

Managed Relocation: Addressing the Nexus of Climate Change, Invasive Species, and Fish and Wildlife Health

Workshop Convened August 27–29, 2024

University of Minnesota, St. Paul

Workshop Summary

Paul Heimowitz¹, Olivia LeDee², Nicholas Cole³, Stanton Enomoto⁴, Robert Fisher⁵, Colin Gillin⁶, Jessica Hellmann⁷, Kris Inman⁸, Aviv Karasov-Olson⁹, Wynne Moss¹⁰, Gregor Schuurman¹¹, Mark Schwartz¹², Kerry Wixted¹³, Tiffany Wolf¹⁴, John Wulschleger¹⁵



Workshop participants.

¹U.S. Geological Survey, Ecosystems Mission Area, Portland, OR, USA, 97204

²U.S. Geological Survey, Midwest Climate Adaptation Science Center, Saint Paul, MN, USA, 55108

³U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO, USA, 80526

⁴Department of the Interior, Office of Native Hawaiian Relations, Honolulu, HI, USA, 96850

⁵U.S. Geological Survey, Western Ecological Research Center, San Diego, CA, USA, 92101

⁶Oregon Department of Fish and Wildlife, Salem, OR, USA, 97302

⁷University of Minnesota, Institute on the Environment, Saint Paul, MN, USA, 55108

⁸U.S. Fish and Wildlife Service, Kenai National Wildlife Refuge, Soldotna, AK, USA, 99669

⁹U.S. Department of Agriculture, California Climate Hub, Davis, CA, USA, 95616

¹⁰U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, MT, USA, 59715

¹¹National Park Service, Climate Change Response Program, Fort Collins, CO, USA, 80525

¹²University of California, Davis, Department of Environmental Science and Policy, Davis, CA, USA, 95616

¹³Association of Fish and Wildlife Agencies, Washington, DC, USA, 20001

¹⁴University of Minnesota, College of Veterinary Medicine, Saint Paul, MN, USA, 55108

¹⁵National Park Service, Water Resources Division, Fort Collins, CO, USA, 80525

Suggested Citation

Heimowitz, P., LeDee, O., Cole, N., Enomoto, S., Fisher, R., Gillin, C., Hellmann, J., Inman, K., Karasov-Olson, A., Moss, W., Schuurman, G., Schwartz, M., Wixted, K., Wolf, T., & Wullschleger, J. Managed relocation: addressing the nexus of climate change, invasive species, and fish and wildlife health. Midwest Climate Adaptation Science Center. (17 pages) Available: <https://mwcasc.umn.edu>

Acknowledgements

This work was supported by the U.S. Geological Survey (USGS) Ecosystems Mission Area. The Biological Threats and Invasive Species Research Program, Climate Adaptation Science Centers, and Species Management Research Program played key roles in developing and implementing this workshop. We also thank the University of Minnesota’s Institute on the Environment for hosting the event. Finally, we are grateful to the workshop participants—from state, federal, non-governmental, and Tribal organizations—for their active engagement and valuable contributions.

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government

Background

Managed relocation (MR) is a term used to describe the intentional translocation of a species outside its natural range for conservation purposes, often in response to long-term landscape changes that reduce suitability of historical habitats. MR is gaining attention from conservation scientists and policy makers. For example, in 2023, the U.S. Fish and Wildlife Service updated regulations under section 10(j) of the Endangered Species Act to provide more flexibility for species recovery by allowing introduction of experimental populations outside historical ranges (U.S. Fish and Wildlife Service, 2023). Associated communication materials noted that the regulation change was necessary given the “growing impacts from climate change and invasive species that cause habitats within species’ historical ranges to shift or become unsuitable” (Department of the Interior, 2022). Unique challenges inherent to MR have prompted recent scientific and policy attention, such as the 2024 National Invasive Species Council publication, *Considering the Risks of Managed Relocation* (National Invasive Species Council, 2024).

