Perceptions of Conservation Introduction to Inform Decision Support Among U.S. Fish and Wildlife Service Employees

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U.S. Department of Interior

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Executive Summary

Around the globe, fish and wildlife managers are facing increasingly complex management issues due to multiscale ecological impacts like climate change, species invasion, and land-use change. Managers seeking to prevent extinctions or preserve ecosystems are increasingly considering more interventionist techniques to overcome the resulting changes. Among those techniques, translocation methods that intentionally move species into new, less impacted habitats are being considered. These types of translocations are known by a range of terms including managed relocation and assisted migration, but the International Union for the Conservation of Nature/ Species Survival Commission (IUCN/SSC) (2013) has proposed conservation introduction as a standard term.

As defined by the IUCN, conservation introduction is the intentional movement of a species or population outside its indigenous range for conservation purposes. Conservation introduction can be divided into two forms: assisted colonization and ecological replacement. Assisted colonization is moving a species outside its indigenous range to prevent extinction or the extirpation of a population. Ecological replacement is moving a species to fulfill an important niche that is necessary within an ecosystem. Proponents suggest these methods are necessary to address the ecological challenges managers are trying to overcome. Opponents point out the potential for species to become invasive, introduce disease or parasites, and cause other cascading impacts throughout the ecosystem. The result is controversy and disagreement. As such, it will be imperative to develop clear guidelines and best practices to be followed within wildlife management agencies to prevent potential unintended outcomes and reduce risk as much as possible.

To this end, the U.S. Fish and Wildlife Service (“Service”) partnered with the U.S. Geological Survey to develop the current project. The intent of this project was to describe the perceptions of Service personnel across many aspects of conservation introduction so that the Service could use this information in the planning and development of their own internal decision-support framework for conservation introduction.

This report is presented in five sections. Section 1 introduces the project and provides an in-depth overview of background literature related to conservation introduction. Section 2 describes the study design, methods, and study participant characteristics. Section 3 describes key results and recommendations related to the development of a Service decision framework. Section 4 investigates a range of perceptions held by participants and establishes baseline information for how Service personnel may view conservation introduction and its application. These include preferred terms and definitions, perceived barriers, perceived risks and tradeoffs, and aspects of success. Section 5 provides an overview of our conclusions for this project.

Overall, we found that conservation introduction is likely to be viewed positively within the Service, but employees offered cautions and caveats. Most participants we interviewed felt that it was a necessary tool that will be indispensable in certain situations but also felt that there was more risk associated with it than with more traditional methods. For this reason, many participants were concerned with the assessment and planning that should be conducted prior to any introduction effort. Our results suggest that many Service personnel will be open to conservation introduction being adopted more regularly but will be looking for clear guidance on how it should be implemented and what scenarios are appropriate for its use.

1 Introduction

Rapidly changing ecosystems require increasingly difficult decisions and consequential tradeoffs by fish and wildlife managers seeking to preserve habitat and protect endangered species (Manning et al. 2009). Such challenges compound over time, putting managers in a position where rapid and robust interventions must occur to prevent the extinction of a species or address the decreasing resilience of desirable ecosystems (Loarie et al 2009). Management actions that focus on incrementally improving available habitat, protecting existing populations, and reducing human impacts carry less risks but may also be too slow to produce desired results under the current rapidly changing conditions (Schuurman et al. 2021).

In response to current management challenges, species translocation has been suggested as a potential method for helping endangered species persist or improving the function of important ecosystems. In these cases, at-risk species may be moved outside their current range to areas that are more viable for the species to thrive or to fulfill ecological functions that were previously filled by a different species. The International Union for the Conservation of Nature (IUCN) formal guidelines classifies these types of translocations as conservation introduction, which it defines as "the intentional movement and release of an organism outside its indigenous range for conservation purposes" (IUCN/SSC 2013). Although other terms and definitions have been used, herein we will use conservation introduction as a representative term for these types of translocations unless specifically referring to other terms cited in the literature.

Many fish and wildlife managing agencies are beginning to investigate the potential benefits of and consequences to using conservation introductions (CI) to overcome the ecological challenges they are facing. CI has been perceived by some as risky and controversial because species moved outside their indigenous range may become invasive or disrupt existing ecosystems. As such, it will be imperative for any organization considering a conservation introduction project to establish or follow an existing decision framework and define best practices to be successful. Decision frameworks provide conceptual structures and principles designed to enhance decision making and integrating a variety of data sources (Sustainability for the Nation Resource Connections and Governance Linkages 2013) and are important tools that allow organizations to make decisions efficiently and with limited disagreement.

The U.S. Fish and Wildlife Service (USFWS, Service) has partnered with the U.S. Geological Survey to investigate the perceptions of Service personnel within the Pacific Northwest (Region 9) and Hawaii and the Pacific Islands (Region 12). In this study, we took the initial steps to gather social science information needed for efficient planning of future conservation introduction projects and, more importantly, assisting the Service in developing an effective and comprehensive decisions-support framework. Our objectives were to:

- Describe the range of perceptions and views of conservation introduction among Service employees in USFWS Region 9 and Region 12

- Describe perceptions of previously published terms and definitions and identify preferences among the study regions
- Identify Service employee perceptions that could lead to disagreement when developing a decision-support framework for conservation introduction within the Service.

This study was designed to focus on USFWS Region 9 and 12 but many of the findings are applicable beyond those two regions and even beyond the Service. As rapid shifts in ecosystem function continue to accelerate due to climate change and other broad-scale impacts, novel management actions may become necessary, and it will be imperative to understand the social implications prior to problems arising.

1.1 Background

1.1.1 What is conservation introduction?

Conservation introduction (CI) is one term in a web of terms and definitions referring to the intentional relocation of a focal species to a new, recipient community. Related terms include assisted migration (McLachlan et al. 2007; Dumroese et al. 2015), managed relocation (Schwartz et al. 2012), and translocation, each of which has been defined in multiple ways (Hallfors et al. 2014). Haskins and Keel (2012) trace the development of CI-related terminology, which started in the early 2000s (table 13.1, p. 231). The IUCN/SSC (2013) suggests the term conservation introduction and divides it into two forms based on intent: assisted colonization, conducted "to avoid extinction of populations of the focal species," and ecological replacement, conducted so that the introduced species can "perform a specific ecological function." For example, assisted colonization might involve the translocation of a population of a frog species to a location outside its indigenous range because its current range is inhospitable, and it is likely to be extirpated soon. In contrast, ecological replacement might involve the relocation of one tree species population to replace another tree species population that has declined, to prevent the decline of the ecological community overall. Much of the CI literature is focused on assisted colonization. However, some research specific to ecological replacement has been done, particularly related to forestry management (Pedlar et al. 2012; Leech et al. 2011; Sansilvestri et al. 2015), these authors argued that CI within forestry should be considered separately from assisted colonization, because it has a different goal (e.g., stable forest output for economic reasons), focus (e.g., populations of common species), and history (e.g., history of acceptability of species relocation within forestry and knowledge of the focal species' invasive potential).

Conservation introduction projects have three major characteristics. First, the threat of climate change is often a central driver, although other existential threats also play a role, including pathogens, invasive species, and land-use change, and may be the main trigger in specific cases (Sansilvestri et al. 2015). Second, CI always involves translocation of species outside their indigenous range. Defining the indigenous range, and predicting species survival outside of it, are key aspects to predicting CI success (Schwartz et al. 2012; Pedlar et al.

2012). Lastly, CI is an intentional translocation of species. It is distinct from modes of migration, such as via habitat corridors (Olden et al. 2011; Lawler & Olden 2011).

1.1.2 Alternatives to conservation introduction

To fully understand perceptions of conservation introduction, it is helpful to understand the alternative options available, since peoples' perceptions of a given management strategy may be significantly shaped by what they are comparing it to. A first alternative is what the IUCN describes as a population restoration: the translocation of species *within* the species' indigenous range, where scientists might be better able to predict its success. This category includes reintroductions (for examples, see Soorae 2016). Other alternatives bear less resemblance to CI and vary in degree of human intervention. One of the least interventionist alternatives is to leave species to adapt, if necessary or possible, on their own. If funding is available, habitat protection and management of competitor species may aid species survival (Keane and Parsons, 2010; National Fish, Wildlife and Plants Climate Adaptation Partnership, 2012). Another frequently mentioned alternative to CI is the creation of habitat corridors, which would involve protecting and ensuring the quality of land along a migration pathway such that species can "naturally" migrate to new locations (see Lawler and Olden (2011) for an analysis of this option). Another alternative is the collection and storage of seeds, eggs, or sperm, to preserve species genetic diversity for future use (Williams and Dumroese 2013; Dumroese et al. 2015; Hoegh-Guldberg et al. 2008). A final, more technologically focused alternative is to help species adapt to climate change via genetic manipulation for climate-resilient traits (Dumroese et al. 2015). Given rising interest in the fate of climate-threatened species, new alternatives may also arise; even at present, the above listed alternatives are not exhaustive.

1.1.3 Defining and predicting conservation introduction success

Broadly, CI success entails the establishment of a viable population that persists over time without too much external aid (Olden et al. 2011; Morris et al. 2021). However, measuring the success of CI depends on many factors, including the species, the goal of the project, the life stage evaluated, and the metrics chosen to best represent success at that stage. There are many metrics for success, such as increase in mass (Bouma et al. 2020; Nigh et al. 2004), mortality rates (Benito-Garzon and Fernandez 2015), and biotic interactions (Liu et al. 2012). Some of these metrics are more difficult to measure for longer-lived species because key biological processes such as reproduction do not occur very frequently (Liu et al. 2012; Burbidge et al. 2011; Williams and Dumroese 2013). Beyond species establishment, some scientists have also measured the translocated population's ability to withstand or spring back after extreme weather events, such as a cold spell (Liu et al. 2012; Martin-Alcon et al. 2016). This metric might help predict survival if the species is sensitive to the extreme weather events associated with climate change.

CI success definitions might also include a lack of negative impacts on the recipient community. For example, evidence that the translocated species has not become invasive,

hybridized in unintended ways with other species in the new habitat, caused the extirpation of another species, or, more broadly, disturbed pre-existing food webs (Olden et al. 2011).

Predicting CI success depends on many factors, but two of the most important are the distance and location of the project. The distance from the source population, in terms of latitude, change in elevation, or location relative to sea level, must be short enough that the species can successfully adapt to new conditions, but long enough to ensure survival as new conditions arise over time due to climate change (Fortini et al. 2017; Williams and Dumroese 2013; Leech et al. 2011). The location must be similar enough for the species to find an appropriate niche (Liu et al., 2012; Burbidge et al, 2011). Predictions of the optimal distance and location may depend on the physical distance (Williams and Dumroese, 2013), the species' current or indigenous range and genetic diversity within that range (Williams and Dumroese 2013; Olden et al. 2011; Leech et al. 2011; Benito-Garzon and Fernandez, 2015), whether the relocation occurs in the same geographic region (Williams and Dumroese 2013), or the difference in temperature (Martin-Alcon et al. 2016). However, none of these metrics are completely reliable. Benito-Garzon and Fernandez (2015) found that a shift northward or an increase in elevation, to achieve lower temperatures, may not be the ideal for all species. Furthermore, in the case of longer-distance relocation, predictions of success may hinge on the species' indigenous range, which is a less reliable type of data (Seddon, 2010; Haskins and Keel, 2012).

Given the difficulty associated with predicting CI success, some research suggests the experimental release of species into the recipient community, to study the effects (Sansilvestri et al., 2015; Williams and Dumroese, 2013; Olden et al. 2011; McLane and Aitken 2012). Mozelewski and Scheller (2021) suggest that forecasting, using simulation models, may also help predict the costs and benefits of CI. However, it is important to note that predicting the optimal relocation site for a particular species will remain inherently uncertain, due to uncertainty in climate forecasting and predicting species responses (Hallfors et al., 2016; Lawler and Olden, 2011; Ferrarini et al. 2016).

1.1.4 Arguments for and against conservation introduction

Within the literature, conservation introduction has garnered both qualified support and cautious dissent. Perhaps contributing to this division is a trend noted by Hewitt et al. (2011); namely, that most CI publications, at least up to 2011, were based on literature reviews or commentary, with very few empirical studies. More empirical studies have been conducted since 2011, but perceptions of controversy surrounding this topic may still be shaped by early conceptual arguments. Arguments for and against CI generally focus on benefits and risks to either the focal species or the recipient community. Other arguments address the ethical, legal, and cultural dimensions of conservation introduction.

1.1.4.1 Benefits and risks to focal species and recipient communities

The primary benefit of CI for the focal species is that it increases its chances of survival in the face of climate change and other existential threats. Some species do not have the adaptations necessary to remain in place and adapt to climate change (Kreyling et al. 2011) or have a limited range that will shrink with climate change (Hallfors et al. 2016). While some species can migrate to new habitat on their own, CI can help species with limited dispersal abilities move to a location with a more suitable future climate (Kreyling et al. 2011). Dispersal may be limited for several reasons, including limited mobility, such as plant species with long life cycles (Leech et al. 2011; Nigh et al. 2004); geographic barriers, such as aquatic species living downstream or in discrete bodies of water; and habitat fragmentation (e.g., Fontaine and Larson [2016] and Lopez [2015]).

Risks of CI for the focal species include risks to the original population of the focal species, as well as risks to the translocated population. Sometimes the population of a rare species is not big enough to split between the new and old location while ensuring the survival of both populations (Kreyling et al. 2011). There may also be uncertainty about whether a focal species will survive in its new habitat. Many factors may affect chances of survival, including a stable, less-disturbed ecosystem (Olden et al. 2011; Peterson and Bode 2020), the presence of genetic diversity representative of the source population (Kreyling et al. 2011; Schafer et al. 2020), presence of ecotypes that are already adapted to a climate like the projected climate of the new location (Kreyling et al. 2011), and even the geographic region (Morris et al., 2021).

There are also risks and benefits of CI to the recipient community. Proponents of CI generally either focus on the benefits of ecological replacement or argue that relocating a species may be less risky than some may think (Novak et al. 2021; Mozelewski and Scheller, 2021; Pedlar et al. 2012, Abeli et al. 2014). Taking a step back from the direct risks and benefits, Kreyling et al. (2011) argue that the risk to biodiversity of inaction is arguably higher than the risk posed by conservation introduction. Similarly, Lawler and Olden (2011) argue that climate change will alter ecosystems so much that the introduction of a new species is not worth worrying about.

Risks of CI for the recipient community include invasion potential, disease introduction potential, and extirpation potential. In a review of 63 articles, the potential for the focal species to become invasive was the most frequently mentioned argument against CI (i.e., thirty-five percent of articles; Hewitt et al. 2011). However, proponents of CI argue that it is rare for an introduced species to become invasive (Kreyling et al. 2011; Bellemare et al. 2017; Novak et al. 2021), in part because invasive species have a common set of characteristics that may make it possible to predict their invasion potential (Olden et al. 2011; Burbidge et al. 2011; Pedlar et al. 2012; Schwartz et al. 2012). Nevertheless, the risk of species invasion is still a concern, given that it may be the second biggest driver of species extinction worldwide (Leech et al. 2011; Bellard et al. 2016), has high potential impact (Peterson and Bode 2020) and is generally irreversible (Hewitt et al. 2011). A second risk to the recipient community is the potential of the

focal species to carry new diseases into the recipient community. To our knowledge, this is a problem rarely addressed in a substantive manner in the literature (Simler et al. 2018). Another risk of CI is that the focal species might extirpate species living in the recipient community, such as through genetic hybridization with closely related species (Olden et al. 2011; Burbidge et al. 2011).

1.1.4.2 Ethical, social, and cultural perspectives

The central ethical debate related to CI is the conflict between those who argue for preserving species whenever possible, given their aesthetic, ecological (Kreyling et al. 2011; Olden et. al 2011), and intrinsic value (McDonald-Madden et al. 2011), and those who argue that moving one species could harm other species and ecosystems that are also valuable (Palmer and Larson, 2014; Schwartz et al. 2012). As Palmer and Larson (2014) state, "The most common objection to assisted migration is not that we lack good, value-based reasons to do it … but that we have good, value-based reasons *not* to do it." In particular, no one can be certain about the ecological risks posed by CI (Albrecht et al. 2013; Schwartz et al. 2012; Ahteensuu and Lehvavirta 2014). As such, CI decision-making is a matter of perspective and values (Neff and Carroll, 2016). Beyond this central issue, Albrecht et al. (2013) highlight many other ethical considerations, such as interspecies and sustainability ethics, which may also be taken under consideration. Despite these issues, many argue that careful reasoning may help identify cases in which CI is ecologically and socially acceptable (Seddon 2010; Palmer and Larson, 2014; Aubin et al., 2011, Richardson et al., 2009).

Public perceptions are another component of CI decision-making (e.g., Rivera et al. 2021) and are a growing area of scholarship. Peterson St. Laurent et al. (2018) surveyed Canadian attitudes toward CI and found that respondents preferred strategies that seemed more "natural," or less interventionist, such as preferring movement of species within their current or indigenous range. However, these preferences may be quite malleable (Findlater et al. 2019), perhaps depending on context (Hagerman and Kozak 2021), or trust in natural resource managers (Peterson St. Laurent 2018, 2019). Public judgment may also be altered by climate change. Aubin et al. (2011) argued that climate change may alter the importance placed on saving native species because the value of native species may change amidst transforming ecosystems and the term invasive species should not be applied because it requires a stable ecosystem whose resources the species are disrupting.

In our search there was little research published on cultural considerations for CI. Pelai et al. (2021) argue that CI decision-making is primarily informed by biophysical types of scientific knowledge, disregarding the perspective of indigenous groups and the public, with the result that these perspectives are largely understudied in the CI literature. Rayne et al. (2020) also identify the absence of indigenous perspectives in CI decision-making and present a framework for engagement. Hagerman and Kozak (2021) argue that CI scholarship has yet to fully examine the human dimensions of CI and demonstrate deliberative methods for engaging diverse perspectives.

1.1.7 Governance and legal issues

The laws, policies, and administrative rules that govern CI are variable, depending on location, jurisdiction, and species, among other factors (Schwartz et al. 2012; McLachlan et al. 2007). The Endangered Species Act (ESA) is the main piece of federal legislation governing CI in the United States. The ESA can create difficulties for the relocation of endangered species, due to stringent regulation of protected species (Sansilvestri et al., 2015). As a result, many programs rely on the 'experimental population' status designation (50 CFR 17.81(a)) within the ESA to perform conservation introduction. According to USFWS, this designation, "can apply to a population of a threatened or endangered species prior to reestablishing it in an un-occupied portion of its former range. In rare instances, when a species' former range is no longer suitable (e.g., due to climate change or invasive species), this designation can also be applied when introducing a species outside of its historical range" (USFWS, 2016). CI projects may also have to comply with National Environmental Protection Act (NEPA) requirements. Other federal regulations that may affect CI efforts include Executive Orders 13112 (1999) and 13751 (2016), which regulate invasive species introductions, and Executive Order 11987 (1977), which regulates exotic species introductions (Shelton et al. 2016). As a result of Executive Order 13112, the National Invasive Species Council established a Managed Relocation Task Team, which published a list of recommendations for CI, to reduce the risk of species invasion (ISAC 2017). In the forestry sector, there are also seed transfer regulations, which determine the official movement of seeds from a particular species (Williams and Dumroese 2013; Benito-Garzon and Fernandez, 2015). According to Brichieri-Colombi and Moehrenschlager's (2016) study of North American conservation translocation projects, which includes conservation introduction, most projects were requested, supported, or funded by the government. Thus, the government plays a role not just in regulating conservation introduction, but also in funding it.

1.1.8 Current decision-making frameworks

In 2013, IUCN published a commonly referenced CI decision-making framework entitled "Guidelines for Reintroductions and Other Conservation Translocations," which defines CI (see "What is a conservation introduction?" for a summary of these definitions), and outlines key considerations at every stage of the process, from deciding whether or how to do a conservation introduction, to the key biological, social, regulatory, and resource feasibility considerations when designing a project, to monitoring and sharing results.

In 2021, the National Park Service (NPS) published a report entitled, "Ecological Risk Assessment of Managed Relocation as a Climate Change Adaptation Strategy." The report focuses on evaluating risk associated with conservation introduction, walking through considerations associated with six questions: "1) What is the risk of no action? 2) What is the risk of the action to the target and the source population? 3) What is the risk of the action to species in the recipient ecosystem? 4) What is the risk of the action to higher order attributes of the recipient ecosystem? 5) What are the risks associated with potential invasion of the target to

non-target ecosystems? 6) What are the ecological risks to species and services valued by society?" (p. 10).

There are also many decision-making frameworks published in the literature, such as Karasov-Olson et al.'s (2021) risk assessment framework, which was co-developed among university researchers, agency scientists and resource managers, Richardson et al.'s (2009) evaluation of social and ecological dimensions of CI, and Hoegh-Guldberg et al.'s (2008) decision framework.

2 Methods

This study used qualitative social science methods to describe the perceptions of Service employees in Region 9 and 12. The strengths of qualitative research allow for exploratory studies that do not require a deep pre-existing understanding of the topic being investigated (Kagram et al. 2010). In this study, the objectives are focused on understanding Service employee's perceptions of conservation introduction rather than describing CI itself. Perceptions could vary widely among Service employees and are likely to include minority views at all levels within the Service. This study is qualitative in nature and is not intended to be representative but instead provides the range of perceptions that exists within the Service. Qualitative data collection also allows researchers to flexibly ask how and why participants hold particular perceptions (Kagram et al. 2010). Investigating how and why perceptions are held, even minority perceptions, is important to identify potential areas of disagreement so that they can be addressed directly in the future.

The following subsections describe the study design and data collection methods that were employed for this study. Section 2.1 describes the data collection effort, section 2.2 describes the data analysis, and section 2.3 describes the characteristics of the participants in this study.

2.1 Data collection

The qualitative data were collected using remote, semi-structured interviews that were conversational and elicited information from another person within pre-determined topics. Semi-structured interviews are well-suited to exploratory qualitive research because they allow flexibility to explore unknown topics while following a consistent format between interviews. Semi-structured interviews are also well-suited to a remote interview format (i.e., phone or video) that was necessary to maintain appropriate health and safety practices related to COVID-19.

Thirty interviews were conducted from January 2021 to June 2021 using Microsoft Teams and audio recorded in the same platform. Best practices and ethical standards for human subjects' research were followed, including obtaining explicit consent to participate. All interviews were conducted one-on-one by a single researcher. Interviews were 45-60 minutes in

length. Each participant was asked for permission to record audio but was asked to turn off their video. Permission was granted by all participants.

There were 7 main topics that we addressed throughout the interviews: (1) the characteristics and background of the respondent, (2) preferred definition and terms, (3) personal perceptions and views of conservation introduction, (4) potential risks and tradeoffs associated with conservation introduction, (5) thresholds for success when conducting conservation introduction, (6) implications of ethical and cultural value associated with conservation introduction, and (7) the institutional culture and opinions within the Service around conservation introduction.

2.2 Data analysis

Audio recordings from the semi-structured interviews were transcribed by a professional transcription service. Analysis of qualitative data relies on a rigorous, systematic process called "coding" (Saldaña 2015) where concepts were identified in specific sections of text and a thematic label was added to any respondent quotes that were associated with that concept. The coding process is iterative and hierarchical where broader codes are used initially to segment and label interview themes. The data are then further segmented into more specific themes under these broader labels. In some cases, initially identified themes were divided under a new label that better represented the range of views for that theme or consolidated under a single label. For this study all interviews were coded using Program R and the software package RQDA.

As part of the initial coding process, an *a priori* thematic coding scheme was developed prior to any coding activities using the literature that was used to identify the main topics for the interviews with broad input from the U.S. Geological Survey (USGS) and Service partners (Figure 1). To further segment these broad themes, a preliminary coding activity was conducted by the author team to develop additional emergent codes that were not represented in the *a priori* codes. Three interviews of the 30 collected (i.e., 10% of the dataset) were selected to represent the range of views we identified in the study. These three interviews were independently coded by the author team using the *a priori* codes and any additional emergent codes that were needed to clarify the respondents meaning. Emergent codes are used when the codes identified from the literature do not fully describe the perspectives brought up by respondents as interpreted by the researcher. Following detailed discussion among the team, the suggested emergent codes from each researcher were combined, parsed, and incorporated into the final codebook. The final and agreed upon codebook was then used by a single researcher to code all interviews (Appendix 1).

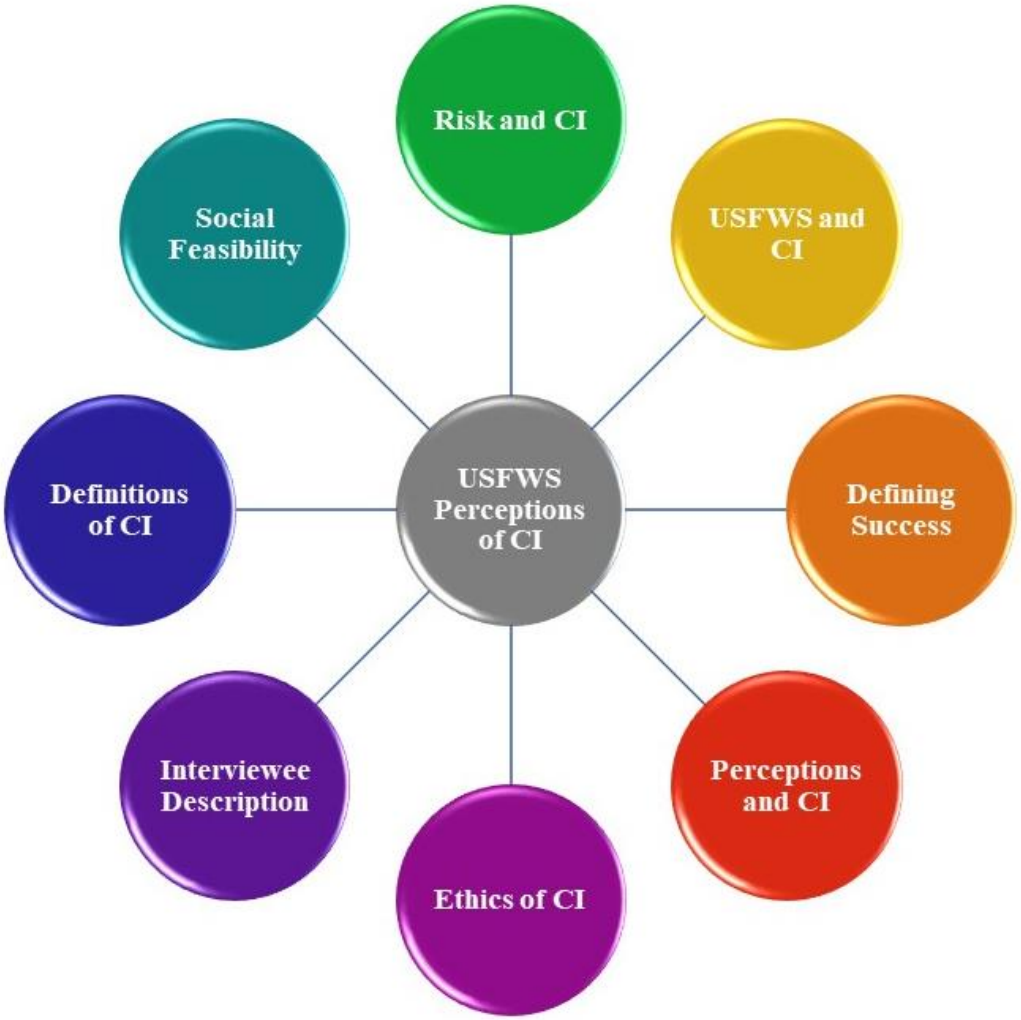

Figure 1. *A priori* thematic codes identified prior to the study and used in the initial analysis of participant interviews. These codes represent overarching themes that describe the perceptions of participants in this study. Detailed descriptions of what each theme represents are provided in Appendix 1. U.S. Fish and Wildlife Service (USFWS); Conservation Introduction (CI).

2.3 Participant characteristics

Most participants included in this study were identified via a convenience sample collected using a voluntary questionnaire that was administered by the Service. Seventy-nine Service employees responded to the pre-screening questionnaire administered by Service partners via email. We used those responses to select and contact 30 individuals following the strata identified as important by partners within the Service including the region participants operated in, the type of position, and the Service program they sit in (Table 1). Seven more potential participants were also contacted to fill in underrepresented strata within the participant group. Of those 37 invitations, we were unable to reach 3 people, 1 refused to participate in the

study, and 3 were not interviewed because saturation of topics had been reached. As such we completed a total of 30 interviews.

Obtaining a representative sample proved challenging with the largest portion of participants coming from the Ecological Services program (Table 1). Fisheries and Refuges were the next most prevalent programs with the rest of the sample being composed of Science Applications, Migratory Birds, Wildlife Conservation, and Cultural Resources. Based on comments from partners in the Service, we still deemed this a representative sample based on the composition of personnel in target regions. For example, all participants from the Fisheries program were based in the Pacific Northwest because very few Fisheries personnel operated in Hawaii and the Pacific Islands.

Among the participants, all but six said that they had previous experience with conservation translocation. The experience ranged across actively capturing and moving species, supervising the planning and execution of a translocation effort, and assisting in the regulatory and permitting requirements. Of the participants who had experience with conservation translocation, 11 said that at least one of the efforts fit the IUCN definitions for conservation introduction. Most participants who suggested they had experience with CI referred to projects that were still in the planning stages and were occurring in Region 12.

Six participants commented on translocation efforts that fell under a reintroduction classification rather than an introduction, specifically referencing species that had been extirpated from an area or believing that they were extirpated from an area based on paleontological evidence. Among these participants there was some confusion around whether something qualified as an introduction.

Table 1. Frequency of participants in the U.S. Fish and Wildlife Service ('Service') across the three strata (Region, Position, Service program) included in the selection process. Region refers to the two Service regions that were included in the study, position refers to the type of position the participant holds within the Service, and Service program is the program the participant operates within according to their Department of Interior profile. Wildlife and Sport Fish Restoration (WSFR).

Participant characteristics	Levels	Frequency
Region	Pacific Northwest (Region 9)	15 (50%)
	Hawaii and Pacific Islands (Region 12)	9 (30%)
	Both	6 (20%)
Position	Direct interaction role	16 (53%)
	Administrative or coordination role	14 (47%)
Service program	Ecological Services	12 (40%)
	Fisheries	5 (17%)
	Refuges	6 (20%)
	Science Applications	3 (10%)
	WSFR - Migratory Birds	2 (07%)
	Wildlife Conservation	1 (03%)
	Cultural Resources	1 (03%)

3 Considerations for developing a decision framework

One of the objectives for this study was to investigate and obtain baseline knowledge needed to develop a decision framework for conservation introduction. Some participants commented specifically on the need for a decision framework and consistent guidance on how and when CI should be used within the Service. For example, a participant in Region 9 stated,

> *" I think that one way to encourage conservation introductions would be to come up with a plan, an action plan, a conservation plan that really would outline steps, phases, project design features, protections, conditions that would be followed for when a project were to occur." (Participant 06, R9)*

Other participants suggested a framework would encourage communication and collaboration between Service programs. A participant in Region 9 agreed, stating that communication of what conservation introduction entails and why it needs to be done across programs will be important.

Over the course of conducting the interviews, a consistent set of themes arose around how and when CI should be used in the Service. Most participants we interviewed were not against the Service conducting CI and felt that it was a necessary tool to preserve at-risk species and ecosystems. When asked how they felt CI was viewed within the Service most participants believed it was viewed positively but offered caveats (Table 2). A minority of participants believed it was viewed as necessary and important or that Service personnel were unaware (Table 2). This breakdown was indicative of how many participants seemed to maintain a cautious and risk adverse view of CI while still recognizing that it may be necessary and effective in certain situations.

Similarly, most participants felt CI was an ethical management practice in most situations (Table 3). Others felt it was only ethical in specific situations and a small minority of participants felt it was unethical in most situations (Table 3). It is important to note that, as a qualitative study, the intention of this study was not to draw conclusions about how CI is viewed within the Service overall or evaluate the degree of acceptance that might exist. That said, there was an overall positive view for CI among the participants we talked to and those participants suggested that they believed CI was not viewed negatively within the Service.

Key finding:

Participants tended to have a positive but cautious view of conservation introduction and often focused on potential uncertainty or risk.

Among participants who maintained a risk-adverse view of CI, they tended to be concerned about the severe consequences of potential mistakes when conducting CI. Although the IUCN guidance and related work address these concerns, when developing a decision framework, it will be important to address these concerns explicitly. In some of these cases, participants made it clear that they believed CI should only be used if other mitigation methods have been tried or there is evidence that they are unlikely to be successful. A participant in Region 9 explained,

"…I'd want to make sure that I exhausted all of the mitigation measures of those threats. Translocation is not necessarily a last resort, but in some cases it is. We want to make sure we're doing everything we can to abate the threat…" (Participant 01, R9)

Some participants believed that the justifiability is case-specific and there should be an evidential requirement to prove that it is appropriate whenever it is being considered. For example, a participant in Region 9 stated,

"Yeah. I would say, as a big picture answer, our assumption should be that we start with the baseline that it's probably inappropriate. Only after we have accumulated a lot of evidence and have a lot of confidence do we even start talking about its appropriateness." (Participant 05, R9)

Further, some participants emphasized that it was imperative for adequate time and effort to be taken to fully describe potential impacts to the source population of the species, the recipient ecosystem and any species that may be affected has occurred. A Region 12 participant stated,

"…I think it would be inappropriate if a thorough evaluation of the impacts, particularly to the receiving ecosystem…if that process isn't thorough enough…" (Participant 20, R12)

Key recommendation:

Explicitly describing the appropriate criteria for assessing a conservation introduction effort will be an important aspect of any decision framework.

The cautious approach we identified among some participants was in direct opposition to others who believed that being too cautious would limit the success of CI projects in the future. A participant in Region 12 pointed out how important moving quickly will be, stating,

"I think there's two sides to it. I think that there are people that are proactive, and the idea is to assist these species and to say, okay, before things get bad, let's be proactive… I err on the side of being proactive and not waiting till the last possible minute…" (Participant 16, R12)

To implement a successful decision framework, it will be imperative to address how CI efforts are being assessed and what actions should be taken to prevent unexpected consequences. These discussions should incorporate strategies laid out in existing frameworks and explicitly state how the Service should use them to limit risk.

Key finding:

Some participants tended to be more risk adverse and suggested stringent planning and data collection necessary prior to conducting an introduction

When participants were asked about changes, they believed needed to happen if CI were to be more widely applied, four participants commented that the Service could not go it

alone and there needed to be more emphasis on public-private partnerships. A participant in Region 12 stated,

> *"I talked about community input. That's one part. Political power and financial is really, really important. We don't have the money to do a lot of these translocations. We don't have, sometimes, the political power, so partnering… Public-private partnerships are important, and there are some policies, I think, in our agency that allow that." (Participant 02, R9)*

Other participants agreed, referencing how important public-private partnerships are to the success of any conservation action. One participant in Region 12 suggested that the partnerships were more important than the introduction or reintroduction efforts themselves to determine success.

Table 2. Frequency of responses by U.S. Fish and Wildlife Service ('Service') participants working in two Service Regions relating to how participants felt conservation introduction was viewed within the Service.

	Region 9	Region 12	Both
Necessary and important	3	1	1
Positively but with caution	6	6	3
Skeptical, too risky	0	0	1
Unaware or considered uncommon	4	0	2

Table 3. Frequency of responses by U.S. Fish and Wildlife Service ('Service') participants working in two Service Regions relating to whether participants felt conservation introduction was an ethical practice for the Service to use.

	Region 9	Region 12	Both
Ethical in most situations	9	3	2
Ethical in certain situations	6	3	4
Unethical in most situations	2	1	0

4 Perceptions of conservation introduction

This section explores the range of perceptions and views that Service personnel expressed about CI as a management technique and implications they perceived around its use within the Service.

4.1 Perceptions of IUCN proposed terms

In this section, we investigate how Service personnel use and interpret the terms for management actions that are associated with translocating species outside their current range for the purpose of conservation. As previously discussed, conservation introduction and its corresponding terms and definitions as proposed in IUCN/SSC (2013) are only a few of the terms that are used to describe these types of translocation efforts. For this study, we drew from the IUCN guidelines and their proposed terminology to ask participants to comment on or suggest alternatives. So that every participant was able to comment from the same minimum baseline of information, an informational paragraph was provided to each respondent that defined the IUCN proposed terms listed under conservation introduction. The paragraph was read during the interview as follows:

> *"The IUCN Conservation Guidelines describes a management action called **Conservation Introduction**, and it describes it as existing in two different forms. The first form is called **Assisted Colonization**, and that is the intentional movement and release of an organism outside its indigenous range to avoid extinction of populations of that focal species. That's one form of conservation introduction. Then, the second form is called **Ecological Replacement**, and that is the intentional movement and release of an organism outside its indigenous range, but to perform a specific ecological function rather than to preserve it and keep it from going extinct. Those two fall under the Conservation Introduction term and are distinct from Conservation Translocation, which is the movement and release of species within their indigenous range; not outside their indigenous range."*

Key finding:

Most participants did not oppose the Service adopting the IUCN guidelines into a decision-support framework associated with conservation introduction or future policy.

Among the participants we interviewed, there was substantial support for adopting the IUCN guidance on terminology and definitions. Most suggested they were already aware of the IUCN guidance and were already incorporating the definitions into their current work. Half of all participants we interviewed stated explicitly that they agreed with the IUCN guidance on terminology for conservation introduction and felt that the Service should adopt those terms and definitions (Table 4). Of the rest of the participants, most were neutral towards the IUCN guidance on terminology.

These participants did not oppose the Service incorporating the guidance but also did not explicitly agree either. In some cases, the participants did not have a specific preference and others referenced issues with ambiguity aspects of the IUCN guidance. Only 2 participants did not believe the definitions were adequate or that the Service should adopt them (Table 4). Most participants either supported, or were neutral, with respect to adopting the ICUN guidelines and terminology within the Service and relying on them to develop a decision-support framework conservation introduction.

Key finding:

Some Service personnel may feel the IUCN guidance is ambiguous in the distinctions drawn between reintroduction and introductions and what evidence is appropriate in determining that distinction.

Despite the lack of opposition to the Service adopting the IUCN guidelines, we identified some areas of ambiguity that could impact how a decision-support framework is interpreted and received. With any decision-support framework, it is imperative to be clear and generalizable to many different situations. Ambiguity in the terms and definitions that underly a framework is especially concerning because it can lead to different interpretations in where and when the framework should be applied, how it should be applied, and who should be using it.

When asked about the IUCN guidance on conservation introduction terms and definitions, a minority of participants suggested that they believed the definitions were too ambiguous. The IUCN/SSC (2013) states that to be considered a conservation introduction, the species must be moved outside their indigenous range and that the indigenous range of a species is the known or inferred distribution generated from historical records or physical evidence of the species' occurrence. Some participants we interviewed suggested that they were confused about what aspects of indigenous range are practical to their purposes within the Service. This view is not isolated to participants in this study, where a preference for using indigenous range over alternate terms (e.g., historical range or native range) is clearly defined but the practicalities of how it should be applied has been questioned (Seddon et al. 2010; Jorgenson D. 2011; Dalrymple and Moehrenschlager 2013).

At the root of this minority view is the perceived practical limitations of indigenous range as it is currently defined. The current definition allows for any historical or physical evidence of a species occurring in an area to include that area in the indigenous range of that species. Of these minority participants, some raised questions about which species occurrence time frames were appropriate for introductions versus reintroductions, what types of evidence should qualify to confirm occurrence, and what distinctions should be drawn between species and sub-species. The definition for indigenous range is broad and leaves substantial leeway to classify a translocation effort as a reintroduction. It seemed that this interpretation was too ambiguous for some participants that we interviewed. This ambiguity could result in opposition of future introduction and reintroduction efforts based strictly on a misinterpretation of the distinctions being drawn.

Key recommendation:

Ambiguity within the distinctions between introductions and reintroductions should be addressed by the decision-support framework to prevent misunderstandings and unnecessary opposition to future projects.

When developing a decision-support framework, it is imperative for all individuals who have a stake in executing the framework to be operating from the same basic assumptions. Given the perceived ambiguity we identified among Service personnel regarding indigenous range and its implications for defining conservation introduction, it will be imperative for any decision-support framework developed by the Service to be clear about how indigenous range is defined and what evidence is appropriate in determining the distinctions between reintroductions and introductions. Doing so will prevent unnecessary disagreement around future translocation efforts because all personnel involved are operating from the same baseline assumptions.

Key finding:

Obtaining funding through traditional sources and for the entire duration of a translocation project was a commonly referenced barrier.

Table 4. Frequency of responses by U.S. Fish and Wildlife Service ('Service') participants working in two Service Regions relating to perceptions of IUCN definitions for conservation introduction.

	Region 9	Region 12	Both
Prefer to use IUCN definitions	9	3	3
Neutral	5	4	3
Prefer alternate terms and definitions	2	0	0

4.2 Perceived barriers associated with conservation introduction

Participants described barriers that covered a wide range of themes related to funding, social acceptance, and support, regulatory or legal barriers, obtaining the appropriate information necessary to alleviate risk and avoid unintended consequences, and biological circumstances. A comprehensive list of the themes and sub-themes related to barriers are provided with descriptions of how each was expressed by participants and a contextual quote that is representative of the theme (Table 5).

Of the participants who discussed funding as a barrier to conducting CI there were three main sub-themes (Table 5). The first was a general awareness that funding is limited and difficult to obtain when seeking to preserve at-risk species or ecosystems. Many of these participants suggested that although funding may be obtained, the magnitude is likely not sufficient to execute conservation introduction effectively. For some, the limited funding barrier connected very closely with ties to social acceptance and support because they felt support and associated financial resources from outside the Service were necessary to offset the limitations of funding available through more traditional means. These barriers also point to limited funding available to managers seeking to conduct a translocation effort, potentially imposing additional difficulty in gaining partnerships to other groups who can assist the Service's effort. An additional theme

that arose was barriers with funding consistency, recognizing that funding may be available, but the time commitments required for translocation projects make planning and executing long-term management actions difficult when funding is only guaranteed in shorter-time increments.

The barriers associated with obtaining the necessary information, were split into two distinct sub-themes (Table 5). These participants all recognized the difficulties inherent in obtaining information to ameliorate risk and avoid unintended ecological consequences they perceived to be associated with conservation introduction. For many of these participants, it seemed that barriers to obtaining the necessary information was rooted in the perception that there is additional uncertainty inherent in introductions and implied that they were more comfortable with reintroductions. Again, the perceived ambiguity in defining indigenous range was referenced, with a minority of participants identifying the importance of obtaining historical or paleontological records for defining translocations as reintroductions rather than introductions. For some there was the perception that the Service may not have the capacity to obtain or interpret information that would define a translocation as a reintroduction rather than an introduction. Historical examples (e.g., zebra mussels, brown trout, and mosquitos) were cited to illustrate their perception that the ramification of species being moved may be impossible to predict.

Regulatory and legal barriers were also regularly cited by participants in the study (Table 5). Regulatory barriers most often referenced the difficulty of operating across political boundaries, especially when it is necessary to move species across them. A participant operating in Region 9 pointed out how difficult it was to obtain the appropriate permits across multiple jurisdictions. We separated legal barriers from regulatory barriers because legal barriers tended to be more associated with statutory compliance, avoiding litigation, or understanding the limitations under related statutory laws. For example, two participants in both regions commented on the lack of clarity on what is required if a species in consideration for CI falls under the Endangered Species Act or related laws. Some participants perceived that the need to avoid litigation was directly connected to other barriers like social acceptance or obtaining prerequisite information. To make this point one participant in Region 9 pointed out the need for well thought-out and clear management plans, stating

> *"Think of a risk and an issue and then create a management plan, so to say, or a plan to be consistent for all projects in the future. That's one way that we work because that helps us avoid litigation. It helps us protect the species." (Participant 06, R9)*

Key finding:

Some participants were concerned with the additional uncertainty associated with conservation introduction including how it is differentiated from reintroductions and what additional information is necessary to reduce the risk of unintended consequences.

The barriers associated with 'social support' (Table 5) were highlighted by 18 of the 30 participants and were by far the most frequently identified barriers These participants distinguished the public, the scientific community, and political

partners. Barriers associated with support from the public often focused on public opinion and how moving species will be perceived by locals interested in either the source population or the recipient ecosystem. A participant operating in both regions commented that they perceived CI to go against the modern importance of native species. They felt an ethical obligation to native species has developed and that it may be difficult to overcome this sentiment among the public or other stakeholders who have internalized that ethic, even in legitimate conservation introduction efforts. Some even perceived that ignoring this could be used as an example of governmental overreach.

Barriers associated with the scientific community were generally based on a perception that CI is controversial and that experts could oppose the Service moving species outside their indigenous range. Similarly, there was a perception that it could be difficult to maintain support from Service partners with similar views. These participants felt that cooperation and logistical support from other species and land managing agencies is necessary for any effort to be successful.

Key recommendation:

Seek input from partnering organizations and stakeholders before or during the development of a decision framework. This could include a follow-up survey or qualitative workshop that seeks input beyond the Service.

Table 5. Participants identified a wide range of perceived barriers that they believed would need to be overcome in any conservation introduction (CI) effort. These perceived barriers were aggregated under a series of themes that represent the general consensus expressed by the participants. A description and representative quote is listed to provide context for each theme.

Theme	Sub-theme	Description	Representative quote
Funding	Funding amount	Difficulty gathering funds to conduct CI that is appropriate to the scale of the problem being addressed	"I guess part of my big question is where do we find the money for these types of things, but I guess it's a separate issue? This is really more about attitudes. I guess money is part of attitudes." (Participant 21, R9)
	Funding consistency	Recognition that funds may be available initially but not long term	"We have to make a commitment for a 10-year project, and we may only know our budget for the next year and a half. These are all the preplanning components that take thought and careful work..." (Participant 03, R9)
	Non-federal partnerships	Ties closely to social support theme and recognizes that support may be required from partners and stakeholders initially and long-term.	"…how do you get your peers. It's not just peers within the agency. It's the agency's peers as well. How do you get the Audubon Society and Sierra Clubs of this world to buy off on some of these things..." (Participant 05, R9)
Information	Prerequisite information	Difficulty obtaining information required to predict likelihood of success, potential risks and undesirable outcomes.	"I think the biggest one is what I just mentioned, just a lack of information. Being able to come up with a full picture of the ecological consequences of something like that. I think that would always be the biggest barrier in my mind to doing something like that." (Participant 29, R9)
	Uncertainty	Unrealistic to trust capacity to understand and predict potential risks and unexpected outcomes is possible	"When you introduce them into that habitat, there's no telling if they're going to react the same way as their normal habitat or if there are factors that you don't understand that may still affect them." (Participant 01, R12)
Logistics	Safe capture and transport	Difficulty of safely capturing and moving species that are already at-risk	"...sometimes technological and logistical considerations. That was a big deal with the millerbird translocation, for sure. Moving a bunch of little insectivorous birds 650 miles by sea and keeping them alive for three days in a boat." (Participant 24, R12)
	Genetic viability	Genetic viability of the focal species and preventing genetic bottleneck effects among the translocated species or the remaining source population	"Is it something that there's actually enough left to make this work? Like, if you have 100 individuals left is there enough genetic diversity there? If you have 50 individuals left is there really enough genetic diversity, there to make it worthwhile?" (Participant 11, R9)
Governance	Regulatory	Obtaining appropriate permits for operating across political boundaries (e.g., International, State, Local, and Private)	"...just getting the permits to do and just ensuring that you've gone through appropriate quarantine before releasing an animal, having quarantine facilities available where you can do that. There's a ton of infrastructure that you need to build up to make these things happen." (Participant 07, Both)
	Legal	Compliance with operating under applicable statutory or judicial law; potential for litigation	"Yeah, because all it takes is—and then given the uncertainties, you're gonna have to make sure that you document very well what you do and have good reasons, and you go through the process very well, so that you can stand litigation." (Participant 05, R9)

Theme	Sub-theme	Description	Representative quote
Social Support	Political support	Obtaining support and partnerships from other agencies and institutions that are necessary for the actions' success	" Again, just based on my experiences with just conservation translocations, establishing a species that had been extricated from a state and just the pushback from neighboring landowners and the political capital that it would take to pass that through… I think there's going to be regulatory hurdles, but there's also, depending on where you're doing it and what the species is, you might have that community barrier as well, community perception barrier." (Participant 14, R12)
	Support of public	Difficulty obtaining support from public that are local to source population and recipient ecosystem	"Another barrier, which is more political, might be the social perception from either the place they're being taken from or the place that they're being brought to." (Participant 21, R9)
	Support of scientific community	Difficult obtaining support from scientific community and peers in natural resource management	"...in our agencies..., you need to look to your peers for support. Cause if you don't get support from your peers, things get really tough, right or wrong. Because sometimes the majority of our peers are not necessarily right, not necessarily fully informed. That's a big challenge, okay." (Participant 05, R9)
	Perceived government overreach	Highly interventional management techniques, like CI, can result in a perception of government overreach or waste of public funds; atypical to what the public is used to.	"...there's nothing that raises people's hackles like conservation introductions, particularly when you start talking about the megafauna… They become the vehicle by which people have concerns about overreach of the federal government..." (Participant 03, R9)
	Economic impacts	Negative economic impacts on locals (e.g., limit of economic opportunity and impacts to previously viable opportunity)	"Local community and private landowner barriers, particularly in most areas where we consider doing these things are in areas where landmasses exist to and resources exist to perpetuate a population of a species which oftentimes lies in direct relationship with public lands or water. Which lies in direct conflict or perceived conflict with tax bases at local and individual scales… (Participant 04, R9)
	Non-native implications	Difficulty obtaining support for CI due to perceived implications for being in opposition of a historical push to emphasis native species in conservation and ecosystem restoration.	"We spend so much of our effort trying to manage non-native species, the perception that you're introducing a non-native to a novel environment purposefully for conservation will, there'll be people who oppose it on the risk factor." ." (Participant 08, Both)

4.3 Risks and tradeoffs for conducting conservation introduction

We analyzed how participants assessed the risks of conservation introduction and which risks they chose to emphasize. When participants were asked to discuss the risks they perceived as associated with conservation introduction, the most common perceived risks were associated with the recipient ecosystems and the potential impacts of moving a species outside its indigenous range could pose to a recipient ecosystem (Table 6). Another set of similarly common perceived risks were acting with too much uncertainty or lacking confidence in the potential outcomes of conducting a conservation introduction. A minority of participants were more concerned about socioeconomic risks and the risks to the source population of the translocated species (Table6). A few participants commented on the risk of waiting too long to attempt conservation introduction and the potential for missed opportunities to save at-risk species and ecosystems.

Key finding:

Many participants in this study were concerned with perceived risks of unexpected and difficult to identify consequences of moving species outside their indigenous range.

Key recommendation:

Provide clear guidance and explanations for how potential conservation introduction efforts are being assessed and potential unintended consequences are being identified.

Among participants who were concerned about risks to the recipient ecosystem, many were concerned with the perceived risk of a translocated species becoming invasive (Table 6). These participants tended to focus on the severity of the consequences of invasion and referred to past examples of conservation-related invasions. These participants were especially concerned with whether rare or unique species existed in the recipient ecosystem. For these participants it seemed important to them that the Service be more risk adverse when rare or unique species, novel habitats, or already at-risk species might be negatively impacted by a CI effort even at the expense of saving an at-risk species or ecosystem. Some participants tied additional perceived risk to certain taxa that might have a higher likelihood to negatively impact the recipient ecosystem (i.e., predators, highly fecund, or highly mobile).

The perceived risk of uncertainty tended to be associated with an aversion to the perceived unknown risks and the Service's ability to accurately identify them. For these participants, there seemed to be a concern that the proper due diligence to identify potential unexpected outcomes would not or could not be completed in the available time. Further, we identified a key overlap between those participants who were concerned about risks to recipient ecosystems and those who were concerned about risks of acting with too much uncertainty or lacking confidence (Table 6). Those who were focused on impacts to recipient ecosystems were often also concerned with outcomes of risks associated with uncertainty or a lack of confidence. Half of participants who

Key finding:

Potential risks to the recipient ecosystem and the perceived lack of knowledge or understanding in identifying potential problems were substantially linked among participants.

commented on perceived risks to recipient ecosystems also commented on the risks associated with uncertainty and lack of confidence.

Other participants who commented on both the perceived risks to recipient ecosystems and the risks of uncertainty and lack of confidence themes seemed to be focused on the issue of being wrong about the potential impacts for moving a species outside its indigenous range and the severe consequences of doing so (Table 6). A participant in Region 9 suggested that establishing refugia in a closed area or zoo was preferable because it is lower risk and serves the same purpose if the objective is to preserve genetic diversity and this sentiment was echoed by a minority of other participants. They felt that limiting movement of translocated species through enclosures or beginning with limited number of individuals would allow unexpected outcomes to be recognized while risk is lower.

Participants who mentioned socioeconomic risks were most concerned about impacts to local communities and landowners that would result in loss of social support that many participants also commented was necessary for success (Table 6). A participant in Region 12 suggested that landowners often respond negatively to conservation efforts that involve threatened or endangered species and if an introduction or reintroduction effort does not go well it can have wide ranging consequences. Two other participants commented on the impacts to public perception and how stakeholders perceiving some management actions as interventionist can negatively impact relationships with stakeholders.

Participants who commented on risks to the source population were consistent in their belief that impacts to source populations are not acceptable and assisted colonization is not an appropriate solution if such risks are likely (Table 6). A participant in Region 9 attributed this risk to waiting too long to conduct an assisted colonization effort. Two other participants also commented on this and were specifically concerned about the genetic diversity in the source population, suggesting any potential CI effort must be sure that the genetic viability of the source population is preserved.

Participants who commented on the perceived risk of no action tended to be focused on at-risk species and were very concerned about potential extinction events (Table 6). These participants commented that ecosystems are already compromised due to large-scale impacts like climate change and some risks are acceptable if it means preventing species going extinct. These participants recognized that due diligence and being confident in expected outcomes are important, but suggested some negative impacts are acceptable and even necessary to preserve at-risk species.

Table 6. List of identified themes related to the perceived risk of conducting conservation introductions within the Service.

Themes	Description	Representative quotes
Risks to recipient ecosystem	Risk of negative impacts to the recipient ecosystem due to impacts from translocated species outside their indigenous range including invasion.	*"… If we know it's going to upset the functioning of that ecosystem just to save this other one, no, we're just doubling down on the chaos that we inflicted that created the problem in the first place. …The implication to your question or the premise of the question is that we could also send that ecosystem into a tailspin and lose other species. Pretty clearly, the answer is no." (Participant 18, Both)*
Risks of uncertainty and lack of confidence	Risk of conducting an introduction with uncertainty or lack of information around potential unintended outcomes	*"Yeah, nature finds a way, you know, and at the organismic level and at the ecological level, their complexity and unpredictability is still so high. The real question to measure is the, what if we're wrong, like create the worst-case scenario and then assess the likelihood of that scenario, potentially being realized. That's what would inform my support or lack of support…" (Participant 08, Both)*
Socioeconomic risks	Risk of negative impacts to communities and other stakeholders that could result in a loss of support	*"I'll throw a quick example of that out there where the wildlife management community did not consider the reintroduction of the grey wolf into <State> as a conservation introduction because they considered it part of their historic range. … The reality being that the social—the lack of social awareness, in my opinion, on that action, that management action, resulted in setting back recovery opportunities for numerous species of fish and wildlife both nationally and locally … for, quite frankly, years if not decades." (Participant 04, R9)*
Risks to source population	Risks of species capture that could result in negative impacts the source population of an at-risk species	*"To me the two risks on that end are making sure that you sort of do your due diligence relative to the donor stock, which at least in the programs that I've been involved with, we have at least tried to…" (Participant 28, R9)*
Risks of no action	Risks of waiting too long or taking no action that could prevent an at-risk species or ecosystem from being saved	*"… We have to take some risks. Maybe there are some downsides, but we have to evaluate. If there are downsides, if there are negative consequences for ecosystems, we have to evaluate those in context. If there are negative consequences, maybe, for other species that are hyperabundant and widespread, let's not worry too much about that…" (Participant 24, R12)*

4.4 Defining success

When asked about the aspects of a successful CI in the short-term and the long-term, participants most chose to interpret the question as translocating species outside their indigenous range to prevent that species from going extinct (i.e., assisted colonization) rather than fill an important ecological niche (i.e., ecological replacement). This species-centric focus carried through most of the interviews, with participants consistently answering from the perspective of preserving at-risk species and preventing extinction, even when the questions were not specific to at-risk species. Therefore, the most prevalent view of success in the short term was characterized by the survival of the translocated individuals throughout the translocation process and their persistence to the point of reproduction. Although this view was most prevalent, there were some who were more focused on the potential consequences of conducting a CI effort. One participant suggested that short-term success should be measured by not doing damage to the source population,

> *"…A lot of times, when we think about moving species, we mine populations that are already depressed. You have to make sure that you, and this is something I learned a long time ago, and I believe in it wholeheartedly, and that is do no harm at the start, out of the gate" (Participant 10, R9)*

Another participant focused more on social factors and suggested,

> *"I would say success in the short term looks like there's no controversy among the human communities affected by this translocation, whether it works or not, that everybody is onboard…we have built consensus, and this is the best thing or the right thing to do under the circumstances." (Participant 18, Both)*

Both participants suggested that views of short-term success should highlight the translocation process itself, in contrast to the majority opinion that focused on establishment of the species to reproduction to prevent extinction.

When asked about long-term success there was some overlap with views on short-term success, but responses were more varied. Again, many participants were focused on the continued persistence of the translocated population and successful reproduction, while others focused on the establishment of breeding grounds, and maintaining an increasing population without imparting negative impacts on the recipient ecosystem. Some participants felt that long-term success should focus on aspects of management. Two participants operating in Region 12 suggested that long-term success was establishing a management plan, staying committed to it, and meeting the stated objectives in the plan. A participant from Region 9 was more concerned with the population no longer requiring continued support from managers stating,

> *"…long-term success would be a population that does not need continued support from humans to persist. A lot of times, when we looked at*

introductions or introducing a population to increase their viability and restore them, I would always push for fixing what caused the population to go away…" (Participant 10, R9)

This suggestion was a slight departure from many other participants who were more accepting of the idea of conservation-reliant species and felt that they had a moral obligation to preserve species or novel ecosystems even if it meant an indefinite management investment.

Participants were asked about hybridization (i.e., the interbreeding of different species that results in a novel offspring) and how that would impact their view of success for a CI project. Some participants were definitive in saying that they felt the effort was a failure if hybridization occurred, but others recognized that there were some situations where hybridization was acceptable. These participants suggested that it should be case-specific and evaluating potential risks for hybridization is a necessary component of any assessments that occurred prior to conducting a CI project. They also felt that any pre-project evaluation should consider how acceptable a hybridization event would be and what actions should be taken if it were to be identified. A small minority of participants felt that hybridization would not change their definition of success if it occurred during an otherwise successful project. These participants reasoned that human actions are regularly inducing hybridization in other contexts. These participants also pointed out that some taxa are much more likely to hybridize (i.e., plants and fish) and it is a normal aspect of species interactions within them so that should be accounted for when considering the success of a CI effort.

5 Conclusions

5.1 Considerations for developing a decision framework

Most participants perceived CI positively but recognized the substantial risks associated with moving species outside their indigenous range. A substantial portion of the participants we interviewed believed that CI is ethical in some or most situations and believed that the Service generally views CI positively, albeit with caution. The risks many participants identified strongly connected with a cautious and risk adverse view of CI. Many commented on the potential negative outcomes that are possible when moving species outside their indigenous range and highlighted the need for stringent planning, assessment, and monitoring prior to and during a CI effort.

Key recommendation:

Ambiguity within the distinctions between introductions and reintroductions should be addressed by the decision framework to prevent misunderstandings and unnecessary opposition to future projects.

5.2 Perceptions of conservation introduction within the Service

Overall, the Service personnel who participated in this study expressed several key themes related to CI that were consistently commented on among participants. Given the prevalence of these findings among the Service personnel in our sample, we identified specific suggestions for topics that will be important to incorporate into a Service decision-support framework.

Key recommendation:

Explicitly describing the appropriate criteria for assessing a conservation introduction effort will be an important aspect of any decision framework.

When participants were asked to comment on the IUCN terms and definitions, few participants expressed specifically negative views. The lack of significant pushback against the IUCN terms and definitions suggests that the Service could easily adopt and incorporate this terminology into a formal decision-support framework. One key caveat to that finding is if the Service does choose to incorporate those terms and definitions, it will be important to clearly define the practical use of indigenous range and the distinction between an introduction and a reintroduction.

Key recommendation:

Seek input from partnering organizations and stakeholders before or during the development of a decision framework. This could include a follow-up survey or qualitative workshop that seeks input beyond the Service.

There was also substantial agreement that social acceptance and support could be a major barrier to the planning and execution of CI efforts, with many participants mentioning it. Participants commented on the challenge of obtaining and maintaining support from communities that are local to the source population where species are being captured but also in the recipient ecosystem to which they are being moved. Participants also commented on the need to obtain support from other fish and wildlife managing agencies and the scientific community. These participants recognized that in most cases, the Service will need to obtain partnerships and

encourage joint actions with other fish and wildlife management entities for any CI effort to be successful. