Montana Invasive Species Council

Report on Science Advisory Panel: Assessing the Invasiveness of a Species

May 5-6, 2025

Contents

Event facilitation and document preparation by: Conservation Collaborations, LLC.

Summary

Montana is proactively addressing and considering invasive species assessment tools to better inform management actions and potential legislative needs. By examining the language for invasive species found in legislative code used by Montana agencies a better alignment of actions can be realized. Further, there are globally accepted tools used to assess species invasiveness which may also be well suited for application in Montana. The use of these assessment tools can advance our confidence and priorities for invasive species management across Montana.

Key Recommendations

- Consider multiple suggested changes to the current MISC definition of invasive species.
- Apply available robust tools to assess species invasiveness. In conjunction with the current work by the Montana Natural Heritage Program, specific tools may be explored for adoption and use to conduct multiple species analysis.
- Focus on pathways rather than species as a strategy to address more than one species at a time.

Figure 1. Adult spotted lantern flies *(Lycorma delicatula*) are not found in Montana.

Introduction

On May 5-6, Montana Invasive Species Council (MISC) gathered multiple experts to provide feedback on current terminology utilized to describe invasive species and the tools available for assessing species invasiveness (see agenda in Appendix A). A MISC Steering Committee developed multiple questions to seek feedback in the process to assess species invasiveness. Questions were provided to panelists in advance of the event and their replies were utilized to guide the in-person discussion. *Questions and Replies* from all panelists are referenced in Appendix B. Thirty-three people attended the Science Advisory Panel event either in-person or virtually (Appendix C).

Goal: Explore current assessment tools and legal language for invasive species determination to understand preparedness in climate or regional changes in capacity to manage invasive species effectively.

Expected Panel Outcomes:

1) Determine if the definition of "invasive" currently used by the Montana Invasive Species Council captures target species or potentially misses economically, culturally, and/or ecologically important species (e.g. regionally native species moving due to climate),

2) Review existing models and current work being done in North America to assess the risk of a species being invasive based on that definition,

3) From outcomes 1 and 2, develop a series of steps for Montana to follow to assess the risk of introduction and establishment of an invasive species to Montana, and

4) Identify steps to assess the potential economic, ecological, and cultural impact of the highest risk species if introduced to Montana.

Panelists:

Panelists were drawn from a broad range of expertise in invasive species, climate change and species assessment from across the United States. The four panelists also ranged in focus work that spanned terrestrial and aquatic species.

Dr. Eva Colberg is a research scientist at the Northwest Climate Adaptation Science Center (CASC), where her work revolves around connecting research with practice to inform and advance the management of climate risks in Northwest ecosystems. As part of this work, Eva coordinates the Northwest Regional Invasive Species and Climate Change (RISCC) Network, which is a partnership of regional agencies and organizations dedicated to helping practitioners address the nexus of climate change and invasive species in the region. Prior to joining the NW CASC, Eva was a Northeast CASC-funded postdoctoral researcher at Cornell University and the interim director of the New York Invasive Species Research Institute, where she worked with members of the Northeast RISCC Network to develop guidelines for climate-smart invasive species management. Her scientific training encompasses community ecology, restoration ecology and social science, with specific interests in the ecology and management of climate change, invasive species and fire.

Dr. Alisha Davidson works as a contractor for the Great Lakes Commission and The Nature Conservancy. Focus areas include risk assessment, regional regulation of organisms in trade, surveillance lists of aquatic invasive species, and most recently, control options for invasive aquatic plants and animals. While she currently works in the Great Lakes, her original training is within the biosecurity field in Australia.

Dr. Deah Lieurance is an Assistant Professor of Invasive Species Biology and Management at Penn State where she works on improving invasive species prevention and management through horizon scanning, risk assessment, and pathway analysis. Other research areas include investigating how rising temperatures and increased CO_2 levels affect invasive plants in forests.

Dr. Elliott Parsons is a specialist with the Pacific Regional Invasive Species and Climate Change (Pacific RISCC) Management Network through the Pacific Islands Climate Adaptation Science Center at the University of Hawai‘i at Mānoa. Elliott holds a Ph.D. in Fish & Wildlife Biology from the University of Montana, and he has almost 15 years of experience working with invasive species in conservation, management and research projects in Hawai‘i. Before his current position with Pacific RISCC which he started in 2022, Elliott most recently led the Nāpu‘u Conservation Project (NCP) at Pu‘uwa‘awa‘a State Forest Reserve on Hawai‘i Island for 12 years for the Hawai‘i Department of Land and Natural Resources. This work included preventing, managing, controlling, and researching

invasive species across almost 40,000 acres of state lands in leeward Hawai‘i that included native dryland forest, rare and endangered species, public hiking and historical trails, and cattle ranching.

Figure 2. *Ventenata dubia* is an aggressive invasive annual grass found in Montana.

Questions for Panelists

The following questions were developed by the steering committee and provided to the panelists prior to the event. The replies from the panelists were used to guide discussion and further exploration.

Questions regarding the definition of "Invasive"

1. Are there examples of species historically considered invasive in North America that would no longer have as much of an impact due to a changing climate? Are any of those species relevant to the regions bordering Montana?
2. What species are included or potentially excluded by the current definition[1], particularly concerning economically, culturally, and ecologically significant species such as those native to the region that may be moving due to climate change?
3. How should historic native range be considered when determining the impact of a species on the economy or environment of a region?
4. Is historic native range relevant any longer to the classification of a species as "invasive?"
5. Are there any examples of using habitat thresholds of "optimal condition," where once passed, a species would be considered invasive, but when below they are not?
6. Can the current Montana definition account for the dynamic nature of species movement and distribution patterns (e.g., barred owl)?
7. How should policy definitions and Executive Orders be considered (e.g., feral horses)? (Post response revised to read "As a community can we standardize terms used that are seen in EOs, otherwise terms become fossilized.")
8. What factors should be included in a scoring process to assign to a species to quantify a threat? Are there existing processes or is a new one needed?

Questions regarding risk assessments that already exist or could be used as examples for Montana

1. Does Montana have any unique risk factors that should be considered in the development of an assessment model?
2. Which risk assessment models exist that would be most relevant to the ecosystems or regions within Montana, or that could be easily duplicated to meet Montana's needs?
3. How do the considerations of pathways and vectors fit into these various models?

[1] See provided Definitions in Appendix.

4. Are there models that incorporate culturally significant species considerations into impact assessments?

Questions regarding the assessment of climate impact of those species to Montana

1. How should a given invasive species' potential to provide climate resiliency benefits be considered? Are there models that do so?
2. What invasive species data collection should we invest in and at what scale is appropriate to assess for climate change to plan for the future?
3. How do we go about acquiring such data? What scale or resolution of data are needed?

Questions regarding the assessment of economic impact of those species to Montana

1. How do we incorporate potential economic benefits of an invasive species into an assessment?
2. What data collection should we be investing in and at what scale to assess impacts to economic resources?
3. How do we go about acquiring such data?
4. What economic impacts should be focused upon in these invasive species assessments?

Questions regarding the assessment of ecological impact of those species to Montana

1. How do we incorporate potential ecological benefits of an invasive species into an assessment?
2. What data collection should we be investing in and at what scale to assess impacts to ecological resources?
3. How do we go about acquiring such data?

Questions regarding the assessment of cultural impact of those species to Montana

1. What are the potential cultural impacts to Montana from invasive species?
2. What data are necessary to assess the impacts of invasive species on cultural resources? How do we go about acquiring such data?

Examining Montana Definitions of Invasive Species

The debate in consistent use of terminology in invasion biology is ongoing. However, there are clear terms that continue to be used by the invasive species community within the US. Aligning the terms used can help create consistency and common understanding for not only researchers, but also legislators, managers and the people of Montana. There are multiple definitions that are utilized by Montana entities with jurisdictional authority to advise or manage invasive species. A summary of these definitions is found in Appendix D. The MISC definition for invasive species was the focus of discussion during the Science Advisory Panel. Elliott Parsons provided a context presentation which generated discussion and suggestions to revise the current definition.

***Current Language**: MCA 80-7-1203 "Invasive Species" means plants, animals and pathogens that are nonnative to Montana's ecosystem and cause harm to natural and cultural resources, the economy, and human health.*

Recommended Language: MCA 80-7-1203 "*Invasive Species" means ~~plants, animals~~ organisms and pathogens that are nonnative to Montana's ecosystems and likely to cause harm to Montana's natural and cultural resources, the economy, and human health.*

An exploration of this definition generated several key recommendations by the panelists to the definition language that would better clarify the scope. The specific changes aim to include the broader term of organisms. Simply listing plants and animals may allow some species to be omitted inadvertently such as a fungus, protist or bacteria. Leaving the word pathogen allows for things that would fall outside of organism, like a disease, to be included.

The addition of the words *likely to* are meant to broaden management capabilities to address invasive species prevention and acknowledges there may be unknowns or uncertainty that cannot be fully anticipated but still should be protected from. This also supports the possibility of regulation or planning that may be done toward a species that may have been identified early with a risk assessment.

Referring to Montana as one ecosystem ignores the many existing ecosystems and therefore making it plural corrects this omission.

Additional considerations from panelists are to:

- The panelists urged consideration of other terms/definitions to be included that would clarify or expand understanding of how species may be viewed in light of changes due to climate, range-shifting species, or other relevant categories. This may include the definitions for native species, nuisance species, pests, weeds, non-native species, or sleeper species.
- There may be situations for some species that are invasive but could fit as an exemption, such as cultivars. This is similar for how Montana currently categorizes Category 3 Noxious Weeds where there is no requirement to control, but it is not legal to intentionally propagate.
- Define "impact" and potentially identify and include other impacts currently not listed in the definition that may be affected by an invasive species. What are the Montana values that are not covered by the currently listed categories? This could be explored by including many voices across Montana.
- Potentially more focus could be placed on a species creating an impact, rather than if it is native or non-native, which may be more useful for management purposes. There could be a rationale for disregarding if a species is native or nonnative but having an impact and therefore creates a prompt to manage regardless of nativity status.

Examining Species Assessment Tools

There is a need to have tools to assess species to help prioritize resources and management actions across Montana's state, federal and tribal entities. The identification of a process that can help clarify how Montana prioritizes and lists species prompted the need for this science advisory panel.

Context presentations from Alisha Davidson, Deah Lieurance and Bryce Maxell generated significant feedback on potential assessment tools that could be used. There are multiple types of protocols that may be considered based on the need, these include invasive risk assessment (predicts), invasion status assessment (diagnoses), prioritization frameworks (optimize resource allocation) and impact classification frameworks (classifies and ranks). Depending on the need (e.g., predict, diagnose and prioritize), then the type of tool used will vary. Risk analysis is a four-step process that includes 1) initiation, 2) risk assessment, 3) risk mitigation, and 4) risk communication.

Species risk assessment tools shared

- Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS) is an aquatic species risk assessment framework that was developed in the Great Lakes but can be used with freshwater species beyond the Great Lakes.
- Australian Weed Risk Assessment (AWRA) is a plant focused assessment tool to identify relative risk that generates a score for a species.
- Plant Protection and Quarantine-Weed Risk Assessment (PPQ-WRA) is used by the US Department of Agriculture which is a modification of the AWRA tool.
- Invasiveness Screening Kits, Aquatic Species Invasiveness Screening Kit (AS-ISK) is a multi-lingual decision support tool used for screening multiple taxa.

Invasion Status Assessment shared

- NatureServe provides the basis for most assessments in the US. Deah Lieurance has created a variation of the NatureServe assessment that adds additional questions for climate and socioeconomic impacts, and management difficulty.
- No specific tools were suggested for animals.