In late August of 2024, prompted by this growing interest, the U.S. Geological Survey (USGS) held a workshop at the University of Minnesota in St. Paul to advance research addressing the intersecting stressors of climate change, invasive species, and fish and wildlife health relative to MR. The workshop objectives were to:

1. synthesize current scientific understanding of MR risks and benefits
2. identify near-term research priorities to understand and reduce risk related to MR
3. foster interdisciplinary, interagency research collaborations
4. yield near-term information, research, and tools

Workshop Structure

The workshop was organized by a small team of USGS program and science center leaders. The organizers curated the invitation list to achieve a diversity of expertise and perspectives, while keeping attendance at a level that could foster meaningful input and exchange. Approximately 50 participants attended the workshop, reflecting a wide swath of expertise relevant to MR and organizational representation. In addition to scientists and managers from many USGS units, the workshop engaged professionals from two Tribal organizations, six other federal agencies, five states, three universities, and two non-governmental organizations (Appendix A). The workshop included presentations and panel discussions prior to sessions on MR science needs and opportunities (Appendix B). A final plenary session engaged participants in a prioritization exercise. Participants then identified one or more priorities for their future engagement. On the last day, work groups associated with those top priority topics met to begin crafting an action plan. Information generated during the workshop was captured by note-takers (Otter AI, 2025) during plenary sessions, and use of flip charts during breakout sessions.

Day 1

Introduction

Olivia LeDee (Regional Administrator, USGS Midwest Climate Adaptation Science Center) opened the workshop, welcoming participants and sharing logistical information. She emphasized the workshop goals to foster collaboration and generate new research initiatives. Olivia introduced Paul Wagner, Deputy Associate Director for USGS Ecosystems Mission Area. Paul shared perspectives on MR as a climate adaptation strategy and expressed appreciation for the workshop benefits. He acknowledged the value of advancing the topic of MR, emphasizing the need for accurate science to inform policy. He also recognized the internal collaboration between three distinct USGS program areas (Biological Threats and Invasive Species Research Program, Climate Adaptation Science Centers, and Species Management Research Program) to organize the workshop. He expressed appreciation for the diverse expertise of participants, which included natural resources managers, research scientists, population modelers, climate adaptation ecologists, decision scientists, invasive species biologists, veterinarians, and social scientists.

Paul Heimowitz (Program Manager, USGS Terrestrial Invasive Species) provided background context on the origin of the workshop, reviewed objectives, and explained the approach for participant recruitment. He briefly addressed terminology issues, including similar terms like assisted migration or colonization and conservation introductions. He emphasized the importance of understanding associated nuances while not getting sidetracked by semantics.

Olivia LeDee reviewed the workshop agenda and summarized initial participant answers to workshop registration questions (Appendix C). Workshop participants then took part in an introductory activity to learn more about each other.

Plenary: Setting the Stage

Jessica Hellmann gave a plenary presentation titled “Some challenges, opportunities and distractions of climate change adaptation suggested by managed relocation.” She defined MR as the intentional movement of species or genotypes to preserve their existence under climate change. Jessica provided background on how MR is an innovative approach to climate adaptation, with a history dating back to 2007. She pointed out several relevant scientific reports on the topic, including the 2009 paper “Multidimensional evaluation of managed relocation”, which identifies four evaluation factors: impacts of MR (or lack of MR) within the source ecosystem, impacts of MR within the recipient ecosystem, practical feasibility, and social acceptability. She noted that MR has both upsides and downsides and emphasized the need for innovative approaches to address the challenges of climate change. She emphasized the social and political aspects of MR and the need for inclusive and equitable approaches. She shared data on relative invasion risks of organisms moving within North America vs. to North America. The Karner blue butterfly (*Lycaeides melissa samuelis*) served as a case study to illustrate MR science and policy complexities and the process of innovation. Ecological models suggest that the butterfly might need to be relocated to different areas to adapt to changing climatic conditions. The case study recognized the need to define objectives and goals clearly, to consider local adaptation and differentiation of species tolerance, and to focus not just on fears but also on aspirations. Associated discussion with participants included recognition of the dynamic nature of ecosystems and the fact that the recipient ecosystems will also be undergoing continuous changes, the need for clear definitions that distinguish MR from other types of species relocation, the importance of framing discussions around conservation

objectives, and the importance of considering both risks and benefits when making decisions about species relocation.

Panel: Climate Change Considerations

A panel on Climate Change Considerations, moderated by Olivia LeDee, featured Mark Schwartz, Gregor Schuurman, and Kris Inman. The discussion focused on the complexities and uncertainties of climate change impacts on biodiversity, such as the vulnerability of narrowly-distributed coastal species facing accelerated sea level rise. The panel highlighted the Black Jewel flower (*Streptanthus glandulosus* spp. *niger*), bull trout (*Salvelinus confluentus*), and Karner blue butterfly as examples, illustrating the challenges of predicting future ranges and the potential for managed relocation. The conversation also covered the importance of understanding risk and aversion, the need for adaptive management, and the role of policy in guiding conservation actions. The Kenai National Wildlife Refuge’s approach to climate adaptation was also discussed, emphasizing the need for community-informed action plans and the use of pathway models to guide decision-making.



Panel: Wildlife Health Considerations

A panel on Wildlife Health Considerations, moderated by Paul Cross, featured Colin Gillin, Alan Franklin, Wynne Moss, and Tiffany Wolf. The panel discussed the complexities and challenges of managing wildlife health, particularly in the context of managed relocations. Key points included the need for better integration of disease risk assessment frameworks into relocation activities, the importance of understanding disease transmission dynamics, and the potential consequences of introducing new pathogens into novel environments. The conversation highlighted the urgency of addressing disease risks to prevent new outbreaks and associated impacts while also acknowledging the limitations of current knowledge and the need for more research. The panelists emphasized the importance of balancing conservation efforts with disease management and the need for public education and engagement to navigate the ethical and practical dilemmas of wildlife relocations.

Panel: Invasive Species Considerations

A panel on Invasive Species Considerations, moderated by Paul Heimowitz, featured Aviv Karasov-Olson, John Wullschleger, Kerry Wixted, and Robert Fisher. The panel discussed the challenges and strategies for managing invasive species, emphasizing the importance of risk assessment and decision support frameworks. The U.S. Fish and Wildlife Service and National Park Service have developed tools for conservation introductions and ecological risk assessments. Presentations included case studies like the Sihek/Guam kingfisher (*Todiramphus cinnamominus*), where invasive brown treesnakes (*Boiga irregularis*) pose challenges to successful MR on Guam and Cocos Island. The panel discussion also covered state policy considerations, the need for collaboration, and the impact of invasive species on ecosystems and public trust. The panel concluded with a focus on the iterative nature of risk assessment and the importance of thorough documentation and public engagement.

Discussion Groups: Barriers to MR

Participants broke into small groups to explore MR issues that could fall outside the science and research needs being addressed for the remainder of the workshop (i.e., what are the other “elephants in the room” and how can they be addressed in other venues?). Some key thoughts emerging from the breakout groups included:

- Terminology inconsistency is problematic
- State and federal policies and regulations need to be refined and aligned to accommodate MR
- There is a need to better communicate about MR to the public and with local groups directly tied to particular projects
- As interest grows in MR, more resources are needed for project implementation and associated monitoring/evaluation
- There is a need to hold a related workshop focused on policy

Impromptu Exercise: Participant Perspectives on MR

A subset of participants initiated an impromptu and informal exercise during the first day to characterize evolution of their own perspectives about MR. The resulting chart captured significant variation in early and current levels of relative optimism/tolerance over the past three decades. Some participants noted little change over time, some noted gradual increases, and some noted much more dynamic fluctuation.

Day 2

Panel: Human Dimensions of Managed Relocation

Mark Wimer facilitated a panel session on Human Dimensions of MR that featured Nick Cole and Stanton Enomoto. The panel focused on integrating social perceptions and cultural knowledge into MR efforts, particularly for endangered species like Hawaiian forest birds. The panelists discussed commonly identified decision-making barriers and the relationship between risk perceptions and knowledge gaps. The panel emphasized the importance of effective communication, adaptive management, and community engagement to address ethical concerns and build trust. Stanton Enomoto highlighted biocultural integration and the need for community permission and adherence to cultural protocols in conservation translocations. Overall, the discussion underscored that successful MR requires balancing scientific, social, and cultural factors through partnerships and continuous evaluation.

Breakout Sessions

On the second day, participants split into five groups to discuss key MR decision challenges and existing efforts. Each group discussed the same prompt questions, including “what are key decision challenges?” and “what are other projects/collaborations we need to know about?”. Participants then split into five new groups and used the results of the first session to create a long, unrefined list of needs and opportunities regarding MR science and decision making (research, information sharing, decision tools, etc.). The groups then organized their list (e.g., lumping) and created tiers (top, middle, bottom) of information and science priorities based on need, opportunity, and potential impact.

Group Activity: Priority Setting

Each breakout group presented their tiered list of priorities to the full audience of participants, and the associated flip chart pages were displayed in the workshop meeting room. Next, participants each used 10 adhesive dots to identify the needs or opportunities that they perceived as most important for near-term action. A plenary discussion of the result led to some combination of related priorities, and the final list of priorities (Appendix D).

Group Activity: Affinity Grouping

Finally, participants completed a self-reflection worksheet and an affinity-grouping exercise to choose one or more top-priority MR science opportunities they wanted to advance, even if only for the remainder of the workshop (i.e., what each participant was interested in/willing to work on further). To address high priority science support needs, six working groups emerged from this activity:

- Policy analysis and science support to provide model guidance/clarity/harmony in MR policy and terminology
- Access to comprehensive data on MR projects (and other types of translocations) across taxa, including lessons learned
- Decision support tools to identify and prioritize MR candidates and associated project opportunities/risks (i.e., what species)
- Decision support tools to determine when to consider/use MR for any candidate species, including risk assessment and human dimensions factors (i.e., how to decide).
- Social science to evaluate attitudes about MR at a project-specific and national scale, including decision-makers and agencies engaged in implementing MR.
- Pre- and post-translocation monitoring tools that consider factors like species-dependent indicators of establishment success and public health.

Day 3

Action Planning

An optional third day was scheduled for participants who had availability and interest to begin work on one of the affinity group priorities. Each affinity group completed an action plan that stated the problem, identified key partners and stakeholders, and defined clear objectives for addressing the issue. The action plan also detailed the chosen approach, deliverables, timeline, and team member responsibilities to guide implementation and accountability. Affinity groups then reported on their initial progress to the full audience of day 3 participants. We closed the workshop with an emphasis on documenting progress, sharing information, and encouraging broader collaboration and support.

Overall Summary

The workshop focused on MR as a strategy to adapt to climate change and other stressors, addressing the ecological, social, and ethical complexities of translocating species to new habitats. Key discussions emphasized the need for innovative research, interdisciplinary collaboration, and comprehensive risk assessment frameworks to guide decision-making. Participants underscored the importance of integrating social science to inform policy and ensure public engagement

in conservation efforts. The workshop generated a prioritized set of MR science needs and opportunities and launched associated task groups. Several of those groups have continued their efforts, with at least one publication under development at the time of this report’s completion. The results of the workshop also have informed USGS funding decisions. USGS workshop leads continue to support and track task group efforts and outcomes.

Additionally, the use of generative artificial intelligence to take notes proved to be a valuable tool for documentation, but it also provided a light–hearted opportunity to produce a lyrical version of a workshop summary (OtterAI, 2025):

“Finding a new home: a conservation odyssey”

*In a world where climates change,
Species seek a safer range.
Moving them is quite a feat,
To find a place where they can beat.*

*Experts gathered to discuss,
How to make this less a fuss.
With science and a social blend,
Ensuring nature won’t offend.*

*Through research, tools, and careful talk,
They’ll help these species find their walk.
In a world that’s always shifting,
They strive to give nature a fitting uplifting.*

Citations

National Invasive Species Council, 2024. Considering the risks of managed relocation. Washington, DC: National Invasive Species Council

Otter.AI, 2025. Otter: AI (August 2025 version) [meeting assistant and transcription]. <https://otter.ai>

U.S. Department of the Interior, 2024. Department of the Interior proposes expanding conservation technique as climate change threatens greater species extinction. Available: <https://www.doi.gov/pressreleases/department-interior-proposes-expanding-conservation-technique-climate-change-threatens> (May 7, 2024).

U.S. Fish and Wildlife Service, 2023. Endangered and threatened wildlife and plants: Designation of experimental populations. Federal Register, 88(126), 42643–42658.

Appendix A. Workshop Participants

Name	Position	Organization
Beauchamp, David	Ecology Section Chief	USGS, Western Fisheries Research Center
Bellinger, M Renee	Research Geneticist	USGS, Pacific Island Ecosystems Research Center
Blandford, Jacob	Climate Adaptation Program Manager	Association of Fish and Wildlife Agencies
Boag, Angela	Climate Resiliency Policy Lead	Colorado Parks and Wildlife
Bronson, Dustin	Research Plant Physiologist	USFS, Northern Research Station
Cole, Nicholas	Research Biologist / Social Scientist	USGS, Fort Collins Science Center
Colvin, Michael	Research Ecologist	USGS, Columbia Environmental Research Center
Cross, Paul	Disease Ecologist	USGS, Northern Rocky Mountain Science Center
Enomoto, Stanton	Senior Program Director	DOI, Office of Native Hawaiian Relations
Erickson, Richie	Research Ecologist	USGS, Upper Midwest Environmental Science Center
Falk, Bryan	Program Analyst	National Invasive Species Council
Fisher, Robert	Supervisory Research Biologist	USGS, Western Ecological Research Center
Fortini, Lucas	Research Ecologist	USGS, Pacific Island Ecosystems Research Center
Franklin, Alan	Supervisory Research Biologist	USDA, National Wildlife Research Center
Gillin, Colin	State Wildlife Veterinarian	Oregon Department of Fish and Wildlife
Gwynn, Becky	Deputy Director	Virginia Department of Wildlife Resources
Halstead, Brian	Research Wildlife Biologist	USGS, Western Ecological Research Center
Hand, David	Fishery Biologist – Decision Support Analyst	USFWS , Columbia River Fish and Wildlife Conservation Office
Hardiman, Jill	Fishery Biologist	USGS, Western Fisheries Research Center
Heimowitz, Paul	Terrestrial Invasive Species Program Coordinator	USGS, Ecosystem Mission Area
Hellmann, Jessica	Director and Professor	University of Minnesota
Hoch, Rachael	Assistant Chief of Inland Fisheries, Aquatic Wildlife Diversity Program	North Carolina Wildlife Resources Commission
Inman, Kris	Supervisory Wildlife Biologist	USFWS, Kenai National Wildlife Refuge
Karasov-Olson, Aviv	Climate Hub Fellow, Climate Adaptation Specialist	USDA, California Climate Hub
Klymus, Katy	Research Biologist	USGS, Columbia Environmental Research Center
Lawler, Josh	Professor	University of Washington
LeDee, Olivia	Regional Administrator	USGS, Midwest Climate Adaptation Science Center
Magness, Dawn	Landscape Ecologist	USFWS, Kenai National Wildlife Refuge
Miller, Brian	Research Ecologist	USGS, North Central Climate Adaptation Science Center
Morelli, Toni Lyn	Research Ecologist	USGS, Northeast Climate Adaptation Science Center
Mortenson, Jack	Wildlife Veterinarian	USFWS, Wildlife Health Office
Moss, Wynne	Biologist	USGS, Northern Rocky Mountain Science Center
Oyler-McCance, Sara	Research Geneticist	USGS, Fort Collins Science Center

Name	Position	Organization
Pennington, Kelly	Invasive Species Unit Supervisor	Minnesota Department of Natural Resources
Schuurman, Gregor	Ecologist	NPS, Climate Change Response Program
Schwartz, Mark	Professor Emeritus	University of California, Davis
Scott, Ally	Deputy Midwest Tribal Climate Resilience Liaison	College of Menominee Nation / Midwest Climate Adaptation Science Center
Shier, Stephen	Climate Specialist	1854 Treaty Authority
Sieracki, Jennifer	Invasive Animals Ecologist	NPS, Biological Resources Division
Twardek, William	Fisheries Scientist	Ecofish Research
VanderWerf, Eric	Director of Science	Pacific Rim Conservation
Walsh, Daniel	Unit Leader	USGS, Montana Cooperative Wildlife Research Unit
Wimer, Mark	Wildlife Program Manager	USGS, Species Management Research Program
Wixted, Kerry	Amphibian, Reptile, and Invasive Species Program Manager	Association of Fish and Wildlife Agencies
Wolf, Tiffany	Associate Professor	University of Minnesota
Work, Thierry	Wildlife Disease Specialist	USGS, National Wildlife Health Center
Wullschleger, John	Fish and AIS Program Lead	NPS, Water Resources Division
Yackulic, Charles	Research Statistician	USGS, Southwest Biological Science Center
Yee, Julie	Research Statistician	USGS, Western Ecological Research Center

Appendix B. Workshop Agenda

Day 1 = Presentations and panel discussions to share emerging research. Panels will represent a mix of management and research perspectives.

8:30–9:00 Gather

9:00–10:00 Welcome, Workshop Goals, Introductions

10:00–10:45 Plenary Presentation: “Some challenges, opportunities and distractions of climate change adaptation suggested by managed relocation”.

- Jessica Hellmann, University of Minnesota

10:45–11:00 Break

11:00–12:00 Panel 1, Climate Change Considerations

- Kris Inman, U.S. Fish and Wildlife Service
- Gregor Schuurman, National Park Service
- Mark Schwartz, University of California – Davis

12:00–1:00 Lunch (on–site)

1:00–2:00 Panel 2, Wildlife Health Considerations

- Alan Franklin, U.S. Department of Agriculture – National Wildlife Research Center
- Colin Gillin, Oregon Department of Fish and Wildlife
- Wynne Moss, U.S. Geological Survey – Northern Rocky Mountain Science Center
- Tiffany Wolf, University of Minnesota

2:00–3:00 Panel 3, Invasive Species Considerations

- Robert Fisher, U.S. Geological Survey, Western Ecological Research Center
- Aviv Karasov–Olson, U.S. Department of Agriculture – California Climate Hub
- Kerry Wixted, Association of Fish and Wildlife Agencies
- John Wullschleger, National Park Service

3:00–3:15 Break

3:15–4:15 Discussion Groups (setting the stage for Day 2)

4:15–4:30 Reflection and Day 2 Prep

Day 2 = Facilitated discussions on key issues in MR related to the nexus of IS, FWH, and CC, and small group breakouts to foster research collaborations.

8:30–9:00 Gather

9:00–9:15 Brief recap of Day 1

9:15–10:00 Human Dimensions of Managed Relocation

- Nick Cole, U.S. Geological Survey – Fort Collins Science Center
- Stanton Enomoto, Department of Interior – Office of Native Hawaiian Relations

10:00–10:15 Break

10:15–11:15 Breakout 1

11:15–12:15 Breakout 2

12:15–1:00 Lunch (on–site)

1:00–2:00 Breakout 3

2:00–2:45 Breakout Summaries

2:45–3:00 Break

3:00–4:15 Priority Setting/Affinity Grouping

4:15–4:30 Next Steps, Opportunities, Day 3 prep, Closing

Day 3 (½) = Optional work time, with facilitation support, to develop a scope of work and action plan for group projects (e.g., research study, synthesis paper, decision tool) for interest topics identified in Day 2.

8:30–9:00 Gather

9:00–11:15 Group Work

11:15–12:00 Action Plan Review/Wrap–up

Appendix C: Summary of Participants’ Pre-workshop Expectations

Prior to the workshop, participants were asked to respond to several questions about their goals and expectations. This information was used to help frame the workshop agenda and format.

What are your expectations for this workshop? How will it be most beneficial to you and your organization?

- **Build Knowledge and Understanding:** Respondents wanted to deepen their understanding of MR by focusing on risks and benefits, decision criteria, and the current state-of-the-science.
- **Foster Collaboration and Networks:** Respondents expected to build connections by sharing case studies, learning from peers, and aligning goals across agencies and organizations.
- **Advance Research and Tools:** Respondents hoped the workshop will set research priorities, produce reviews or agendas, and develop practical decision-support tools to guide management.
- **Strengthen Implementation and Policy Context:** Respondents wanted clearer insight into how MR is currently implemented, including agency practices, regulatory frameworks, and practical management challenges.
- **Practical Takeaways for Organizations:** Several expected workshop outcomes to benefit their organizations and partners through regional planning, interagency collaboration and decision support.

What are 4–5 topics related to managed relocation that you hope to learn more about during this workshop?

- **Risks, Uncertainties, and Tradeoffs:** Respondents wanted to learn how to evaluate ecological risks associated with MR, including invasiveness, disease, and interactions with resident species. They also sought guidance on weighing tradeoffs, such as costs versus benefits, risks of inaction, and the role of climate change in amplifying uncertainty.
- **Species Selection and Suitability:** Responses focused on learning how to decide which species to move and under what conditions. Participants wanted clarity on prioritization frameworks, criteria for identifying good or poor candidates, and questions about timing, distance, and how much suitable habitat is required for success.
- **Approaches and Strategies:** Respondents emphasized the value of case studies and lessons learned from past or ongoing MR efforts. They wanted to know what has worked, what has failed, and what indicators are being used to measure success.
- **Decision-support Tools and Methods:** Respondents hoped to better understand the tools that can guide planning and implementation. This included structured decision-making frameworks, quantitative methods for assessing feasibility and success, and emerging techniques such as eDNA or metagenomics to help reduce uncertainty.
- **Human Dimensions and Engagement:** Respondents stressed the importance of understanding how people and institutions shape MR. They wanted to learn about decision-maker

perspectives, socio-economic and psychological barriers, strategies for community engagement, and the role of Indigenous rights and perspectives in determining whether MR is acceptable and effective.

Any new or upcoming research or management activity related to managed relocation that you are excited to share during the workshop?

- **Species Reintroductions and Translocations:** Frequently mentioned activities involved the movement or restoration of species. Respondents highlighted reintroductions of salmon and steelhead in the Pacific Northwest, brook trout reintroductions to evaluate different strategies, planning for sea otter reintroduction to historical range, and projects involving ESA-listed snakes in California. Other examples included translocations of endangered Hawaiian birds, albatrosses to the Channel Islands, and creating novel wetlands for western spadefoot toad.
- **Climate Change–Driven Modeling:** Several responses pointed to new modeling and experimental work guiding relocation under changing climates. Examples included climate refugia modeling, species distribution models for rare species, and lidar-based habitat suitability mapping for Hawaiian birds.
- **Frameworks, Policies, and Decision Processes:** Respondents also noted new institutional tools and processes in development. These included white papers from the National Invasive Species Council to coordinate federal activity, the Pacific Region’s Decision Support Framework, potential updates to U.S. Fish and Wildlife Service policy, and planning processes at Kenai National Wildlife Refuge to consider trade-offs in boreal-to-temperate forest transitions.
- **Genetics, Genomics, and Disease Research:** Some respondents described work using genomics to inform relocation, such as studies on greater sage-grouse adaptive divergence, screening brook trout populations for genetic diversity and hatchery introgression, and range-wide datasets to assess adaptive capacity. Others pointed to new disease-related challenges, including a virus discovered in Kauai ducks, declines in Hawaiian crows complicating reintroduction, and research on antimicrobial resistance and SARS-CoV-2 in wildlife.

Appendix D: Compiled List of MR Science Needs and Opportunities

Note: Each of the bulleted items below originated as a priority from at least one of the 5 breakout groups that evaluated MR science needs and opportunities. Numbers in parentheses reflect the total number of dots placed by participants to designate their sense of the item's priority. Letters A–G were attached after the voting, during a plenary discussion, to designate potential affinity groups.

- Policy research and science support to provide model guidance/clarity/harmony in MR policy and terminology (20) = A
- Comprehensive policy analysis for “natural”, “native”, and MR (9) = A
- Comprehensive database on translocations across taxa, to promote research opportunities and evaluate the use of guidance (21) = B
- Documentation and extract lessons learned from prior MR efforts (12) = B
- Develop decision criteria to determine priorities (23) = C
- Develop a candidate list based on status/traits/threats (20) = C
- Refine scenarios/identify candidates (“screen”) for when to use MR – an “emergency response” approach (9) = C
- Develop a baseline decision tree tool (menu of choices) that can be adapted to context to consider using MR, including values (19) = D
- Develop guidelines for prioritization that specify triggers for MR action and no-action, resulting in palliative care and risk assessments including practical and cultural values and principles (27) = D
- Social science to evaluate attitudes and barriers to implement MR, including avoiding where values will prevent it (21) = E
- Research to understand manager decision-making processes and constraints to implement MR (20) = E
- Social science for implementing, overcoming barriers/resistance (5) = E
- More info on MR perceptions for individual cases and at national scales (2) = E
- Monitoring toolset – pre/post (16) = F
- Develop a mitigation bank-like platform for invested/interested stakeholders to share MR info and interest that results in incentives for action, fosters collaboration, and provides MR opportunities (19) = G
- Identify opportunities for ecological realignment and the concept of push and pull (18) = G
- Identify high priority systems for considering multi-species/ecosystem-level MR; concentrate research effort and development of case studies here (18)
- Tools to rapidly calculate ecological and social costs and benefits, to apply to individual MR projects (17)

- Communication strategies for misinformation and information; need for communication tools for all: public, partners, stakeholders (17)
- Ethics research to learn from indigenous knowledge about opportunities and best practices for MR (15)
- Tools and scientific information to inform evaluation of MR disease risks and enhance disease resilience (13)
- Develop training for managers and decision-makers about the background and current state of MR (13)
- Research the role of genomics management and local genetic adaptation in MR success, planning, and decision-making (12)
- Develop standards for contingencies that trigger action and develop exit strategies (11)
- Tool to better evaluate invasiveness potential of MR target species (9)
- Develop priority/triage list for MR (8)
- Research on innovative biological research and management including CRISPR, captive care, habitat management (7)
- Predictive frameworks/models for evaluating threats (e.g., downscaled climate conditions) and guidance for estimating vulnerability (6)
- Better info and models across scales and time (e.g., climate; land use change) to support localized MR evaluations (6)
- Develop communication plan and tools for best practices for implementers (5)
- Develop decision criteria/contingencies for implementation (4)
- Education resources for MR for public, managers, policy makers (4)
- Research exploring MR for ecological replacement (3)
- Research synthesizing existing MR efforts to summarize best practices and examples/case studies (1)
- More guidance, building on recent FWS and NPS resources, to guide MR project implementation, such as how to build a team of relevant experts (1)
- Human relocations: the intersection between human and species relocation, as related to communications (1)
- Compile existing information/examples of MR activities, people, and technical (and plain language) communication plan (0)