al., 2019). Although common buckthorn management can occur at any time of the year, it is recommended to perform foliar spraying in late fall to minimize the risk of damage to desirable vegetation (Davis and Mangold, 2018; Missoula County, 2024). Cutting or girdling buckthorn without subsequent herbicide treatment can result in the development of new shoots on the shrub (Davis and Mangold, 2018). Therefore, high density and large common buckthorn plants should be managed with a combination of mechanical and chemical control,

such as the cut-stump method (Davis and Mangold, 2018; Bernhardt et al., 2022). Herbicide should be applied to living tissue. Medium-sized common buckthorn (stems up to 6 in. or 15.25 cm in diameter) can be treated with a basal bark herbicide application, whereas large individuals (stems > 6 in. or 15.25 cm in diameter) should be treated with a cut-stump and herbicide treatment (Davis and Mangold, 2018). It is also recommended to use systemic herbicides, such as glyphosate, to kill common buckthorn root systems; however, glyphosate is non-selective and should be used cautiously to avoid harming desired vegetation (Davis and Mangold, 2018). Always read and follow the label.

Prescribed Fire

Occasional prescribed fire will not eliminate common buckthorn, but repeated burns or integration with herbicides can be effective (Davis and Mangold, 2018). Burning stimulates common buckthorn seedling germination, but with five to six years of consistent burning it can reduce buckthorn seedbanks (Panke and Renz, 2012). Five seconds of flame application with a propane torch at the stem will kill plants 2 in. (5 cm) or less in diameter (Panke and Renz, 2012). However, burning buckthorn trees requires a hot fire and in a forest setting, fire intensity is often limited by little to no fuel on the forest floor due to dense shading and competition from buckthorn (Schuster et al., 2024). In grasslands, it's likely to only top-kill established plants and there will be resprouts (Schuster, 2024a).

Biological Control

Thus far, attempts to identify a viable and specific biological control agent for common buckthorn have been unsuccessful due to lack of host specificity (Gassmann et al., 2012; Gassmann and Toševski, 2014; Ricklefs and Riddle, 2024). Further research is likely necessary to find an effective biocontrol method for common buckthorn management.

Revegetation

Regardless of the control method used, active revegetation is recommended after common buckthorn management (Anfang et al., 2019). Revegetation suppresses reinvasion of common buckthorn after removal and/or treatment (Wragg et al., 2021). Additionally, active revegetation and restoration at common buckthorn removal sites increases plant diversity (Larkin et al., 2014). Revegetation is highly recommended at all common buckthorn removal sites; however, revegetation may be most necessary in less acidic, clay soils (Wragg et al., 2021). After a one-time restoration effort, enhanced ecosystem function and services may not be observed as years of ongoing, active management are necessary to reach this level of benefit (Larkin et al., 2014). Although it is crucial to swiftly establish vegetation that offers cover and prevents erosion, it is equally important to preserve the genetic integrity and ecological interactions found in the locally adapted populations (Lesica and Allendorf, 1999). When revegetating, it is recommended to use as many genotypes and as much genetic variation as possible (i.e., collect seeds from many different habitats), especially if the disturbance from buckthorn was severe (Lesica and Allendorf, 1999). It is also recommended to use local genotypes, if possible, especially at large sites; however, genetics are not the only important factor to consider while revegetating, cost and availability are also crucial factors (Lesica and Allendorf, 1999).



Photo Credit: Patrick Breen, Oregon State University, Bugwood.org

RUSSIAN OLIVE (*ELAEAGNUS ANGUSTIFOLIA*)

Species Overview

Russian olive (*Elaeagnus angustifolia*) is a non-native tree with silvery foliage (Figure 13); leaves are lanceolate and smooth-edged. The stems (Figure 14) of Russian olives are red-brown in color and have thorns 1–2 in. long (approximately 2.5–5.0 cm). Leaves and thorns are alternately arranged on the stem. Small flowers (Figure 13) bloom in early spring through early summer, and are often clustered near the base of the leaves. Mature trees (age dependent on geography; likely > 7 years in Montana, but could occur as early as 4 years) bear a hard, olive-like fruit (Figure 15), which mature in late

summer (Lesica and Miles, 2001a). The bark of older Russian olives becomes increasingly ridged or sometimes shredded in appearance (Figure 16). The average life span of a Russian olive tree is around 50 years (Pearce and Smith, 2001). The root system of the Russian olive includes extensive vertical and horizontal growth (Lesica and Miles, 2001a), extending to 40 feet (12.2 m) deep (Forest Service, 2014).

Russian olives primarily reproduce via seed, with dispersal via river flow transport and wildlife (Olson and Knopf, 1986a; Olson and Knopf, 1986b). Germination may occur under varied conditions (e.g., varied seasonality, light and moisture availability) (Shafroth et al., 1995) and viability is estimated at up to 3 years (Pearce and Smith, 2001).



Figure 13. Flowering Russian olive. Photo credit: Paul Wray, Iowa State University, Bugwood.org. 2025c).



Figure 14. Russian olive thorns. Photo credit: Joseph Berger, Bugwood.org.



Figure 15. Russian olive fruits. Photo credit: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org.



Figure 16. Variability in the bark of a mature Russian olive. Photo 5500219 credit: T. Davis Sydnor, The Ohio State University, Bugwood.org. Photo UGA2307050 credit: Patrick Breen, Oregon State University, Bugwood.org.

An additional study found that 28-year-old seeds stored in ambient, dry conditions retained high (77%) viability (Scianna et al., 2012). The results from Scianna et al. (2012) indicate that in situ viability greater than 3 years is possible and further testing is necessary. Results from Muscha et al. (2023) indicate that viability and germination success can be severely reduced with the introduction of fire and at increasing fuel loads.

Russian olives are notably tolerant of a variety of conditions (Table 1). Russian olive can thrive in upland areas (even with minimal annual rainfall) (Carman and Brotherson, 1982; Laursen and Hunter, 1986; Stannard et al., 2002) and wet-saline soils (Stannard et al., 2002; Scianna, 2016). Its nitrogen-fixing capability allows it to tolerate poor soil quality and low mineral content (Forest Service, 2014; Pokorny et al., 2020). Additional nitrogen from Russian olive does not benefit other trees; they are gaining nitrogen from other sources and ultimately competing with Russian olive for nutrients (DeCant, 2008). While it can thrive in soils with greater sodium

content (i.e., sodic soils), it's likely to be outcompeted by saltcedar, if present, in these areas (Carman and Brotherson, 1982). If damaged, Russian olives are also capable of re-sprouting from exposed roots or at the trunk (Lesica and Miles, 2001a).

Table 1. Ecological tolerances of Russian olives, ranging from Low to High. Produced with adaptation from Pearce and Smith, 2001.

Criteria	Russian Olive Tolerance
Shade	Moderate
Salt	High
Drought	High
Flooding	Moderate
Ice Damage	Low
Fire	High
Flow Regulation	High

Its life history traits (e.g., deep root systems, tolerance to less-than-ideal conditions, and seed dispersal mechanisms) are what made Russian olive a likely choice for shelterbelt plantings in previous decades. However, those traits are also why it is so invasive and outcompetes native species.

Extent of Range/Habitat Suitability Index

Native Range

Russian olive's native range (Figure 17) occurs across much of western Asia, Russia, and Mediterranean countries (Little, 1961; Bartha and Csiszár, 2008). It primarily occupies riparian or coastal habitats

(Zouhar, 2005; Katz, 2016) within its native range. Often noted for its effectiveness in erosion control (Stannard et al., 2002; Katz and Shafroth, 2003), as wildlife habitat (Borrell, 1962), and for its hardiness to dry conditions (Borrell, 1962), Russian olive has been knowingly introduced around the world. It is noted to thrive in a broad range of soil and hydrological conditions (Little, 1961; Borrell, 1962; Elias, 1980).

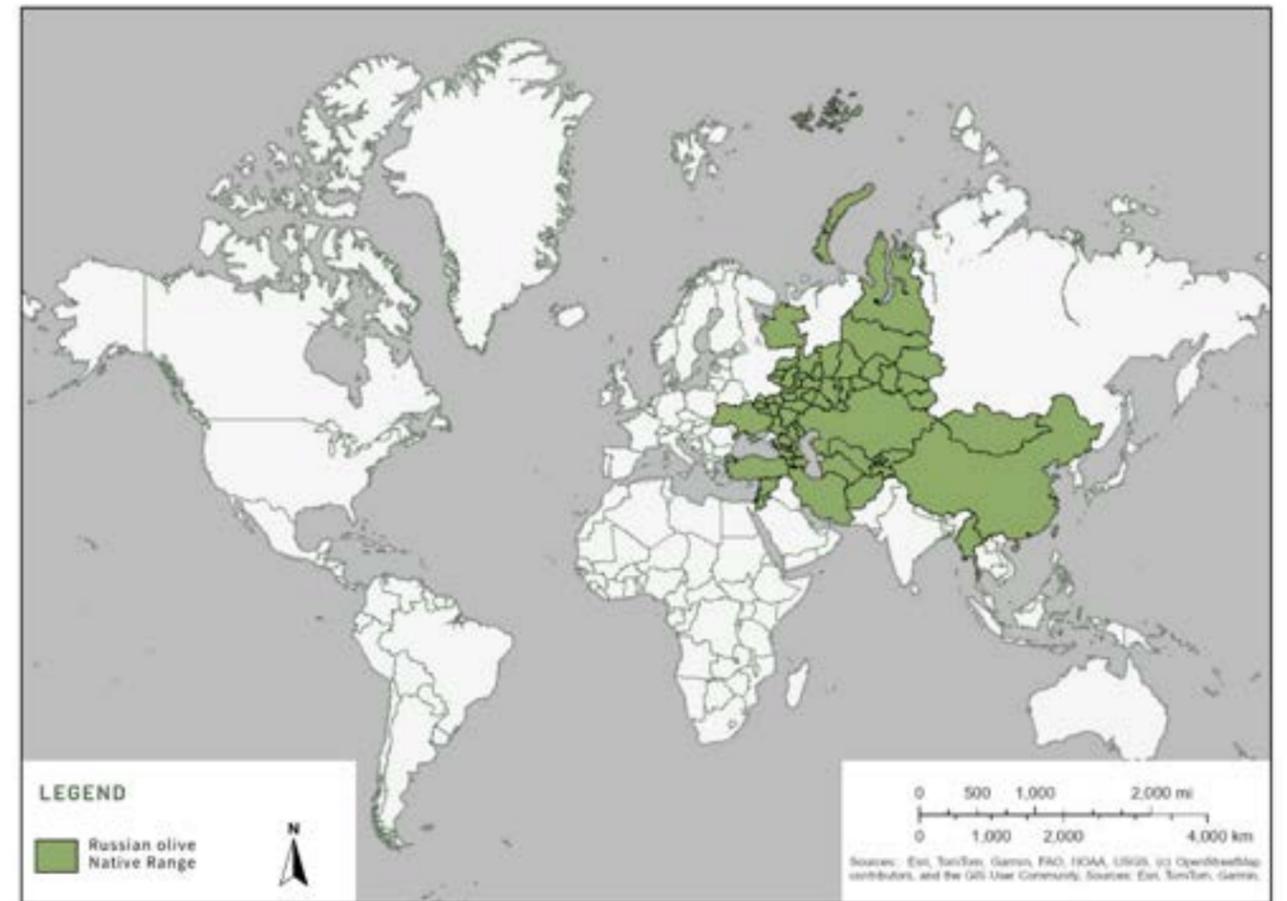


Figure 17. Russian olive's native range developed from World Flora Online (2025a) database. Range within Russia is provided at the Republic scale to better represent geographic scope.

Invasive Range

Horticultural intent has largely driven the introduction of Russian olive outside its native range (Figure 18). Purposeful plantings have likely led to naturalization of Russian olive in central European and northern African countries (Bartha and Csiszár, 2008). Russian olive was originally introduced to North America prior to 1900 (Knopf and Olson, 1984) as an ornamental plant for its silvery foliage and noted hardiness in the northern Great Plains and Rocky Mountains (Little, 1961). Friedman et al. (2005) identified Russian olive as the fifth

most dominant riparian species in the western United States; an achievement reached within just 100 years after its introduction. It occurs in most Canadian provinces and this is largely attributed to introduction via the Canadian Government’s Prairie Shelterbelt Program (De Clerck-Floate and Weyl, 2024). Much like in the North American invaded range, Russian olive has formed monocultures in the Argentinian riparian areas of the Río Negro valleys (Klich, 2000).

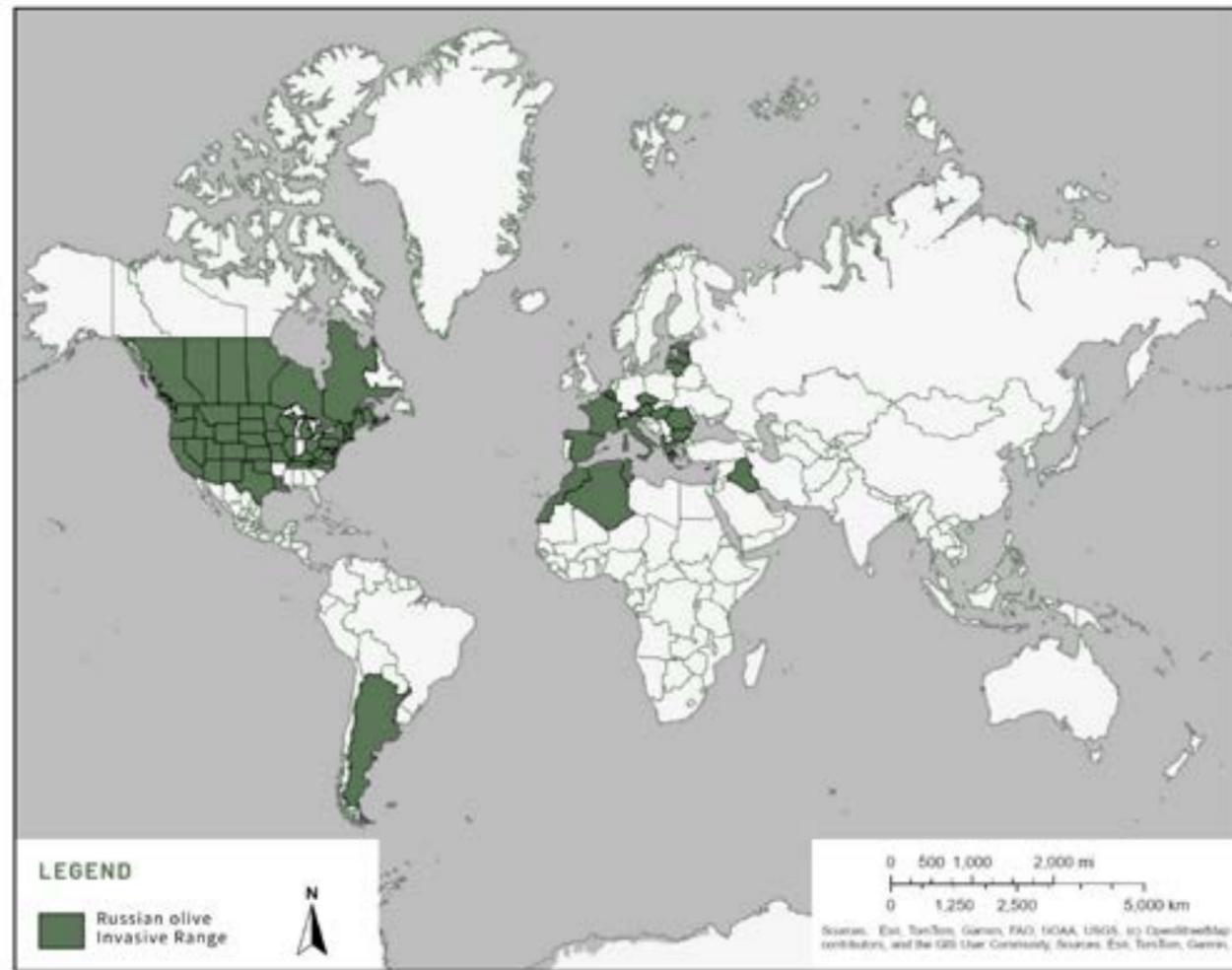


Figure 18. Russian olive’s invasive range developed from records in the World Flora Online (2025a) and Global Biodiversity Information Facility (2025a) databases. Range within North America is represented at the state/provincial scale to better represent geographic scope.

Range within Montana

Russian olive has commonly been planted as a windbreak or shelterbelt species across Montana (Lesica and Miles, 2001a). Today, Russian olive (Figure 19) is also present as a dominant or sub-dominant species in multiple riparian areas (Lesica and Miles, 1999; Lesica and Miles, 2001a). This is no surprise as significant correlation has been identified between nearby Russian olive plants in upland areas and plants present in riparian areas (McShane et al., 2015), indicating impact on dispersal. Dense stands of Russian olive occur along the Yellowstone River and its tributaries, as well as along the Marias, Musselshell, Milk, Missouri, and Sun Rivers (Hansen et al., 1995; Lesica and Miles, 1999; Lesica and Miles, 2001a; Zouhar, 2005; Combs and Potter, 2011; Nagler et al., 2011; USACE and YRCDC, 2015). In some areas, Russian olive occurs in intermixed stands

with native riparian species (Katz and Shafroth, 2003). Russian olive is currently listed as a state Priority 3 regulated weed (MDA, 2019). Priority 3 species are not considered noxious. However, they are prohibited for resale or distribution as they have potential for significant negative impacts (MDA, 2019). Russian olive has received noxious status in both Missoula and Treasure Counties (MDA, 2024; Missoula County, 2024).

Shafroth et al. (2010) indicated that neither Russian olive nor saltcedar have fully occupied their potential ranges in the U.S. However, more recent state-focused habitat suitability models (Figure 20) show that Russian olive now occupies most of the areas with moderately to optimally suitable habitat (MTNHP, 2025c) across the state. Montana is near the northern limit of Russian olive’s range (Lesica and Miles, 2001a), and now occurs in most counties of the state (MTNHP, 2025a; EDDMaps, 2025). Russian olive is locally dominant, forming dense thickets (Figure 21) in Montana’s riparian areas

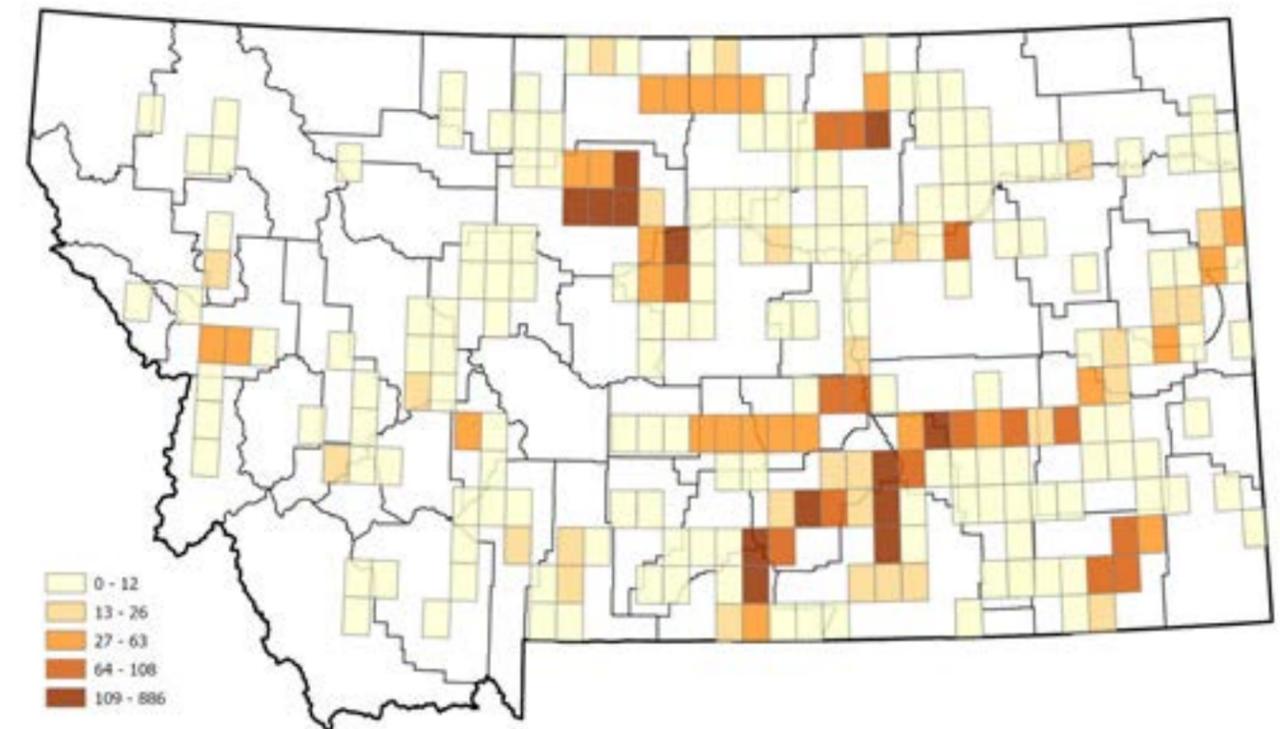


Figure 19. Map of Russian olive generated from Montana Natural Heritage Program Generalized Observations (2025a).

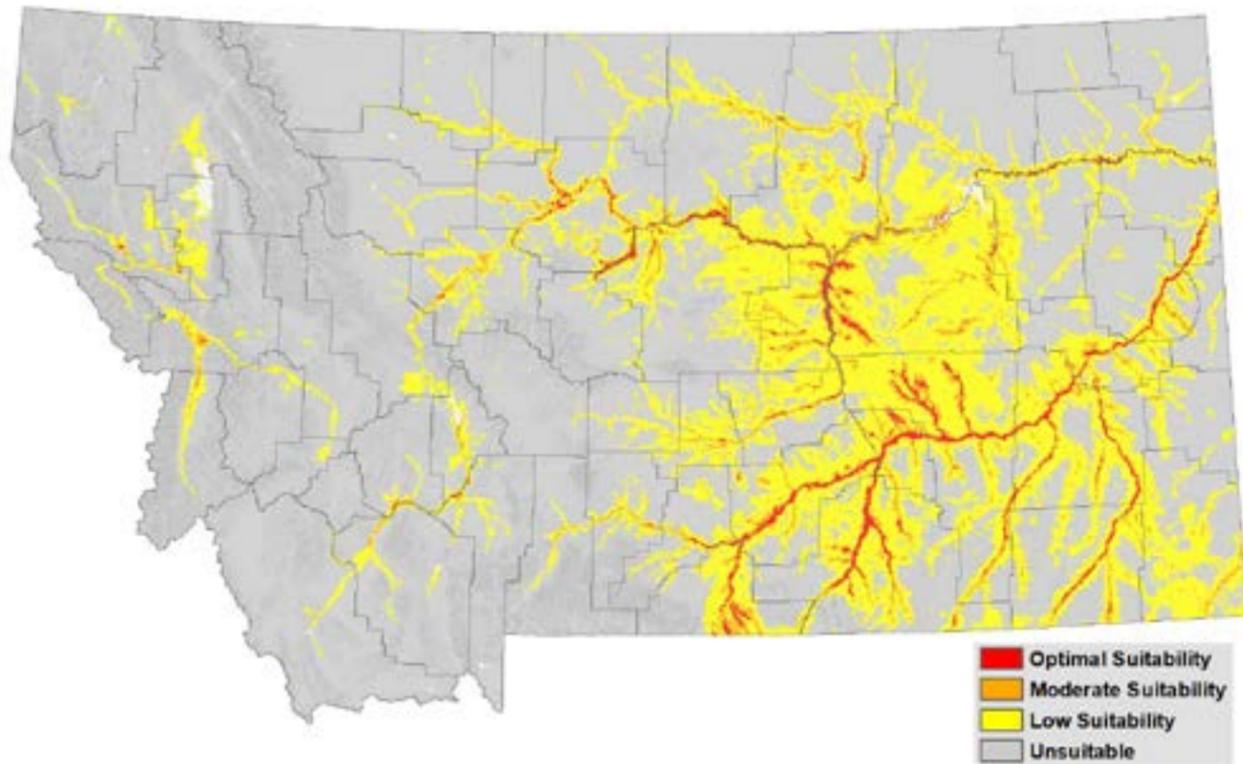


Figure 20. Habitat suitability map (MTNHP, 2025c) of Russian olive. Suitability ranges from low (yellow) to moderate (orange) to optimal (red). Low suitability classification likely represents areas where Russian olive may occur in scattered or patchy distributions (MTNHP, 2025c). Whereas, moderate to optimal classified areas are more likely to have continuous habitat for Russian olive (MTNHP, 2025c).

(Pearce and Smith, 2001; Zouhar, 2005; Nagler et al., 2011; Lesica et al., 2012). Along the lower Marias River, Lesica and Miles (1999) found that the most abundant occurrences of Russian olive were near domesticated plantings. Later results from the Milk River (Pearce and Smith, 2001) further imply dispersal from intentional plantings, where researchers reported that Russian olive outnumbered native plains cottonwood (*Populus deltoides*) across the basin. It is especially aggressive in abandoned channels and islands, occupying approximately 4,600 acres (1,862 ha) of the Yellowstone River's 100-year floodplain. Lesica and Miles (2001a) calculated Russian olive densities on the Marias and lower Yellowstone Rivers to average 186 trees and 676 trees per hectare (equivalent to 2.5 acres), respectively. The most densely covered area surveyed on the Yellowstone had 5,120 Russian olives in a single hectare (Lesica

and Miles, 2001a).

Pathways of Introduction

Since its initial introduction, Russian olive plantings were encouraged by land management agencies for shelterbelt usage. By the mid-2000s, NRCS had removed it from the Montana preferred plant list (Montana Audubon, 2010a) and YRCDC recommended that it not be planted in the Yellowstone River Valley and further called for control and eradication of existing plants (Montana Audubon, 2010a; Pick, 2013). The DNRC committed to ceasing the sale of Russian olive through their nursery stock (Montana Native Plant Society, 2008; Montana Audubon, 2010a; Montana Audubon, 2010b), and interest groups petitioned for statewide regulation (Montana Native Plant Society, 2008;

Montana Audubon, 2010a; Montana Audubon, 2010b). These initiatives were taken due to the spread of Russian olive and its impacts to Montana's major river systems and their tributaries.

Upland windbreak plantings have been found to increase further establishment of Russian olives in riparian corridors (Lesica and Miles, 2001a; Pearce and Smith, 2001). Short- and long-distance dispersal occurs via birds and other wildlife (Olson, 1974; Pearce and Smith, 2001; Edwards et al., 2014; Campbell and West, 2022). Seed viability after digestion and dispersal occurs at varying rates and distances depending on the species. For example, Edwards et al. (2014) found that European starlings (*Sturnus vulgaris*) readily fed on Russian olive seeds, but often regurgitated them within 30 minutes, maximizing the estimated distance of dispersal at 25 miles (approximately 40 km) from the origin

tree. The results of testing indicated that seeds consumed by European starlings had a positive impact on germination success (Edwards et al., 2014). Comparatively, Campbell and West (2022) found that coyotes (*Canis latrans*) and porcupine (*Erethizon dorsatum*) also ingest Russian olive seeds. Their study determined that, in comparison to control seed germination (71% germination at site 1 with 21.55 ± 1.36 days to germination), seeds ingested by porcupines germinated at approximately the same rate (60% germination at site 1 with 20.45 ± 0.83 days to germination) and those ingested by coyotes germinated at a greater rate (94% germination at Site 1 with 11.17 ± 0.38 days to germination). The researchers (Campbell and West, 2022) indicated that coyotes are more likely than porcupines to contribute to long-distance dispersal (discussion factored in home range size, distance travelled daily,



Figure 21. Dense Russian olive growth (with a range of age classes present) along the Yellowstone River. Photo Credit: Jennifer Muscha, USDA-ARS, Livestock and Range Research Laboratory, Miles City, Montana.

and number of bowel movements daily). Furthermore, beavers (*Castor canadensis*) tend to select against Russian olive for forage, and favor plains cottonwoods (Lesica and Miles, 1999; Lesica and Miles, 2004a). Channel catfish (*Ictalurus punctatus*) (Cheek et al., 2024) and common carp (*Cyprinus carpio*) (Heinrich et al., 2021) are considered effective dispersal agents of Russian olive seeds. Once established in riparian areas, dispersal of Russian olive is also facilitated via water and ice transport (Pearce and Smith, 2001; Stannard et al., 2002).

Impacts

Once celebrated for its hardiness, effectiveness in shelterbelts, and habitat value for wildlife (Van Dersal, 1939; Laursen and Hunter, 1986), we now know Russian olive's impacts (e.g., dominance of riparian corridors, outcompeting native species, channelization of streams and rivers, reduced water quality) outweigh those perceived gains.

Native Plant Communities and Soil Dynamics

Native plant communities are impacted by Russian olive's presence (Katz and Shafroth, 2003; Reynolds and Cooper, 2011; Katz, 2016) and its management or removal (Katz and Norton, 2016; Tuttle et al., 2016; Espeland et al., 2017). The degree to which these impacts occur is lacking in peer-reviewed literature (Shafroth et al., 2010; Katz, 2016). Often, Russian olive is associated with higher instances of non-native species (Katz and Shafroth, 2003; Reynolds and Cooper, 2011; Katz, 2016), particularly in understory growth (Tuttle et al., 2016). Non-native species associated with Russian olive include but are not limited to brome (*Bromus japonicus*, *B. inermis*) (Reynolds and Cooper,

2011; Tuttle et al., 2016), Russian knapweed (*Rhaponticum repens*) (Mahoney et al., 2019), purple loosestrife (*Lythrum salicaria*) (Holroyd and Eberts, 2000), and cheatgrass (*Bromus tectorum*) (Knopf and Olson, 1984). Overall impacts to plant communities are likely to vary greatly between ecosystems with light and water availability playing a critical role (Tuttle et al., 2016).

Russian olive leaf litter contributes to greater soil N levels and higher available organic matter (DeCant, 2008; Follstad Shah et al., 2009; Katz, 2016). Nitrogen levels are higher in monotypic stands of Russian olive as compared to mixed stands with cottonwoods (Tuttle et al., 2016). In upland settings, Russian olive leaf litter decomposes at faster rates than native leaf litter (Katz, 2016). However, the opposite occurs at riparian sites.

Water Quality and Stream Dynamics

Russian olive's leaf litter contributes to inefficiencies in organic matter processes in streams (Royer et al., 1999; Mineau et al., 2011; Mineau et al., 2012). Specifically, efficiency (measured as a ratio of ecosystem respiration to organic matter input) could be reduced by up to 14% where Russian olive infestations occur (Mineau et al., 2012). In this study, the researchers found that while benthic organic matter from the influx of Russian olive leaf litter increased nearly four times over, respiration remained the same, signaling an overarching stress to the system (Mineau et al., 2012).

High water consumption has, historically, been of prime concern with Russian olive and saltcedar invasions (Shafroth et al., 2010). However, research (Shafroth, 2010; Nagler et al., 2021) indicates that Russian olive likely uses (via evapotranspiration) similar quantities to native riparian species (e.g., cottonwoods and

willows) (Figure 22). Water savings after woody invasive removal efforts is often found to be temporary unless chronic woody and weedy vegetation removal is conducted (Huddle et al., 2011). Therefore, woody invasive management should be motivated by more than recovering water yields alone (Nagler et al., 2021).

Russian olive establishment along rivers facilitates channel narrowing, and triggers channel incision (Reynolds et al., 2014; Scott et al., 2018). When Russian olives are removed from stream adjacent locations, fluvial processes may be restored with a reduction in channelization (Jaeger and Wohl, 2011). However, these results (conducted in Arizona) are likely to be highly variable due to spatial and temporal factors (Jaeger and Wohl, 2011).

Wildlife and Livestock

For decades, Russian olive has been promoted for its ability to provide wildlife habitat and structure, particularly for avian species (Van Dersal, 1939; Borell, 1962; Knopf and Olsen, 1984). Pervasive public perceptions of Russian olive management efforts and its potential impact to winter habitat (upland game birds being of particular concern) exist. However, research has found that when it occurs in monotypic stands, habitat value and use is not equivalent to that of mixed (native/Russian olive) or native stands (Mahoney et al., 2019). Forage of Russian olive seeds as well as nesting use and success is likely to vary widely

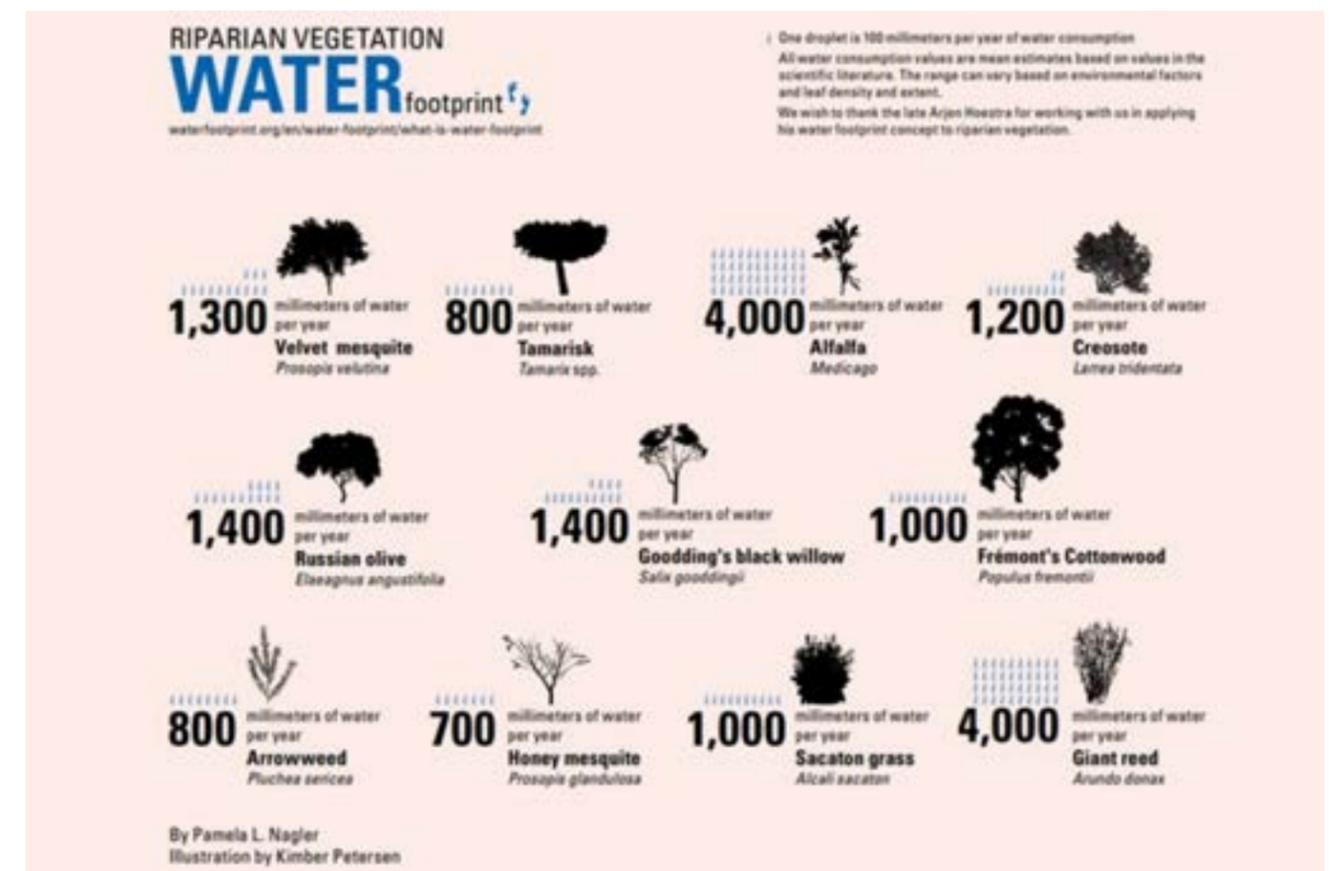


Figure 22. An overview of water consumption with common Southwestern riparian species. Species known to occur in Montana include alfalfa, saltcedar/tamarisk, and Russian olive. Other species of the genera *Salix* and *Populus* are found in Montana. While this was not developed for Montana riparian galleries, the data supports that Russian olive is not a high water consumer in comparison to other riparian species. Figure copied directly from Nagler et al., 2021.

among avian species (Katz and Shafroth, 2003; Shafroth et al., 2010). For example, Stoleson and Finch (2001) found mourning doves (*Zenaidura macroura*) and yellow-breasted chats (*Icteria virens*) preferred nesting in Russian olive but cavity nesters are absent. Additional research suggests that nest predation may be greater in Russian olive stands due to greater density of corvids, e.g., black-billed magpies (*Pica hudsonia*) and American crows (*Corvus brachyrhynchos*) (Knight and Fitzner, 1985; Gazada et al., 2002). Nest parasitism by cowbirds was also more likely to occur in Russian olives (Stoleson and Finch, 2001). Furthermore, Mahoney et al. (2019) found that fewer species made use of Russian olive stands in the breeding season in Utah. They also found that species using monotypic Russian olive stands differed from those using mixed stands of native and non-native trees. These results suggest that mixed vegetation stands provide more diverse habitat structure and forage than Russian olive stands, ultimately supporting greater biodiversity (Mahoney et al., 2019). However, they caution that occupancy studies do not properly assess habitat quality and further study is necessary. Impacts from Russian olive on avian communities are likely to vary widely from site to site (Katz, 2016).

Russian olive has been shown to facilitate the continued presence and increased abundance of piscine invasive species. Heinrich et al. (2021) report the 4x increase in the abundance of common carp population observed since the early 1970s in Deep Creek, Idaho could not be sustained, according to bioenergetic modeling, without the nutrient subsidy provided by Russian olives. Similarly, a species-specific bioenergetic model determined that Russian olive drupes contributed 35.6% of energy and satisfied 38% of metabolic demand in channel catfish residing in the San Juan River in the southwestern U.S., regardless of time of year or

benthic aquatic invertebrate availability (Cheek et al., 2024).

Few studies provide conclusive insight on resident arthropod communities and their abundance and diversity within stands dominated by Russian olive (Shafroth et al. 2010). In a study completed in British Columbia, Collette and Pither (2015) found that thrips (flying insects in the family Thripidae) occurred in abundance on Russian olive whereas flies (families Chloropidae and Heleomyzidae) and true crickets (family Gryllidae), while also unique to Russian olive observations, were present but significantly less abundant. West et al. (2023) attributed greater variation in arthropod relative abundance but not in species richness or diversity to plant physical/structural and compositional changes in Russian olive removal plots vs. plots where established Russian olive plants remained undisturbed. Arthropod diversity or lack thereof could be driving impacts to and activity of other taxa (e.g., insectivores) within these sites.

Grazing livestock and other ungulates are largely impacted by reduction in biomass production for grazing caused by Russian olive. Dense growth of Russian olive can also impede access to water (Espeland et al., 2014). Russian olive is non-toxic and largely not palatable to livestock, especially mature trees (Pearce and Smith, 2001; Zouhar, 2005).

Irrigation Infrastructure

Woody invasive species, like Russian olive, can be detrimental to irrigation infrastructure (Shafroth et al., 2010). Clearing the canals of woody invasives is imperative to maintain flow, water quality, and access. Regular monitoring and maintenance to repair damaged infrastructure can be chronic where infestations occur (Shafroth et al., 2010). Few peer-reviewed

studies on the direct impacts of Russian olive on irrigation infrastructure in North America are available.

Management Strategies

A wide array of management strategies (Appendix C) may be employed on Russian olive stands with varying success. Considerations for each option should be made based on the location, its cultural importance, and any potential non-target impacts. An integrated approach where multiple strategies are utilized over time with frequent monitoring is widely regarded as the best plan of action (Combs, 2010; Shafroth et al., 2010; Pick, 2013; Stannard et al., 2022; Cisneros, 2024; Leary, 2024). Frequent monitoring for seedling establishment and re-sprouts should be conducted at project sites and on adjacent properties and treated appropriately (Combs, 2010). Length of time and effort for monitoring removal sites should be included in all funding requests (Cisneros, 2024; Leary, 2024).

Herbicide

Herbicide is a common management strategy for Russian olive, and often combined with mechanical approaches (Stannard et al., 2002; Pokorny et al., 2020). There are different application methods depending on tree size, density, and project location (Combs, 2010; Shafroth et al., 2010; Pick, 2013). Basal bark applications, where herbicide is sprayed directly on the entire circumference of the stem, is most appropriate for young Russian olives [stem diameter < 3 in. (7.5 cm)] (Stannard et al., 2002; Combs, 2010; Forest Service, 2014). Basal bark applications can occur year-round (Forest Service, 2014), but should not be conducted when the bark is wet, frozen, or under frost (Combs, 2010). Foliar (herbicide applied

broadly to canopy) applications are effective for young Russian olives [< 6 ft (approximately 1.8 m) in height] and should be conducted during the active growing season (Forest Service, 2014). For larger trees, aerial (helicopter, fixed-wing plane, or drone) foliar applications may be appropriate (Forest Service, 2014). This may be the only option in remote areas where ground transportation to the site is difficult. For older Russian olives, the cut-stump method is a common practice, where a sawyer cuts the tree at ground level and an applicator follows to apply herbicide immediately to the stump (Forest Service, 2014). Herbicide should be applied to living tissue. Great care should be taken so the sawyer does not outpace the applicator (Cisneros, 2024); the stump should be cleaned of any residual sawdust prior to application (Forest Service, 2014). This method (Figure 23) can also be applied using a tree shear implement attached to a skidsteer or other similar equipment. Cut-stump treatments are effective year-round so long as the herbicide does not freeze when applied (Combs, 2010). However, for best results, avoid cut-stump treatments during the active growing season.

Girdling may be used in the summer where horizontal cuts are made through the bark and cambium around the entire trunk to reveal a 3–4 in. (7.5–10 cm)-wide belt where herbicide is then applied (Forest Service, 2014). Herbicide can also be injected with industry hatchet or injection applicators (Forest Service, 2014).

Effective herbicides include but are not limited to imazapyr, triclopyr with basal bark oil, aminopyralid, and glyphosate (Stannard et al., 2002; Combs, 2010; Shafroth et al., 2010; Pick, 2013).



Figure 23. Rather than employ an on-foot sawyer for very large Russian olives, a shear implement on a skidsteer may be utilized for the cut-stump method. In this application, the operator will apply herbicide with the skidsteer implement or an applicator may follow on foot to apply herbicide directly to the stump. Photo Credit: Jennifer Muscha, USDA-ARS, Livestock and Range Research Laboratory, Miles City, Montana.

Each herbicide has its caveats for effectiveness and often timing is critical (Stannard et al., 2002; Shafroth et al., 2010). For example, glyphosate is nonselective and should be used carefully to mitigate any non-target impacts (Shafroth et al., 2010), such as in spot treatments or injections (Forest Service, 2014). Use caution with imazapyr as it can persist and be mobile in the soil (Douglass et al., 2016). Always follow the label to avoid non-target impacts. Triclopyr is used in basal bark or cut-stump methods (Stannard et al., 2002; Combs, 2010; Shafroth et al., 2010). However, when paired with 2,4-D, triclopyr may be used in foliar applications (Stannard et al., 2002). Imazapyr is appropriate for use in cut-stump, injection, or girdling applications for larger plants or in foliar applications for seedlings and saplings (Forest Service, 2014). It is critical to read and follow the manufacturer's label on any herbicide

applications. Herbicide applications must be thorough for success (Shafroth et al., 2010).

Mechanical Removal

Young saplings (Figure 24) may be pulled by hand or with a weed pulling tool (DiTomaso et al., 2013; Pick, 2013). However, this method is labor and time intensive in even small patches. Mowing saplings can be a quick (although indiscriminate) management strategy, but will need to be repeated yearly (Stannard et al., 2002). Mowing is not feasible when stems are greater than 1 in. (2.5 cm) in diameter (Stannard et al., 2002). Mechanical interventions without complete removal (e.g., girdling, cutting, incomplete pulling) or coinciding herbicide treatment may trigger root or stump sprouts (Stannard et al., 2002). Re-sprouts are likely to develop multiple stems and, without intervention, produce dense

growth that is increasingly difficult to treat later (Combs, 2010). Full mechanical removal may be best employed in non-riparian areas due to the severity of ground disturbance (Pick, 2013). It has been found that removing whole plants may result in restored channel morphology and re-widening; these results, however, are expected to be highly variable on site location (Jaeger and Wohl, 2011).

After mechanical interventions (e.g., cut-stump applications), burning of slash piles is effective at removing woody debris from the project site (Combs, 2010). Slash piles may take up to a year to dry fully before burning (Combs, 2010). Further recommendations regarding biomass management are available in Appendix C.

Fire

Prescribed burning alone has not been confirmed as an effective means of Russian olive eradication (Combs, 2010; Shafroth et

al., 2010; Muscha et al., 2023), but may be used for suppression purposes (Forest Service, 2014). In simulation experiments, fire has been shown to significantly reduce seed germination success at four fuel loads (Muscha et al., 2023). Specifically, germination is reduced by 80% at low fuel loads (1,500 kg/ha) and essentially all germination is removed at high fuel loads (4,500 kg/ha). Therefore, a fall fire in the second year after Russian olive removal could be an effective means of killing seedlings and stem resprouts in previously treated areas (Muscha et al., 2023).

Grazing

Similarly to prescribed fire, grazing is not considered an effective method for Russian olive eradication (Combs, 2010; Shafroth et al., 2010; Marlow, 2024). Grazing may enhance the impact of other treatment methods, suppressing remaining plants (via depressed plant condition) or controlling young regrowth



Figure 24. Dense patch of young Russian olives (plants with light green foliage in the middle ground) along the Yellowstone River. Hand pulling, mowing, or lopping are options for managing Russian olive saplings and seedlings. Mowing or lopping may be conducted in conjunction with herbicide application. Photo Credit: Jennifer Muscha, USDA-ARS, Livestock and Range Research Laboratory, Miles City, Montana.

(Marlow, 2024).

Biocontrol

Canada has approved the use of the gall mite (*Aceria angustifoliae*) as a classical biological control method of Russian olive (CABI, 2024; De Clerck-Floate and Weyl, 2024). A petition for its field release in the U.S. was submitted in 2019 (Marini et al., 2021); approval of that petition is ongoing (CABI, 2024). Under field testing in the native range, *A. angustifoliae* has been shown to reduce reproduction (i.e., flower and fruit production) capabilities by three-fold with no foreseen non-target species impacts (Weyl et al., 2020). Use of a biological control agent that does not result in Russian olive mortality (but does reduce or remove reproductive capacity) is more likely to appease those who hold great value to Russian olive remaining in their upland windbreaks (De Clerck-Floate and Weyl, 2024). Observations (in 2024) from Canadian field releases made in 2023 confirmed that the mites successfully overwintered (R. De Clerck-Floate, personal communication). Additional information on mite population dynamics, phenology, and dispersal under North American field conditions will become available following additional years of release site monitoring.

Repeated defoliation by grasshoppers paired with ongoing drought conditions have been observed as a contributing factor to Russian olive mortality along the Yellowstone River (J. Muscha, personal communication). Further observation and study are necessary to understand the scope of this observation, if it is anomalous, and/or occurring elsewhere.

Revegetation

Revegetation may be helpful to mitigate regrowth at Russian olive management sites (Espeland et al., 2017). Removal methods can result in disturbed soils, which may increase

erosion and provide an opportunity for Russian olives and other undesirable or noxious species to emerge (Stannard et al., 2002). Follow-up monitoring of Russian olive resprouts and new seedling germination will be necessary (Stannard et al., 2002; Combs, 2010; Shafroth et al., 2010; Espeland et al., 2017; Cisneros, 2024). Plants used in revegetation or restoration plots are likely to spread into adjacent areas so this should be considered when making plant choices (Espeland et al., 2017). It is best to avoid strongly selected cultivars (Lesica and Allendorf, 1999) and to limit livestock usage during the plant establishment phase (Lesica and Miles, 1999). Livestock limitation is recommended in the first growing season to avoid damage to seedling plantings; exclusionary tools (e.g., vegetation cages, fencing) may be useful, especially when full pasture rest is not feasible. Consult with local, state, tribal, or federal agency staff to determine the best species to plant in your area.

Prioritization Considerations

With the extensive time, labor, and cost associated with woody invasives management, it is imperative that steps are taken to prioritize efforts for their greatest impact and to leverage available funding. Prioritization considerations should be made in relation to age, density, location, and land use where stand management is planned. Pick (2013) suggests that it is best to remove all plants before they begin to produce seed (removal at or before 7 years). Early detection and rapid response ensure that further dispersal is mitigated or removed (Combs, 2010; Pick, 2013; Forest Service, 2014; Courtney et al., 2024). Additionally, employing treatment in areas of isolated or patchy Russian olive coverage should be prioritized over tackling large, contiguous areas (Pick, 2013; Forest Service, 2014).



Photo Credit: Bonnie Million, Bureau of Land Management, Bugwood.org

SALT CEDAR (*TAMARIX RAMOSISSIMA*, *T. CHINENSIS*, AND ASSOCIATED HYBRIDS)

Species Overview

Tamarix ramosissima, *T. chinensis*, and their hybrids are regularly referred to by the single common name, saltcedar (Pearce and Smith, 2003). Saltcedar can most easily be identified during the flowering season. In Montana, saltcedar flowers from spring to September or October (Jacobs and Sing, 2007). During this time, drooping clusters of small pink or white flowers will form in narrow, spike-like arrangements (Figure 25).

Outside of the flowering season, saltcedar is noted by 1-2mm. (0.04 - 0.08 in.), scale-like leaves that are arranged alternately and resemble cedar (Jacobs and Sing, 2007; Lesica et al., 2012) as seen in Figure 26. Within stands of saltcedar (Figure 27), individual plants can range in height from 1-5 m (3.3 - 16.4 ft)

tall and have reddish/brown branches (Jacobs and Sing, 2007; Lesica et al., 2012).

Saltcedar thrives in early-succession environments and is considered a phreatophyte, a plant with deep roots that draws water either from the water table or the overlying soil, similar to native cottonwoods (Lesica and Miles, 2001a). While its growth is light-dependent and individuals in shaded areas show reduced growth and stem density, it is not fully hardy, with stems often dying back during harsh winters (Lesica and Miles, 2001a). However, hybridization between *T. ramosissima* and *T. chinensis* has increased its genetic diversity, enhancing cold tolerance and adaptability (Friedman et al., 2011; Gaskin et al., 2012). This genetic variability also complicates management, as hybrids can be more challenging to target with biological control methods. Saltcedar is listed as an invasive species in much of the southwestern U.S. (USDA and NRCS, 2004) and a Priority 2B in Montana, meaning that it is abundant and widespread in many counties (MDA, 2019).



Figure 26. Saltcedar leaves are scale-like and arranged alternately. Branches are reddish-brown and leaves visually resemble cedar leaves. Photo Credit: Nicole Kimmel, Government of Alberta, Bugwood.org



Figure 25. Saltcedar flowers typically occur in Montana from spring (March-May) to fall (September-October). Flowering season is often the easiest time to identify saltcedar as the flowers are likely to stick out among other riparian woody species. Flowers are often pink or white and will have a spike-like arrangement. Photo Credit: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org



Figure 27. Saltcedar stand. Photo Credit: Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

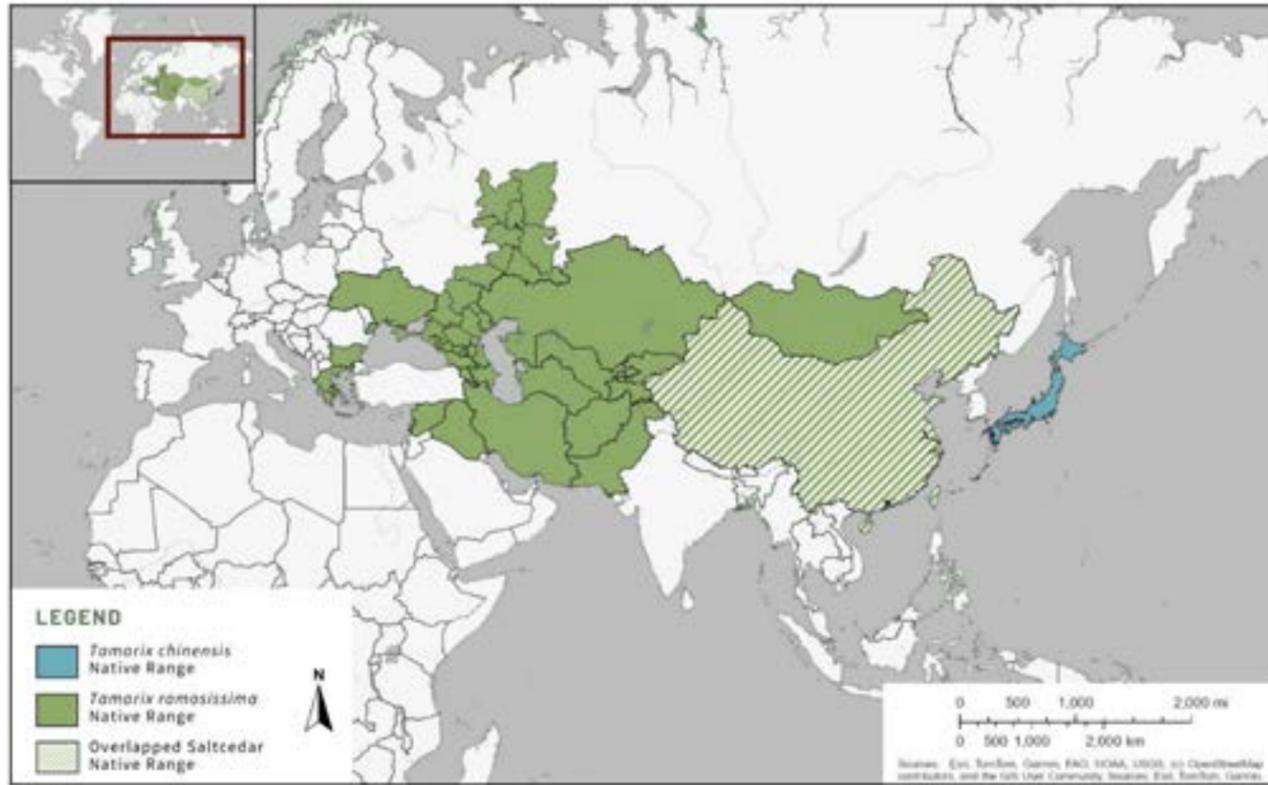


Figure 28. Saltcedar’s native range developed from World Flora Online (2024c-d) database. Range within Russia is provided at the Republic scale to better represent geographic scope.

Extent of Range/Habitat Suitability Index

Native Range

Saltcedar or tamarisk is native (Figure 28) to Europe and Asia (Lesica and Miles, 2001b). *Tamarix ramosissima* and *T. chinensis* have overlapping native ranges through much of Asia, including China and Mongolia (Baum, 1978; Zouhar, 2003). Hybridization is well-documented within and outside the native range (Gaskin and Shaforth, 2005; Gaskin and Kazmer, 2009; Gaskin et al., 2012). Species capable of hybridization often exhibit great adaptation for invasiveness (Stebbins, 1959; Gaskin, 2016). Saltcedar species and hybrids thereof tend to thrive in dry, saline habitats across temperate and subtropical climates (Gaskin and Kazmer, 2009; Jacobs and Sing, 2007).

Invasive Range

As with the first two species, saltcedar has also been intentionally introduced around the world for cultivation purposes (Figure 29). Originally introduced to the U.S. as early as 1856 (Robinson, 1965), saltcedar became well established in the southwestern U.S. by the early 1900s (Nagler et al., 2011). It had been largely introduced for erosion mitigation, windbreaks, and ornamental plantings. Saltcedar has become a dominant riparian plant in the western United States, particularly impactful in the Southwest (Nagler et al., 2011). Within the Southwest, it reportedly occurs in every major watershed (Zouhar, 2005). DeLoach et al. reported in 2006 that saltcedar occupied nearly 2 million acres (over 800,000 ha) in North America. Invasion status of multiple *Tamarix* species (including *T. ramosissima* and *T. chinensis*, among others) in Argentina remain in



Figure 29. Saltcedar’s invasive range developed from records in the World Flora Online (2025c-d) and Global Biodiversity Information Facility (2025c-d) databases. Due to concerns for misidentification between species or the presence of hybrid records, the saltcedar complex (*Tamarix chinensis*, *T. ramosissima*, and all associated hybrids) is represented as a whole. Range within North America is represented at the state/provincial scale to better represent geographic scope.

the early stages (McKay et al., 2017) and are described as “spontaneous populations” (Natale et al., 2013). Saltcedar occurs in arid and semi-arid wetland and riparian areas of Argentina, including along the coast (Natale et al., 2013).