Classification of Impact Tools shared

- Generic Impact Scoring System (GISS) is a scoring system used to assess the environmental and economic impact of invasive mammals.
- Environmental Impact Classification for Taxa (EICAT) is the global standard developed by the International Union for Conservation of Nature (IUCN). ECAT+ development is underway. Does not constitute a risk assessment.
- Socio-Economic Impact Classification of Alien Taxa (SEICAT) is a standardized method to classify and categorize the impacts of taxa to human well-being and livelihood/socioeconomic. SEICAT+ development is underway.
- Invasive Species Environmental Impact Assessment (ISEIA) is a protocol that allows the assessment, categorization and listing of non-native species from any taxonomic group.

Considerations for conducting assessments

GLANSIS: The method used by GLANSIS to complete an assessment is to find one or two experts in the taxa of interest to complete the assessment, then pass on for external expert review to provide feedback and potential revisions. Often with risk assessments peer review is used, but capacity will become an issue. A listing committee and building consensus on a result would be a valuable way to approach completing assessments.

Ecological Regions: Divide Montana into geographic zones by major topography (i.e. East-West of the Continental Divide), hardiness zone map, and Koeppen's climate classification map. Ecological regions can get complicated as they may not adhere to county lines.

Consensus: A consensus method strategy could look at species distribution and then seek participation from experienced managers for prioritization to get a list of species of greatest concern. This could be followed up with the appropriate assessment that includes the science behind it. In general, this method should consider what partners, what species, and what tools will be needed to complete assessments.

Regional Dialog: Dialog and cooperation with neighboring states and provinces could be beneficial in the development of species lists. Regional dialog could help harmonize perspective on species, particularly for range shifting species.

Montana: Montana has not yet applied uniform invasive species assessment protocols or scoring to Montana's nonnative species. However, Montana Department of Agriculture and Montana Fish, Wildlife & Parks utilize assessment tools for nonnative species petitioned for listing. Since 2017, Montana Natural Heritage Program (MTNHP) has served as the location for nonnative species occurrence data.

To provide a watchlist of species, MTNHP has taken iNaturalist data for non-native records outside of the state within an 800 km radius of the center of Montana to identify species that may pose a risk to Montana. These species are the most numerous and closest proximity to Montana's border (Figure3, See map online). This could serve as a starting list for a horizon scan, or to focus prevention.

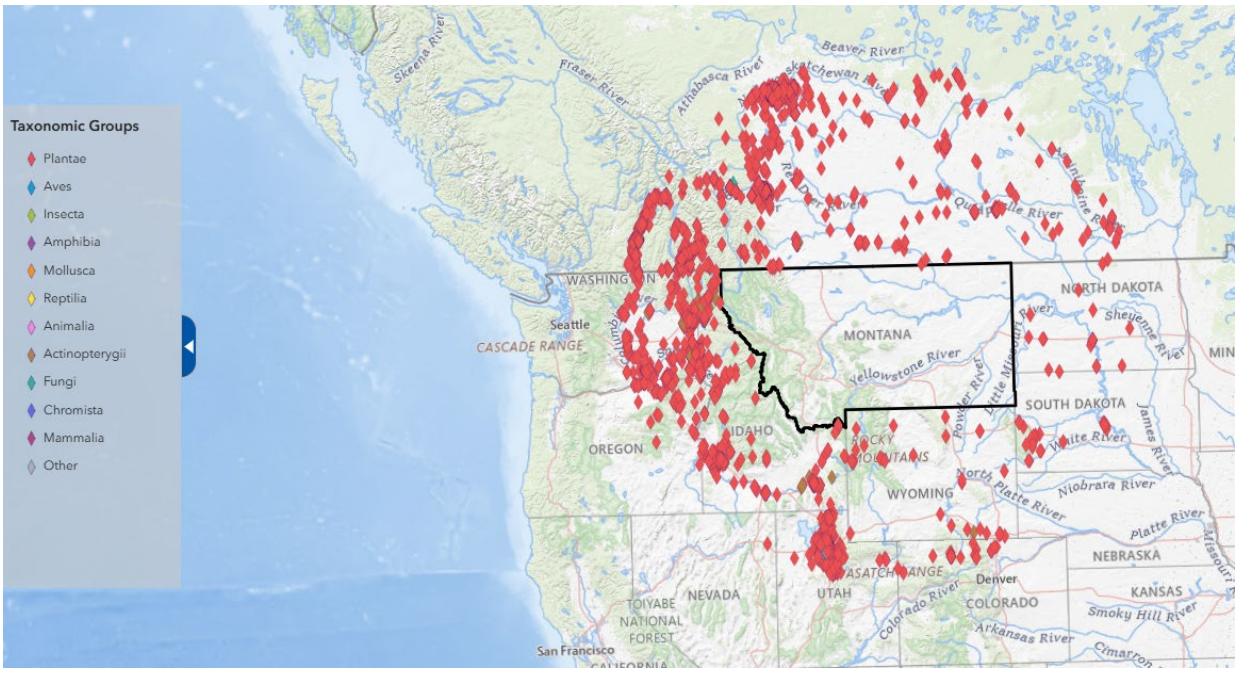


Figure 3. MTNHP map of iNaturalist Non-native Species Watch List for Montana. iNaturalist records for plant species not documented in Montana but within an 800 km radius of the center of Montana.

Species Status Assessment: In a species status assessment there are questions that consider impacts to agriculture, forestry, right-aways, managed landscape, recreation and property values. There are many ways to set up an assessment program for work to be done in the State. Some examples include university students, working under the guidance of a professor, who could complete assessments, or Extension could develop a program to undertake assessments. If assessments do not include culturally significant species, one strategy may be to include Tribes and other communities when developing these processes.

Risk assessment and status assessment vary in the amount of time they might take to complete. Assessments will need to be re-visited or updated on a cycle of 10 years for low and high risk, and 2-3 years for moderate risk.

Pathways: Pathway frameworks or pathway risk analysis compared to species risk analysis can be helpful to classify and focus management.

Using the current invasive species “priority” lists provide robust case studies to make connections to policymakers and others and are a tool to communicate the importance of focusing on these species. Consider creating a top ten pathways list in conjunction with the species list. The pathway and species lists can assist in management decision making needs.

Considerations: If different assessment tools are being used across taxa, can they be compared across taxa and do we need to rank them? For an assessment, scores may be included based on risk but not on ranking. A practical outcome of ranking might be to focus funding for control efforts or prevention. Species could be ranked within a particular sector, like which species have the biggest impact to recreationists, hunters, or agricultural groups. Communicating science, the values at risk, and potential consequences of an action are needed to guide management and policy.

Consideration of Climate Perspectives

Eva Colberg provided an overview of climate information in species assessments, details for Montana climate shifts, and suggestions for climate-smart management. The following table references key parameters from the Montana Climate Assessment.

Metric	Trend	Projection
Atmospheric CO_2 concentrations	• Increased > 100 ppm since statehood	• **Increase**
Average temperature	• Increased by 0.5°F/decade • Greatest increase in spring	• **Increase** by 3–7°F by 2050 • Greatest increase in summer, winter, & SE MT
Max. temperatures	• Greatest increase in spring	• **Increase** 3–8°F by 2050
Days above 90°F	• --	• **Increase** by 5–35 days by 2050, especially in NE and S MT
Min. temperatures	• Increased most in winter & spring	• **Increase** 3–7°F by 2050 • Greatest increases in Jan. & SE MT
Frost-free days	• --	• **Increase** 24–44 days by 2050, especially in W MT

Modified from Whitlock et al 2017. MT Climate Assessment.

Several key details were shared to link management of invasive species and climate:

- Climate driven range shifts in species. Non-native species (across a broad taxa type) are spreading at faster rates than native species and are better able to keep up with climate change.
- Sleeper species[2] may become invasive with climate change.

[2] "Sleeper populations are established populations of introduced species whose population growth is limited by one or more abiotic or biotic conditions. Sleeper populations pose an invasion risk if a change in those limiting conditions, such as climate change, enables population growth and invasion." From O'Uhuru et al. 2024

- We are data limited around climate impacts on invasive species ranges in the Northwest. Managers spend more time managing the current species rather than on emerging and future invasions.
- As plant hardiness values change in Montana, this could be an area where there may be new or different plant species in demand and in trade.
- Species phenology may differ between non-native and native species. Non-native species may be better able to shift their phenology. This may disrupt timelines for management actions. There may be a need to adapt management with warmer temperatures and drier spring and summer seasons arriving earlier.
- An increase in temperature and CO_2 levels could reduce the efficacy of different invasive species control treatments. This could change the expected management outcomes.
- An increased vulnerability of native ecosystems could force re-evaluation and adjustment of restoration targets. Compounding effects of extreme climate events and invasive species will require integrating invasive species management into extreme event preparedness.
- Consider climate change when discussing invasive species policy and planning.

There are multiple opportunities to educate on climate/invasive species issues:

- A trend for "Last chance" tourism may prompt different or more people to visit Montana.
- A unification of education messages could be helpful. Communication with neighboring states and provinces on possible ranging shifting species and their management priorities was suggested.

Err on the side of caution, and do not look favorably on the idea that an invasive species may provide benefits based on their climate resilience as these will likely come at a detriment and cause harm to native ecosystems. Using non-native species to drive "nature-based" solutions can alter native ecosystems with negative impacts (e.g., introduction of *Mysis* shrimp to Flathead Lake to enhance kokanee salmon). The potential advantages do not offset the risk posed by invasive species. There is little information for climate interactions for invasive species, so use caution when benefits are being stated. Scenario planning might be a way to move forward with conservation strategies under uncertainty with climate change and invasive species interactions.

Establishing and maintaining good statewide collection reports (knowing what and where species are) has multiple functions and could be used toward climate projections when completed. Data sharing and information sharing are important to minimize duplication of effort and provide robust information for modeling and management planning. Using

remote sensing to assist with data collection could be a way to advance terrestrial datasets, and possibly for floating aquatic plants. Absence (non-occurrences) data is needed for good species distribution modeling.

Consideration of Economic Perspectives

A context presentation from Nanette Nelson with Flathead Lake Biological Station provided multiple aspects of economics in species assessments.

To quantify economic impacts of invasive species, an examination of the potential costs to mitigate and lost revenue is needed. In some cases, the biology of a species must be assumed to determine the costs (i.e., assumed populations across all waterbodies and complete infestation). Securing detailed information on the probability of introduction, probability of establishment and probability of dispersal will create a more robust economic impact assessment.

Bioeconomic models can allow managers to evaluate trade-offs in minimizing costs and selecting different approaches, particularly when there are limited resources and efforts. Data intensive and modeling intensive approaches can provide more descriptive paths forward. Credible comprehensive estimates of invasive species impacts are needed to provide decision makers with an understanding of the sense of scale of the problem and the level of resources needed to prevent or mitigate damages from invasive species.

Use caution if extrapolating species-specific analysis, as not all aspects will apply to species in the same way. In some analyses, the biology of the species will be included in the assessment. Therefore, biological information would vary across species which would make extrapolation potentially inappropriate. Seek feedback from an economist to bring additional insights into those species comparisons.

When seeking economic impact figures, Invacost numbers may be more accurate than historic seminal publications (e.g. Pimentel et al. 1999 & 2005) that generalized economic impacts of various taxa. It may be important to consider estimates on a regional scale. Looking closely at the origins of data provided and indicated in the impacts will be critical.

Consult with economists to understand what numbers are needed to insert into an analysis as to not overstate the estimates. Pathway analysis versus a species-specific analysis would potentially provide a cost of prevention but not necessarily the benefits that would arise from prevention.

Assumptions must be made in economic models as managers assume particular mitigation options. Assumptions may not always be perfect but can be informed. Case studies can help speak about the problem. Standards for how management costs are

reported or archived can facilitate better communication of costs associated with invasive species.

Interstate commerce data, tourism data, pet trade data or household movement data may be important to assist in impact assessments particular to invasive species. Culturomics[3] and community science are ways to consider how to obtain information in alternate ways.

Panelists recommended clearly avoiding the notion that an economic benefit of an invasive species may outweigh the ecological, cultural or economic risks that a species might pose. The decision to include the benefit or not is something that should be done prior to an analysis. Clear communication that minimizes mixing terms and benefits will be important.

