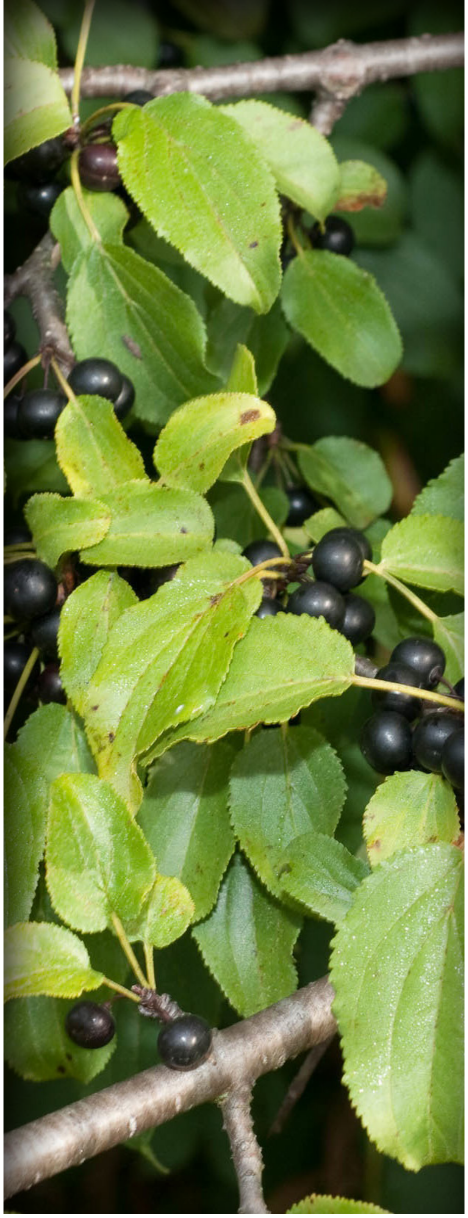

2026 REPORT:

Current and Future Expected Costs of Woody Invasive Species in Montana

Russian Olive (Elaeagnus angustifolia), Tamarix (Tamarix chinensis, T. ramosissima, and hybrids thereof) & Common Buckthorn (Rhamnus cathartica)

ISAN
INVASIVE SPECIES ACTION NETWORK

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Montana Invasive Species Council

FLATHEAD LAKE
BIO STATION
UNIVERSITY OF MONTANA

Current and Future Expected Costs of Woody Invasive Species in Montana—

Russian Olive (*Elaeagnus angustifolia*), Tamarix (*Tamarix chinensis*, *T. ramosissima*, and hybrids thereof) & Common Buckthorn (*Rhamnus cathartica*)

Nanette M. Nelson[1]

Diane Whited[1]

with assistance from Braden Burkholder[2]

[1]Flathead Lake Biological Station, University of Montana, Polson, Montana USA

[2]Montana Natural Heritage Program, Montana State Library, Helena, Montana USA

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Executive Summary

Russian olive (*Elaeagnus angustifolia*), Tamarix (*Tamarix chinensis*, *T. ramosissima*, and their hybrids), and common buckthorn (*Rhamnus cathartica*) increasingly threaten Montana's riparian ecosystems. The Woody Invasive Working Group (WIWG) was established to established to develop and coordinate management efforts targeting these focal woody invasive species. A WIWG core objective was quantifying the actual and potential economic impacts of these invasions, in recognition of the value of species-specific data in effective planning and control.

To provide that information, we surveyed county weed district coordinators and public land managers, collaborated with the Montana Natural Heritage Program to produce species-specific habitat suitability maps under current and future climate scenarios, estimated the real and expected costs of mitigation now and in the future, and reviewed the literature on riparian ecosystem services and economic impacts to key sectors.

Habitat Suitability

We used MaxEnt modeling to predict current and future (2041–2070) habitat suitability for each species under a mid-range climate scenario. Under current conditions, optimal habitat covers approximately 7,400 km² for Russian olive, 5,000 km² for Tamarix, and 6,300 km² for common buckthorn. Climate projections indicate substantial expansion: optimal habitat for Russian olive increases by 46%, while Tamarix faces a far more dramatic 224% increase, driven by warming temperatures and increased aridity. We did not model future habitat for common buckthorn due to limited occurrence data.

Mitigation Costs

We surveyed 44 land managers and found that Russian olive is the most widely encountered species (reported by 82% of respondents), followed by Tamarix (42%) and common buckthorn (22%). Reported mitigation expenditures totaled $5.5 million for Russian olive and Tamarix combined and $159,000 for common buckthorn. Average annual mitigation costs were $7,809 per hectare for Russian olive and Tamarix and $1,201 per hectare for common buckthorn.

Delaying action will substantially increase costs. We estimated current expected mitigation costs at $44 million for Russian olive and $28 million for Tamarix. Under future climate conditions, those figures rise to $69 million (+56%) for Russian olive and $103 million (+272%) for Tamarix. We estimated current expected mitigation costs for common buckthorn at $7 million.

Economic Sector Impacts

Of five sectors we assessed—municipalities, industry, agriculture, recreation, and tourism—we found evidence of impact for three.

Agriculture: Potential losses in agricultural cash rents were minimal in nearly all scenarios, exceeding 1% of baseline values in only two cases: pasture and hay rents declined by an estimated 3.4% from Russian olive and 1.2% from Tamarix. We estimated total rent losses at

$4.2 million for Russian olive, $3.2 million for Tamarix, and $13,304 for common buckthorn—the latter affecting soybean and oat production.

Municipalities and Industry: Invaded and uninvaded riparian ecosystems provide comparable levels of key regulating services—water quality maintenance, erosion control, and flow regulation—suggesting that managing Tamarix or Russian olive is unlikely to yield additional benefits for these sectors. However, Tamarix has been linked to channel narrowing and increased flood frequency, highlighting the need for a fuller accounting of riparian ecosystem services and site specific conditions of proposed control efforts before drawing conclusions on the benefits to be gained from management.

Recreation and Tourism: Recreation and tourism represent a substantial share of Montana's economy. We did not assess these sectors, however, because no studies measuring public preferences for invasive species management outcomes were available. The one relevant study we identified used economic impact analysis, a method that measures gross economic activity rather than changes in welfare. To capture public preferences and non-market values, economists have used photo-elicitation surveys and surveys eliciting the public's willingness-to-pay for outcomes from invasive species control programs, among other approaches.

Conclusions and Recommendations

Early action on Russian olive and Tamarix management is economically warranted. Delaying control will substantially increase costs, particularly for Tamarix, whose optimal habitat is projected to expand dramatically under climate change. Agricultural losses from all three species are modest under current conditions but will likely grow as invasions expand.

A critical gap in the evidence base is the absence of public preference data—information essential for weighing different courses of action to maximize economic, social, and environmental benefits. We recommend that WIWG undertake expert elicitation to develop an ecosystem services prioritization framework and invest in research to capture the public value of invasive species management to restore riparian areas. Continued on-the-ground monitoring is also essential, as habitat models cannot estimate species abundance at invaded sites.

Introduction

Montana’s riparian ecosystems are increasingly threatened by the spread of Russian olive (*Elaeagnus angustifolia*), Tamarix (*Tamarix chinensis*, *T. ramosissima*, and their hybrids), and common buckthorn (*Rhamnus cathartica*), hereafter referred to as focal woody invasive species or focal species. In response, the Woody Invasive Working Group (WIWG) was established to develop and coordinate management efforts targeting these focal woody invasive species. WIWG participants represent a wide range of groups including state, federal, and tribal agencies; municipalities; non-governmental organizations; landowners; producers; academics; congressional representatives; among others. A core WIWG objective was quantifying the actual and potential impacts of these invasions, in recognition of the value of species-specific data in effective planning and control.

Woody invasive species’ impacts to invaded ecosystems include disruption of ecosystem processes, changes in the provision of ecosystem services, the manifestation of those impacts to human well-being, and the costs to economic sectors that rely on those ecosystems. Ecosystem services are benefits provided by the environment that contribute to human well-being (Millennium Ecosystem Assessment 2005). The concept of ecosystem services is the predominant paradigm that links ecosystem function and human welfare (Fisher et al. 2009). This conceptual framework was adopted by the Millennium Ecosystem Assessment (2005), which broadened the interpretation of ecosystems to include the services that they provide, the benefits humans receive from ecosystem services, and how human actions alter ecosystems and the provision of those services (Box 1). The Millennium Ecosystem Assessment was one of the first global study’s that explicitly accounted for the connection between nature and human well-being (Carpenter et al. 2009). In this accounting of human benefits derived from the environment, the Millennium Ecosystem Assessment focused on value and utilitarian framing, a point of criticism voiced by some (Muradian & Gomez-Baggethun 2021).

Box 1. Ecosystem services are grouped into three categories: provisioning, regulating and maintenance, and cultural. Provisioning services are the material goods collected from riparian areas (e.g., timber, seeds, genetic resources); regulating and maintenance services sustain environmental quality (e.g., pollutant capture, carbon sequestration, hydrology, flood control, wildlife habitat, etc.). Cultural services include the non-material benefits that contribute to human well-being, culture, and spiritual development (recreation, aesthetic and spiritual value, mental health).

In Montana, riparian areas are the primary ecosystem under invasion pressure by the focal species of this study. The riparian zone comprises the stream channel and that portion of the terrestrial landscape from the high water mark towards the uplands where flooding and the water table continue to influence vegetation (Naiman et al. 1993, Naiman & Decamps 1997). The importance of riparian zones far exceeds the land area they occupy because the interactions between terrestrial and aquatic ecosystems results in a wide range of species, environmental processes, and ecosystem services (Poff et al. 2011, Gregory et al. 1991, Naiman et al. 1993, Naiman & Decamps 1997). Riparian area restoration is widely recognized as essential to the resilience and adaptive capacity of both human and ecological systems, given the broad array of ecosystem functions and services these areas provide (Capon et al. 2018). These functions and services include water quality regulation, nutrient cycling, carbon storage, biodiversity support, flood mitigation, bank stabilization, aesthetics, and recreation, among others (Naiman et al. 1993, Sweeney et al. 2004, Tabacchi et al. 2000). In addition to invasive species, riparian areas are under intense pressure from a host of anthropogenic activities, such as streamflow regulation by dams, pollution, land-use change, timber harvesting, water diversion, deforestation, and grazing (Poff et al. 2011, Riss et al. 2020). Invasive species and climate change have been identified as the top two major threats to riparian ecosystems in western North America (Poff et al. 2011).

WIWG sought information on the economic costs (realized and expected) of the focal woody invasive species to the state of Montana's natural and cultural resources and major economic sectors. To provide the needed information, we surveyed county weed district coordinators and public land managers to gather data on their focal species-related mitigation expenditures, management approaches, and concerns. We also identified the spatial extent of the invasions with the help of the Montana Natural Heritage Program (MTNHP). Our collaboration with MTNHP produced species-specific habitat suitability maps under current and future climate scenarios. The combination of mitigation costs and likelihood of establishment of our focal species allowed us to estimate realized and expected total cost of mitigation now and in the future. To help decision makers evaluate management tradeoffs, we reviewed literature on the potential impacts of the focal species on riparian ecosystem services, using both quantitative and qualitative methods.

Methods

Survey of County Weed District Coordinators & Public Land Managers

Questionnaire Development

To collect mitigation cost data from county weed district coordinators and public land managers, referred to as managers henceforth, we created a questionnaire based on a riparian restoration cost calculator developed by RiversEdge West (formerly Tamarisk Coalition). The calculator is an excel spreadsheet that asks the user for a variety of site-specific inputs to estimate Tamarix and Russian olive removal and restoration costs (RiversEdge West, n.d.). Similar to the cost calculator, the questionnaire for this study broke down costs of mitigation into three phases—control methods; biomass reduction; and revegetation, long-term monitoring, and maintenance (see Appendix A for questionnaire and summary tables).

The questionnaire collected recent cost data (projects initiated or completed in the last 3 years) from the surveyed managers. Managers initially answered the following question, "Over the past 3 years, have you taken any actions to eliminate or reduce [focal woody invasive species]". If yes, the manager then were presented a series of questions for that species with the following preface, “Please answer the following questions for your most recent project involving [focal woody invasive species] … Please provide the requested information for a project that was active in the last year …”

Additional questions to help characterize costs included the management goal (suppression, eradication), site characteristics (acreage, canopy cover, stem size), who completed the project (in-house, contractor, volunteers), and project duration for each of the three phases. We asked managers whether they believed the focal woody invasive species would have negative ecological impacts and negatively influence various economic sectors. Initial drafts of the survey were reviewed by WIWG and two experts; we edited the survey based on their feedback.

Depending on their answers, managers were asked the same set of questions for each of the three focal woody invasive species: Russian olive, Tamarix, and common buckthorn. The questionnaire was programmed in Qualtrics, which allowed us to use skip patterns or conditional logic. Skip patterns direct respondents to a series of questions based on a previous answer; therefore, managers only saw questions for the focal woody invasive species they actively manage.

Sampling Frame

The initial sampling frame included all county weed district coordinators in Montana. Because there were only 54 active weed coordinators at the time of this study, we conducted a census of the population of interest. After a discussion with WIWG, the sampling frame was expanded to include additional public land managers including individuals employed by Conservation Districts, Montana Fish Wildlife & Parks, Montana Department of Transportation, Montana Department of Natural Resources & Conservation, U.S. Forest Service, Bureau of Land Management, Natural Resource Conservation Service, Montana State University Extension, Bureau of Indian Affairs, private businesses, and not-for-profit conservation organizations. The expanded sampling frame added 69 points of contact for a total sample size of 123.

Survey Administration

Managers received an email with a request to participate in the study and a personalized link to access the online survey. Initial emails were sent to county weed district coordinators on May 14, 2025 with follow-up reminder emails sent on May 19th and 22nd and June 2nd, 2025. An invitation email to the expanded list of contacts was sent on May 27, 2025 with follow-up reminder emails sent on June 2nd and 9th, 2025. A final attempt was made on October 20, 2025 to all individuals who had yet to complete the survey. Survey data collection was closed on November 12, 2025. Of the 48 responses received, 31 respondents were county weed district coordinators; 44 respondents provided useful information.

Habitat Suitability Modeling

Estimating mitigation costs requires knowing where Russian olive, Tamarix, and common buckthorn occur across Montana. We used MaxEnt, a widely used habitat suitability modeling software, to predict where each species is most likely to occur (Merow et al. 2013). MaxEnt combines species occurrence data with biotic and abiotic factors (temperature, precipitation, and land cover) mapped to 90x90-m raster pixels to predict the current distribution and relative habitat suitability of each species (Phillips et al. 2006, Phillips et al. 2017).

Selection of Climate Modeling Variables

To evaluate the effects of changing climatic conditions on the likely future distribution of the focal species, a second habitat suitability model for each focal species was estimated using future climate projections as data inputs. These climate projections were based on the latest high-resolution climate simulations used in the Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC 2023, Liang et al. 2020). The broad-scale climate data were downscaled to an 800m^2 resolution using ClimateNA (v7.60). ClimateNA is a freely available tool that downscales monthly historical and climatic data at point or grid scales to localized regions within North America. We selected the 2041–2070 timeframe to model potential changes in climate as an estimate of the immediate future. Further, we choose the Shared Socioeconomic Pathway 2 (SSP2), a narrative describing a possible future development pathway for society with attention to its use of fossil fuels. SSP2 is considered the "middle of the road climate scenario," balancing differences in a high consumption/economic gain model versus a sustainable model—low consumption/population growth (Riahi et al. 2017). Initial climate variables for the state of Montana (Table 1) were generated at an 800m^2 resolution, and then resampled to 90m^2 to be compatible for use in the habitat suitability modeling for each species of concern.

Table 1. Climate variables used in habitat suitability modeling

Climate Variables
Degree Days above 5°C
Max July Temperature (°C)
Minimum January Temperature(°C)
Mean Annual Precipitation (mm)
Percent Winter Precipitation (0 – 1)
Annual Number of Frost-Free Days

Estimating Realized and Expected Mitigation Costs

From the survey data, we estimated three separate mitigation costs—realized, expected, and an average with upper and lower 95% confidence intervals. *Realized* costs are the actual expenditures reported by managers; e*xpected* costs are the probability that a certain mitigation cost will be incurred times the cost, and can account for incomplete information on *realized* costs. Some reasons for having incomplete information include: 1) partial coverage of mitigation activity (not all managers replied to the survey invitation or did not completely fill out the survey once initiated); 2) a woody invasive species is known to be present, however, a manager lacks the capacity, such as budget, personnel, or time to mitigate such occurrences; or 3) a woody invasive species is known to be present but its actual presence is unknown to the manager.

To estimate *realized* costs, we asked managers to report their actual expenditures and the project-specific characteristics associated with control of the focal woody invasives species on the lands they manage. We then estimated an average mitigation cost amd 95% confidence intervals for each species using a bootstrap method that resampled the data 10,000 times. The 2.5th and 97.5th percentiles of the resulting sampling distribution define the lower and upper confidence bounds. This method provides a non-parametric that makes no assumptions about the underlying distribution of costs.

Expected mitigation costs are a function of four stages of the invasion cycle: the probability of introduction, the probability of establishment, the rate of dispersion, and abundance, with abundance driving the magnitude of both mitigation costs and economic and ecological impacts. While implementation of an invasion model is beyond the scope of this study, it is possible to use the results of the habitat suitability models to incorporate invasion ecology into estimating the expected costs of mitigation. Specifically, we interpreted MaxEnt's complementary log-log (cloglog) output as the probability of presence of the focal species in each grid cell or pixel on the landscape (Phillips 2017). However, this interpretation of cloglog is strongly dependent on the sampling design (Phillips 2017). Thus, we assumed the presence data used in the model represents a random sample of space (rather than individuals) and sampling bias is negligible (Merow et al 2013).

The total expected value of the cost of mitigation for each individual species was calculated as follows:

$$E[Cost_{tot}] = Cost_{avg} \times Area_{cell} \times \sum_{i=1}^{n} P(presence)_i$$

where $Cost_{tot}$ (dollars yr^{-1}) is the total annual cost of mitigation, $Cost_{avg}$ (dollars $\text{m}^{-2}\ \text{yr}^{-1}$) is the average annual mitigation cost, $Area_{cell}$ (m^2) is the area of each cell or pixel on the landscape, $P(i)$ is the predicted probability of presence at pixel *i*, and *n* is the total number of pixels.

Impacts to the State of Montana's Natural and Cultural Resources

We also used a qualitative approach to assess the impacts of the focal species on Montana's natural and cultural resources, with the goal of supporting decision makers in their analyses of management tradeoffs. Hence, we framed the analysis around the ecosystem services provided by riparian ecosystems, which makes explicit the link between ecosystem function and human well-being. We reviewed the literature on riparian ecosystem services, with particular attention to studies that evaluated the outcomes of invasive species management outcomes using the ecosystem services framework.

Estimating Potential Losses to Key Economic Sectors

We conducted a literature review to identify the economic sectors most likely to be affected by the focal species, and to find existing damage cost estimates that could be extrapolated to

Montana. Where quantitative estimates were unavailable, we addressed the economic impacts qualitatively.

To estimate potential costs to the agricultural sector, we adapted the approach of Nagler et al. (2024) to estimate the foregone economic value from weed infestations on agricultural land in Montana. Specifically, we estimated the potential impact to grazing resources and crop production within the optimal habitat of each focal species. We estimated the reduction in agricultural value using three inputs: a baseline economic value of unimpacted agricultural production, an estimated reduction in production on a per-hectare basis, and the acreage of each agricultural land cover type overlapping with optimal habitat of the focal species.

We collected values for Montana's agricultural land cover from the Cropscape Database (2025) for soybean and oat acreage and the National Land Cover Database (2024) for rangeland (shrub/scrub and herbaceous), and pasture and hay. We estimated the baseline economic value of agricultural production using annual cash rent per hectare in 2024 (U.S. Department of Agriculture's [USDA] 2026). For rangeland and pasture and hay, we used cash rent for pastureland, while soybean and oat cropland used cash rent for non-irrigated cropland (Table 2).

We obtained estimates of percent loss in agricultural value for each affected land cover type from the literature (Table 3). Estimates of percent loss in cash rents were based on the reduction in biomass resulting from invasion. For Russian olive, we used an estimate of 55% decrease in agricultural rent reported in Nagler et al. (2024). Lacking a Tamarix specific estimate, we applied the same percentage loss as was used for Russian olive. It is widely understood that common buckthorn is a host for oat crown rust (*Puccinea coronate*) and the soybean aphid (*Aphis glycines*) (Ragsdale et al. 2011, Nazareno et al. 2018). An infestation of soybean aphids can reduce soybean yield by 40% (Ragsdale et al. 2011). Oat crown rust epidemics have caused serious crop failure in the U.S. with severe outbreaks resulting in 20% crop loss and milder oat crown epidemics reporting <10% loss (Nazareno et al. 2018). We used estimates of 40% and 20% decrease in agricultural rent for soybeans and oats, respectively.

Table 2. Annual cash rent per hectare by land cover category

Land cover category	2024 Annual cash rent ($ ha^{-1})
Rangeland	$20.26
Pasture & hay	$20.26
Cultivated cropland	$75.37

Table 3. Agricultural rent loss estimates by land cover category

	Rangeland	Pasture & hay	Soybean	Oats
Russian olive	55%	55%	na	na
Tamarix	55%	55%	na	na
Common buckthorn	na	na	40%	20%

Results

Estimates of Focal Woody Invasive Species Habitat Suitability

The initial habitat suitability model outputs were spatial datasets of continuous logistic values that ranged from 0–1 with lower values representing areas predicted to be less suitable habitat and higher values representing more suitable habitat. The continuous outputs were reclassified into habitat suitability classes—optimal, moderate, and low—and aggregated within 259-ha hexagons (Figures 1–3). Model runs including future climate data were estimated for Russian olive and Tamarix only. The smaller sample size for presence of common buckthorn (n=28) resulted in an overall lower model confidence especially for model estimation with future climate data, hence we did not include model outputs for future climate conditions in our results.

Projected climate conditions in the near-future (2041–2070) increased the predicted area of optimal habitat for both Russian olive and Tamarix with a much stronger influence on Tamarix. Under current climate conditions, optimal habitat for both species was concentrated along the river corridors in Eastern Montana (Figures 1A, 2A). Predictions under future climate conditions expanded optimal habitat laterally within riparian areas for both species, with slight gains in Western Montana for Russian olive (Figure 1B, 2B). **Optimal habitat for Tamarix increased by 224%** from 5,000 km^2 to over 16,000 km^2, while optimal habitat for Russian olive increased by 46% from 7,400 km^2 to 10,800 km^2 between current and near-future (2041–2070) climate conditions (Table 4).

Optimal habitat for common buckthorn was predicted in smaller, discontinuous patches scattered across Montana, in contrast to the distributions of Russian olive and Tamarix concentrated in riparian areas (Figure 3). Common buckthorn optimal habitat occurred in only a few riparian areas and in wetland ecosystems, such as the predicted distribution south of Flathead Lake. Under current climate conditions, the predicted area of optimal habitat for common buckthorn fell between that of Russian olive and Tamarix (Table 4). The model performs reasonably well with limited data, but likely underpredicts suitable habitat for common buckthorn in riparian areas of eastern Montana (Montana Natural Heritage Program, 2025).

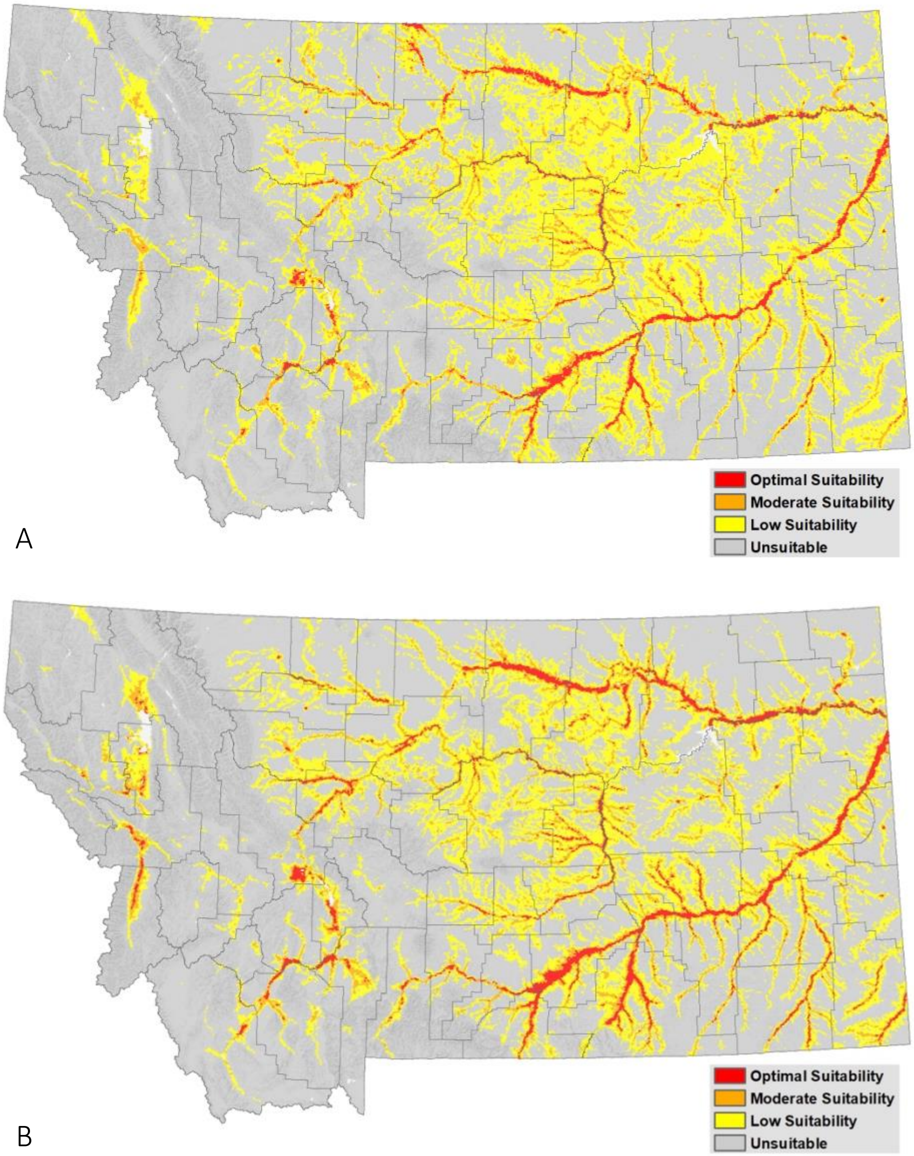

Figure 1. Distribution of Russian olive habitat suitability under current (**A**) and future (**B**) climate conditions. Future projected climate conditions (**B**) showed an increasing concentration of optimal habitat for Russian olive along river corridors with some lateral spread away from river channels compared to current conditions. Source Montana Natural Heritage Program (2026).

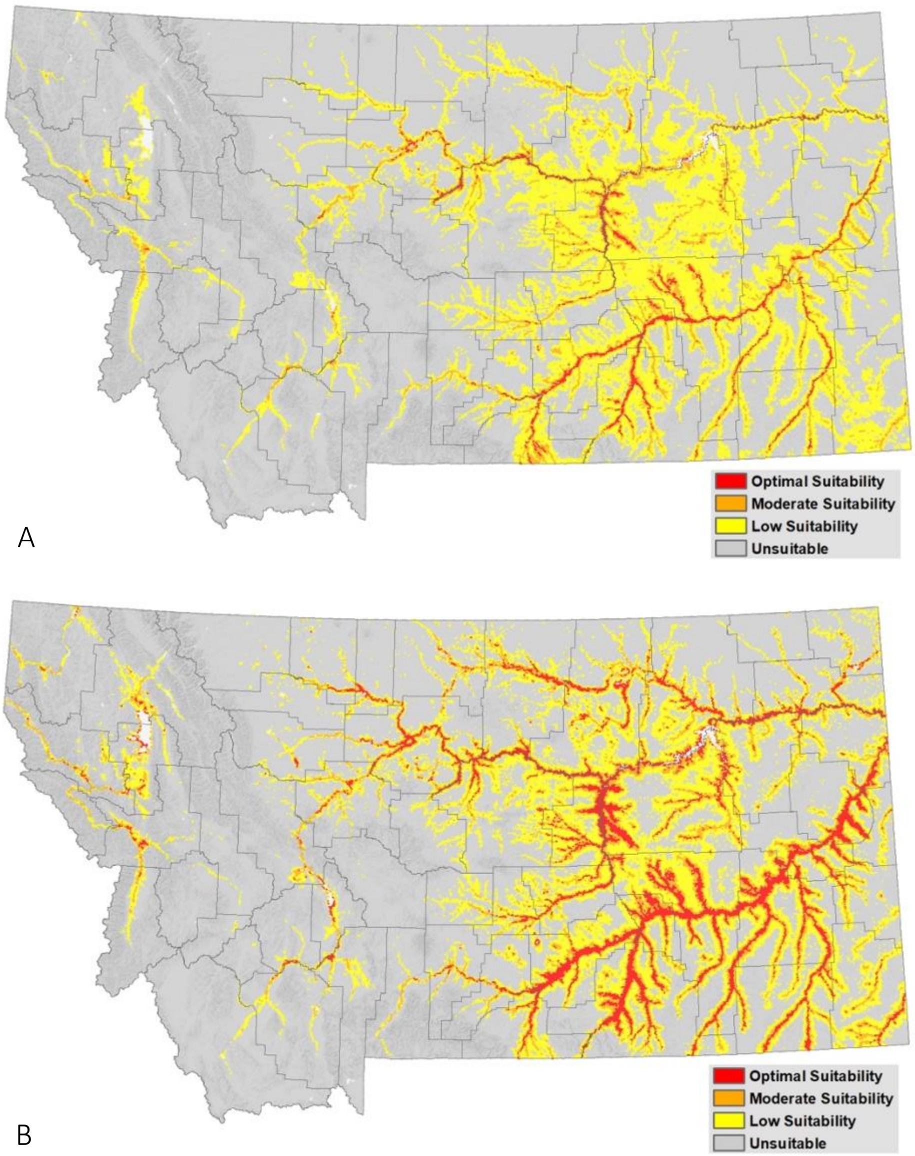

Figure 2. Distribution of Tamarix habitat suitability under current (A) and future (B) climate conditions. The current distribution of optimal habitat for Tamarix is primarily in Eastern Montana (**A**). Distribution of Tamarix habitat suitability under future (**B**) climate conditions showed an intensifying of optimal habitat along river corridors with definitive lateral spread away from river channels compared to current climate conditions (**A**).

Table 4. Areas of predicted habitat suitability

Habitat suitability	Area of predicted habitat (km^2)		Percent change in predicted habitat
	Existing Climate Scenario	Projected Climate Scenario	
Russian olive (*Elaeagnus angustifolia*)			
Optimal suitability	7,378	10,768	+46%
Moderate suitability	10,731	11,711	+9%
Low suitability	69,693	62,223	-11%
Total predicted habitat	87,802	84,702	-4%
Tamarix (*Tamarix ramosissima, T. chinensis, and their hybrids*)			
Optimal suitability	4,997	16,167	+224%
Moderate suitability	8,712	14,242	+63%
Low suitability	68,797	61,585	-10%
Total predicted habitat	82,506	91,993	+11%
Common buckthorn (*Rhamnus cathartica*)			
Optimal suitability	6,277	na	na
Moderate suitability	25,320	na	na
Low suitability	64,581	na	na
Total predicted habitat	96,178	na	na

na – not applicable

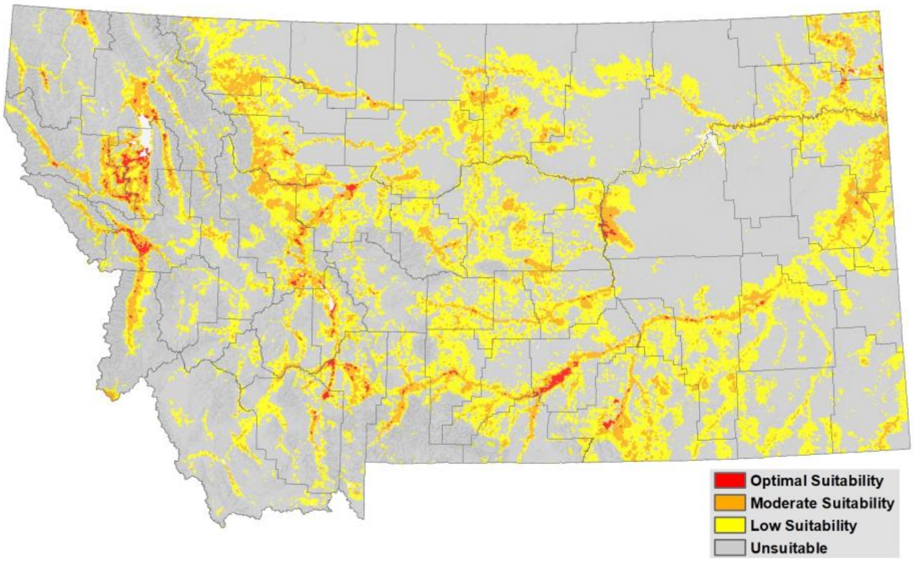

Figure 3. Distribution of common buckthorn habitat suitability under current climate conditions. Optimal habitat suitability for common buckthorn was patchy across Montana with larger aggregations occurring in Western and Southern Montana.

Mitigation Cost Estimates—Realized, Expected, and Future

Of the 36 managers (82%) who responded yes to the presence of Russian olive on the lands they manage, 15 managers (42%) reported mitigating for Russian olive in the past 3 years (Table 5). Sixteen managers reported Tamarix present (42%), with 12 managers (75%) reporting recent mitigation projects. Only 8 managers (22%) reported the presence of Common buckthorn, with 4 managers (50%) reporting recent mitigation projects.

Table 5. Presence of focal woody invasive species reported by managers

Species	No. of managers reporting focal species present (% of total)	No. of managers reporting mitigation action taken (% of total)
Russian olive	36 (82%)	15 (42%)
Tamarix	16 (42%)	12 (75%)
Common buckthorn	8 (22%)	4 (50%)

Managers were asked for their opinions regarding the ecological and economic impacts of Russian olive, Tamarix, and common buckthorn on the lands they manage (Table 6 and Table 7). A majority of managers believed that Russian olive (74%), Tamarix (75%) and common buckthorn (88%) would impact recreation. Two-thirds of managers agreed that Russian olive (67%) and Tamarix (69%) would have economic impacts on livestock grazing. A majority of managers expressed concern for economic impacts to hunting of game species from Tamarix (75%) and common buckthorn (62%). Nearly all managers identified Tamarix (88%) and common buckthorn (88%) as having negative ecological impacts; fewer managers were concerned about the ecological impacts of Russian olive (63%) to the riparian ecosystem.

Table 6. Managers expressed concern for focal species impact to economic sectors

Species	n	Crop Yields	Livestock grazing	Hunting	Recreation
Russian olive	27	8 (30%)	18 (67%)	12 (44%)	20 (74%)
Tamarix	16	3 (19%)	11 (69%)	12 (75%)	12 (75%)
Common buckthorn	8	1 (12%)	2 (25%)	5 (62%)	7 (88%)

Note: Zero respondents replied that common buckthorn was of concern to timber growth, yield, and stock.

Table 7. Managers expressed concern for focal species negative ecological impacts

Species	n	Negative ecological impact
Russian olive	35	22 (63%)
Tamarix	16	14 (88%)
Common buckthorn	8	7 (88%)

Far fewer managers reported actual mitigation costs than those indicating having conducted recent mitigation projects (Table 5 & Table 8). Answer attrition began when managers were asked to recall the specifics of the project they were reporting on, including management goal (eradication or suppression), total site acreage, average canopy cover, average stem size, numbers of personnel completing the project, and project duration and cost by mitigation phase. Project specific questions were intended to provide insight on overall project costs. For instance, we could assume higher costs would be expected on a project that had heavy canopy cover (51–100%) and a goal of eradication compared to a project with light canopy cover (0–20%) with suppression as the goal. Further, we thought that understanding how project funds were spread across the 3 phases of mitigation—removal, revegetation, monitoring—was of interest in part to document the inclusion of ongoing monitoring to control for the reemergence of the woody invasive species of interest. Survey results are summarized in Appendix A.

Realized Costs

From the information provided by managers on site-specific characteristics and project costs, we calculated the average annual mitigation expenditure by species (Table 8). A total of 14 managers reported spending $2.2 million on Russian olive and $3.3 million on Tamarix mitigation for a total of $5.5 million. Only 3 managers reported mitigation expenditures on common buckthorn totaling $159,000. These estimates combine mitigation projects that vary in invasion levels (measured as percent canopy cover), management goal, and mitigation phases completed (removal, revegetation, monitoring), which accounts for the wide confidence intervals observed.

We combined cost data for Russian olive and Tamarix into one estimate for several reasons. The two species are typically managed using the same primary removal methods. The main exception is the use of a biological control agent, the tamarisk leaf beetle; however, biological control was not reported as a mitigation method by Montanan managers. Because mitigation costs generally depend on infestation density and site conditions—and given the limited number of reported cost observations—combining the two species increased the sample size and improved the precision of the estimates by narrowing the confidence intervals somewhat.

Table 8. Estimates of total realized and average annual mitigation costs

Species	n	Total Realized Cost (USD)	Average Cost (USD ha^{-1})	95% C.I. Lower	95% C.I. Upper
Russian olive & Tamarix	14	$5,475,209	$7,809	$2,219	$14,923
Common buckthorn	3	$159,143	$1,201	$425	$1,895

n – number of observations

Expected and Future Costs

Delaying mitigation of Russian olive and Tamarix will result in substantially higher management costs in the near-future (2041–2070) compared to today (Table 9). For Russian olive, estimated management costs within the predicted range of optimal habitat were $44 million today (95% CI $13–$84 million), rising to $69 million (95% CI $20–$132 million) in the near-future—a 56% increase. **The projected cost increase for Tamarix was far more dramatic, jumping 272%**

from $28 million (95% CI $8–$53 million) today to $103 million (95% CI $29–$197 million) in the near-future. All near-future estimates are reported in 2025 dollars and do not account for inflation, allowing for direct comparison with current costs. The expansion of optimal habitat area was the primary driver of increased costs, though the cost and habitat increases do not align precisely because the cost calculations incorporated probabilities of presence.

We estimated expected mitigation costs for common buckthorn at $7 million (95% CI $2–$12 million), lower than Russian olive and Tamarix. The average annual mitigation cost per hectare for common buckthorn was roughly 6.5 times lower than for Russian olive and Tamarix, explaining its comparatively lower total expected cost.

Table 9. Total expected cost estimates under existing and projected climate scenarios

Habitat suitability	Climate scenario	Cost (million USD)	95% C.I.		Percent change in expected costs
			Lower	Upper	
Russian olive (*Elaeagnus angustifolia*)					
Optimal	Future	$68.9	$19.6	$131.7	+56%
	Current	$44.2	$12.6	$84.4	
Moderate	Future	$22.7	$6.5	$43.4	+10%
	Current	$20.7	$5.9	$39.5	
Tamarix (*Tamarix ramosissima, T. chinensis, and their hybrids*)					
Optimal	Future	$103.0	$29.3	$196.8	+272%
	Current	$27.7	$7.9	$52.9	
Moderate	Future	$24.7	$7.0	$47.3	+69%
	Current	$14.7	$4.2	$28.0	
Common buckthorn (*Rhamnus cathartica*)					
Optimal	Current	$7.3	$2.4	$11.5	na
Moderate	Current	$14.5	$4.8	$23.0	na

na – not applicable

Impacts to Ecosystem Services Provided by Riparian Areas

Our literature review had three objectives: summarize the ecosystem services provided by riparian areas, identify the effects of the focal species on those services, and assess the likely changes in ecosystem services following their control. Two studies, taken together, directly addressed all three objectives. Riis et al. (2020) developed a framework for riparian vegetation management that identifies synergies and tradeoffs between ecosystem services across vegetation types, ranking each service based on how widely and how often it is supplied (Table 10). Gonzalez-Sargas et al. (2024) adapted this framework and applied a similar ranking system to compare ecosystem services provided by a Tamarix-dominated riparian area against three post-control scenarios—native upland vegetation, native riparian, and native riparian meadows. In both studies, rankings reflected the authors' expertise in each ecosystem service area.

Table 10. Definitions of the ranking categories of relative importance of ecosystem services.

	Spatial scale			
Temporal scale	Global	Regional	Local	Unknown
Common	High	High	Medium	Unknown
Less than common	High	Medium	Low	Unknown
Uncommon	Medium	Low	Low	Unknown
Unknown	Unknown	Unknown	Unknown	Unknown

Source: adapted from Riis et al. (2020)

Application of Ranking Categories to Montana

To illustrate how this framework applies to woody invasive species management in Montana, we summarized the relative importance of regulating ecosystem services provided by a Tamarix-dominated riparian area compared to native riparian vegetation following Tamarix control (Gonzalez-Sarga et al. 2024) (Table 11). The first three ecosystem services—filtration/removal of pollutants and nutrients, erosion control, and flow regulation—ranked high in importance for both Tamarix-dominated and post-control of Tamarix. In theory, removing Tamarix and revegetating with native species would maintain the same high level of these ecosystem services, offering no discernable additional benefit. Habitat provision and fire regulation, on the other hand, ranked differently across the two scenarios—medium and low, respectively, under Tamarix dominance compared to high for both ecosystem services under native vegetation. For these two ecosystem services, Tamarix control is an opportunity to gain benefits.

Both Riis et al. (2020) and Gonzalez-Sarga et al. (2024) included cultural ecosystem services in the lists of services provided by riparian ecosystems. Riis et al. (2020) chose not assign the relative importance of these services due to a lack of data to support such an assessment; Gonzalez-Sarga et al. (2024) did provide rankings for cultural services though the studies used to make the assessments were not documented.

Table 11. Regulating ecosystem services and benefits provided by riparian vegetation in Tamarix-dominate and post-Tamarix control scenarios

Ecosystem Service	Benefits	Tamarix-dominated	Native vegetation post-Tamarix control
Filtration or storage, removal of nutrients	Reduction in pollutants, nutrients, and sediments reaching streams	High	High
Erosion control	Reduction of erosion and sediment loads to streams	High	High
Flow regulation	Damage mitigation of extreme flows	High	High
Habitat provision	Nursery habitats; sustaining populations	Medium	High
Fire regulation	Reduction in fire damage costs	Low	High

Source: Gonzalez-Sargas et al. (2024)

Costs to Economic Sectors

Our literature review led us to focus on five economic sectors: municipalities, industry, agriculture, recreation, and tourism. Based on the ecosystem services and disservices supplied by the focal species and their location riparian areas, we expected the focal species to negatively impact agriculture while providing benefits to municipalities and industry. We did not assess recreation and tourism because no published studies estimating economic losses or measuring public preferences for focal species management outcomes were found.

Agriculture

Potential losses in agricultural cash rents from reduced biomass production exceeded 1% of baseline annual agricultural values in only two scenarios: pasture and hay cash rents declined by 3.4% for Russian olive and 1.2% for Tamarix. Statewide baseline annual agricultural cash rent varied widely by land cover category: rangeland was highest at $461 million, followed by pasture and hay at $24 million, and soybean and oats combined at $2.3 million (Table 12). Potential annual agricultural losses from Russian olive and Tamarix were estimated by applying a 55% reduction in cash rents to optimal habitat that overlapped with rangeland and pasture and hay. For common buckthorn, losses to soybean and oat production were estimated using reductions of 40% and 20%, respectively (Table 13). Russian olive and Tamarix reduced agricultural cash rents by an estimated $4.2 million and $3.2 million, respectively, each representing <1% of the combined baseline annual agricultural values for rangeland and pasture and hay. Common buckthorn losses were considerably smaller, with agricultural rent reductions of $12,505 (0.7% of the soybean baseline value) and $799 (0.2% of the oat baseline value).

Table 12. Baseline estimate of annual agricultural cash rent values by agricultural land cover category for Montana

	Rangeland	Pasture & hay	Soybean	Oats	Total
Land cover area (hectares)	22,745,580	1,193,896	25,333	5,205	--
Annual per-hectare agricultural production value	$20.26	$20.26	$75.37	$75.37	--
Baseline estimated annual agricultural values	$460,885,121	$24,191,465	$1,909,274	$392,286	$511,569,611

Table 13. Potential loss in annual agricultural values

	Rangeland	Pasture & hay	Soybean	Oats	Total
Optimal habitat overlapping with agricultural land cover category (hectares)					
Russian olive	306,395	74,426	na	na	455,247
Tamarix	262,778	25,473	na	na	313,724
Common buckthorn	na	na	415	53	468
Percent decrease in agricultural cash rent (%)					
	55%	55%	40%	20%	--
Potential loss in agricultural value on optimal habitat (% of baseline agricultural value)					
Russian olive	$3,414,602 (0.7%)	$829,436 (3.4%)	na	na	$4,244,038 (0.9%)
Tamarix	$2,928,514 (0.6%)	$283,882 (1.2%)	na	na	$3,212,397 (0.7%)
Common buckthorn	na	na	$12,511 (0.7%)	$799 (0.2%)	$13,310 (0.6%)

na – not applicable

Municipalities and Industries

Municipalities and industries will likely benefit from the ecosystem services of riparian areas with or without Tamarix (Table 11). Riparian areas filter excess nutrients, pollutants, and sediment, thereby regulating water quality and potentially reducing the need for municipalities and industries to invest in costly treatment infrastructure or technology upgrades (Riis et al., 2020, Gonzalez-Sarga et al. 2024). Further, floodplains and riparian areas reduce the frequency and magnitude of flooding regardless of Tamarix presence, lowering the risk of infrastructure damage (Riis et al., 2020, Gonzalez-Sarga et al. 2024). However, Tamarix's influence on flow regulation has been linked to channel narrowing, which can increase the frequency and intensity of flooding (Barz et al. 2008). This example illustrates the regional and local variation that makes careful evaluation of Tamarix control outcomes essential (Shafroth et al. 2005).

Discussion

Our Mitigation Cost Estimates in Context

Strict comparison between our mitigation cost estimates for Russian olive, Tamarix, and common buckthorn with existing published estimates have been challenging. Our cost estimates included project cost data that combined multiple control methods as well as, in some cases, the costs of revegetation and/or monitoring. Published estimates typically reported costs for specific control methods such as cut-stump (hand cutting) or mechanical with herbicide treatment, mechanical extraction of root crown, or hand herbicide applications. Very few estimates were found that included biomass reduction or long-term monitoring.

Our estimate of annual mitigation costs for Russian olive and Tamarix was \$7,809 ha^{-1} (95% CI \$2,219–\$14,923 ha^{-1}). For comparison, we selected cost estimates cited by the Tamarisk Coalition for two control methods that were reported by managers in our study—cut-stump with herbicide treatment and mechanical cut with herbicide treatment (Tamarisk Coalition 2008). Cost estimates for cut-stump with herbicide treatment ranged from \$4,942 ha^{-1} for light infestation (20% canopy cover) to \$22,240 ha^{-1} for heavy infestation (>50% canopy cover). Cost estimates for mechanical removal of above ground biomass followed by herbicide treatment ranged from \$1,240 ha^{-1} for light infestation to \$9,390 ha^{-1} for heavy infestation. Heavy infestation cost estimates for both control methods included the costs for biomass reduction and revegetation. These estimates reveal the broad range of costs driven by control technology and species abundance. Our mitigation cost estimates for Russian olive and Tamarix fall within the range cited in the Tamarisk Coalition resource.

In general, our mitigation cost estimate for common buckthorn is in line with numbers reported by others. Our estimate of annual mitigation costs for common buckthorn was \$1,201 ha^{-1} (95% CI \$425–\$1,895 ha^{-1}). The Anoka Nature Preserve removal project cited a cost of \$996 ha^{-1} for herbicide treatment, biomass harvest, and controlled burns, a mitigation cost estimate similar to our own (Anoka Conservation District 2014). A 2018 survey of public land managers in Minnesota reported average annual costs for common buckthorn control of \$1,577 ha^{-1} for manual removal, \$529 ha^{-1} for mechanical removal, \$526 ha^{-1} for herbicide treatment, and \$173 ha^{-1} for controlled burns (Reinhardt et al. 2019). Summing the Minnesota cost estimates for mechanical removal and herbicide treatment, a combination of methods seen in our data, resulted in a mitigation cost of \$1,055 ha^{-1}, a number similar to our estimate.

Current and Future Costs of Mitigation

Delaying mitigation of Russian olive and Tamarix will substantially increase future costs to Montanans. Without adjusting for inflation, expected mitigation costs would increase by 56% for Russian olive and 272% for Tamarix. The dramatic projected increase in Tamarix costs reflects the substantial increase in optimal habitat predicted in our habitat suitability modelling under future climate conditions. Our results are similar to other studies showing climate-driven increases in temperature and aridity will favor Tamarix, with suitable habitat across the western U.S. projected to increase 62% by 2080 (McShane et al. 2015, Stromberg et al. 2010, Perry et al. 2012).

Interpreting MaxEnt output as a probability of presence allowed us to incorporate ecological data into the calculation of expected costs. However, MaxEnt predicts habitat suitability at a landscape scale and cannot estimate species abundance at a particular location, only where a species is most likely to occur. In other words, the model cannot tell us whether the best habitat is 90% occupied or only 10% invaded (Merow et al. 2013), which directly influences our current and future mitigation costs estimates. MNHP emphasizes that model outputs should inform landscape-scale (>64 ha) planning and urges managers not to rely solely on model outputs but to continue on-the-ground surveys for the focal species of interest (MTNHP 2026a–c, 2025).

Economic Sector Impacts

Of the five economic sectors potentially affected by our focal woody invasives species—municipalities, industry, agriculture, recreation, and tourism—the literature provided evidence on three.

Municipalities and *industry* depend on rivers and streams for water supply. Invaded and uninvaded riparian ecosystems provide comparable levels of ecosystem services, including water quality maintenance, erosion control, and flow regulation, suggesting that managing Tamarix, and likely Russian olive, would not yield additional benefits for these sectors. However, this conclusion is limited to the ecosystem services mentioned here; a broader assessment of riparian ecosystem services is needed to determine whether invaded and uninvaded habitats differ in their overall value to municipalities and industry. This example highlights the need for a careful evaluation of focal species control outcomes to account for regional and local variation across potential management sites and ensure the desired economic and ecological benefits are achieved (Shafroth et al. 2005).

We also estimated potential *agricultural* losses from the focal woody invasives species. Impacts to pasture and hay and rangeland from Russian olive and Tamarix stem from the overlap between these land cover categories and optimal habitat suitability model outputs. Our economic loss estimates for both Russian olive and Tamarix were minimal and consistent with figures reported for Wyoming—potential losses from Russian olive across suitable habitat in Wyoming totaled $1.7 million, representing <1% of total agricultural value for pasture and hay (Nagler et al. 2024). Suitable habitat estimation in Wyoming was modeled using the USGS Invasive Species Habitat Tool, which closely parallels our use of MaxEnt to model optimal habitat suitability. We applied the same method to estimate economic losses from common buckthorn to soybean and oat production. Losses were again minimal, reflecting both the low level of invasion and the relatively small markets for these crops in Montana. Soybeans account for 1.5% of the state's total agricultural production value, while oats represent <1% and mostly used for livestock feed.

Recreation and *tourism* represent a substantial share of Montana's economy. Outdoor recreation expenditures accounted for 4.9% of the state's gross domestic product in 2024 (U.S. Bureau of Economic Analysis 2026), and in 2022 Montana's tourism industry attracted 12.5 million visitors who spent $5.82 billion that supported 43,900 jobs (Bureau of Business and Economic Research 2024). Beyond economic contributions, outdoor recreation also supports social well-being. A 2023 survey found that 97% of Montana residents consider outdoor recreation important to their quality of life (Bermingham et al. 2023).

We did not assess impacts to the *recreation* and *tourism* sector because no studies measuring public preferences for invasive species management outcomes were available. While one study estimated wildlife-related recreation losses in Nevada from terrestrial invasive species at $6–$12 million (Eiswerth et al. 2017), it relied on economic impact analysis, a method that measures gross economic activity, such as spending and jobs, rather than changes in welfare. This approach fails to capture public preferences and omits non-market values like environmental quality and human well-being, and ignores substitution effects, which can inflate estimated impacts (Joseph et al. 2020). This is a critical gap, given the economic and social wellbeing outcomes fostered by these two sectors and that a majority of managers surveyed believed that focal species negatively impact recreation.

Using Ecosystem Services to Guide Management Priorities

Riparian areas have been studied across a wide range of scientific and applied disciplines including hydrology, biology, ecology, geology, management, and restoration (Gregory et al. 1991, Riis et al. 2020, Gonzalez-Sargas et al. 2024). As a result, individual studies tend to focus on a narrow set of attributes that reflect the authors' particular field of inquiry, providing little understanding of the full array of ecological processes and communities present in riparian zones (Gregory et al. 1991). Riis et al. (2020) addressed this gap by converting the existing knowledge of riparian areas into a comprehensive accounting of ecosystem services to simplify decision-making for riparian vegetation managers. Gonzalez-Sargas et al. (2024) applied this framework to Tamarix control demonstrating how ecosystem services can be integrated into the evaluation of invasive species management.

In Montana, a thorough accounting of riparian ecosystem services and the relative importance of those services as a function of vegetation type (i.e., native versus invaded) could form the basis for **prioritizing invasive species management in areas that produce the greatest benefits**. WIWG could develop this prioritization framework through expert elicitation, bringing together WIWG participants to share their professional judgements on the expected changes in ecosystem services resulting from focal species management across multiple jurisdictions.

A serious challenge in managing Montana's focal woody species is the absence of studies on public preferences for management outcomes, yet public acceptance of outcomes is essential to restoration success (Heldt et al. 2016). We recommend securing funding to **evaluate Montana residents' preferences for outcomes associated with focal species control**. Without data on individual preferences, we cannot reliably maximize economic, social, and environmental benefits from control efforts (Nelson & Bohmholdt 2021).

Economists have several tools for eliciting public preferences for environmental outcomes. Photo-elicitation surveys have evaluated the public's aesthetic appreciation of riparian ecological condition, though restored ecological condition and aesthetic appreciation were not always aligned (Arsenio et al. 2019, Le Lay et al. 2013, Junker & Buchecker 2008). Willingness-to-pay surveys have estimated the benefits arising from riparian programs that improve specific ecosystem services (Trenholm et al. 2013, Colby & Orr 2005, Loomis et al. 2000, Holmes et al. 2004). While these studies demonstrate that the public values the benefits provided by riparian areas, the public's perception of restoring riparian areas through woody invasive species control remains an unanswered question.

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Appendix A. Woody Invasive Species Survey

Is Russian olive currently on the land you manage?

Table A.1. Russian olive presence

	n	%
Yes	36	82
No	8	18

Is Tamarisk currently on the land you manage?

Table A.2. Tamarisk presence

	n	%
Yes	16	42
No	22	58

Is Common Buckthorn currently on the land you manage?

Table A.3. Common Buckthorn presence

	n	%
Yes	8	22
No	29	78

In which of the following areas are you concerned about economic impacts?

Table A.4. Russian olive will have economic impacts

	n	Yes	%
Crop yields	27	8	30
Livestock grazing	27	18	67
Hunting, game species	27	12	44
Recreation	27	20	74

Table A.5. Tamarisk will have economic impacts

	n	Yes	%
Crop yields	16	3	19
Livestock grazing	16	11	69
Hunting, game species	16	12	75
Recreation	16	12	75

Table A.6. Common Buckthorn will have economic impacts

	n	Yes	%
Crop yields	8	1	12
Livestock grazing	8	2	25
Timber growth & yield	8	0	0
Timber stock	8	0	0
Hunting, game species	8	5	62
Recreation	8	7	88

Are you concerned about negative ecological impacts?

Table A.7. Russian olive will have negative ecological impacts

	n	%
Yes	22	63
No	13	37

Table A.8. Tamarisk will have negative ecological impacts

	n	%
Yes	14	88
No	2	12

Table A.9. Common Buckthorn will have negative ecological impacts

	n	%
Yes	7	88
No	1	12

Russian Olive

Over the past 3 years, have you taken any actions to eliminate or reduce Russian olive?

Table A.10. Took action to eliminate or reduce Russian olive

	n	%
Yes	15	42
No	21	58

What was your management goal?

Table A.11. Management goal for Russian olive

	n	%
Eradication	4	33
Suppression	8	67

What wast the total site acreage?

Table A.12. Site size (acres)

Mean	Min	Max	Median
1,263	1	10,000	57.5

What wast the average canopy cover for Russian olive (%)?

Table A.13. Canopy coverage

	n	%
Light (0-20%)	5	50
Moderate (21-50%)	3	30
Heavy (51-100%)	2	20

What was the average stem size (inches)?

Table A.14. Average stem size (inches)

Mean	Min	Max	Median
7	0.5	36	3

Who completed the project? (check all that apply)

Table A.15. Project personnel

	n	Yes	%
Inhouse	11	10	91
Contractor	11	5	45
Volunteer	11	2	18

What was the project duration (years)?

Table A.16. Project duration (years)

Project Component	Mean	Min	Max	Median
Removal	7	1	26	4
Revegetation	4	1	6	4
Monitor	7	1	26	4

Project costs ($/acre/year)

Table A.17. Russian olive project costs ($/acre/year)

			95% CI	
Species	Total	Mean	Lower	Upper
Russian olive	2,179,623	4,858	783	9,591

Tamarisk

Over the past 3 years, have you taken any actions to eliminate or reduce Tamarisk?

Table A.18. Took action to eliminate or reduce Tamarisk

	n	%
Yes	12	75
No	4	25

What was your management goal?

Table A.19. Management goal for Tamarisk

	n	%
Eradication	7	64
Suppression	4	36

What wast the total site acreage?

Table A.20. Site size (acres)

Mean	Min	Max	Median
455	1	2,500	28

What wast the average canopy cover for Tamarisk (%)?

Table A.21. Canopy coverage

	n	%
Light (0-20%)	7	88
Moderate (21-50%)	1	12

What was the average stem size (inches)?

Table A.22. Average stem size (inches)

Mean	Min	Max	Median
2	0.5	6	2

Who completed the project? (check all that apply)

Table A.23. Project personnel

	n	Yes	%
Inhouse	10	8	80
Contractor	10	2	20
Volunteer	10	2	20

What was the project duration (years)?

Table A.24. Project duration (years)

Project Component	Mean	Min	Max	Median
Removal	7	1	20	3
Revegetation	0	0	0	0
Monitor	8	3	15	5

Project costs ($/acre/year)

Table A.25. Tamarisk project costs ($/acre/year)

			95% CI	
Species	Total	Mean	Lower	Upper
Tamarisk	3,298,586	1,280	173	2,895

Common Buckthorn

Over the past 3 years, have you taken any actions to eliminate or reduce Common Buckthorn?

Table A.26. Tokk action to eliminate or reduce common buckthorn

	n	%
Yes	4	50
No	4	50

What was your management goal?

Table A.27. Management goal for common buckthorn

	n	%
Eradication	3	100

What wast the total site acreage?

Table A.28. Site size (acres)

Mean	Min	Max	Median
36	8	50	50

What wast the average canopy cover for Common Buckthorn (%)?

Table A.29. Canopy coverage

	n	%
Moderate (21-50%)	2	67
Heavy (51-100%)	1	33

What was the average stem size (inches)?

Table A.30. Average stem size (inches)

Mean	Min	Max	Median
4	3	6	4

Who completed the project? (check all that apply)

Table A.31. Project personnel

	n	Yes	%
Inhouse	3	2	67
Contractor	3	0	0
Volunteer	3	1	33

What was the project duration (years)?

Table A.32. Project duration (years)

Project Component	Mean	Min	Max	Median
Removal	5	3	6	6
Revegetation	0	0	0	0
Monitor	0	0	0	0

Common Buckthorn project costs ($/acre/year)

Table A.33. Common cuckthorn project costs ($/acre/year)

			95% CI	
Species	Total	Mean	Lower	Upper
Common Buckthorn	159,143	486	172	767