Range within Montana

Robinson (1965) indicated that saltcedar establishment had largely not occurred along Montana’s major river systems until the 1960s. This

is considerably later than the arrival of saltcedar throughout the rest of the West (DeLoach et al., 2006; Nagler et al., 2011; Gaskin et al., 2012). However, by the late 1990s, saltcedar occupied over 250 miles of river throughout southeastern Montana (Grubb et al., 1997). In Montana (Figure 30), saltcedar either occurs in monocultures or mixed stands with Russian olive or native riparian species (e.g., willows and cottonwoods) (Hansen et al., 1995). Saltcedar can be readily found along the Yellowstone River and its tributaries, the Missouri River, the Bighorn River, the Powder River, and along the shoreline of Fort Peck

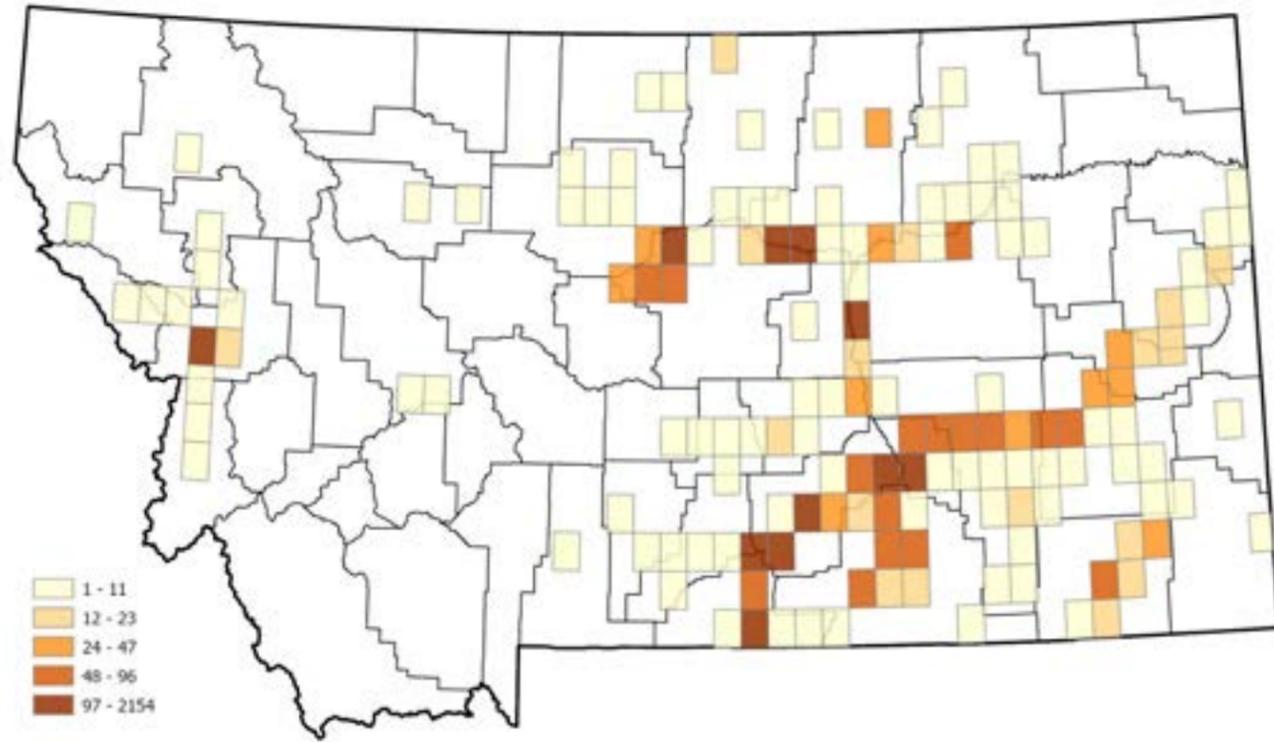


Figure 30. Map of saltcedar generated from Montana Natural Heritage Program Generalized Observations (2025f)

Reservoir (Hansen et al., 1995; Lesica and Miles, 2001b; Pearce and Smith, 2003; Nagler et al., 2011; USACE and YRCDC, 2015). Gaskin and Schaal (2002) found that hybrid saltcedar (*T. ramosissima* x *T. chinensis*) are present in Montana.

Saltcedar thrives in disturbed riparian systems, and broad-scale changes (e.g., human stabilization of rivers and streams) facilitate conditions that favor this species. In Montana, saltcedar is also found outside of riparian settings, including along irrigation ditches, stock ponds, reservoirs, and roadside borrow pits (Jacobs and Sing, 2007). Saltcedar is highly adaptable to temperature variations. For example, plants from Montana exhibit reduced height in colder climates but maintain growth comparable to Arizona populations in terms of branching (Sexton, 2000). Saltcedar shows no significant limitation from growing season length or winter temperatures, facilitating its spread into new areas. Saltcedar is widespread across

much of its suitable range in Montana (Figure 31).

Pathways of Introduction

Saltcedar’s invasive success is credited to both ornamental planting and natural spread. The first introduction of saltcedar to the United States was likely in the early 1800s when it was sold in New York City by the Old American Nursery (Robinson, 1965). Nurseries in California in the mid-1800s began selling saltcedar for ornamental, windbreak, and erosion control purposes (Robinson, 1965). Robinson suggests that the earliest evidence of saltcedar escaping cultivation dates back to the 1870s, and by the 1920s, escaped saltcedar had formed stands along riverbeds large enough to gain attention.

In Montana, genetic studies suggest that ornamental plants may contribute to wild populations through hybridization but are not the sole source of

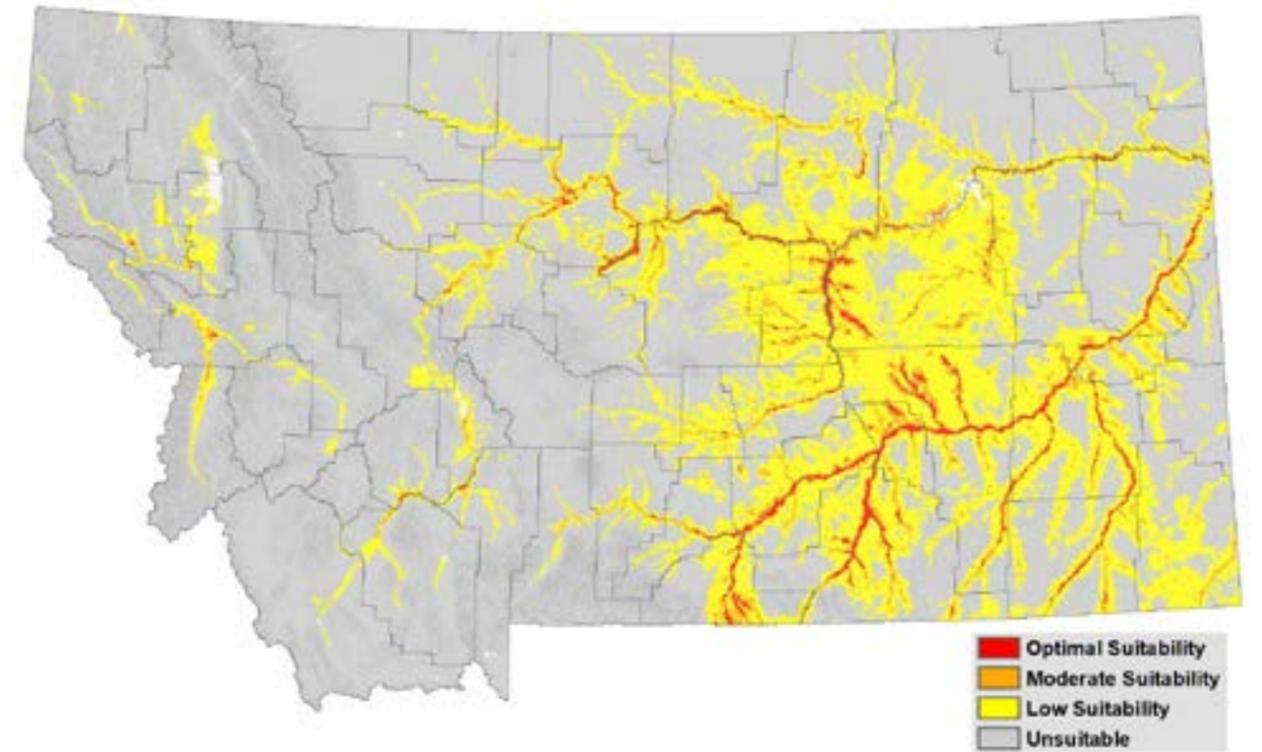


Figure 31. Habitat suitability map (MTNHP, 2025d) of saltcedar. Suitability ranges from low (yellow) to moderate (orange) to optimal (red). Low suitability classification likely represents areas where saltcedar may occur in scattered or patchy distributions (MTNHP, 2025d). Whereas, moderate to optimal classified areas are more likely to have continuous habitat for saltcedar (MTNHP, 2025d).

wild saltcedar (Gaskin and Kazmer, 2006). Wild populations of saltcedar today are likely due to a combination of intentional planting and decades of natural seed dispersal by wind, water, and wildlife. These wild populations’ pervasiveness and their keen ability to form dense stands is attributed to saltcedar’s prolific seed production, high seedling establishment rate, and ability to regenerate through crown and root sprouts (Jacobs and Sing, 2007). Hundreds of thousands of seeds are produced by mature (3 years old) (Figure 32) saltcedar each year (Jacobs and Sing, 2007). Saltcedar seeds are typically dispersed via wind and water, which is facilitated by the apical pappus (set of hairs on the tip of the seed coat) on each seed (Jacobs and Sing, 2007).

Impacts

Saltcedar impacts are largely context dependent, though infestations are known to negatively affect

plant communities, wildlife, fire dynamics, fluvial geomorphologic processes, and soil nutrient availability.

Native Plant Communities and Soil Dynamics

Few species are able to thrive in the understory of saltcedar stands. The species that do thrive are often other invasive plants, leading to lasting impacts on native plant communities even after saltcedar removal occurs (Douglass, 2013; Sher et al., 2018; Douglass, 2024). Saltcedar invasion is linked to increased soil nutrient loading (C, K, Mg, N, and Na) (Araya et al., 2022). Not only is saltcedar more tolerant of saline soils, but also increases soil salinity by exuding salt from its leaves to levels that native species cannot tolerate (Shafroth et al., 1995; 1997; Duan et al., 2022).



Figure 32. Mature saltcedar plant outside a residence in Alberta, Canada. Photo Credit: Nicole Kimmel, Government of Alberta, Bugwood.or

Wildlife

Wildlife, especially bird communities, have been measurably disrupted by saltcedar presence. The woody habitat that saltcedar provides is not functionally equivalent to the habitat provided by native plant communities (Sogge et al., 2008; Raynor et al., 2017; Douglass, 2024). In saltcedar stands, native arthropod diversity decreases, and cavity and canopy nesting birds are less abundant (Sogge et al., 2008; Shafroth et al., 2010; Raynor et al., 2017). Conversely, abundant saltcedar expands habitat for bird species that would not naturally occur in these locations; small rodent diversity also grows (Shafroth et al., 2010). This change can fundamentally alter the wildlife structure and dynamics in these systems.

Fire

In areas with saltcedar stands, fires are more severe and burn hotter because of the buildup of dead and senescent stems (Busch, 1995; Ellis, 2001). While

saltcedar leaves are not highly flammable, the growth structure of the plants leads to understory litter that can be highly flammable. Additionally, saltcedar is often the first species to emerge, resprouting from existing root crowns, after fire (Ellis, 2001).

Water Quality and Stream Dynamics

It is a common misconception that saltcedar is a high water-user. In fact, a study by Glenn and Nagler from 2005 shows that saltcedar uses very similar amounts of water as native woody riparian species. However, saltcedar is more drought tolerant than native cottonwood and willows. This is because its roots can access deeper groundwater sources, and it can withstand drier conditions for longer periods. The combination of deeper roots and higher drought tolerance allows saltcedar to occupy areas that are farther away from the primary river channel than native species. Consequently, the expansion of saltcedar in some riparian systems could result in slight increases in water usage and reduced

groundwater recharge in other areas (Nagler, 2024).

Saltcedar significantly impacts streamflow, sediment deposition, and flood intensity, altering riparian ecosystems (Robinson, 1965). The establishment of saltcedar facilitates channel narrowing, and triggers channel incision leading to overbank floods (Auerbach et al., 2013; Reynold et al., 2014; Scott et al., 2018). Dense stands can degrade water quality and reduce livestock access to forage and water (Pick, 2013). Additionally, the changes in leaf litter attributed to saltcedar has the potential to influence the structure and functionality of stream ecosystems (Shafroth et al., 2010). These changes may secondarily impact aquatic invertebrates by altering the habitats for these species and, in turn, their prey potential for fish populations (Shafroth et al., 2010).

Management Strategies

Effective management of saltcedar involves IPM strategies combining mechanical, chemical, and biological controls (Appendix D). Understanding that the saltcedar populations in Montana are a result of hybridization brings an additional set of challenges for management and control (e.g., increased cold hardiness and difficulty with assigning consistently effective biocontrol methods) (Friedman et al., 2011; Gaskin et al., 2012). Because saltcedar infestations systemically impact the areas in which they are present, removal efforts and reestablishment of native species must be paired with a larger commitment to restoring functional equivalence within the system (Nagler, 2024).

Herbicide

Herbicides are commonly used for saltcedar control practices. The MSU Extension saltcedar guide (Grubb et al., 2010) describes management efforts for young saltcedar using cut-stump, basal bark, and root plowing strategies. For cut-stump management, trees should be cut within 2 in. (5 cm) of the soil surface using a chainsaw or shears and treated with an herbicide within a few minutes for best

results. Herbicide should be applied to living tissue. Herbicide options suggested include aminopyralid, triclopyr, imazapyr, or glyphosate (Grubb et al., 2010). However, care should be taken with glyphosate applications; its nonselective nature increases the risk of impacts to non-target species. Use caution with imazapyr as it can persist and be mobile in the soil (Douglass et al., 2016). Always follow the label to avoid non-target impacts. Any saltcedar resprouts should be retreated within 4–12 months of initial cut and herbicide application (Grubb et al., 2010). For basal bark treatment, herbicide should be applied to the entire circumference of the lowest 18 in. (45.7 cm) of intact stems. The recommended herbicide for basal bark treatment is triclopyr formulated for use with an oil carrier designed to penetrate bark. It is important to note that even aquatic labelled glyphosate, triclopyr and imazapyr should not be applied directly to open water or below the mean high-water mark without all proper licensing and permitting.

Pick (2013) outlined herbicide management strategies for a range of age class and densities. For plants that are < 10 years old, have stems with small (> 4 in. or 10.2 cm) diameters, basal bark (herbicide with surfactant) application may be deployed with backpack or ATV-mounted sprayers. For areas of moderate density (small patches with multiple plants), Pick (2013) recommends prioritizing treatment of larger, older trees that can produce viable seeds with the cut-stump method. These larger trees (stem diameter > 3 in. or 7.5 cm; height > 6 ft or 1.83 m) should be cut to just above ground level and the stump treated with herbicide within 10 minutes of being cut. For trees < 6 ft (or 1.83 m) tall, foliar application may be most useful. In these cases, herbicide plus surfactant can be sprayed on the canopy between June and September for best results (Pick, 2013). It is important to note that these methods are likely to result in a dead, standing skeleton, which may need mechanical removal. For high density (areas with a nearly closed or closed canopy, no understory present, plants that are > 10 years old, and stems that are > 4 in. or 10.2 cm in diameter) management of saltcedar in riparian zones, aerial herbicide application is suggested to occur before the leaf color change of the fall occurs (Pick, 2013).

Mechanical Removal

Per the recommendation of the 2013 Long-term Strategy for Russian Olive and Saltcedar Management, an IPM plan should be instilled prior to management action and removal methods should be chosen that result in the least possible ground disturbance (Pick, 2013). In this management strategy, it is recommended that plants be removed prior to 7 years of age, before they begin to produce seed, and removal priority should be placed on isolated patches and monotypic stands. For root plowing of young trees, plows should be set to 12–18 in. (30.5–45.7 cm) below the soil surface through a saltcedar stand to cut the root crowns (Grubb et al., 2010). Once the root crowns are cut, the plowed vegetation should be piled and burned. Root plowing is only recommended for sites with severe infestations because this method causes extensive site damage (Grubb et al., 2010). For plants that are < 10 years old, have stems with small

(> 4 in. or 10.2 cm) diameters, or are in areas where special cultural or environmental considerations and ground disturbances must be minimized, hand removal is most cost effective in labor and time (Pick, 2013).

Following any herbicide treatment, trees should not be removed for at least 3 years. In non-riparian areas with high densities of saltcedar, mechanical removal should be primarily used (Pick, 2013). For all instances of management, from low to high density areas, regular monitoring and follow-up treatments will be necessary to address resprouting. Additionally, for removal in high density areas, restoration and revegetation is recommended when funding and capacity are available.

Revegetation

Lesica and Allendorf (1999) emphasize the importance of using local genotypes, preserving genetic variation, and avoiding strongly selected cultivars during

restoration efforts. Promoting native cottonwood regeneration through livestock management and flood flow maintenance is essential to suppress saltcedar invasion (Lesica and Miles, 2004b). Along Fort Peck Reservoir’s shoreline, flooding is likely to control saltcedar populations if reservoir levels are raised to full pool for 3 consecutive months (June-September) approximately every 5 years. It is also of note that, in Montana, it has been suggested that tamarisk invasion can best be mitigated by promoting native cottonwoods through minimizing livestock damage and maintaining flood flows timed to initiate cottonwood recruitment (Lesica and Miles, 2001b).

Grazing

While livestock typically choose to graze on cottonwood and willow rather than saltcedar, cattle, sheep, and goats will graze saltcedar on occasion (Jacobs and Sing, 2007). In a study conducted in Texas, Boer-cross goats were found to consume saltcedar at higher rates than willow *Baccharis salicina* over a 14-day feeding trial (Muñoz et al., 2017). Another study from Texas (Parker and Scott, 2021) found that while Rambouillet lambs and Boer-Spanish cross goats consume greater amounts of saltcedar, cattle (Angus-Hereford cross heifers) were showing increased consumption of saltcedar across feeding trials, indicating that cattle may be a viable option for saltcedar control, as well.

Biocontrol

Biocontrol with *Diorhabda carinulata* (northern tamarisk beetle) has had success with stands of Montana’s hybrid saltcedar (Gaffke et al., 2018; Ricklefs and Riddle, 2024). The beetles are used to strip the plant of its foliage, disrupting water regulation, which leads to desiccation and diminished carbon storage in the root system. Beetles typically cause nearly 100% defoliation, but saltcedar is rarely killed by a single event (Dudley and DeLoach, 2004; Gaffke, 2018). Significant branch die back (Figure 33)

and plant mortality typically occurs after repeated defoliation; however, multiple defoliation events may occur each year (Nagler et al., 2012). Jacobs and Sing (2007) report that the beetles prefer to feed on tender, young foliage and may be able to defoliate up to 162 ha (approximately 400 acres) of saltcedar within 3 years of release. Beetles must be reared within the state where they will be released; in practice, to date, usually on individually caged, infested potted saltcedar plants in a greenhouse as interstate transport is no longer permitted, which significantly limits the number of beetles available for field release. The use of *D. carinulata* aggregation pheromones to intentionally retain low-density beetle releases on-site (Gaffke et al., 2018; 2019; 2020a; 2020b), coupled with temporary whole-tree release caging (Figure 34), has significantly improved agent establishment and impact (Figure 35) in Montana. Guidelines and recommendations for releasing field populations of tamarisk beetles in Montana are currently being developed. To date, releases have occurred on the Musselshell, Yellowstone, and Missouri Rivers.



Figure 33. Defoliation on saltcedar plant by larval feeding from northern tamarisk beetle. Photo Credit: Whitney Cranshaw, Colorado State University, Bugwood.org



Figure 34. Temporary caging to retain *Diorhabda carinulata* released on saltcedar. Snow Creek, eastern Montana. Photo Credit: Sharlene E. Sing, USDA Forest Service, Rocky Mountain Research Station.



Figure 35. Saltcedar plant immediately after temporary cage was removed following defoliation by *Diorhabda carinulata* (center), flanked by untreated saltcedar. Snow Creek, eastern Montana. Photo Credit: Sharlene E. Sing, USDA Forest Service, Rocky Mountain Research Station.

04

EXISTING PROGRAMS & AUTHORITIES

The existing programs and authorities managing noxious weeds across Montana are described in great detail in Chapter 7 of the Noxious Weed Management Plan (MDA, 2017). Herein, we provide a more concise description of the organizations in relation to their work in woody invasive species management.

LOCAL Conservation Districts

Each of the 58 conservation districts across the state serves as a resource for community members. They provide technical assistance and education to conserve natural resources within their district boundaries. Some conservation districts within the state may seek funding for woody invasive species management and/or related education. For more information about the work conducted by Montana's Conservation Districts, visit macdnet.org.

County Weed Coordinators/Districts

There are 56 county weed districts across Montana. Each of which is responsible for developing localized noxious weed plans, managing woody invasives on county-owned or managed lands, coordinating management efforts within their districts, and monitoring woody invasive species. Many county weed staff members also provide education and outreach to the public. Visit mtweed.org/weeds/weed-districts for a directory of the individual county weed districts.

County Extension

The Montana State University Extension staff serve as an educational and practical resource for all Montanans. Community members across the state may contact their local Extension office for assistance in identifying and/or managing woody invasive species. More information on the Extension program can be found at montana.edu/extension.

Irrigation Districts

Among their responsibilities, Montana's irrigation districts are charged with the maintenance of irrigation canals and infrastructure. Management of woody invasive species falls within this responsibility and is critical to maintaining efficiency, water quality, and longevity.

Municipalities

Local city governments are responsible for managing woody invasive species on city-owned property. Municipalities across Montana have related city ordinances and/or their own noxious weed management plans to enforce and implement.

REGIONAL (WITHIN MONTANA): Watershed/Conservation District Councils:

Watershed or Conservation District Councils represent the conservation districts within a given area [e.g., those eleven conservation districts serving the main stem of the Yellowstone River known as the Yellowstone River Conservation District Council (YR CDC)]. The districts within the councils work together for the betterment of their represented region or watershed. They provide technical assistance and financial support for necessary projects and help identify priorities for their area. These councils have played integral roles in woody invasive species management in Montana. For example, the Missouri River Conservation District Council (MRCDC) was a leader in the development and success of the Montana Saltcedar Team and the YR CDC and its partners identified large scale woody invasive species intervention as a priority within the Cumulative Effects Analysis (USACE, 2015).

Central and Eastern Montana Invasive Species Team (CEMIST):

CEMIST works collaboratively with local, state, and federal partners to provide invasive species management resources across central and eastern Montana. Woody invasive species remain one of their priorities for education and outreach. Visit cemist.org to learn more about CEMIST's ongoing efforts.

STATE

Bureau of Mines and Geology

The Bureau of Mines and Geology is housed within Montana Technological University. They conduct studies and report upon surface and

groundwater availability and impacts across the state. Additionally, their Environmental Program researches water quality issues. While resulting research publications have not been directly associated with woody invasive species, these data are critical to understanding water resource management. For more information about the Bureau of Mines and Geology's important work, go to mbmg.mtech.edu.

Department of Agriculture (MDA)

Montana Department of Agriculture serves as the primary resource for all noxious weed management, including woody invasive species. MDA provides education, coordination, and oversight for woody invasive species management. Additionally, the Noxious Weed Trust Fund (a leading source of funding for management, research, and education efforts) is administered by MDA. More information about the Noxious Weed program at MDA is available at agr.mt.gov/Noxious-Weeds.

Department of Fish, Wildlife, and Parks (FWP)

Montana Fish, Wildlife, and Parks manages lands, such as wildlife management areas, state parks, fishing access sites, and hatcheries, where woody invasive species occur. Their annual report (Sieges, 2023) outlines acres infested and management efforts by species and location. However, Russian olive is not addressed within the report. FWP's Wildlife Habitat Improvement Program (WHIP) grant is eligible for use on woody invasive species management. To learn more about FWP's dedication to managing noxious weeds, go to fwp.mt.gov/conservation/habitat/noxious-weed-management.

Department of Environmental Quality (DEQ)

The Department of Environmental Quality is charged with upholding Montana's water quality (both surface and groundwater). This includes permitting for some invasive species treatments that occur at water's edge, ensuring that water quality is maintained and impacts to non-target organisms are minimal. Details on the work of the Water Quality Division at DEQ can be found at deq.mt.gov/water.

Department of Natural Resources and Conservation (DNRC)

The Department of Natural Resources and Conservation manages state school trust lands across Montana. Staff are tasked with identifying and monitoring infestation on trust lands. A portion of the DNRC annual budget is dedicated to management of noxious weeds, including woody invasive species, that occur on state school trust lands. Additional funds are eligible for distribution toward woody invasive management efforts via the Watershed Management Grant and Rangeland Improvement Loan programs. Go to dnrc.mt.gov/TrustLand to learn more about the state school trust lands managed by DNRC.

Department of Transportation (MDT)

The monitoring and treatment of noxious weeds, including woody invasive species, in the rights-of-way across the state are overseen and conducted by MDT. A copy of the current Statewide Integrated Roadside Vegetation Management Plan can be found at mdt.mt.gov/other/webdata/external/maint/2018-2024_vegetation_mgmt_plan_final.pdf.

Montana Audubon

In 2017, Montana Audubon held a workshop dedicated to woody invasive species, which highlighted important research and management efforts. Since then, they've maintained a webpage with resources from that workshop for public access. As part of their mission, they provide education and outreach about natural resource conservation, including impacts from woody invasive species. The Montana Audubon Center was the location for the first Science Advisory Panel dedicated to management best practices for woody invasive species. For details from the 2017 workshop, go to:

mtaudubon.org/birds-science/raptor-migration-and-conservation/montana-audubon-river-initiative/conservation-workshop.

Montana Invasive Species Council (MISC)

The Montana Invasive Species Council (MISC) coordinates with public and private partners for the prevention, early detection, and control of invasive species. MISC funded two Science Advisory Panels on woody invasives and invested time and effort to the Working Group's activities. MISC is administratively attached to DNRC. For more information and to read the SAP reports visit invasivespecies.mt.gov.

Montana Native Plant Society (MNPS)

The Montana Native Plant Society is a non-profit; they serve as a resource for information on native plant species and are dedicated to educating the public about the values of native flora and its habitats. Their mission is to preserve, conserve, and study Montana's native plants and plant communities.

Montana State University (MSU)

Aside from their educational contributions through the Extension program, MSU has supported woody invasive species management across the state with critical research. Their Agricultural Experiment Stations have historically tackled noxious weed and woody invasive issues. Working with local, state, and federal partners, MSU has contributed significantly to peer-reviewed literature on important topics, such as biocontrol. The University's current faculty have contributed consistently to efforts within the Working Group, including presenting at the first Science Advisory Panel. Resources on invasive plant management, including publications, from MSU can be found at montana.edu/extension/invasiveplants.

Montana Weed Control Association (MWCA)

Montana Weed Control Association is a non-profit organization. Their members are professionals in the weed management field, representing weed districts, government agencies, applicators, and other organizations. MWCA provides an important forum for training, education, and networking for industry personnel. To learn more about their initiatives, visit mtweed.org/about.

Natural Heritage Program (MTNHP)

Montana's Natural Heritage Program serves as a data clearinghouse for natural resource professionals across the state, whose data is addressing much more than just invasive species. Their extensive online resources include the MapViewer application where users may navigate through and visualize species ranges and individual observation records (from a multitude of sources). MTNHP also manages

Predicted Suitable Habitat Models, which aid in prioritizing management efforts. Managers can also use MTNHP databases to find any overlap of imperiled species (or species of concern) with woody invasive management plans, which can be helpful in mitigating non-target species impacts. Also housed within the Montana State Library, the Montana Field Guide site provides easily accessible information about species in the state including their native, nonnative, or noxious distinctions. You can access all of MTNHP's vast resources at mtnhp.org.

University of Montana (UM)

Much like MSU, UM has also contributed to woody invasive management, research, and peer-reviewed publications. Their faculty have participated in the Working Group's efforts consistently, including a Spatial Analysis Laboratory faculty presentation at a Working Group meeting. Additionally, researchers from UM's Flathead Lake Biological Station are completing an Impact Study to better understand the realized and expected impacts of woody invasives on Montana's economy and natural resources. To learn more about the Spatial Analysis Laboratory's work at UM, visit umt.edu/spatial-analysis-lab.

Trout Unlimited

Montana's Trout Unlimited is active in funding watershed restoration efforts as well as providing education on water quality and angler advocacy. They have an historic reputation for their support of invasive species prevention efforts in their publications and outreach resources. More information about Trout Unlimited's on-the-ground work, go to montanatu.org/our-work.

TRIBAL

The following tribal territories encompass more than 5 million acres in total:

- Blackfeet Reservation
- Crow Reservation
- Flathead Reservation
- Fort Belknap Reservation
- Fort Peck Reservation
- Little Shell Chippewa Tribal Capital
- Northern Cheyenne Reservation
- Rocky Boy's Reservation

Woody invasive species management across Indian trust lands may be funded and/or conducted by the Bureau of Indian Affairs (BIA) or by tribal resource departments. Some management may also be conducted with county weed districts (MDA, 2017).

REGIONAL (MULTI-STATE)

Greater Yellowstone Coordinating Committee (GYCC)

The Greater Yellowstone Coordinating Committee brings together agency and organizational personnel within the Greater Yellowstone Ecosystem (GYE) for increased collaboration in conservation. They maintain two subcommittees dedicated to invasive species (Terrestrial and Aquatic). The annual funding opportunity for work within the GYE leverages funds across agencies and can be used for management efforts. Learn more about the GYCC and their history at fedgycc.org.

Northern Rockies Invasive Plants Council (NRIPC)

The Northern Rockies Invasive Plants Council is a non-profit dedicated to invasive plants issues in the northern Rocky Mountain states. Their publications (e.g., Bean et al., 2017) have contributed significantly to biocontrol research. Additionally, past conferences have focused heavily on woody invasive species issues, including a dedicated symposium on Russian olive at the 2016 conference in Boise, Idaho (NRIPC, 2016). More detailed information about the NRIPC and its efforts may be found at nripc.weebly.com.

FEDERAL

Department of Agriculture (USDA)

Agricultural Research Service (ARS):

The Agricultural Research Service serves as the dedicated research agency within the USDA. Montana's ARS facilities have been instrumental in gaining a better understanding of woody invasions and best practices for management. Long-term studies are ongoing at multiple facilities aimed at important topics, such as seed viability (Muscha et al., 2023) and revegetation success (Espeland et al., 2017). Additionally, ARS staff have presented at both Science Advisory Panels and consistently supported and contributed to the Working Group's efforts. To learn more about ARS, its mission and vision, visit ars.usda.gov/about-ars.

Forest Service:

The Forest Service manages eight national forests across Montana and the invasive species that occur within them. In addition to monitoring and management, the Forest Service is dedicated to education, outreach,

and technical assistance. The Forest Service's Rocky Mountain Research Station has been instrumental in contributing to woody invasive research, particularly with investigating and rearing biocontrol methods. Staff from the Forest Service and Rocky Mountain Research Station have consistently contributed to the Working Group's efforts, including a presentation at the first Science Advisory Panel. Learn more about the Rocky Mountain Research Station and its important work at research. fs.usda.gov/rmrs.

Natural Resources Conservation Service (NRCS):

The Natural Resources Conservation Service contributes to woody invasives management through public education, funding, and research. Their extensive technical resources are available for landowners and managers alike and their funding opportunities have broad applicant eligibility. To learn more about the Service's programs and opportunities, visit nrcs.usda.gov/programs-initiatives.

Department of Defense (DOD)

Army Corps of Engineers (ACE):

The Army Corps of Engineers has supported woody invasive management in and around Montana's waterways and reservoirs. The Corps supported the Montana Saltcedar Team, conducted management efforts for Russian olive and saltcedar around Fort Peck Reservoir (USACE, 2016), and published the Yellowstone River Cumulative Effects Analysis with YRCDC (USACE and YRCDC, 2015). Montana's USACE properties and staff are managed by and within the Omaha District; visit nwo.usace.army.mil to learn more about the District and their work.

Department of Interior (DOI)

Bureau of Land Management (BLM):

The Bureau of Land Management's staff employ integrated weed management strategies on all noxious species, including woody invasive species. In addition to direct implementation from the Bureau, the BLM also funds partner-led management efforts through cooperative agreements. The BLM is supportive of ongoing research efforts on important topics, such as biocontrol methods. For up-to-date information on woody invasives efforts in the Montana-Dakotas Region, go to blm.gov/programs/weeds-and-invasives/blm-control-strategies/montana-dakotas.

Bureau of Reclamation (BOR):

The Bureau of Reclamation manages five reservoirs (and surrounding lands) in Montana. The BOR collaborates with partners to fund woody invasive species management efforts on their and neighboring acreages. Additionally, BOR is dedicated to furthering education and outreach on invasive species. The BOR's WaterSMART grant program is available to a wide swath of applicants and can fund planning and implementation of management efforts for woody invasive species, especially when water availability and quality is at stake. To learn more about the extensive WaterSMART funding opportunities, visit usbr.gov/watersmart.

Fish and Wildlife Service (FWS):

The Fish and Wildlife Service manages woody invasive species on Refuge lands across Montana with the primary objective of conserving wildlife and their habitat. Staff from FWS and local wildlife refuges have consistently participated in the Working Group efforts. Visit fws.gov/office/montana-ecological-services to

learn more about FWS' efforts across the state.

Geological Survey (USGS):

The Geological Survey has contributed greatly to the understanding of woody invasions in North America, especially with saltcedar and Russian olive. While the USGS does not manage its own land in the state of Montana, they do serve as the primary research agency within the DOI. Their continued research on woody invasives has helped drive decisions from Montana's managers. You can read more about their extensive investigation into saltcedar and Russian olive control (Shafroth et al., 2010) at pubs.usgs.gov/sir/2009/5247.

National Park Service (NPS):

The National Park Service manages monuments, parks, battlefields, historic sites, trails, and recreation areas across Montana, where woody invasives occur. Their mission is to preserve these lands and resources for future generations. Therefore, the NPS engages in management of woody invasives as well as research and outreach on their impacts. Visit nps.gov/state/mt to learn more about the NPS' work across the state.

INTERNATIONAL

Crown Managers Partnership (CMP)

The Crown Managers Partnership consists of managers, academics, tribes, and First Nations within the Crown of the Continent Ecosystem (including Montana, Alberta, and British Columbia). The mission of this voluntary organization is to utilize a collaborative approach to foster stewardship across jurisdictional borders. Providing non-technical education about invasive species remains one

of their priorities. Along with sharing challenges and success on management efforts across the ecosystem, they also maintain a database of invasive species photos. To learn more about CMP and the Crown of the Continent Ecosystem, go to crownmanagers.org.

The Nature Conservancy (TNC)

The Nature Conservancy is a worldwide organization dedicated to conservation through implementation of evidence-based initiatives, working with policymakers and industry, and partnering with local communities. They contribute to public outreach on the impacts of invasive species and managing woody invasives on the landscape. They own and manage lands in Montana where woody invasive species occur; you can learn more about their Montana-based work at nature.org/Montana.

North American Invasive Species Management Association (NAISMA)

The North American Invasive Species Management Association is a membership-based non-profit dedicated to empowering invasive species management and the field's professionals across North America. They provide technical resources and training to professionals as well as outreach to the public. Their events provide a forum for networking and collaboration. Visit naisma.org to learn more.

Society for Range Management (SRM)

The Society for Range Management is a membership organization for range

management professionals. Their events provide networking opportunities for greater collaboration among the field's professionals and a space for presenting innovative research and management techniques. Their website houses educational resources for audiences ranging from K-12 education through career veterans, including vast information on woody invasives (and invasive species as a whole). They edit and manage two peer-reviewed publications: *Rangelands* and *Rangeland Ecology and Management*. Learn more about SRM at rangelands.org.



Photo credit: Molly Masters, Missouri River Conservation Districts Council.



Photo credit: Molly Masters, Missouri River Conservation Districts Council.

05

STRATEGIES & ACTIONS FOR IMPLEMENTATION

Potential strategies and actions for the management of woody invasive species are vast. Therefore, this list is not exhaustive (Table 2). However, the strategies presented are both tenable and in need of consistent prioritization.

These are in addition to direct management efforts toward the eradication of these species with prioritization for project locations that have the greatest economic and ecological impact. Individually, they do not fulfill goals and objectives, nor do they fully address gaps and challenges that remain. Comprehensively, they represent an effective path forward for stakeholders.



Photo credit: Molly Masters, Missouri River Conservation Districts Council.

Table 2. A non-exhaustive list of strategies and actions for implementation for woody invasive management. The associated goals and objectives addressed by each action or strategy are presented alongside.

Strategy or Action	Goal / Objective Addressed
Continue to meet as a stakeholder group to tackle current and future challenges	· Oversight and Coordination
Support research for innovative management and monitoring methodologies	· Funding · Long-term Control
Coordinate among agencies and organizations on multiple scales (with priority of watershed or greater scale)	· Oversight and Coordination · Long-term Control · Funding · Mapping and Monitoring
Provide outreach and technical assistance to landowners to encourage collaboration and management efforts	· Outreach and Education · Long-term Control · Mapping and Monitoring
Seek technical support for managers at the local and county levels, including funding to increase capacity at seasonal and year-round scopes	· Oversight and Coordination · Long-term Control · Funding
Provide and/or develop outreach to the general public about the impacts of these species, associated regulations, and the risks posed by online sales	· Outreach and Education · Long-term Control
Support broadscale training for the adoption of new and innovative management and monitoring techniques	· Oversight and Coordination · Outreach and Education · Long-term Control
Share results of new information regarding management, monitoring, and economic considerations.	· Oversight and Coordination · Outreach and Education · Long-term Control · Mapping and Monitoring
Encourage use of reporting tools by key demographics, such as outdoor recreators and agricultural producers	· Oversight and Coordination · Outreach and Education · Long-term Control · Mapping and Monitoring
Advocate for increased funding availability for noxious weed and woody invasive species management	· Funding · Oversight and Coordination · Long-term Control · Mapping and Monitoring
Review and adopt the Management Plan as needed (ideally every 5-10 years), including potential adaptations associated with climate change and range expansions.	· Oversight and Coordination · Long-term Control
Participate in regional invasive species management efforts, when possible	· Oversight and Coordination · Funding
Identify research and information gaps associated with climate change and range expansions	· Oversight and Coordination · Mapping and Monitoring · Long-term Control

Implementation and Priority Overview

Table 3. List of implementation strategies or actions paired with the lead and cooperating organizations on each effort, potential funding sources for each action, estimated annual need to take that action, and a priority level (High, Med, or Low). This priority overview was developed through open discussion during the third meeting of the Working Group.

Strategy or Action	Lead Organization(s)	Cooperating Organizations	Potential Funding Source(s)	Annual Anticipated Funding Needed	Priority Level
Continue to meet as a stakeholder group to tackle current and future challenges	· Core Planning Group	· Working Group	· Industry · NWTf · Western IPM	State and Federal Funding	High
Support research for innovative management and monitoring methodologies		· Academia · Federal Partners · Industry		Highly Dependent Upon Scope	High
Coordinate among agencies and organizations on multiple scales (with priority of watershed or greater scale)	· Working Group	· MWCC	· NRCS Technical Assistance · CD Education · NWTf		High
Provide outreach and technical assistance to landowners to encourage collaboration and management efforts	· MSU Extension · Weed Districts · Conservation Districts	· CEMIST · Various Agencies and NGOs		Highly Dependent Upon Scope	High
Seek technical support for managers at the local and county levels, including funding to increase capacity at seasonal and year-round scopes		· AmeriCorps · MCC · MWCA			High
Provide outreach to the general public about the impacts of these species, associated regulations, and the risks posed by online sales		· CEMIST · MISC · MDA · MWCA · Various Agencies and NGOs · MSU Extension		\$5,000 to \$20,000 (dependent upon initiatives, likely per organization)	High
Support broadscale training for the adoption of new and innovative management and monitoring techniques	· MDA · MWCA	· Industry	· Western SARE · Industry		High
Share results of new information regarding management, monitoring, and economic considerations.	· MDA · MWCA · MSU Extension	· Industry · MISC			High
Encourage use of reporting tools by key demographics, such as outdoor recreators and agricultural producers	· MTNHP · MISC	· CEMIST · Various Agencies and NGOs	· State and Federal Funding		High
Advocate for increased funding availability for noxious weed and woody invasive species management		· All Stakeholders		To Meet Current Personnel and Management Costs	High
Review and adopt the Management Plan as needed (ideally every 5-10 years), including potential adaptations associated with climate change and range expansions.	· Core Planning Group	· Working Group			Medium
Participate in regional invasive species management efforts, when possible		· Various Agencies and NGOS			Low
Identify research and information gaps associated with climate change and range expansions	· Academia · Federal Partners			Highly Dependent Upon Scope	High

06

GAPS & CHALLENGES

Although collaborative efforts have been extensively applied to woody invasive species management across Montana, gaps and challenges remain. In order to address each of these challenges, agency partners and other key stakeholders will need to remain committed.

Dedication to purposeful collaboration and continued recruitment of partners will be critical for success. The following are not presented in rank order. They are regarded as equivalent in need and should be considered as such for funding or other purposes:

MIXED AND CHECKERBOARD OWNERSHIP

These species cross a patchwork landscape of ownership, including state trust, (municipal, county, state, and federal) public, and private lands. Therefore, management efforts can result in inconsistent coverage due to patchwork ownership and gaps in collaboration with neighboring landowners. Joint effort between

landowners is necessary and management efforts should be applied to neighboring parcels for landscape level impacts. Gaps of untreated areas should be prioritized to reduce downstream spread and repeated introduction to previously eradicated areas. Significant investment in public outreach to producers and private landowners will be required as will continued collaboration among organizations and agencies from municipal to federal levels. Development of and support for programs that incentivize landowners to engage in management practices may be necessary.

COST AND FUNDING

As with any invasive species management at a statewide scope, cost would be an expected primary challenge. This is exacerbated with woody invasive species management due to the higher cost of herbicide paired with the extensive time and effort investment required (as compared to management of most other noxious weed species). Organizations in some areas of the state chronically face limited budgets and personnel, hindering their ability to employ management at scale. Therefore, large funding opportunities should be leveraged to serve multiple jurisdictions for equitable access to those with resource restrictions. At a time when the funding landscape for large projects becomes increasingly uncertain, it is expected that this challenge will be difficult to overcome.

Additionally, funding for a group or individual to lead the implementation phase of this plan is currently lacking. In addition to monitoring efforts toward priority areas, correspondence with agencies and other stakeholders will be required. Implementation efforts are also likely to require data sharing for tracking treatments; promoting research of and education for new advancements in treatment or monitoring practices; providing technical assistance to producers and landowners; seeking funding

opportunities; and fostering relationships with stakeholders, agency staff, and landowners alike.

UNDERSTANDING OF SCOPE

There is a lack of comprehensive range data for these species; this is particularly true for common buckthorn. In cases where organizations or individuals have local presence and absence data, it would be beneficial for this data to be shared and available on a statewide basis for the purpose of landscape and/or watershed-level management planning. Additional efforts may be necessary for wider reporting to occur across the state (e.g., encouraging outdoor recreators or other members of the public to report via application). It would be most appropriate to include ecological and economic impact information to be shared to those audiences in any efforts supporting public reports, as this may help encourage participation. Comprehensive range data is critical for large scale planning and prioritization as well as risk (of spread) assessments.

PUBLIC PERCEPTION, AWARENESS, AND REGULATORY STATUS

The perception of these species' ecological and economic impacts among the public is varied. For instance, many hold strong beliefs that Russian olive provides premiere habitat for species (e.g., upland game birds). Some hold strong opinions that management efforts are without impact due to ongoing spread via wildlife and livestock. In areas where woody species are sparse, Russian olive is appreciated for its hardiness. Shifting strong public opinion

is difficult, especially since Russian olive does not have statewide noxious status. Common buckthorn faces a lack of public awareness. Additionally, both common buckthorn and saltcedar have noxious classification. However, enforcement is lacking. Persistent and multi-faceted outreach and awareness will likely be necessary, including from agencies, NGO partners, and landowner champions. Messaging should include species impacts and will likely benefit from in-person delivery as well as exposures via field tours.

BIOCONTROL AVAILABILITY AND STATUS

Biological control agents can play a critical role in integrated management efforts. Biocontrol for saltcedar is limited due to interstate transport restrictions, overwintering viability, and rearing capacity. However, the northern tamarisk beetle has shown effective at defoliating Montana's hybrid saltcedar. The biological control agent for Russian olive has not yet received full approval for use in the United States. However, if approved, may be a fitting option and compromise for Russian olive stands that are valued and removal is not desired. Lastly, researchers have not identified a highly targeted agent for common buckthorn. Availability and approval are key for the inclusion of biological control in the management of these three species.

07

CONCLUSION

This Plan represents a unified commitment to addressing one of Montana's most pressing ecological and economic challenges. Without timely and coordinated management, woody invasive species will continue to spread, disrupt native communities, and impose increasing costs on landowners and natural resource agencies.

Intentional management of the focal species addressed in this plan (common buckthorn, Russian olive, and saltcedar complex) is crucial to mitigating the impacts woody invasive species have on riparian health, agricultural productivity, recreation, and biodiversity.

Through Science Advisory Panels and Working Group meetings, with collaboration from agencies, landowners, NGOs, and community stakeholders, we have come to understand the scope of risk posed by woody invasives in Montana. By considering the life histories of each focal species or complex, their pathways of introduction, and existing local and regional

control efforts, this Plan provides a framework for integrated management moving forward. It emphasizes prevention, early detection, rapid response, and long-term monitoring. These approaches are proven to be both more effective and more cost-efficient than delayed intervention. Historically, funding for woody invasive management in Montana has been limited, fragmented, and short-term. This is why the Plan underlines the need for large funding opportunities to be shared across jurisdictions to aid in large-scale control and monitoring efforts. Importantly, it also recognizes that success will depend not only on technical treatment and removal best practices but on education, outreach, and shared responsibility across jurisdictions.

Strategies and actions for implementation described herein are ambitious yet achievable. With sufficient oversight, secure funding, consistent mapping and monitoring, and ongoing investment in outreach and education, this Plan can help guide Montana towards landscape-level management and local eradication. To be successful, the partnerships that shaped the Plan must guide its implementation, ensuring accountability and adaptability as conditions and science evolve. Montana's landscape, including its rivers, farms, rangelands, and recreation areas, is vital to both the cultural identity and economic livelihood of its residents. Implementing this Plan is an investment in protecting those values and resources for future generations. By working together, stakeholders can not only reduce the spread and impact of woody invasive species but also safeguard the ecological resilience and economic prosperity of the state.

08

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Photo credit: Molly Masters, Missouri River Conservation Districts Council

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Photo credit: Molly Masters, Missouri River Conservation Districts Council

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APPENDIX A: WORKING GROUP INITIATIVES

WORKING GROUP MEETINGS

The first meeting of the full Working Group was held on September 6, 2023 in Lewistown at the Calvert Hotel. Attendance was hybrid with a virtual option via Zoom. Thirty-four people attended with broad representation, including weed districts, conservation districts, municipalities, NGOs, academia, private industry, state congress, and agencies (both state and federal).

The agenda included a history of the Working Group, an overview of the NWTF grant and ISAN contract, a presentation of the geographic scope for each species, a timeline of previous management/research efforts across the state, an overview of the proposed outline for the Plan, a discussion of the existing programs and authorities for management, an overview of the SAP process, and discussion of potential topics and experts for the SAP. Some key takeaways were:

- We need a better understanding of the coverage of common buckthorn statewide. It is suspected that buckthorn has spread more than current monitoring data suggests and a more comprehensive understanding will better inform habitat suitability modelling.
- The Working Group and Plan should be strategic about discussing Russian olive (e.g., utilizing “problematic” to describe its

spread), as cultural views are strong held but highly divergent. Historically, proposed management and outreach efforts have received little support.

- The Plan will need to include a decision framework since treatment methods and applications vary greatly based on density, resources available, and other factors.
- Barriers to implementation are likely to include funding and labor force issues. It was revisited throughout the meeting that an overall objective needed to be that any large funding be leveraged, when possible, particularly for counties with lower populations and (historically) less access to funding and labor.
- The Working Group may want to seek action or funding from the Environmental Quality Council (EQC). If so, a high quality one-page fact sheet would be helpful and needs to be developed for presentation by summer 2024.

The meeting was closed out with a call for information on any previous or current project efforts be sent to ISAN to compile relevant documents in one location. An open invitation to be included in the Core Planning Group meetings was extended. ISAN would develop an expanded draft outline to include known citations and brief summaries for each. The Core Planning Group would meet to draft questions, narrow experts, and begin planning the SAP with an expected date in November 2023. The next Working Group meeting would be in the winter [potentially in January 2024 timed in conjunction with the Montana Weed Control Association (MWCA) annual conference]. The meeting minutes were sent to the Working Group invitee list (over 120 stakeholders) on September 25, 2023.

The second meeting of the Working Group was held at the Yogo Inn in Lewistown on February 13, 2024. The meeting was held in a hybrid fashion with in-person attendance at the Yogo Inn in Lewistown and virtual attendance via Zoom. We had 64 attendees. The agenda included presentations on the following topics: Learned Experiences from Management Plan Development, Results from the Land Manager Survey, Aerial Imagery, UAV Herbicide Application, Invasive Species Retail Initiatives, and Planting Choices for Revegetation Initiatives. Each presentation was followed by open discussion from the Working Group. Additionally, open discussion sessions were held on the following topics: Funding Opportunities and Strategies, SAP Topics and Experts, and Next Steps. Some of the key takeaways were:

- We need to prioritize quantifying the scope (impacts) and extent (size) of the issue and contact Bryce Maxwell at Montana Natural Heritage Program (MTNHP) to assist with suitability mapping.
- The group extensively discussed mapping as a prominent gap. While mapping is useful in quantifying the scope of the problem and can be compelling to funders, it should be listed as a priority item within the Plan rather than an SAP topic. Additionally, the group suggested that mapping be broken down by river system within the management plan. The possibility of creating a mapping guidance sheet was discussed as well to assist in narrowing the scope of the work and clearly understanding mapping parameters.
- Identify priority areas, which should then be outlined in the management plan.
- The Plan will need a coordinator to carry on work after ISAN’s contract concludes in Fall

2024.

- EQC should be contacted for support soon.

The meeting was closed out with a call for assistance in writing the management plan. The Core Planning Group would meet soon to finalize the topic for the next SAP, which would be tentatively planned for Spring 2024 (potentially in conjunction with the next MISC Quarterly meeting). In May, a small group would plan to attend the EQC meeting in Helena. The final Working Group meeting would be tentatively scheduled for this summer. Due to the expected length of time to address the effort, a separate draft review meeting may be scheduled.

The third and final Working Group meeting was held on September 10, 2025, in Lewistown at the Yogo Inn. Attendance was hybrid with a virtual option via Zoom. There were 12 in-person attendees and 25 virtual attendees at this meeting. The agenda included presentations on topics including an update on the woody invasive species impact study, public perceptions of Russian olive in Wyoming, nursery inspections and the risk of online plant sales, UAV mapping and herbicide application, an update on Russian olive listing in Missoula, and an overview of education and outreach efforts to date. Key takeaways included:

- The woody invasive impact study has been granted a no-cost extension. Members of the working group can help with the impact study by completing the survey if they have not already and forwarding it to others.
- Several presenters and the group discussed the public perception of Russian olive and how to navigate mixed public opinions. The takeaway from these discussions was that public outreach about Russian olive

is sometimes met with opposition, but education is not impossible if done with consideration for the audience.

- Online plant sales pose an ongoing risk of distributing woody invasive species; however, the issue is being addressed locally where possible and nationally by the horticulture inspector society and plant board.
- The Carbon County saltcedar project highlighted that UAVs can be particularly effective at precision spraying, but require a significantly amount of preparation, specialized training, and financial investment ahead of time.
- Education and outreach materials created by the Working Group are publicly available for review and printing on the MISC website (woodyinvasives.mt.gov). Additionally, the woody invasive species radio advertisement and sponsored content article have been published by Northern Ag Network.
- The final draft of the Plan will be sent to a graphic designer for the layout and design before the Plan is sent out to the public for review and comment by October 31, 2025.

The meeting ended with a guided discussion on the forward movement of the working group.

Unanimously, Working Group members at the meeting agreed to remain active participants of the group. Additionally, the group decided to continue meeting—ideally twice annually—to address the goals outlined in the Plan and update the Plan as needed.

LAND MANAGER SURVEY

A land manager survey (Appendix E) was developed by the Core Planning Group to answer questions about the following categories (Table A1): management areas and species ranges, invasive species perceptions, and management initiatives and challenges. Paper and digital surveys were available to managers attending the 2024 MWCA Annual Meeting in Billings. A link to the digital survey was also sent via email to the entire Working Group listserv in an effort to gain responses from those unable to attend the MWCA conference in person. In total, 59 surveys were received from representatives of state agencies, federal agencies, municipalities, county weed districts, and NGOs (Figure A1). The results of the survey were presented and discussed at the second Working Group meeting.



Figure A1. Coverage of Land Manager Survey Results [N = 59 responses from filled (green) counties]. There was broad representation of stakeholders, including state agency, federal agencies, feeral agencies, counties, municipalities, an NGOs. There were six respondents who indicated statewide management. An additional seven respondents did not describe their management area.

Two common themes within survey results indicated that 1) the manager was unaware of the presence of common buckthorn, and 2) Russian olive is not considered a problem or it only occurs in shelterbelts (within their particular management area). Based on management initiative questions, more respondents were actively managing saltcedar than Russian olive; common buckthorn had the fewest respondents indicating active management. As expected in this same trend, understanding of impacts and management techniques were greatest for saltcedar followed by Russian olive with common buckthorn trailing much farther behind. These trends matched the expectations of the Core Planning Group. The final question

on the survey asked the respondent to identify the greatest need/s for management. Five options were provided with a sixth “Other” category that the respondent could comment upon. Respondents were asked to mark all that applied. The results ranked as follows: 1) Public Interest, Approval, and/or Understanding; 2) Funding; 3) Labor; 4) Monitoring; 5) Technical Expertise in Treatment Options; 6) Other.

Table A1. The framework of the Land Manager Survey based on goals set forth by the Core Planning Group. A copy of the full survey is available in Appendix E.

Management Area and Species Ranges	Invasive Species Perceptions	Management Initiatives and Challenges
Describe your Management Area	Land Managers	Are you Currently Managing these Species?
Report Presence/Absence of Each Species	Landowners/Producers	Would you Manage with Barriers Removed?
Estimate Cover and Density for Each Species	Other Residents	What are the Greatest Barriers to Management?

SCIENCE ADVISORY PANELS

Management/Best Practices Panel, November 2023:

After approaching experts for their potential participation in the SAP, November 20, 2023 was identified as the best date for the event. With the potential for a federal government shutdown on November 17, 2023, ISAN attempted to minimize federal employee participation as panelists while balancing the need for subject expertise. Six experts agreed to participate and present on the following subjects:

- Casey Cisneros from Larimer County (Colorado) Land Stewardship Program/ Department of Natural Resources to present on Russian olive and saltcedar management.
- John Leary from RiversEdge West to present on monitoring.
- Dr. Clayton Marlow from Montana State University Department of Animal and Range Sciences and Western Sustainable Agriculture Research and Education to present on grazing.
- Dr. Mike Schuster from University of Minnesota Department of Forest Resources and the Minnesota Invasive Terrestrial Plants and Pests Center to present on both common buckthorn management and revegetation and restoration at previously infested buckthorn sites.
- Dr. Sharlene Sing from United States Forest Service Rocky Mountain Research Station to present on biocontrol methods.
- Dr. Natalie West from United States Department of Agriculture Agricultural Research Service Northern Plains Agricultural Research Station to present on revegetation and restoration.

In order to ensure a best possible outcome with a potential federal shutdown looming, arrangements were made as back-up plans for the two federal employee panelists. Dr. Sing's presentation would be given by Dr. David Weaver, a research collaborator from Montana State University Department of Land Resources and Environmental Services. Dr. West would plan to present at the next Working Group meeting in person. Additionally, since many of the stakeholders are federal employees, ISAN made plans to make the recording and presentation PDFs available to the Working Group after the fact. Thankfully, these back-up plans were not necessary and a shutdown was averted with the passage of a stopgap funding measure.

Fifty-five people registered to attend the SAP. Based on the registration link, 25 in-person attendees and 32 virtual attendees were expected. We had 20 in-person attendees, including moderators and panelists. An additional 24 attendees participated virtually. Extensive discussion was had between presentations and during the open discussion at the end of the day. Discussions covered a wide range of topics, including anecdotal observations in treatment, the importance and nuances of (timing of and audience for) education and outreach efforts, impacts from changes to historical fire and grazing regimes, engaging volunteers in management efforts, and maximizing limited resources to implement phases of management based on priority.

A video recording of the SAP was sent to the Working Group on November 21, 2023. It was accessible from a SharePoint drive administered by ISAN with additional access to other meeting materials (including the initial Working Group meeting in Lewistown). ISAN sought written consent from each presenter to share presentation files in PDF format as well as email contact information ([Proceedings](#)). Full written minutes were distributed to the

Working Group via email and SharePoint drive. This Panel resulted in a final report to MISC (Ricklefs and Riddle, 2024).

Environmental and Economic Impacts Panel, October 2024:

Originally, an SAP addressing the environmental and economic impacts of woody invasive species was expected in spring 2024 (to be scheduled alongside a quarterly MISC meeting). However, there was difficulty scheduling experts in a short timeframe. Therefore, the second Panel was postponed for fall 2024 to avoid the summer field season. Six experts agreed to participate and present on the following subjects:

- Dr. Cameron Douglass from the United States Department of Agriculture Office of Pest Management Policy presented on known environmental impacts of Russian olive and saltcedar invasions described in peer-reviewed literature.
- Dr. Becky Epanchin-Niell from the University of Maryland Department of Agricultural and Resource Economics presented on the economics of both invasive species and invasive species control.
- Dr. Sunny Jardine from the University of Washington School of Marine and Environmental Affairs presented on monetizing economic impacts.
- Jennifer Muscha from the United States Department of Agriculture-Agricultural Research Service Fort Keogh Livestock and Range Research Laboratory presented on known environmental impacts from Russian olive and saltcedar invasions, including lessons learned from Fort Keogh's past and ongoing research efforts.
- Dr. Pamela Nagler from the United States Geological Survey Southwest Biological Science Center presented on water usage

of woody invasive species in the American Southwest.

- Dr. Mark Renz from the University of Wisconsin-Madison College of Agricultural and Life Sciences presented on known environmental impacts from common buckthorn invasions.

Before the Panel, 37 stakeholders replied to the registration (22 of whom indicated virtual attendance). A total of 36 people attended the Panel, including moderators and Panelists. Each expert fielded questions following their presentation and a great deal of discussion was had during the final Question and Answer session and wrap-up. Discussions covered a wide range of topics, including gaining an understanding of tribal values and considerations in relation to woody invasions; considering impacts from woody invasions to wildfire and other natural disaster resilience; potential topics for the final Working Group meeting; encouraging partnerships with hunting, fishing, and other special interest groups; and ongoing development of resources for risk assessment and evaluation.

ISAN sought written consent from each presenter to share presentation files in PDF format as well as email contact information ([Proceedings](#)). On October 18, 2024, ISAN uploaded a video recording to the Working Group SharePoint as well as presentation files. These files are intended for Working Group members who were not able to attend and for future access if stakeholders would like to revisit the topics discussed. This Panel resulted in a final report to MISC (Ricklefs et al., 2024).

APPENDIX B: COMMON BUCKTHORN MANAGEMENT GUIDE

COMMON BUCKTHORN MANAGEMENT: An IPM Guide for Montana

The following was developed by Montana’s managers in conjunction with the efforts of the Woody Invasives Working Group. These best practices should be utilized to achieve your management goals of suppression, containment, or eradication. Decontamination of equipment and boots should be incorporated to ensure common buckthorn is not moved between project sites.



	WINTER December January February	SPRING March April May	SUMMER June July August	FALL September October November
Best Management Practices*				
Seasonal Identification Characteristics	Gently scraping the bark reveals a bright yellow cambium.			
Manual May suppress, contain, or eradicate depending on density. Utilize flagging to distinguish between lookalike species.			Seedlings emerge in April. In comparison to native lookalike species, it leafs out earlier and keeps leaves on longer (after first frost). Manual or mechanical removal is effective when followed with spot treatments. Consider before plants go to seed.	Identification may be easiest for volunteers in fall.
Herbicide** Effective for containment and eradication objectives.	Avoid cut-stump applications in negative temperatures.			Cut-stump applications are highly effective and easy to identify in fall.
Cultural Suppression only, unless paired with other practices	Use of prescribed fire is best suited for young plants in open areas. Repeat once every 3 years.			
		Goats may graze young plants. Good for limited access areas.	Foliar applications (plants < 6' tall) must occur in the active growing season.	Best practice: Follow-up grazing in fall.

*An effective, targeted biological control agent is not available for common buckthorn management efforts.
**See next page for herbicide recommendations and considerations.

FOLLOW-UP MANAGEMENT ACTIONS ARE CRITICAL FOR SUCCESS!

Continue monitoring the project site for at least 5 years.

- Monitoring may occur year-round, but ID is easiest in the fall.
- Utilize mapping and/or flagging to mark treatment sites.
- Document re-treatment efforts.
- Pull or treat weeds that emerge from the seed bank to allow native species to thrive.

Consider the following post-treatment site clean-up:

- In areas of low density with plants that don't bear fruit/seeds, lop branches and scatter them at the site.
- If masticating, leave material to stifle regrowth (i.e., "Cover It Up!").
- In public areas, consider hauling materials off-site for destruction.
- In areas of high density, make slash piles and burn after 1 year of drying.

EMPLOYING INTEGRATED PEST MANAGEMENT (IPM):

Utilizing IPM maximizes effectiveness by employing multiple management strategies at a given site. A project site is likely to dictate which management strategies are most appropriate. The possibilities are vast; below is an example:

HEAVILY-RECREATED SUBURBAN PARK:



- Large, older common buckthorn that are difficult to access
- Dense growth of young common buckthorn

- Contract mastication for the dense growth area prior to plants going to seed, allowing for access to patch of older common buckthorn. Flag native species within patch for avoidance.
- Leave masticated materials to "Cover It Up!"
- Utilize cut-stump treatments with foam-tipped daubers and dye on older common buckthorn in fall.
- Pile materials for burning (burn the following winter).
- Monitor annually. Manually remove seedlings.
- Re-treat as necessary: Stumps in fall with basal bark application. Spot treat masticated area with foliar application in growing season.

HERBICIDE RECOMMENDATIONS:

Application Type	Herbicide
Basal Bark	Triclopyr
Cut-Stump	Aminopyralid Imazapyr Triclopyr
Foliar	Triclopyr
Injection/Girdling	Glyphosate Imazapyr

- All proper licenses and permits must be obtained.
- Read labels carefully - the label is the law! For specific guidance on ratios, use/need of surfactants, etc., consult the manufacturer's label and/or a local technical professional (e.g., Extension agent, county weed coordinator, MDA staff).
- Aquatic formulations of herbicide and surfactants must be used near water.



COMMON BUCKTHORN
Woody Invasive Species



COMMON CHOKECHERRY
Native Species

HAVE QUESTIONS?

For additional information, consult the Statewide Management Plan or contact:

- Your Local Extension Office
- MT Dept of Agriculture: (406) 444-3144 or agrweeds@mt.gov
- Your Local Weed District

APPENDIX C: RUSSIAN OLIVE MANAGEMENT GUIDE

RUSSIAN OLIVE MANAGEMENT:

An IPM Guide for Montana

The following was developed by Montana's managers in conjunction with the efforts of the Woody Invasives Working Group. These best practices should be utilized to achieve your management goals of suppression, containment, or eradication. Decontamination of equipment should be incorporated to ensure Russian olive seeds are not moved between project sites.



Best Management Practices*	WINTER		SPRING		SUMMER		FALL					
	December	January	February	March	April	May	June	July	August	September	October	November
Seasonal Identification Characteristics	Grey/brown papery bark (mature trees) and reddish-brown smooth bark (younger trees) with thorns.											
Manual Suppression only, unless paired with other practices. Effectiveness may vary.	Hand pulling is most effective for young seedlings and easiest in spring with moist soils. Works well when utilizing volunteer help. Mechanical mastication alone is ineffective for control, but useful for clearing high-use areas. Lopping, cutting, or mastication alone will result in extensive regrowth from the stump/root.											
Herbicide** Effective for containment and eradication objectives.	Applications in mild winter conditions are effective.											
Cultural Suppression only, unless paired with other practices. Effectiveness may vary.	Consider the use of prescribed fire in the year following herbicide treatment to kill seeds and seedlings.											
	Goats may graze young plants. Good for limited access areas.											
	Foliar applications (plants < 6' tall) must occur in the active growing season.											
	Basal bark/cut stump/injection treatments can be more effective in fall as herbicide movement to the roots is increased in this period.											
	Follow-up utilizing high-intensity/short-duration methods.											

*An approved biological control agent is not currently available for Russian olive management in the United States.
**See next page for herbicide recommendations and considerations.

FOLLOW-UP MANAGEMENT ACTIONS ARE CRITICAL FOR SUCCESS!

Continue monitoring the project site for at least 5 years.

- Monitoring may occur year-round; utilize mapping and/or flagging.
- Pull or treat weeds that emerge from the seed bank to allow native species to thrive.
- Document any re-treatment efforts.

Consider the following post-treatment site clean-up:

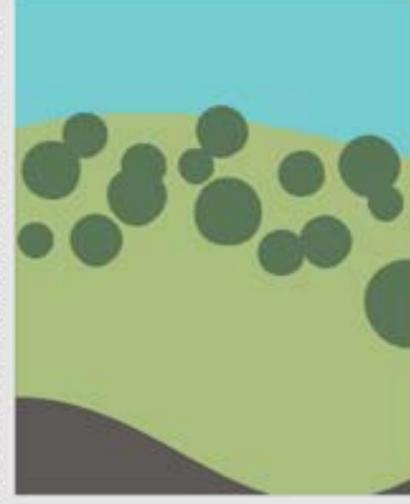
- In areas of low density with plants that don't bear seeds, lop branches and scatter them at the site.
- In areas of high density, make tall, straight-sided slash piles and burn after 1 year of drying. Densely packed piles will burn better.
- If mulching, do so immediately due to the wood's tendency to harden and the stringiness of older bark.

EMPLOYING INTEGRATED PEST MANAGEMENT (IPM):

Utilizing IPM maximizes effectiveness by employing multiple management strategies at a given site. A project site is likely to dictate which management strategies are most appropriate. The possibilities are vast; below is an example:

RIPARIAN AREA NEAR FISHING ACCESS SITE:

- Publicly accessible land
- Young Russian olive
- Mature Russian olive interspersed with few cottonwoods
- Tributary



- In growing season, apply foliar treatment to young Russian olives.
- In fall, utilize cut-stump treatments with sawyers due to large stem diameters on mature Russian olive. Masticate foliar treatment area. Utilize equipment to make tall, dense slash piles for burning.
- Issue prescribed burn for following winter to burn piles and kill seeds and seedlings.
- Due to heavy public use, select native shrubs and trees for revegetation.
- Monitor annually.
- Re-treat as necessary using herbicide on resprouts and/or hand pulling newly germinated seedlings.

HERBICIDE RECOMMENDATIONS:

Application Type	Herbicide
Basal Bark	Triclopyr
Cut-Stump	Imazapyr Triclopyr Glyphosate
Foliar	Triclopyr Aminopyralid
Injection/Hatchet/Girdling	Glyphosate Imazapyr

- All proper licenses and permits must be obtained.
- Read labels carefully - the label is the law! For specific guidance on application rates, use/need of surfactants, etc., consult the manufacturer's label and/or a local technical professional (e.g., Extension agent, county weed coordinator, MDA staff).
- Aquatic formulations of herbicide and surfactants must be used near water.

REVEGETATION RECOMMENDATIONS:

Revegetation at treatment sites has been shown to increase diversity and native plant cover. Based on budgetary or labor restrictions, efforts toward retreatment and continued monitoring may be prioritized over revegetation and restoration objectives. Avoid revegetation efforts in areas where water and ice scour are known to occur frequently.

In cases where revegetation efforts are possible or necessary, consider the following:

- Address other undesirable or invasive vegetation that may be released by the removal of Russian olive before planting.
- Select native tree and shrub species that match ecological site characteristics. Visit bit.ly/NRCSGuidelines for more information.

HAVE QUESTIONS?

For additional information, consult the Statewide Management Plan or contact:

- Your Local Extension Office
- MT Dept of Agriculture:

• Your Local Weed District

(406) 444-3144 or agrweeds@mt.gov

APPENDIX D: SALT CEDAR MANAGEMENT GUIDE

SALT CEDAR MANAGEMENT:

An IPM Guide for Montana

The following was developed by Montana's managers in conjunction with the efforts of the Woody Invasives Working Group. These best practices should be utilized to achieve your management goals of suppression, containment, or eradication. Decontamination of equipment should be incorporated to ensure saltcedar is not moved between project sites.



	WINTER December January February	SPRING March April May	SUMMER June July August	FALL September October November
Best Management Practices*				
Seasonal Identification Characteristics	Reddish-pink bark. Leaf scales resemble asparagus.			
Manual Suppression only, unless paired with other practices. Effectiveness may vary.	Hand pulling is very effective on first year saplings with removal of full root crown. Most easily conducted in spring with moist soils. Works well when utilizing volunteer help. Mechanical mastication alone is ineffective for control, but useful for clearing high-use areas.			
Herbicide** Effective for containment and eradication objectives with few non-target impacts.	Applications are effective in mild winter conditions. Foliar applications (plants < 6' tall) must occur in the active growing season. Lopping/cutting when treated allows for easier follow-up monitoring.			
Cultural Suppression only, unless paired with other practices. Effectiveness may vary.	Use of prescribed fire may be suitable for opening access to dense stands. Could produce intense fire. Goats may graze resprouts; useful in limited access areas. Follow-up grazing in fall. Utilize high-intensity/short-duration. Montana's hybrid saltcedar.			

**The northern tamarisk beetle is not currently available for widespread field release, but has been found effective at defoliation of Montana's hybrid saltcedar.
**See next page for herbicide recommendations and considerations.

FOLLOW-UP MANAGEMENT ACTIONS ARE CRITICAL FOR SUCCESS!

Continue monitoring the project site for at least 5 years.

- Monitoring may occur year-round.
- Utilize mapping and/or flagging tools to document progress.
- Remove or treat weeds that emerge from the seed bank to allow native species to thrive.
- Document any re-treatment efforts.

Consider the following post-treatment site clean-up:

- In areas of low density with plants that don't bear seeds, lop branches and scatter them at the site. If located on an incised stream, scatter branches outside the streambed.
- In areas of high density, make tall, condensed slash piles and burn after 1 year of drying. Equipment is helpful to make piles, push material in while burning, and to spread ash after burning takes place.

EMPLOYING INTEGRATED PEST MANAGEMENT (IPM):

Utilizing IPM maximizes effectiveness by employing multiple management strategies at a given site. A project site is likely to dictate which management strategies are most appropriate. The possibilities are vast; below is an example:

INCISED RIPARIAN AREA:



- Public Land
- Young saltcedar from previous flood event
- Established saltcedar within bank
- Saltcedar seedlings from run-off
- River

- Treat young plants with a foliar application in the active growing season.
- Digging to each rootball, use injection application on established saltcedar. Lop stems and toss them outside the incised riverbed.
- Return in the fall to manually or mechanically remove within the foliar treatment area.
- Optional based on land use: Pile materials for burning with equipment, producing tall, dense slash piles. Burn piles in the winter.
- Monitor annually.
- Re-treat as necessary.

HERBICIDE RECOMMENDATIONS:

Application Type	Herbicide	Application Considerations
Basal Bark	Triclopyr	Basal bark is effective for treating all size classes.
Cut-Stump	Aminopyralid Imazapyr Triclopyr	In low density areas, use loppers and a hand sprayer to apply herbicide. In areas of very high density, cut-stump is not plausible without significant labor and cost investment.
Foliar	Aminopyralid Triclopyr 2,4-D	In higher density areas, consider foliar treatment in active growing season followed by mechanical removal in the fall or winter.
Injection/Hatchet/Girdling	Glyphosate Imazapyr	Consider in low density areas where flooding occurs (top growth is short and stems are buried in sediment) or where stems have enough girth to allow for injection or girdling.

- All proper licenses and permits must be obtained.
- Read labels carefully - the label is the law! For specific guidance on application rates, use/need of surfactants, etc., consult the manufacturer's label and/or a local technical professional (e.g., Extension agent, county weed coordinator, MDA staff).
- Aquatic formulations of herbicide and surfactants must be used near water.

HAVE QUESTIONS?

For additional information, consult the Statewide Management Plan or for additional technical support, contact:

- Your Local Weed District
- Your Local Extension Office
- MT Dept of Agriculture: (406) 444-3144 or agrweeds@mt.gov

APPENDIX E: LAND MANAGER SURVEY

Woody Invasives Working Group

LAND MANAGER SURVEY

The Woody Invasives Working Group has received funding from the Noxious Weed Trust Fund to draft a Statewide Management Plan for common buckthorn, Russian olive, and saltcedar. This survey is being used to compile information from land managers across Montana to better inform these efforts. Results of this survey will remain anonymous. Please be sure to complete the front and back pages of this survey.

1. Where do you or your organization manage land and/or natural resources in Montana (county, city, watershed, etc.)?

2. Are the following species present in the area described in Question #1:

Common Buckthorn	Russian Olive	Saltcedar
<input type="checkbox"/> Yes	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes
<input type="checkbox"/> No	<input type="checkbox"/> No	<input type="checkbox"/> No
<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know

3. If present, please estimate the number of acres infested and density for each species' location in the area described in Question #1. Please use descriptors, such as "along the _____ River."

Species & Location	# of Acres Infested	% Density
--------------------	---------------------	-----------

4. In your experience, are the following species a concern to the following users: A) You, as a Land Manager; B) Landowners/Producers in Your Community; C) Other Residents in Your Community?

Common Buckthorn	Myself	Landowners/Producers	Other Residents
	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes
	<input type="checkbox"/> No	<input type="checkbox"/> No	<input type="checkbox"/> No
	<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know

Russian Olive	Myself	Landowners/Producers	Other Residents
	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes
	<input type="checkbox"/> No	<input type="checkbox"/> No	<input type="checkbox"/> No
	<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know

Saltcedar	Myself	Landowners/Producers	Other Residents
	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes
	<input type="checkbox"/> No	<input type="checkbox"/> No	<input type="checkbox"/> No
	<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know	<input type="checkbox"/> I Don't Know

If you responded "No" for any species, why not?

Common Buckthorn	Russian Olive	Saltcedar
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5. Are you currently managing or removing the following species?

Common Buckthorn	Russian Olive	Saltcedar
<input type="checkbox"/> Yes	<input type="checkbox"/> Yes	<input type="checkbox"/> Yes
<input type="checkbox"/> No	<input type="checkbox"/> No	<input type="checkbox"/> No

If you responded "Yes," provide a short description of application method/s (e.g., herbicide, mechanical removal, biocontrol, and/or revegetation)?

Common Buckthorn	Russian Olive	Saltcedar
------------------	---------------	-----------

6. If you answered "No" for any species in #5, would you be interested in managing or removing them if additional resources were available?

Yes
 No
 N/A

7. In your opinion, what is the greatest need in regard to managing woody invasive species in your area? Check all that apply.

Funding
 Labor
 Monitoring
 Public Interest, Approval, and/or Understanding
 Technical Expertise in Treatment Options
 Other: _____

8. Additional Comments:

If you have not been included in previous communication about the Woody Invasives Working Group and would like to be in the future, email your contact information to Sara Ricklefs from Invasive Species Action Network at sara@stopais.org. The next meeting will be on February 13, 2024 at The Yogo Inn in Lewistown.

Thank you for your participation! We appreciate it immensely as we work to draft the Statewide Management Plan for Woody Invasive Species. Please submit this form to the MWCA Annual Meeting Registration Table, Montana Invasive Species Council (MISC) booth, or to the moderator during the Woody Invasive Species Presentation Sessions.

APPENDIX F: IDENTIFICATION TRI-FOLD BROCHURE

HOW TO REPORT

Reporting suspect and/or woody invasive species is very important! Monitoring and reporting is an important part of controlling invasive species in Montana. If woody invasive species are not controlled, they can increase habitat loss, damage riparian areas, and are extremely costly to remove.

Suspected invasive species can be reported at inaturalist.org online or in the mobile app.

MANAGEMENT RESOURCES

For additional support and information on Montana woody invasives, please contact the following management resources:

- Your local extension office
- Your local weed district

Saltcedar along the Yellowstone River near Billings, MT. Photo Credit: USDA NRCS MT

Common Buckthorn Leaves. Photo Credit: Leslie J. Mehrhoff, University of Connecticut, Bugwood

WOODY INVASIVES WORKING GROUP

Woody invasive plant management was identified as a key recommendation in the Yellowstone River Cumulative Effects Analysis report. Since then, a Woody Invasives Working Group (comprised of land management agencies & NGOs) formed to create a management plan that would encompass all Montana watersheds.

CONTACT DETAILS

Montana Department of Agriculture
agrweeds@mt.gov | (406) 444-3144

agr.mt.gov/Noxious-Weeds



WOODY INVASIVE SPECIES IN MONTANA

HOW TO IDENTIFY & REPORT

COMMON BUCKTHORN

Rhamnus cathartica

IDENTIFICATION

- Large shrubs or small trees (6-20ft tall) that have deciduous leaves, remain green long into the fall compared to native species
 - Has both alternate and opposite to sub-opposite leaves and buds
 - Leaves have 3-6 pairs of veins that arc from the mid-vein towards the pointed leaf tip
- Green-yellow flowers with 4 sepals and petals



BUCKTHORN NATIVE LOOKALIKES



Alderleaf Buckthorn



Common Chokecherry

RUSSIAN OLIVE

Elaeagnus angustifolia

IDENTIFICATION

- Tall shrubs or small trees (up to 26ft tall) with branches that are orange-brown in color with white-mealy hairs (trichomes)
- Leaves are alternately arranged, narrowly lanceolate, white-mealy blades, and silvery undersides
- Branches have alternating thorns
- Olive-like fruits are silvery-green and dry



RUSSIAN OLIVE NATIVE LOOKALIKES



American Silverberry



Silver Buffaloberry



Canada Buffaloberry

SALT CEDAR

Tamarix chinensis, T. ramosissima, & hybrids

IDENTIFICATION

- Wispy, shrubby growth form (3-17ft tall) that often occurs in riparian areas
- Multi-stemmed growth with red-brown bark
- Deciduous leaves that are very small, grey-green, and sit closely to branches
- Short clusters (racemes) of tiny pink flowers that can cover the shrub during the growing season



SALT CEDAR NATIVE LOOKALIKES



Rocky Mountain Juniper



Western Redcedar

COMMON BUCKTHORN

Rhamnus cathartica

IDENTIFICATION

- Large shrubs or small trees (6-20ft tall) that have deciduous leaves, remain green long into the fall compared to native species
 - Has both alternate and opposite to sub-opposite leaves and buds
 - Leaves have 3-6 pairs of veins that arc from the mid-vein towards the pointed leaf tip
- Green-yellow flowers with 4 sepals and petals



BUCKTHORN NATIVE LOOKALIKES



Alderleaf Buckthorn



Common Chokecherry

APPENDIX G: MANAGEMENT PLAN PUBLIC COMMENTS AND

Management Plan Public Comments & Responses

The following public comments were submitted electronically during the public comment period between November 4, 2025 and December 7, 2025. Upon receipt, the Core Planning Group reviewed all comments and formulated responses to each. In their formulation, additional consultation with peer-reviewed literature, professional societies, and technical experts occurred. Any personal identification has been removed from submissions. However, organizational representations have been left in full (as they were submitted, if provided). Each comment is provided in italics with the formal response provided directly below in bold.

The biggest concern I have with Buckthorn is identification. Most people have no idea what it is! It grows well, is hardy, has flowers and produces fruit. A friend of mine was going to make 'elderberry' jam from the fruit! If folks don't know what it is, they won't do anything to stop the spread. It is a LOT harder to get rid of than most of the invasive species in Montana.

We thank you for your input and agree that further investment in public outreach and education is critical.

Regarding Russian Olive: Long distance dispersal of Russian Olive is based on some pretty correlative research. Clearly the argument makes sense, but is not definitive. Russian Olive has some tremendously beneficial attributes on uplands and saline seeps and is very much liked by a majority of producers that have them in their windbreaks and shelterbelts. By disallowing their planting and sale in Montana the cumulative negative effects of potential appropriate plantings on specific sites such as saline seeps and uplands are noticeable as no other replacement species has been found. Considering the enormous range and number of these shrubs across Montana, eliminating their appropriate use does more harm than good. I would suggest adding a statement that "managing Russian Olive on upland and saline seep areas can have beneficial outcomes for wildlife such as sage grouse, partridge species and pheasants as well as landowner shelterbelt objectives. Control and elimination of this species should be focused on riparian areas and areas within a 1-mile radius." I am working on a draft of "Best management practices for Russian Olive" that I will present to the Montana Invasive Species Council in a year or so.

We thank you for your input and feedback.

We disagree that the collection of research on long distance Russian olive seed dispersal is correlative in nature. The dispersal studies (wildlife, water, ice transport) cited have been repeatedly supported in the documentation of Russian olive spread, noxious weed listing justifications, and removal of agency recommendations in shelterbelt plantings across North America.

Public perceptions and benefit to upland birds are addressed within the Plan (see pages 36-37, 70, 99). However, we state clearly that mixed or native stands are of greater habitat value as demonstrated in numerous studies. Additionally, we provide evidence that Russian olive stands serve non-native species more so than native species. The Plan does not condemn landowners with existing Russian olive shelterbelts or windbreaks. Furthermore, the Plan describes both historical promotion of the species' utility by land agencies as well as the eventual removal of those recommendations due to outside impact to riparian systems.

As currently written, the Plan does not address the use of Russian olive in saline seep mitigation. However, Montana land agencies/landowners have other targeted tools at their disposal for this purpose (e.g., specialty grass seed mixes).

It is our opinion that this Plan continuously communicates the need for prioritized management of these species in riparian areas, first and foremost. Finally, it is outside the scope of the Plan to argue the validity of Russian olive's classification as a Priority 3 regulated weed. That responsibility lies with the Montana Department of Agriculture's Noxious Weed Program and local county weed districts.

Overall, this is a well written and scholarly document. I just have a minor comment to propose for the Buckthorn section titled "Impacts to native species". I think the fact that buckthorn has been shown to impact woody overstory and understory natives in riparian areas has very significant potential ramifications for riparian habitat and associated wildlife. This point is not currently made, so I propose adding to this section a couple of sentences like "In Montana, buckthorn appears to suppress native woody overstory and understory species in riparian habitats (Ortega et al. 2019). Transforming riparian habitats from native cottonwoods and shrubs to buckthorn could have dramatic impacts on these highly productive systems with important ramifications for a range of wildlife species." Note that the Ortega et al. 2019 paper is already cited in this section, so no need to add the reference to the citations.

We thank you for your input and feedback. This suggestion has been adopted in full.

This document is timely in need for the State of Montana. The background information on why from the resource need to who initiated the need, followed by information on each of the three species gives a good explanation as well. First big comment, will there be any particular State entity/agency that holds this as a platform for how the state manages each of these species? While it is great the need came from various levels, it needs to have the State backing it. I fully admit that I looked hardest at the Russian olive section, as that is what impacts me currently, but

I did read about the other two species. One comment would be on working on cohesiveness on treatment. Both salt cedar and olive talked about cuts-stump herbicide treatment, yet if I was just learning about this method I would be confused. Olives had not to do this during the active growing season, which I have done for 14 years now and don't know why this would be the case. There was information of treating stumps quickly, but no details as to what does that mean. I've set a rule of within 30 minutes of cutting, mostly so the sawyers don't forget what they have cut or put trees on stumps. Then in salt cedar there was talk about 2" stump left and treating that. Neither talked about ensuring you only need to treat the live wood. All to say, I think there could be some clarifying of how cut-stump herbicide treatment works so anyone picking up this plan can understand. In the revegetation section of olives there is a comment about limiting livestock on areas being revegetated/planted. There is some information out there that grazing in winter can help knock down what has grown (especially annual weeds), put in nutrients, and be beneficial to native plantings. If there were any tweaks to layout, it would be the best management tools/actions. Consistency as well as better details is needed to make it a more rounded plan. Make this plan a tool for landowners to know the why as well as how.

We thank you for your input and feedback. This suggestion has been adopted in part.

This document was created as a collaboration among multiple local, state, and federal agencies. Montana Department of Agriculture and Montana Invasive Species Council have agreed to promote the usage of the Plan and its updates.

We are aware of continuous discussion about the window in which herbicide should be applied within the cut-stump method. The cut-stump descriptions provide clarity on quick herbicide application based on Science Advisory Panel presentations and gray literature references:

Page 39 (Russian olive): "...a sawyer cuts the tree at ground level and an applicator follows to apply herbicide immediately to the stump."

Page 51 (saltcedar): "...should be cut to just above ground level and the stump treated with herbicide within 10 minutes of being cut."

The Plan has been updated to reflect application of herbicide on living tissue in cut-stump treatments.

On Page 39, we do not outright discourage treatment in the spring or active growing season, we simply provide insight from the Combs (2010) paper that treatment outside the active growing season will yield best results.

On Page 42, the recommendation to limit livestock refers to newly planted or established vegetation within the first growing season. Based on Science Advisory Panel recommendations, this may be with use of vegetation cages and/or resting the treatment site from livestock altogether. The section has been updated to reference exclusion tools (e.g., vegetation cages, fencing) to provide greater clarification on the recommendation.

- *Cover page - Change document title to include Montana such as "Montana Woody Invasive Species Statewide Management Plan"*
- *Cover page - Change photo to one that shows the problem you're trying to address with this plan. A riverscape would be great, but use a photo with incised channels, landscape degradation and a monoculture of Russian olive or Tamarisk. It needs to be illustrative of the challenges these species pose.*
- *Pg 2 - Change photo to include invasive species.*
- *Pg 7 - Exec Summary - Can you explain the "urgency" around implementation of this plan in greater detail?*
- *Pg 24 - Herbicide application - rather than "systematic" herbicide, the correct term is "systemic" herbicide.*
- *Pg 30 - Is scarification through an animal's gut necessary to inhibit germination? I think it is, which is a key life history trait to include - but worth double checking the literature and not taking my word for it.*
- *Pg 39 - Treatments should **not** be made during the spring because it's not effective.*
- *Pg 39 - I don't think 2-4D is effective and should not be on this list of recommended herbicides.*
- *Pg 40 - It is worth noting that imazapyr leads to the "ring of death" and secondary weed invasion. It also has the potential to damage nearby desirable trees because it's so mobile in the soil.*
- *Pg 41 - Add best practices for managing biomass after mechanical removal because it decomposes so slow. I hate to leave wood on site if it can be helped.*
- *Pg 42 - Add a subsection for adaptive management and monitoring because it's a major component of implementation.*
- *Pg 51 - There's too much emphasis on non-target effects of glyphosate. It is non-selective, but not as problematic as imazapyr because it doesn't move in the soil profile. I'd argue that this disclaimer on herbicide application should focus on imazapyr.*
- *Pg 66 - Add an action to survey watersheds, determine the actual extent of the problem and identify high priority corridors to treat/protect. I'd even go so far as prioritizing common buckthorn to start with since it's distribution is in question and somewhat limited compared to the other two species.*
- *Pg 67 - Add an action around financial feasibility and cost/benefit of this work. There needs to be some defensible economic data that is focused on Montana or one of Montana's key watersheds to create local urgency for funders, landowners and managers.*

- Pg 71 - There's reference to landscape level eradication of these invasive species. I would change that to local eradication and landscape level management to temper expectations.

We thank you for your feedback and input. These suggestions have been adopted in part.

The Plan title has been updated to Montana Woody Invasive Species Statewide Management Plan.

The Cover photo has been updated to reflect a healthy Montana cottonwood gallery.

The Executive Summary is intended to serve as a brief summary of the Plan's purpose. Details regarding the urgency around implementation can be found in later sections of the plan (e.g., Introduction, Conclusion).

The incorrect usage of “systematic” has been updated to “systemic.”

A literature review indicates that scarification via digestion is not a requirement for germination.

We do not outright discourage treatment in the spring or active growing season, we simply provide insight from the Combs (2010) paper that treatment outside the active growing season will yield best results.

2,4-D has been removed from the recommended herbicides for Russian olive treatment.

An additional sentence about imazapyr’s potential for non-target impacts (e.g., persistence and soil mobility) has been added as suggested in the Russian olive and saltcedar sections.

Biomass management recommendations that were originally included in the Fire subsection of Russian olive management have been moved to the Mechanical Removal section. Additional details on biomass management may be found in the Russian olive IPM guide (Appendix C). The reader has been directed there for additional information.

Adaptive management and monitoring are addressed in the introductory Management Strategies section paragraph on page 39. Furthermore, use of adaptive management and monitoring are highlighted as critical in the Goals and Objectives, Strategies and Actions for Implementation, IPM Guides, and Conclusion.

Mapping and monitoring is identified as an overall goal with primary and secondary priorities described within. Additionally, six Strategies and Actions are tied to that overall goal.

An Impact Study is currently underway with researchers from the Flathead Lake Biostation/University of Montana to better understand impacts on economic measurements, including costs and benefits. One of the existing strategies was updated to include the distribution of those results once complete.

The suggestion for referencing landscape-level management and local eradication has been adopted.

Following are my comments on the Montana Woody Invasive Management Plan:

Page 6, Executive Summary, first paragraph: The text states invasives “have been shown to increase soil erosion, exacerbate river channelization, and reduce water access and biomass production for grazers,...”. On Page 8, in the second paragraph, the text states invasives “have contributed to reduced water access and biomass production for grazers, damaged irrigation infrastructure, increased soil erosion, exacerbated river and stream channelization, and negatively impacted recreation.” I feel the two lists of impacts should match listing these major impacts from woody invasives. A person reading the summary would miss that invasives damage irrigation infrastructure and negatively impact recreation.

Page 13, Partners and Support: I am surprised that several groups are missing from helping develop this plan, most notably the Montana Native Plant Society. The Montana Urban and Community Forestry Association also deals with these species in stream corridors through communities. The other obvious groups missing are important wildlife groups like the National Wildlife Federation, Montana Wildlife Federation and Pheasants Forever. Also, Important livestock and agricultural groups are missing like the Montana Stockgrowers Association, National Farmers Union, etc. Finally, I think the Montana Nursery and Landscape Association needs to step up and be a part of this plan as they are one of the groups that could introduce the next invasive woody plant. Hopefully, these groups will comment on the plan like MUCFA is.

Page 20, second paragraph: This reviewer would agree that buckthorn has not been adequately reported across Montana. I have observed buckthorns in riparian areas in Townsend and Choteau. I will encourage MUCFA members to get buckthorn observations to the Montana Natural Heritage program database.

Page 36, Impacts section. I am surprised to see no mention of Fire Dynamics under Russian Olive as is mentioned under saltcedar. This is a major concern to the Montana Native Plant Society and other organizations concerned about important plant communities. Historically, river corridors like the Yellowstone River were dominated by cottonwoods with an understory of juniper and shrubs. Fires typically flashed through the community igniting the junipers and the fire would likely not jump into the crowns of the cottonwoods. Now, with the midsized Russian olives in these stands, the fires typically reach the crowns of the cottonwoods and kill them. And what returns after the fire? Russian olive. Cottonwoods need flooding to reproduce. Please add this important impact to the Russian olive section.

Page 38, Infrastructure section: I would recommend changing the title of the section to Irrigation Infrastructure to match the impacts listed in earlier sections.

Page 45, footer: The footer lists Russian olive and should list saltcedar.

Page 50, Fire section: I would change this section title to Fire Dynamics.

Page 51, Management Strategies, first line: This is the first mention of IPM. I would write it out the first time for those unfamiliar with Integrated Pest Management (IPM).

Page 58, after Montana Invasive Species Council: I would list the Montana Native Plant Society as the main source of information on native plant species in Montana. Contact for a one paragraph summary for the document.

Other groups may also be worth mentioning as listed earlier in the comment on Page 13, Partners and Support.

General Comment: I think the document needs a list of potential woody species that need to be watched for their invasiveness. Here is where the Montana Nursery and Landscape Association should be able to help as many other states list some ornamentals that are for sale in Montana as invasive.

Thank you for the opportunity to comment.

We thank you for your feedback and input. These suggestions have been adopted in part.

Pages 6 and 8: The suggestion to match the impacts listed has been adopted.

Page 13: The Partners and Support section is reflective of those organizations that participated actively in the Working Group meetings and listserv. We utilized public notices to promote Working Group efforts and welcome any participation from broad stakeholders into the future. That section is likely to be updated in future updates due to changes within participation of the Working Group.

Page 20: We encourage further reporting and outreach to better understand the range of common buckthorn.

Page 36: Unfortunately, the topic of Russian olive fire dynamics represents a gap in literature. Therefore, wildfire (and resulting impacts to desirable species within mixed stands) is unaddressed in this section of the Plan. Available literature does note that prescribed fire is largely unsuccessful for suppression of mature Russian olive due to resprouting. Therefore, Russian olive resprouts post-wildfire could be of potential concern. If future Russian olive publications address fire dynamics, it would be a notable improvement for future Plan drafts.

Page 38: The suggestion to update the Russian olive Impacts Infrastructure section to Irrigation Infrastructure has been adopted.

Page 45: The footer tab correction has been adopted.

Page 50: The suggestion to update the section heading was not adopted due to personal preference.

Page 51: The first mention and the definition of IPM occur on page 14. The suggestion to define the acronym on page 51 was not adopted.

Page 58: The Montana Native Plant Society was added to the Existing Programs and Authorities section as a source for native plant information with their non-profit status and mission statement.

We feel that the suggestion to provide a list of potential woody species to watch is outside the scope of the Plan and is the responsibility of the Noxious Weed Program at Montana Department of Agriculture and local weed districts.

We appreciate the opportunity to comment on the Woody Invasive Species Statewide Management Plan. We are writing on behalf of over 900 members of the Montana Native Plant Society. The Society is a non-profit organization dedicated to preserving, conserving, and studying Montana's native plants and plant communities, and educating the public about the values of our native flora and its habitats. The 2025 Statewide Management Plan is very thorough and contains a lot of information, including references to extensive literature. MNPS has only a few suggestions that may help to slow the spread of woody invasive species. The management plan should place a stronger emphasis on public involvement on private and public land. Farmers, ranchers and hunters are often the first to encounter these species and with the proper training can take measures to aid in the removal of them. By playing a critical role in early removal efforts, these early actions can reduce the spread of young difficult to locate plants due to their size, reducing the opportunity for plants to mature and increase the seed bank. These recreationists require training to ensure they are properly identifying and reporting these invasive species. These species are relatively easy to identify and that can help aid in faster and more efficient removal strategies. Landowners need to be provided with comprehensive education about installing alternative plant species or varietal releases that can withstand extreme weather and still provide effective wind and erosion control. We urge the inclusion of stronger public engagement and education components. By equipping land owners, recreationists and community members with the knowledge and tools to act early Montana can reduce long-term management costs and foster shared responsibility.

We thank you for your feedback and input. These suggestions have been adopted in part.

Throughout the Plan and associated outreach efforts, we encourage the inclusion of private landowners, producers, and outdoor recreators to play a key role in reporting. We also support agency or organization-led volunteer efforts (e.g., Buckthorn Bandits). However, we have not included any information about training outdoor recreators to pull or engage in management activities in unsupervised situations. While the Pull Your Share program has been successful in this way for herbaceous weed management efforts, there may be concern from land management agencies for unsupervised woody intervention. Considerations include that proper species identification is critical and can be difficult at the seedling stage when hand removal is most effective and lowest risk. Therefore, supervision of any management efforts from a responsible agency or NGO is encouraged.