Data needs for economic impacts rely on managers accounting for management costs. Focus groups could help build data on what is valued by managers, stakeholders and other communities. It may be valuable to consider other important aspects or indices of life in Montana that are not going to fall into an economic category of impact, such as measuring quality of life or food security.

Consideration of Cultural Perspectives

A context presentation from Fernando Sanchez with the University of Montana suggested multiple areas to consider and meet potential cultural perspectives on invasive species. Invasive species management frameworks might include cultural perspectives by incorporating cultural values, cultural interests and concerns.

Management actions and strategies could incorporate multiple cultural areas, including

- Impacts on Tribes' traditional world views
    - Principle of relatedness (invasive species are seen by the Tribe as contributing to the loss of relatives)
    - Principles of connectedness (disturbance caused by invasive species may be seen as impacting the health of the native ecosystem)
    - Principle of reciprocity (Tribes consider themselves obliged to reciprocate by caring for the health of the gift of nature)
- Impacts on a community's historical culture
    - Collective and personal historical culture (academic and population history)
    - Dimensions of environmental history (scientific data, Elder and culture bearer shared knowledge, observations, personal experience, place-based knowledge)

[3] Culturomics studies human behavior and cultural trends through the quantitative analysis of digitized texts.

    - Collective and personal perception of a past that is gone (ecological disturbance creates a discrepancy between the present state of habitat and memory of how it was).
- Impacts on traditional uses and customs
    - Threats on the viability of plants and animals that may have been part of the community for time immemorial for different uses
    - Threats on partaking in traditional subsistence practices
    - Threats on opportunities for recreation and social gathering because of restricted access to impacted resources.

Engaging with Tribes and cultural groups allows invasive species management actions to potentially mitigate impacts to cultural needs and priorities. Cultural knowledge, Elder knowledge, place-based knowledge, and western science knowledge should be used to inform and strategize management actions. Multiple suggestions to create culturally aware invasive species management included

a) using both top-down and bottom-up knowledge,

b) bringing cultural conservation goals together with invasive species management goals,
c) incorporating communities into decision making process, and
d) using a systemic approach to knowledge discovery and management.

Biophysical data is going to be different from cultural data in how it is shared, or may have non-tangible values, or be of historical reference. There might be different levels of cultural knowledge that may not be openly shared but still may have a high cultural value that needs protection.

Obtaining cultural data is about engaging in the community and collaboration, and in many cases requires a partnership with Tribes and other communities. Specifically, one will need to build trust and work with Tribes, Elders, knowledge keepers and knowledge holders. Start by exploring with Tribes and other communities to ask what their values are. How can cultural views help us think about and improve our relationships with the natural world? There are differences in the perceptions in how change and impacts to the landscape are taking place. Sometimes the values and concerns attached to a place in terms of management are different.

Closing Panelist Thoughts

Alisha Davidson - Due to uncertainty that can influence invasive species management, it may be beneficial to document or add language to appropriate Montana policy that “when there is doubt or uncertainty, then we will act to protect Montana’s resources”.

Deah Lieurance – The science advisory panel process to intentionally consider how the state is approaching assessing invasive species is great and the result will be very productive.

Elliott Parsons – This approach that Montana is taking looks to be a model for others to use in the future. Start with values to lead the conversation on invasive species assessment.

Eva Colberg – The interdisciplinary discussion has been positive, and there are future opportunities to expand this conversation, share resulting process and relevant data within the region.

Next Steps

The following actions and items were suggested by participants for possible next steps.

Administrative

- A discussion summary and all resources provided by panelists in responses/discussion will be provided to participants and housed on the MISC website.
- Recommendations shall be presented to MISC at the July 2025 meeting.
- Consider resource allocation and funding sources.

Refining Definition

- A proposed flow chart was suggested to standardize approaches to nomenclature and how species could be initially categorized (see Figure 4 created by L. Greenwood, The Nature Conservancy).
- Once reviewed by MISC, it may be possible to bring language changes before the next legislature.

Assessing Invasiveness

- MISC will hold a follow up meeting to determine a strategy for completing species assessments. At this meeting multiple areas of information could be determined including potential identification of participants, specific tools to be used, and identification of role for Montana Natural Heritage Program in species assessments. Ideally an assessment process could be used that would speak across jurisdictions.
- An initial process might take several species and utilize multiple tools in assessments to better understand which best suits Montana needs.
- Be clear about which outcomes Montana is interested in – are we trying to predict, diagnose, or prioritize species.
- Amend tools for Montana for an analysis on specific species in 2025.

Pathways

- Initiate a meeting to discuss the identification and prioritization pathways that result in a one-page document.

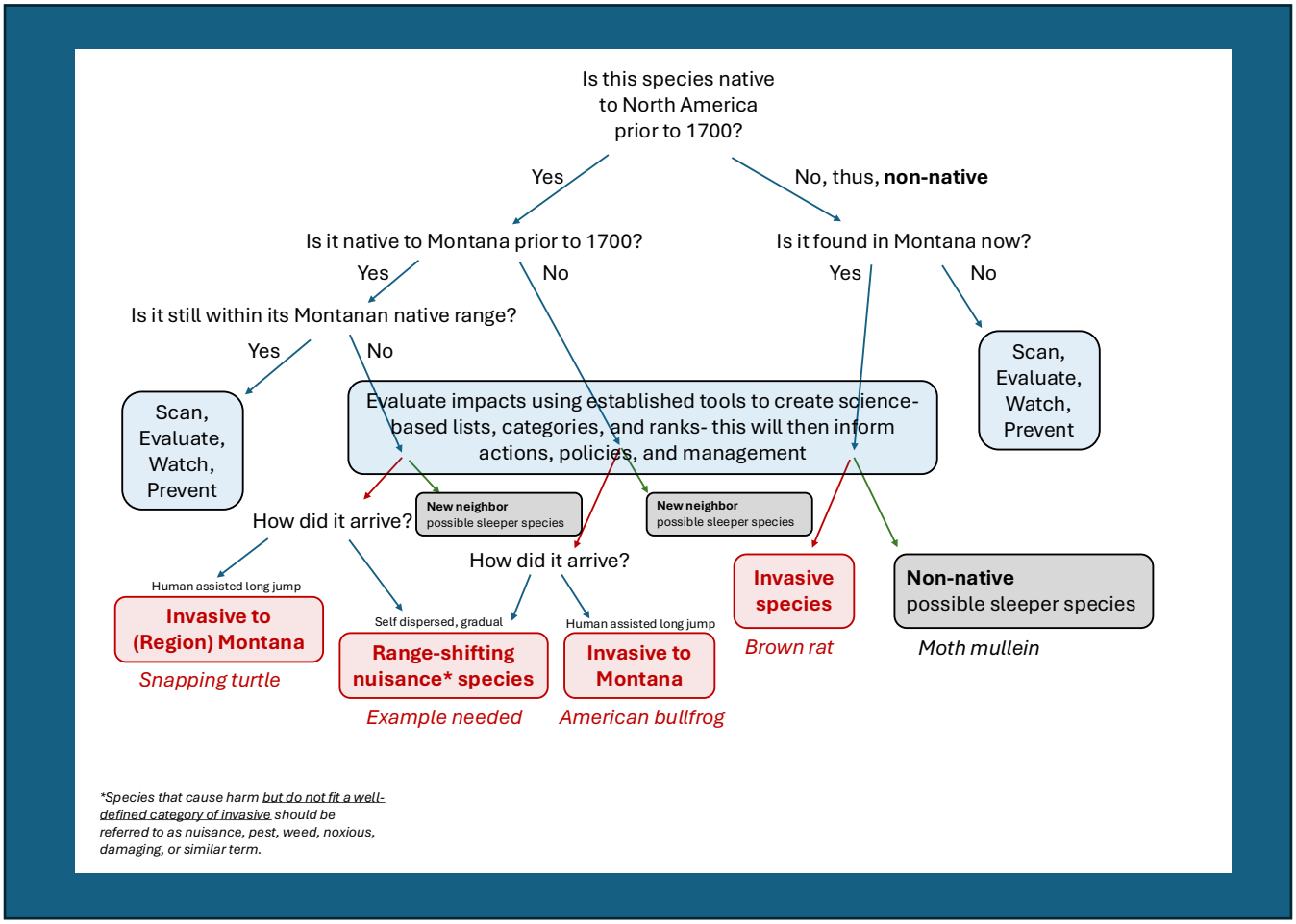


Figure 4. A proposed flow chart was suggested to standardize approaches to nomenclature and how species could be initially categorized (created by L. Greenwood, The Nature Conservancy).

Appendix A: Event Agenda

May 5

Balsamroot Conference Room, Missoula County Department of Ecology Building

Welcome		
8:30 – 8:40 am	**Welcome from the Montana Invasive Species Council**	Liz Lodman, MISC Administrator Steve Wanderaas, MISC Chair
8:40 – 8:50 am	Defining the Need for A Science Advisory Panel on Assessing Invasiveness	Bryce Christiaens, Missoula County Department of Ecology
8:50 – 9:00 am	Overview of Goal and Outcomes Panelist Introductions	Leah Elwell, Conservation Collaborations
Topic One: Defining Invasive		
9:10 – 9:50 am	*National and International Perspectives for* *Defining Invasive Species*	Elliott Parsons
9:50 – 10:10 am	**Break**	
10:10 -12:00 pm	Discussion on the Nuance of Invasive and Native <u>Question Review Topics</u> • Historic Native Range • Habitat Thresholds • Species Movement and Distribution • Factors to Quantify Risk	Panelists
12:00 – 1:00 pm	**Lunch On-Site**	Provided by MISC
Topic Two: Risk Assessment Tools		
1:00 – 1:30 pm	*GLANSIS Risk and Impact Assessment Frameworks*	Alisha Davidson
1:30 – 2:00 pm	*Assessing the Threat: Tools for* *Invasion Risk, Status and Impact*	Deah Lieurance
2:00 – 2:30 pm	*Montana's Invasive Species Data Resources and NatureServe's Assessment Protocol*	Bryce Maxell, MT Natural Heritage Program
2:30 – 3:00 pm	Discussion	
3:00 – 3:10 pm	**Break**	
3:10 – 4:00 pm	Discussion of Risk Assessment Tools and Recommendations	Panelists
4:00 – 4:45 pm	Exploring Proposed Assessment Elements with Montana Relevant Species • Ventenata	Panelists

	• Bullfrog	
4:45 pm	Review Day 1 and Day 2 Preview	Leah Elwell
5:00 pm	**Adjourn**	
6:00 pm	No-Host Reception at Cranky Sam Public House, 233 W Main St, Missoula	

May 6
Balsamroot Conference Room, Missoula County Department of Ecology

8:30 – 8:45 am	Welcome // Day 1 Highlights	Leah Elwell
Risk Assessment Considerations of Climate, Economics and Culture		
8:45 – 9:15 am	Consideration of Climate	Eva Colberg
9:15 – 9:45 am	*The Ways in which Economist Measure Costs Associated with Invasive Species*	Nanette Nelson, Flathead Lake Biological Station
9:45 – 10:30 am	*Cultural Impacts of Invasive Species in Montana: Stakeholders, Values at Risk and Management Strategies*	Fernando Sanchez, University of Montana, Cobell Land and Culture Institute
10:30 – 10:45 am	**Break**	
10:45 – 12:00 pm	Discussion <u>Question Areas</u> • Incorporating climate resiliency benefits, economic benefits, and cultural impacts • Data collection needs and acquisition to assess impacts • Data scale and resolution needs	Panelists
12:00 – 1:00 pm	**Lunch On-Site**	Provided by MISC
1:00 – 1:30 pm	Panelist Closing Remarks	Panelists
1:30 – 2:00 pm	Public Comments Recommendation Review Next Steps and Wrap Up	Leah Elwell
2:00 pm	**Adjourn**	

Appendix B : Questions & Replies

Replies to from each panelist are indicated by first and last initials.

Questions regarding the definition of "Invasive"

1. Are there examples of species historically considered invasive in North America that would no longer have as much of an impact due to a changing climate? Are any of those species relevant to the regions bordering Montana?

    - AD: I can't think of any that would have reduced impact due to climate change. But in general, any aquatic invasive species (AIS) that had narrow, cold-water thermal tolerances could have reduced abundance/impact.

    - EC: I'm not sure about ones with documented decreases in impact, but models do predict decreased habitat suitability with climate change in the Pacific Northwest for some invasive species (Gervais et al. 2020; Nikkel et al. 2023; Montana is included in Gervais et al.'s definition of the PNW, but Nikkel et al. focus on the part of the PNW west of the Cascades). But a theoretical, modeled decrease in impact is different from documented decreases in impact; I think the precautionary principle is worth mentioning with any modeling results.

    - EP: There is a good article on an invasive species expected to shift range and distribution with climate change published in 2009 "Climate change and plant invasions: restoration opportunities ahead?" – Global Change Biology, Bradley et al. 2009. In it the authors show that both range expansions and contractions are possible. One species, for example, *Centaurea biebersteinii* (Spotted Knapweed), has the potential for substantial retreat in eastern Montana by 2100 (see Figure 5 in the paper). https://www.doi.org/10.1111/j.1365-2486.2008.01824.x

        - Implicit in this question I think is a definition of invasive species that includes impact – and impact can be viewed through many different lenses, e.g., ecological impact, cultural, socio-economic, human health, etc. Because of this, "impacts" can change (increase or decrease) because of human action (e.g., invasive grasses that are grazed by livestock close to the ground can reduce the risk of wildfire spread). So – there are a number of possibilities: 1) impacts could increase in Montana in the future due to changes in the abundance, spread, and/or per-capita effects of an invasive species (or any combination of these) with no change in human behavior/response, 2) impacts could increase in Montana in the future with no changes in anything ecological (no change in invader abundance, distribution, spread, or effects), but with changes in human behavior/response that are altered due to climate change, or 3) impacts could increase or decrease due to a combination of changes in the first two (invader changes and human response changes).

        - As well, both questions above could consider whether species were already present in Montana, or not yet present (as species are likely to shift within Montana as well as show up from southern neighboring states). One example of the complexity is a hypothetical crop pest that has big impacts currently to agriculture in Montana, but in the future, it will be too hot and dry to grow this crop – in this case the "impact" may disappear not because the pest couldn't be supported theoretically by the new

climate, but because the crop is no longer grown and so there is no longer an "impact." The idea of sleeper species, or invasive species that have a lag time before they erupt, increase in abundance, and have impacts suggests that non-native species present in Montana now without impacts will likely have impacts in the future. On the other side of the coin (and more in line with the question), there are examples of population collapse in invasive species (e.g., invasive birds and ants), which could lead to decreases in impacts in the future in Montana. These could be due to demographic stochasticity (e.g., small populations), changing climatic conditions and habitat suitability, or introductions of new competitors, predators, or pathogens that affect the invasive species in question. For example, after the introduction of the invasive two-lined spittlebug in Hawaii recently, there was a large decrease in invasive Kikuyu grass in some pasture lands. Kikuyu grass is highly competitive and suppresses many other species, so after the grass started to die-off in huge areas, a large diversity of other plants started to come in.

- The second complication here is scale – North America is an enormous area which includes a large number of ecosystem types (e.g., Holdridge Life Zones), and species, many of which are not likely to impact Montana currently or in the future. So, I would change this sentence: "Are there examples of species historically considered invasive in North America" by adding "that are not yet present in Montana, but 1) are likely to arrive or 2) are present but are likely to decrease in abundance or distribution in the future." By narrowing this down to a region of the U.S., we might be able to get at a list of species that may matter more or less given the current ecosystem types present and the ecosystem types likely to be present in the future in Montana.

- Finally, if we can focus on the invasive species that have or are likely to have impacts on different sectors in Montana, we may be able to use freely available online range shifting tools for invasive plants (e.g., through EDDMaps) to see which species may shift into Montana with different climate change scenarios, though these are predictions based mostly on climate envelope models, and actual bioshifts are likely to be more complex. Another approach could be to list the climate impacts Montana is expected to face and then list the invasive species that are expected to benefit or be harmed by those impacts.

- DL: From the perspective of my previous position at UF IFAS Assessment, once something is determined to be invasive, that's it. They don't ever take it out of that category because the species has shown its ability to cause negative impacts. What I think would be difficult is proving (with data) that the potential impacts lessen with climate change. It's hard enough to get good data about impacts happening in the present.

2. What species are included or potentially excluded by the current definition[4], particularly concerning economically, culturally, and ecologically significant species such as those native to the region that may be moving due to climate change?

    - AD: A few notes on possible general exclusions:

[4] See provided Definitions document.

- "cause harm" - what about species that 1) have caused harm elsewhere but not in MT (either because they are in early phases of introduction or not yet established in MT), or 2) may cause harm but due to lack of research, impacts are not documented (also fairly common scenario).
- I would suggest something like: An invasive species is any non-native or native organism that, due to its introduction or a significant change in environmental conditions, causes or is likely to cause ecological, economic, or cultural harm by disrupting native ecosystems, impacting human health or livelihoods, or altering culturally significant resources or practices.
- Whether you include native species or not, is up for discussion.

- EC: As Alisha points out, the present-tense-only of "cause harm" in MCA 80-7-1203 is limiting. The language in the Montana Aquatic Invasive Species Act (MCA 80-7-1003) is broader in this regard, and includes language to not only indicate past/present harm but also potential future harm ("likely to cause harm"); such language allows for preventative listing of species, including climate-driven range-shifting invasive species, and sleeper species whose impacts may increase in the future.
  - Potential unintended inclusions: livestock and domesticated animals; Washington State's definitions of invasive species include extra language to avoid this: see RCW 79A.25.310, ""Invasive species" *does not include domestic livestock, intentionally planted agronomic crops, or nonharmful exotic organisms,"* and RCW 77.135.010, ""Invasive species" means nonnative species of the animal kingdom that are *not naturally occurring in Washington for purposes of breeding, resting, or foraging*, and that pose an invasive risk of harming or threatening the state's environmental, economic, or human resources. Invasive species include all stages of species development and body parts. They may also include genetically modified or cryptogenic species."
- EP: There are many definitions on the document, so I will interpret this to mean the first one (Montana Invasive Species Council) definition: ""Invasive Species" means plants, animals and pathogens that are nonnative to Montana's ecosystem and cause harm to natural and cultural resources, the economy, and human health."
  - <u>Potentially Included:</u>
    - Species non-native to Montana (presumably any in the world).
    - Species that cause harm to natural and cultural resources, the economy and human health.
    - Species from 2 Kingdoms – Animals and Plants (unclear what pathogen refers to).
  - <u>Potentially Excluded:</u>

- The time period of nativity is unclear (how far back can we go to assess native status?). Glacial cycles and periods mean the plant communities have changed significantly over time.

- It is unclear how the other Kingdoms are included or excluded from this definition (e.g., Fungi, Protista, Archaea/Archaebacteria, and Bacteria or Eubacteria). Referring to just "organism" or "species" could help be inclusive of these Kingdoms.

- Species that are non-native to the ecosystems of surrounding states (even if those same ecosystems are found in Montana) may be excluded because the focus is only on Montana's ecosystems. This means that invasive species in Idaho in ecosystems that are the same (e.g., same forest type) but are not yet in Montana may be missed. It might be better to have a bioregional approach with a larger scale (e.g., that are non-native to the Rocky Mountain west and great plains).

- Invasive species that cause impacts may be excluded if those impacts do not fall into the categories listed – e.g., cultural practices, recreational opportunities, quality of life, food security, or economy-adjacent practices (e.g., family or community farms that are not done for economic purposes).

- Invasive species that affect Indigenous communities may be excluded if there are different concepts of nature besides "resources." E.g., for species that are considered kin/family members, impacts from invasive species may not fall into any of those impact categories.

- This may exclude native invasives or native sleeper species – e.g., native species in Montana that shift outside of their natural range but remain in Montana and cause impacts.

- Excluded may be species that are likely to cause harm as the current definition lists "cause harm." It is unclear where that harm is caused – if that harm can be caused in the introduced range outside of Montana, then any invasive species in the world could fall into this definition. Also, groups may disagree on which species matter and what harm matters – conflicts over whether a species causes harm or not could occur. Who gets to decide what constitutes harm?

    - DL: Adding to the discussion, I too think the "likely to cause harm" is critical to the definition. Otherwise regulation and management will never cover any prevention efforts *before* a species is introduced or early in its invasion history. Essentially, anything you'd use a risk assessment (or in horizon scanning) for would not be managed until it became a problem.

3. How should historic native range be considered when determining the impact of a species on the economy or environment of a region?

    - AD: I'm not certain of the intent of this question. Do you mean a distant native range, for example Europe and how those impacts could be applied in MT, or if it is native to part of Montana and is expanding across the state and how to measure those impacts?

- EC: Historic native ranges can provide helpful information about which conditions species can handle and which species can co-exist together, but are not indicative of the entire variation in conditions/interactions a species can have nor are they fixed in time or space. Oregon's criteria for regulating nonnative wildlife species (OAR 635-056-0140) include considering "whether the species' natural range and habitat is similar to Oregon's climate and habitat" and "whether the species can survive in Oregon," which don't explicitly consider the potential for climate change (but also could theoretically include some leeway for potential to survive in a future climate in Oregon…). Also note that they use "natural range," which is rather nonspecific (and non-defined) wording. A more climate-adaptive wording could include considering whether the species' historic native range "similar to Montana's *current or predicted future* climate and habitat." I think the criteria within OAR 635-056-0140 also show a helpful way of considering historic native range/ "natural range" by considering it as one amongst many factors that could influence whether a species is worth regulating or not (and determining a species as high risk for solely the range category could be enough to regulate it, but medium/low risk rankings would require looking at other criteria as well).
    - A note on the flipside of this question, which is how nativeness should be defined… NYS defines native species as, "with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem, or in New York State," and defines nonnative species as, "a species not indigenous to an ecosystem under consideration or to New York State, and includes an individual specimen."
- EP: It seems like the question underlying this question is what determines native status? Ecosystems and communities in the recent past are likely to vary significantly from those in the distant past, especially considering glacial cycles. If non-native is part of the definition of invasive species, then a definition for native species will need to be agreed upon. There are tradeoffs in how fine or course the definition is. For example, if folks agree that native species should be protected and it is a coarse filter (e.g., let's say native = last 50,000 years), then many species could be protected as native and there may not be state or federal funds or support to limit or control those species, even if they have "impacts." If it is a fine temporal filter (say last 11,000 years – of the Holocene epoch), then likely fewer species will be considered native and more funding and support will be available to control a larger number of species. The period of time that society wishes to conserve/preserve is critical here.
    - The impact of a species on the economy I think is more clearcut. Native pests and weeds can have large impacts on the economy. If the key part of this is native vs. non-native status, then by definition, if a species is defined as native, it is not considered to have a negative impact (at least as an invasive species). If we want more control over species that can have an impact on the economy, have a definition for invasive species that is more encompassing; if we want to have less control (e.g., rules in place that protect more species as native), then have a less encompassing definition. For the environment – species can have huge effects on their surroundings – e.g., ecosystem engineers. But because we label them as "native" these are usually spoken of as "effects," not "impacts," and those effects are seen as a good thing. But if those same species were introduced to new environments – then the same engineering effects could likely be considered negative impacts and they would likely be labeled as ecosystem-transforming

invasive species (the worst of the worst). So how native and non-native are defined is key.

- I think the big thing here is the process – who decides and how this is decided and whether there is upstream deliberative engagement prior to any decisions. If the community does not have any input and this is an agency decision for example, there may not be any public support and it may be difficult to implement.

4. Is historic native range relevant any longer to the classification of a species as "invasive?"

    - AD: Good question! If invasiveness is purely measured by negative impact, and could include both native and non-native species, then I guess not. (My background is to use nonindigenous status first, and then measure impact. I've not worked with invasive natives before).

    - EC: I think it is still relevant (see previous answer), but agree that it's worth asking questions about what happens when species that don't meet the historic-native-range component of "invasive" definitions still have impacts (and whether it's helpful to regulate them in the same ways, and thus define them similarly). That said, I think "native invader/native invasive" creates more confusion and ambiguity than other terms. I do think the framework Deah and Elliott put forth with other iRISCC folks is very helpful for thinking about native/invasive/range-shifting terminology.

    - EP: If the definition of historic native range is something like: "The historic native range of a species is the area where it naturally evolved and existed, without human intervention, before any significant human-driven introductions or expansions," then I think this could be highly problematic in defining native, non-native, and invasive species. First, species disperse all the time and there are good examples of long-distance dispersal of native species to new areas unassisted by humans. They are then in areas they did not "evolve", so does that make them non-native? Second, how much evolution is needed for this definition, and can we even determine that for the majority of species? Third, humans have been modifying ecosystems on earth for thousands/tens of thousands of years, likely influencing species spread and dispersal – how do you know what factors led to species spread in the past, especially a long time ago? So, I think there are a lot of problems in relying on this, but I am not sure those problems were less so in the past. Ultimately, how we define invasive species depends on what we value and what we want to protect (and who gets to decide).

    - DL: I am still hesitant to call natives invasive even with other factors like climate change. As someone who does extension, this becomes very tricky for science communication. We do have terms that cover natives including weeds, nuisance, pests that can be (and have been) used in these situations.

5. Are there any examples of using habitat thresholds of "optimal condition," where once passed, a species would be considered invasive, but when below they are not?

    - AD: I have not used this approach before and do not feel I have sufficient experience to contribute.

    - EC: I don't have experience with this approach.

- EP: It depends if you are using the definition of invasive species that relates to spread in a new environment vs. spread + impact. For the definition including impact this is really in the eyes of the beholder/who is being impacted. There could be a threshold after which a spreading species starts to have significant economic impacts to a company whereas before the low density did not matter much.
    - For a definition of invasive that just includes transport, introduction, establishment, and spread (without impact), there are many examples of lags for "sleeper species" – or time periods that passed without much of a change followed by a dramatic change (e.g., some kind of threshold was passed). The dramatic change could be due to the introduction of a specialist symbiont that was not present in the past, or changes in environmental conditions or demographic factors. I bet it depends on the individual species – and the factors that control the distribution and abundance of a species are going to differ by species.
    - Also, to answer this question I think we need to know 1) what the climatic tolerances are for a species (e.g., its climate niche), and 2) where within its climate niche it is. Many invasive species in Hawaii are still spreading across their current climate niche because their dispersal is constrained – some have been spreading over 100 years and likely have not reached equilibrium conditions. If the species was at the edge of its climate niche, and that niche was shifting (e.g., northwards or upwards), then the species could potentially shift to follow its climate niche. But if it was in the middle of its current climate space, then shifting climate conditions might do nothing (e.g., no real change outside of its range).
- DL: I also have no experience with this approach.

6. Can the current Montana definition account for the dynamic nature of species movement and distribution patterns (e.g., barred owl)?
    - AD: This might be difficult. Could add language, eg, that addresses species that are "expanding their range and causing ecological harm," regardless of their overall native status.
    - EC: Without a defined temporal scale for how to apply the term "nonnative," the current definition is a bit ambiguous as to whether it allows for dynamic distribution shifts. Defining nativeness/non-nativeness relative to "historic native range," although also temporally ambiguous, might actually allow easier listing of species who have recently moved into the state, such as barred owl. Additionally, limiting the definition to species that currently cause harm does not account for dynamic impact patterns (which could also be byproducts of shifting ranges and abundances), but could become more flexible if the wording is adjusted to consider past, present, and potential future harms.
    - EP: I am not sure which definition this refers to (it looks like there are multiple on the sheet). I think the answer to this question depends on how native/non-native is defined and assessed, and how much Montana wants to protect range-shifting species and the ability of ecosystems to shift and change in the future as the climate changes, and how much folks want things to stay the same. If stay the same, then "resist" part of RAD is appropriate. If change, then Accept or Direct would be appropriate. As I read the current MISC definition, it is too difficult to tell whether it can account for the dynamic nature of species movement or not.

- DL: see my response above for alternative terminology that would cover native species that may become an issue.

7. How should policy definitions and Executive Orders be considered (e.g., feral horses)?
    - AD: I don't think I have enough relevant legal expertise for this question.
    - EC: As with Alisha, I don't think I have the legal expertise this question requires.
    - EP: I need more info here – which policies – county, state, or federal? For the U.S. Federal Executive Orders on Invasive Species (e.g., 13112 in 1999, and 13751 in 2016), I think the definitions (e.g., 2016 one) should be looked at seriously. For example, the 2016 definition: "'Invasive species' means, with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health" I think is good for a number of reasons, 1) the with regard to a particular ecosystem gives it context – i.e., that it is the ecosystem/place we are talking about where a species is native or not native to that ecosystem, 2) organism is all inclusive, 3) whose introduction causes or is likely to cause – the "is likely" to cause provides flexibility as non-native species that are assessed as high risk can be included even if there are no records of invasiveness (I think a 2015 article found that up to a quarter of invasive species were found to not be invasive elsewhere// Global rise in emerging alien species results from increased accessibility of new source pools), and 4), invasive species can cause impacts to human health, but this definition includes animal and plant health as well, so that is more encompassing of species important to people. It does leave out/exclude some things (see above for my list of exclusions).
        - I am not aware about executive orders re: feral horses. Is this in relation to the Wild Free-Roaming Horses and Burros Act of 1971? I will say this – when "impact" is included as a criterion for invasive species, how to determine what constitutes an impact, how that impact is measured, and who determines which impacts are acted upon is really important. Will the community be included in the decision making? There are many examples of invasive species conflicts in Hawaii where impacts are not agreed upon, or acknowledged by all groups. For example, is mesquite an invasive tree in Hawaii? Many do not like the thorns or the fact that it takes up valuable space that could be planted with native species on the coast. BUT – it is a significant shade tree in really sunny/exposed areas, it reduces wind speeds, and it is an incredible food plant – the seed pods are edible and can be ground into flour, the small plants are high protein for livestock, and the tree branches and trunks can be made into fence posts. So, is this a valuable species or an invasive species? I think the ultimate outcome matters less than the process that determines the outcome and how equitable it is.
    - DL: I am also not in a position to answer this question.

8. What factors should be included in a scoring process to assign to a species to quantify a threat? Are there existing processes or is a new one needed?
    - AD: have worked with a variety of frameworks and have done a comparative analysis of factors they each include (can provide paper upon request). Of all of these, I prefer the GLANSIS framework, https://www.glerl.noaa.gov/glansis/index.html. While aquatic focused, it could be adapted to fit terrestrial species. It includes pathway, establishment and impact

assessment, as well as a variety of impact types. It does not have onerous data requirements. I would encourage adapting a process/framework if at all possible - there are some good ones out there.

- EC: I haven't personally used/implemented any risk assessments, but my understanding is that there do exist frameworks that could be adapted for Montana's specific goals and needs.

- EP: I have not done risk assessments so I am going to mostly bow out of this one – however, climate matching for current and future climates is going to be more and more important to include in the future in risk assessments. As well, there is recent work demonstrating that updates to existing risk assessments are needed. For example, Pfadenhauer and Bradley 2024(Quantifying vulnerability to plant invasion across global ecosystems) showed that the 10s rule is likely an underestimate and more species should be considered as potentially invasive. As well, another paper by the same authors in 2023 found that biogeographic properties of plants native habitats can inform invasive plant risk assessments (Remember your roots: Biogeographic properties of plants' native habitats can inform invasive plant risk assessments).

    - I have heard that it takes a while to do a thorough risk assessment, so processes that can narrow down species lists are highly needed. As well, many components of an assessment could be useful between regions which changes in only a few questions – so I think there is great potential in sharing of risk assessments between regions and automating part of the process (maybe this is in development, I am not sure). Finally, I think the threat part of this may be the hardest – what impacts are we focusing on and how do we assess threats across sectors, groups, stakeholders, etc? The Hawaii Pacific Weed Risk Assessment is one example of an assessment that I am familiar with, though a process for determining socio-economic impacts I am less sure about. There is the SEICAT - Socio-economic impact classification of alien taxa, that could be helpful here though I have never used it. The EICAT (The Environmental Impact Classification for Alien Taxa) is the IUCN standard for measuring the severity of environmental impacts. My guess is that these two frameworks do well in some regards and not in others (Using the IUCN Environmental Impact Classification for Alien Taxa to inform decision-making)

- DL: This is about using the right tool for the job. If the species is already in the area (Montana), a Status Assessment should be conducted to *diagnose* the invasion status. If the species is not present or has not established yet, a risk assessment is appropriate. EICAT and SEICAT are NOT risk assessments, they are just tools to categorize impacts which is only one part of risk determination (likelihood a species will be introduced/establish/spread and the consequences (impacts).

- DL: I also don't think we need to keep reinventing the wheel. There are tools out there that can be modified for a region…the Invasiveness Screening Kits, A-WRA, Naturserv Status Assessments, etc. Creating new tools is a waste of time in my opinion and if more people use the same methods, we can share information much more easily.

Questions regarding risk assessments that already exist or could be used as examples for Montana

1. Does Montana have any unique risk factors that should be considered in the development of an assessment model?

- AD: I am not aware of any unique only to Montana, but I am not an expert on the state. From what I can tell, Montana's most unique invasive species risk factors stem from its vast, remote terrain with mountainous microclimates, rapid climate change impacting diverse ecosystems, its status as a headwaters state spreading aquatic invasives widely, high wildfire risk amplified by invasives like cheatgrass, and the particular vulnerability of tribal lands and cultural resources.

- EC: From what I know about Montana, the predominance of rangeland in the state merits consideration for potential for invasive species spread, impacts (on livestock and grazing), and interaction with fire. An assessment model for the state should also consider the potential of risk to Tribally-important species and habitats, water quality and use, fire risk, tourism, and rare/sensitive habitats within the state.

- EP: I would say yes – though the unique factors may be similar to factors present in other largely rural large Western states that includes mountains and plains. For Montana, both agriculture and hunting and fishing are very important (based on my experience living in Montana for 6 years), and so impacts or threats to large- and small-scale agriculture and fish and wildlife need a lot of consideration. In particular, threats to subsistence living needs to be seriously examined. Other factors to consider: border with Canada – what responsibility does Montana have in managing and controlling invasive species so they do not spread north and become an issue in Canada? Interconnected waterways, streams, and rivers are very important and facilitate the movement of native and non-native species.

    - I think another risk factor is the incredible diversity of wildlife species and remote wilderness areas in Montana. Invasive species pathways into protected areas are likely to change and wilderness areas are likely to be at risk. Managers will need to decide if those areas should be left alone (e.g., “untrammeled by man”), or if active interventions are needed in order to keep those areas in or resembling their current state. Finally, as one of the northern most states, Montana may be a refuge for native and indigenous species that are shifting north, as well as a recipient of invasive species shifting north. As invasive species are likely to shift much faster than natives, as ecosystems change in Montana invasive species may establish and pre-empt space. So, an assessment really needs to look at species in neighboring states, especially to the south.

- DL: as I said in the previous response, there is no need to invent a new tool. Tweaks on risk assessment can account for abiotic conditions like precipitation, soil type, climate, etc. For example, the A-WRA can be modified for your region by changing 3-4 questions (I just did this for Pennsylvania).

2. Which risk assessment models exist that would be most relevant to the ecosystems or regions within Montana, or that could be easily duplicated to meet Montana’s needs?

    - AD: As identified before, I like GLANSIS in that in case do both plants and animals. The APHIS Weed Risk assessment is also well established: https://www.aphis.usda.gov/plant-pests-diseases/noxious-weeds/noxious-weeds-program-risk-assessments

    - EC: Again, I haven’t personally done any risk assessments, but I do know that Northeast RISCC colleagues have assessed established non-native species for “sleeper species” potential to become negatively impactful using the EICAT framework for ecological impacts

in combination with questions about species' socioeconomic impacts, which habitats in the region were impacted, and current and future range projections (this paper). In particular, the model of having a list of habitats that occur in Montana and noting which ones a given species impacts during the assessment process, alongside other questions about Montana specific risks (fire risk, rangeland risk, etc.) could be helpful to consider.

- EP: I am going to defer to Deah on this one!
- DL: There are a few tools that could work. I am looking at the ISKs for aquatics in PA. The A-WRA is the most widely used tool for plants. It is accessible in that it does not require any special software. The PPQ WRA the feds use does require ArcGIS and a program called @ risk for uncertainty analysis. There are pros and cons to many of these tools. We do have a paper in review that might be of interest that provides insights into what the risk analysts use, why they do assessments, what tools, etc. https://preprints.arphahub.com/article/153054/list/18/

3. How do the considerations of pathways and vectors fit into these various models?
    - AD: GLANSIS has a stand alone pathway assessment. Pathway detail could be modified for terrestrial species.
    - EC: I don't have experience with this.
    - EP: I think you would need to have an idea of what pathways are bringing and are likely to bring invasive species into Montana in the future so that species that move along those pathways can be assessed first. If there are no pathways for a species into the state then perhaps it does not need to be assessed (?). There are good frameworks for introduction pathways, I recommend Appendix 1 of Katelyn Faulkner's "Classifying the introduction pathways of alien species: are we moving in the right direction?" in NeoBiota. Next step would be to identify the most important pathways, and then prioritize them for attention. Some pathways have received a lot of research and attention (ornamental plant pathway), and others less so (movement by hikers). Research may be needed into which pathways invasive species have arrived into Montana in the past – for an example of this kind of work in Hawaii see Brock and Daehler 2021(Plant naturalization trends reflect socioeconomic history and show a high likelihood of inter-island spread in Hawai'i). Some pathways may be able to be identified and others may be more difficult to identify or impossible. I would say as a final step, identifying the highest shared priority pathways that may result in the movement of the worst invasive species, and then targeting those for attention and future policy could be a good way to go about it. The Don't Move Firewood campaign is a good example of focusing on a pathway that can be the source of multiple invasive species moving across state lines. I do not have much to say on vectors, but you need to know what exactly is moving invasive species to be able to stop or slow it. For example, knowing that Coconut Rhino Beetle is moving around due to ships is one thing, but knowing that the larvae are moving around in the soil one specific horticultural potted plant in containers on ships is much better info to know (so general and specific info are needed).
    - DL: In my experience, I haven't seen explicit consideration of pathways in the risk assessments I have used except for questions about anthropogenic uses (plants in trade). Pathways are considered in the Status Assessment I have been working on with Nancy

Loewenstein. We are currently working on developing a framework or approach to pathway analysis for secondary pathways.

4. Are there models that incorporate culturally significant species considerations into impact assessments?

    - AD: GLANSIS does this, to an extent.

    - EC: I'll highlight again the Washington Invasive Species Council's efforts to assess spotted lanternfly impacts on culturally significant species (Jessica La Belle has presented on this in several places, including last year's NAISMA; a recording of a version of this talk available here).

    - EP: Good question! I do not know – but I think this is critical for an equitable response to invasive species. I think the focus has largely been on agricultural pests and weeds, and less so on biodiversity, but this is a new frontier in the field that I think needs a ton of attention – i.e., how to assess the impact of invasive species on culturally significant species. Some of this may be easy for all to see and some may require working with social scientists to uncover. There is recent federal guidance on incorporating Indigenous Science and Knowledges into federal policy – perhaps some of this could be adapted for the state if it does not exist (See Memorandum for heads of federal departments and agencies, Nov. 30, 2022).

    - DL: The tools I use do not include impacts to culturally significant species but they do include impacts to property, agriculture, right of ways, etc. This should change.

Questions regarding the assessment of climate impact of those species to Montana

1. How should a given invasive species' potential to provide climate resiliency benefits be considered? Are there models that do so?

    - AD: This is not my specialty. However, my takeaway is that it's important to approach this with caution, as seemingly beneficial short-term effects can often mask long-term ecological damage.

    - EC: I would advise caution here: incomplete information about a species' negative impacts could mean that an apparent net benefit of a species might actually still be a net negative, especially when considering the importance of native biodiversity for climate resilience and the potential for invasive impacts on native biodiversity.

    - EP: An older ISAC white paper that was exploring invasive species impacts said that to be considered invasive, the harm must outweigh the benefits (See Invasive Species Definition Clarification and Guidance Approved by ISAC on April 27, 2006 Submitted by the Definitions Subcommittee of the Invasive Species Advisory Committee) . For non-native species not yet present, it makes sense to keep them out as invasive species prevention is much more efficient and effective than dealing with species after they arrive. But for species that are already present, they should be assessed for all of their positive and negative impacts. The EICAT+ Framework is one that allows assessment of positive effects of non-native species. See Vimercati 2022 (The EICAT+ framework enables classification of positive impacts of alien taxa on native biodiversity). Climate resiliency is one potential benefit. Recent ISAC white papers have identified invasive species as a large contributor to the loss of climate resiliency – but it is possible that some species could increase resilience. For example, if

coconut palms, which help hold together the shoreline of many low-lying islands are wiped out by the coconut rhinoceros beetle, then a non-native tree that stabilizes shorelines and reduces erosion could potentially be brought in to accomplish the same or similar positive effects. In Hawaii, invasive cattle introduced in the 1800s led to the damage of forests and widespread erosion and foresters used non-native trees to stabilize slopes, create forest cover, and reduce erosion and sedimentation of the coral reefs. It largely worked, those areas are forested now with many non-native and invasive trees, but some trees have spread extensively throughout the state causing damage (e.g., silver oaks). So – ideally, non-invasive species would be used to help provide climate resiliency benefits. IMO – native species should be sought first, non-native and non-invasive species second, and only as a last resort should an invasive species be considered – after all, if negative impact is included in the definition, then by definition that introduction would cause negative impacts.

- DL: This is a tricky question because potential benefits SHOULD NOT be considered to cancel out negative benefits. Risk assessment can be used to determine the invasion risk for species that are proposed for introduction, or species already in the area but will be used in a different way that increases propagule pressure. RA can be used to select species from a list of potential 'nature-based' climate solutions with a low risk. High-risk species should not be used unless there is a way to mitigate that risk.

2. What invasive species data collection should we invest in and at what scale is appropriate to assess for climate change to plan for the future?

    - AD: Also not my specialty, but I'd suggest remote sensing, citizen science (see https://www.misin.msu.edu/), eDNA technology. I think long-term monitoring to track changes at a variety of geographic scales is important.

    - EC:

        - Range/suitability projections under a few different climate scenarios can be helpful to get a better sense at potential for spread/impact, which can help inform prioritization of species (if Montana is well within the suitable range in multiple climate scenarios, that can be an added reason to consider the species invasive/potentially invasive). For state listing purposes, these could be fairly coarse-scale, but to be useful for informing local management, ≤1 km projections would be better.

        - Real-time mapping and reporting is a helpful baseline for projections, and can also be helpful for knowing which species are currently arriving where (and useful for EDRR). A state-wide geospatial database (geared for use by managers) and community science reporting (geared for use by the general public) could both be helpful for this, especially if integrated with larger-scale datasets that include observations from beyond Montana's borders.

    - EP: This sounds like a good survey of managers, decision makers, and policy makers in Montana! I think the regional scale (rocky mountain west), state scale, and local/watershed scall all matter and all have to be considered for climate change. Pfadenhauer and Bradley 2024 (Quantifying vulnerability to plant invasion across global ecosystems) did a great job showing why scale matters for calculating invasion rates (see Figure 4). It is hard to choose a scale that matters most, but management happens at the local/watershed level where

actual decisions are made regarding management, so if this scale is not a focus, then the results may not affect or matter for management.

- For data collection – species occurrence data is critical as are data points where species were not detected (species absence sites). Many species distribution modeling efforts are using what is called pseudo absences which are guesses at where a species is absent, because good data on absences is lacking. This data is probably collected by all land management agencies and institutions, perhaps some of them use the ArcGIS collector App, or other software. Ideally, invasive species data would be collected into a central repository and data portal (see the Hawaii Climate Data Portal as an example of this for climate-related data - https://www.hawaii.edu/climate-data-portal/. If data is not being collected, cleaned, aggregated, and then made available for researchers – at least on public lands, this is probably holding back research in the state. SIREN (US National EDRR program) is soliciting some data for their tool which could also be contributed to. The other data need is abundance/density data. As many species have impacts due to their abundance (i.e., impact increases as abundance increases), having abundance data for invasive species will be important to track abundance-range shifts over time and potentially to track shifting impacts over time. This is going to be plot-level data. There are some standardized ways of collecting plot level data – such as NEON, USFS FIA, NPS Data Inventory and Analysis, and the Permanent Plot Networks which are worldwide. This plot level data could also be aggregated into a central repository and shared with researchers along with downscaled climate data for Montana for easier climate-impact modeling and species distribution mapping.

- DL: better information about environmental tolerances should be available. More occurrence records, herbarium entries, etc. will help with distribution modeling. Surveillance innovations to help determine where a species might be can help to determine invasion status.

3. How do we go about acquiring such data? What scale or resolution of data are needed?

    - AD: Not my specialty, but a few ideas:

        - Leverage existing databases like GLANSIS, GBIF (Global Biodiversity Information Facility), and USGS databases.

        - Utilize satellite imagery (e.g., Landsat, Sentinel) for large-scale vegetation mapping and change detection.

        - Employ aerial surveys (e.g., drones, aircraft) for higher-resolution monitoring of specific areas.

        - Apps like MISIN (above)

        - At the state Scale, medium-scale data (e.g., 100-m to 1-km grid cells) is needed for targeted monitoring and management.

    - EC:

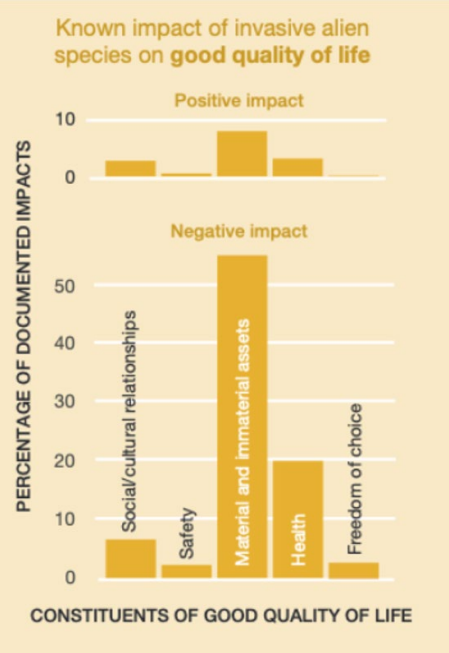
        - Both citizen/community science and practitioner reports provide helpful geospatial information:

- WA Invasives App enables anyone in the state to report a sighting, and syncs with EDDMapS (which also has the benefit of being able to easily integrate all the other data on EDDMapS, including from other states).
- NY's iMapInvasives has a mobile app for both public and professional use

- EP: Need to find out who is collecting the data and who has it, what data collection standards are being followed and how the data is stored and organized, and then if no central repository exists, determine who a trusted entity is that could collect/keep this data. Finally, MOUs may be needed for data sharing agreements. Data for public and private lands may require different levels of access and protection. For scale/resolution, I would say GIS point data is really needed for SDMs for invasive species and abundance plots. Having maps of invasive species by reserve or unit (a larger scale) would be good too, but not as helpful for modeling potential range shifts. For climate data (e.g., future temperature/rainfall for different climate scenarios), high resolution downscaled products are best.
- DL: Multiple scales. Local can help with invasion status, global can help with distribution modeling for risk.

Questions regarding the assessment of economic impact of those species to Montana

1. How do we incorporate potential economic benefits of an invasive species into an assessment?
    - AD: The GLANSIS Framework has a beneficial assessment component.
    - EC: I don't have experience with this.
    - EP: See my discussion of EICAT, EICAT+, and SEICAT. Again – if it is an invasive species, it is probably bad by definition. I think for a beneficial species it would probably be classified differently – e.g., as an agricultural plant or animal, as a culturally important species, etc. As soon as something is classified as invasive, the natural tendency I think among managers is to want to eradicate it or control/manage, get rid of it. So my advice would be to classify it differently and use the classification of invasive species as those that society has deemed harmful (overall) to the economy. If there are serious economic benefits to a species that causes harm – then a real serious discussion needs to happen and a clear and transparent process identified for how to move forward (does the benefit outweigh the harm and who or what is being harmed).
    - DL: You don't. Not in a risk assessment or status assessment. Perceived positive impacts should not be used to 'offset or understate' negative impacts produced by invasive species, which in many cases can be irreversible, such as species extirpation and ecosystem transformations. Benefits do not cancel out negative impacts and actually benefits increase the invasion risk because the species would possibly be used more. Another concern is "who determines the value?" Conflicting views here can cloud the risk or invasion status determination. Further, in the IPBES report, the number of positive impacts was much lower than negative impacts. From IPBES-Indigenous Peoples and local communities document **92% negative 8% positive impacts** on nature.
    - DL: In risk analysis, there are 4 steps…1. initiation; 2. Risk assessment; 3. Risk mitigation; 4. Risk communication. Benefits should be considered outside the assessment in Risk Mitigation as a part of PRA.



2. What data collection should we be investing in and at what scale to assess impacts to economic resources?

    - AD: Economic assessment is difficult. A lot of data is anecdotal. It depends how much resources you have - contracting with someone who specializes in economic assessment of invasive species seems the best route. However, many frameworks allow for qualitative assessments of impact if quantitative data is not available.

    - EP: For modeling species distributions and range shifts you need species occurrence data (GIS points with e.g., Lat/Long, or X/Y coordinates), as well as absences (points where the species is not currently found). Ideally those are collected in a standardized way across the state in some kind of grid pattern so that range shifts can be modeled and detected. Collect plot level abundance/density data too. If the impacts are ecological (e.g., impacts to species diversity/richness), then those should be standardized and collected across the state in a way to track impact shifts. Scale is probably going to need to be at the parcel level – e.g., farm, agricultural field or lot, wildlife sanctuary, etc. in order to detect real economic impacts, as well as the state level if comparisons are going to be made with other states (or estimates will be compared back in time with Montana itself).

3. How do we go about acquiring such data?

    - AD: I have generally used published research, or state agency or industry (eg fisheries) reports.

    - EP: Need to have a trusted program to do this – probably best to hire folks within the sectors who are most affected to track this. Having lived in Montana my #1 here is trust. Who does this analysis would be secondary – whether that is a college or university, non-profit, agency, etc. But I would guess most places will be hesitant to report losses/damages due to invasive species.

4. What economic impacts should be focused upon in these invasive species assessments?
    - AD: See GLANSIS assessment templates (attached).
    - EP: What economic sectors matter most to Montanans? My guess would be agriculture, tourism and recreation, hunting and fishing, construction, mining, oil & gas, health (which is also economic). But this really needs to be driven by the state and what residents think is the most important. If there is an economic research organization at a college or university, or chamber of commerce that could be a good place to start.
    - DL: Create a separate screen and consider agriculture, forestry losses, cost of management, property loss.

Questions regarding the assessment of ecological impact of those species to Montana

1. How do we incorporate potential ecological benefits of an invasive species into an assessment?
    - AD: The GLANSIS Framework has a beneficial assessment component.
    - EC: I don't have experience with this.
    - EP: See EICAT +. My answers are not really going to change that much for the different sectors, though I think EICAT + is more focused on the environment. Again, I think if the state classifies it as an invasive species, the goal should be to eradicate, control, or manage it to reduce impacts. If it causes harm and provides benefits, a clear and transparent process needs to be identified to determine the pathway forward and this should include upstream deliberative engagement to ensure an equitable result. Finally, who the winners and losers are should be determined by the laws and policies of the state and the state constitution. If this is not clear, then laws should be passed that address this. However, my guess is that in many cases – the species has been identified as invasive because it has harmful effects that outweigh any ecological benefits. Where research is lacking, research should be done. So for example, does a non-native plant provide flowers for native pollinators or birds? I worked on an invasive plant for years (tree tobacco) that was the host plant for the endangered Blackburn sphinx moth. The native host tree was in severe decline. As a result – we had to do 10+ years of research to determine to what extent the moth was using the tree tobacco for reproduction before we could move forward with removal. It had big impacts – it literally swallowed up roads that we could not use anymore. So I would say that it is important to have an understanding of the biology and ecology of invasive species and how they affect and contribute to the ecological community before removal/management, otherwise there is a chance for unintended consequences.
    - DL: See above…I have such big concerns about including this in the risk or status determination.
2. What data collection should we be investing in and at what scale to assess impacts to ecological resources?
    - AD: Given the number of species and variety of impacts, trying to collect impact data for all would be nearly impossible. I would use published data (including grey literature, if it can be verified), and focus on identifying priority species/impacts for which no research exists to

invest in your own data collection. Scale would depend on impact type (eg impacts to an entire ecosystem or single water body).

- EC: The Blossey Lab at Cornell University and the New York Invasive Species Research Institute (NYISRI) have been working on a sentinel plant indicator method (such as used in this paper; I'm also attaching a writeup from a workshop we did on the topic) to measure the ecological impacts of invasive species and other stressors in a standardized manner that can be readily implemented by non-specialists.

- EP: Same thing as above, but more focus on ecological impacts – e.g., reductions in species richness, diversity, and evenness due to the invasive species – as well as mechanisms for impact (how this is happening – is it due to competition, apparent competition, predation, etc.). Scale = plot level to watershed to region. You can't focus on just one scale as scale affects the results and conclusions.

- DL: we need more research on species in general to get good data on impacts. Changes in biodiversity, soil chemistry and hydrology, changes to food webs, etc.

3. How do we go about acquiring such data?

    - AD: Use existing data (published, databases like USGS NAS, or grey literature). Can also use impact data from other invaded systems (eg impacts of common carp in Australia).

    - EC: One starting place could be using the EICAT framework (intended to be based on published data), which breaks down ecological impacts into twelve different categories of impact mechanisms. The Montana Natural Heritage Program might have data on which native species face risks from which invasive species (this could also be useful for looking at impacts to economically and culturally important species).

    - EP: Partnerships and collaborations with ecologists, biologists, wildlife biologists, folks that work at natural resource agencies, USFS, NPS, UFWS, etc. Need to have an entity that has trust and authority to collect and analyze data or store it in a central repository.

        - There are a lot of online resources - I pulled this sentence from a PrePrint (Canavan et al. March 2025 (Risk assessment in practice: Insights into invasive species risk assessments from a survey of users): "Respondents listed 143 generally open-access databases that they frequently use to conduct risk assessments, with the most commonly used sources being the CABI Invasive Species Compendium, occurrence records from the Global Biodiversity Information Facility (GBIF), and taxonomic information from the Integrated Taxonomic Information System (ITIS)."

    - DL: Within the Kunming Montreal Global Biodiversity Framework, there are targets that really get at what is needed for information sharing-Target 20-Strengthen Capacity-Building, Technology Transfer, and Scientific and Technical Cooperation for Biodiversity. Target 21-Ensure That Knowledge Is Available and Accessible To Guide Biodiversity Action. Generally, we need to work on standardizing assessment tools and databases for information sharing.

Questions regarding the assessment of cultural impact of those species to Montana

1. What are the potential cultural impacts to Montana from invasive species?

    - AD: Invasive species in Montana can threaten cultural identity by:

- Disrupting Indigenous traditions and knowledge.
- Reducing recreational opportunities and tourism.
- Altering landscape aesthetics and cultural values.

- GLANSIS captures some of these.

- EC: Potential cultural impacts from invasive species in Montana include potential negative ecological impacts on culturally important species, First Foods, and fish and game species; damage or disruption to cultural and historic sites; and impediment of recreation.

- EP: There are potentially huge impacts to cultural practices, identity, resources, sovereignty, food security, traditions, and lifeways, especially to Tribes. However – there may be huge differences in whether and how invasive species are defined and understood by Tribal members and representatives. There may not be a place for this category as popularly defined by Western Science for example, and the worldviews which underpin the category. This represents a largely unexplored area IMO in the invasive species profession which has barely broached the topic of how Indigenous communities define and respond to invasive species.

    i. From my limited understanding, I would suggest that funding go to support Indigenous scholars, scientists, and resource managers for research into, or prevention, management, and control of invasive species on Tribal lands, and that other ways of knowing be incorporated into state planning frameworks if they are not in there already. How we view, interact with, understand, and participate in nature has a lot to do with what we perceive as harm or benefits, and I think in many cases the harm cannot be separated from the social context in which the harm occurs. In other words, it is not the invasive species causing the harm, it is the species in the context that causes the harm. And as such, we may be able to change the context to reduce or eliminate the harm. For example, non-native and invasive flammable grasses readily ignite in hot, dry, and windy conditions in Hawaii which can cause huge damage to property and loss of life (e.g., Lahaina, Maui 2022 fire). However, if those same grasses are grazed by livestock, it can reduce flame lengths, and the resulting matrix across the landscape of grazed and ungrazed areas (patchy fuels), can slow down wildfire spread and give firefighters a better chance to stop the fire and put it out. Two of the reasons that wildfires have become such huge issues are the abandonment of agricultural lands and land banking. For the first, huge areas of former sugarcane and pineapple lands have been abandoned and they have been replaced by fast growing invasive grasses that create huge biomass and fire fuel loads. For the second, it can be more profitable to buy land in Hawaii and do nothing (sit on it/bank it), and wait for the value to increase and then sell it for a profit than it is to actually do something with it – e.g., develop it, farm, etc.). So these two social contexts, which are based on incentive structures, combine with the species themselves to create the risk. The risk itself is not independent of the social circumstances. All of this is to say that we need to pay way more attention to the social context of invasive species and how to reduce impacts. One method has been called the MIM approach or "Managing Impact Modifiers" – see Dunham et al. 2020 (What to do when invaders are out of control?). To circle back to the question, the social context on Tribal lands is likely different than outside of Tribal lands, which may help or hinder invasive species, and this should be recognized I think.

2. What data are necessary to assess the impacts of invasive species on cultural resources? How do we go about acquiring such data?

    - AD: For some, assessment by an internal team would be sufficient. For indigenous impacts, would suggest working with indigenous groups.

    - EC:

        i. Part of this will require knowing which native species are culturally significant and potentially at-risk due to invasive species (and which invasive species pose these risks), which may be published already to some extent due to T&E species assessments; however, information on which species are culturally significant to Indigenous groups in particular can be sensitive due to past criminalization of traditional uses through federal policy, and any effort to gather this information must consider this sensitivity. For an example of how to approach this sensitivity, see Washington Invasive Species Council's collaboration with cultural resource staff at the Washington State Recreation & Conservation Office and Department of Fish & Wildlife to identify culturally significant plants with potential to serve as host plants for spotted lanternfly. Tribes should be consulted and considered as collaborators and co-managers from the start with such efforts.

        ii. In a similar vein, understanding which culturally significant habitats are at risk from invasive species may include sensitive information, and may introduce additional questions of how to protect such areas in ways that uphold Tribal sovereignty.

        iii. I wonder whether Montana Natural Heritage Program could be partnered with to find information on which (potential) invasive species pose threats to culturally-important species, too.

    - EP: Work with social scientists! Also – this may need to be a state level project as many federal partners have to make data publicly available due to current laws/policies. As a result, Tribes may be unwilling to share data with federal partners (or state partners if similar laws and policies exist regarding data access/transparency, etc.). So – move at the speed of trust, support those who steward cultural resources in their work, find out what impacts there are and successful practices, and follow laws, policies, and guidelines that ensure Tribal data sovereignty. Do this through long-term relationships and not parachute science, and do it for the right reasons (to help communities, not to get publications). Finally, I believe it is best when cultural practitioners lead the way here.

Appendix C. Participant Contact

Name	Affiliation	Email
Panelists		
Eva Colberg	Northwest Climate Adaptation Science Center	evamc@uw.edu
Alisha Davidson	Great Lakes Commission	Alisha.dahlstrom@gmail.com
Deah Lieurance	Penn State University	dzl5661@psu.edu
Elliott Parsons	Pacific Region Invasive Species and Climate Management Network	eparsons@hawaii.edu
Participants		
Amy Alder	Rosebud County Weed District	amy.adler@rosebudcountymt.gov
Jill Allen	Jefferson County Weed District	jallen@jeffersoncounty-mt.gov
Margo Anderson	USDA Forest Service	margo.anderson@usda.gov
Jake Blackstone	USDA Forest Service	Jacob.Blackstone@usda.gov
Allison Borges	USDA Forest Service	allison.borges@usda.gov
Amber Burch	Beaverhead County Weed District	aburch@beaverheadcountymt.gov
Jessica Bushnell	Broadwater County	Brweed@broadeatercountymt.gov
Jacob Chadwell	MT DNRC	Jacob.Chadwell@mt.gov
Jasmine Chaffee	MT Dept. of Agriculture	jchaffee@mt.gov
Pam Converse	Pondera County Weed District	weeds@ponderacounty.org
Michelle Cox	USDA Forest Service	michelle.cox2@usda.gov
Michelle Cummins-Lower	Mineral County Weed Board	michelleiphone2017@icloud.com
Grace Davison	Broadwater County	crewlead@broadwatercountymt.gov
Jacob Doyle	USDA Forest Service	jacob.doyle@usda.gov
Leah Elwell	Conservation Collaborations	leah@conservationcollaborations.com
Megan Evans	Alberta Invasive Species Council	execdirector@abinvasives.ca
Ian Foley	MT Dept. of Agriculture	ifoley@mt.gov
Dyar Frank	USDA Forest Service	dyar.frank@usda.gov
Leigh Greenwood	Nature Conservancy	lgreenwood@tnc.org
Russ Hartzell	MISC	russ.hartzell2@mt.gov
Kelly Hendrix	WMCC	kelly.hendrix@mt.gov
Paul Kusnierz	Avista	paul.kusnierz@avistacorp.com

Participant	Affiliation	Email
Karen Laitala	Powell County	klaitala@powellcountymt.gov
Krista Lammers	WMCC	krista.lammers@mt.gov
Casey Lewis	MWCC	Casey.Lewis@mt.gov
Bridger Line	NWTF	bline@nwtf.net
Liz Lodman	MISC	liz.lodman@mt.gov
Monica Lomahukluh	USDA Forest Service	monica.lomahukluh@usda.gov
Dennis Longknife	Fort Belknap Indian Community	dclongknife@gmail.com
Kylee Macks	USDA APHIS PPQ	Kylee.macks@usda.gov
Jane Mangold	MT State University - Extension	jane.mangold@montana.edu
Daren Many	USDA Forest Service	daren.many@usda.gov
Phil Matson	Flathead Lake Biological Station	phil.matson@umontana.edu
Bryce Maxell	MT Natural Heritage Program	bmaxell@mt.gov
Craig McLane	MT FWP	cmclane@mt.gov
Jessica Mitchell	University of MT	jessica.mitchell@mso.umt.edu
Nanette Nelson	Flathead Lake Biological Station	nanette.nelson@flbs.umt.edu
Erik Norderud	USDA APHIS PPQ	erik.d.norderud@usda.gov
Stephen Phillips	PSMFC	sphillips@psmfc.org
Sara Ricklefs	Invasive Species Action Network	sara@stopais.org
Dan Rostad	Yellowstone River Conservation District	dan.rostad@mt.nacdnet.net
Fernando Sanchez	University of MT	fernando.sanchez@mso.umt.edu
Chase Scheffler	US Fish and Wildlife Service	chase_scheffler@fws.gov
Brent Smith	CEMIST	cemist.manager@gmail.com
Evana Somlyay	Bureau of Land Management	evanasomlyay@blm.gov
Jackson Strand	MT State University	jstrand894@gmail.com
Braden Stremcha	MT Dept. of Agriculture	braden.stremcha@mt.gov
Ron Torretta	USDA Forest Service	ronald.torretta@usda.gov
Josh Wagoner	MT Dept. of Agriculture	josh.wagoner@mt.gov
Steve Wanderaas	MISC	
AnnaMarie White	Mineral County	whiteannamarie@yahoo.com
Kate Wilson	Bonneville Power Administration	klwilson@bpa.gov
Lori Witham	USDA APHIS PPQ	lori.m.witham@usda.gov

Participant	Affiliation	Email
Brenda Witkowski	BLM	bwitkows@blm.gov
Thomas Woolf	MT FWP	thomas.woolf@mt.gov
Will Young	USDA Forest Service	will.young@usda.gov

Appendix D: Invasive Species Definitions

State of Montana

Montana Invasive Species Council
MCA 80-7-1203 "Invasive Species" means plants, animals and pathogens that are nonnative to Montana's ecosystem and cause harm to natural and cultural resources, the economy, and human health.

Montana Aquatic Invasive Species Act
MCA 80-7-1003 "Invasive Species" means upon mutual agreement of the directors of the departments, a nonnative aquatic species that has caused, is causing, or is likely to cause harm to the economy, environment, recreational opportunities, or human health.

County Weed Act
MCA 7-22-2101"Noxious Weeds" means any exotic plant species established or that may be introduced into the state that may render land unfit for agriculture, forestry, livestock, wildlife or other beneficial uses or that may harm native plant communities and that is designated as a statewide noxious weed by rule of the department.

County Vertebrate Pest Management
MCA 7-22-2501 "Vertebrate Pests" means jackrabbits, prairie dogs, ground squirrels, pocket gophers, rats, mice, skunks, raccoons, bats and the following depredatory and nuisance birds: blackbirds, cowbirds, starlings, house sparrows and feral pigeons, when such animals and birds are injurious to agriculture, and other industries, or the public.

Exotic Wildlife
ARM 12.6.2201 "Exotic Wildlife" means a wildlife species that is not native to Montana: foreign or introduced. "Prohibited Species" means live, exotic wildlife species, subspecies, or hybrid of that species, including viable embryos or gametes, that may not be possessed, sold, purchased, exchanged, or transported in Montana.

Feral Swine
MCA 81-28-101 "Feral swine" means a hog, boar, or pig that appears to be untamed, undomesticated, or in a wild state, or appears to be contained for commercial hunting or trapping.

Federal

Executive Order 13751 (2016) – "Invasive species" – means with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal or plant health. "Non-native species" or "alien species" means with respect to a particular ecosystem, an organism, including its seeds, eggs, spores or other biological material capable of propagating that species, that occurs outside of its natural range. "Pathway" means the mechanisms and processes by which non-native species are moved, intentionally or unintentionally, into a new ecosystem.

Executive Order 13112 (1999) – Invasive Species – "alien species" means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species that is not native to that ecosystem.

Nonindigenous Aquatic Nuisance Prevention and Control Act (1990) – "aquatic nuisance species" means any non-indigenous species that threatens the diversity of abundance of native species of the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters.

Appendix E: Suggested Resources

Bradley et al. 2009. Climate change and plant invasions: restoration opportunities ahead? Global Change Biology,

Colberg, E.M., Bradley, B.A., Morelli, T.L. and Brown-Lima, C.J., 2024. Climate-Smart Invasive Species Management for 21st Century Global Change Challenges. *Global Change Biology*, *30*(10), p.e17531. https://doi.org/10.1111/gcb.17531 (open access)

Colberg, E.M., Morelli T.L., & C.J. Brown-Lima. 2024. Guidelines for Climate-Smart Invasive Species Management for the Northeast. NE RISCC Management Network. https://doi.org/10.7298/2nqt-1s83

Council for Agricultural Science and Technology (CAST). 2024. Preventing the Next Plant Invasion: Opportunities and Challenges. Issue Paper 73. CAST, Ames, Iowa.

Campbell, M. L. 2008. Organism impact assessment: risk analysis for post-incursion management.– ICES Journal of Marine Science, 65.

Campbell, M.L. and Hewitt, C.L. 2008. Introduced marine species risk assessment – aquaculture. In M.G. Bondad-Reantaso, J.R. Arthur and R.P. Subasinghe (eds). Understanding and applying risk analysis in aquaculture. FAO Fisheries and Aquaculture Technical Paper. No. 519. Rome, FAO. pp. 121–133.

Fusco, E.J et al. 2024. The emerging invasive species and climate-change lexicon. Trends in Ecology and Evolution. https://doi.org/10.1016/j.tree.2024.08.005

Gervais J.A. et al. 2020. Climate-induced expansions of invasive species in the Pacific Northwest, North America: a synthesis of observations and projections. Biological Invasions.

Mangold J., S. A. Frame-Martin and E.D. Raile. 2021. Noxious weed views and behaviors in Montana after 25 years of public education. Invasive Plant Science and Management. https://doi.org/10.1017/inp.2021.35

Maxwell et al. 2024. Annual grass invasion and wildfire deplete ecosystem carbon storage by >50% to resistant base levels. Communications Earth & Environment.

O'Uhuru, A.C., Morelli, T.L., Evans, A.E., Salva, J.D. and Bradley, B.A., 2024. Identifying new invasive plants in the face of climate change: a focus on sleeper species. *Biological Invasions*, *26*(9), pp.2989-3001.

Pfadenhauer W. G and B. A. Bradley. 2024. Quantifying vulnerability to plant invasion across global ecosystems. Ecological Applications, e3031.

Pfadenhauer, W. G., Nelson, M. F., Laginhas, B. B., & Bradley, B. A. 2023. Remember your roots: Biogeographic properties of plants' native habitats can inform invasive plant risk assessments. Diversity and Distributions, 29(1), 4-18.

Salmón, E. 2020. Iwígara: American Indian Ethonobotanical Traditions and Science. Timber Press.

Seebens, H. et al. 2018. Global rise in emerging alien species results from increased accessibility of new source pools. Proceedings of the National Academy of Sciences, https://doi.org/10.1073/pnas.1719429115

Wallingford, P.D., Morelli, T.L., Allen, J.M., Beaury, E.M., Blumenthal, D.M., Bradley, B.A., Dukes, J.S., Early, R., Fusco, E.J., Goldberg, D.E. and Ibáñez, I., 2020. Adjusting the lens of invasion biology to focus on the impacts of climate-driven range shifts. *Nature Climate Change*, *10*(5), pp.398-405.

GLANSIS: NOAA Great Lakes Environmental Research Laboratory - Ann Arbor, MI, USA

North Central RISCC website

Northwest RISCC website

5B-57.001. Definitions, 5B-57. Introduction Or Release Of Plant Pests, Noxious Weeds, Arthropods, And Biological Control Agents, 5B. Division of Plant Industry, 5. Department of Agriculture and Consumer Services, Florida Administrative Code

NW RISCC database of invasive species definitions and lists relevant to the region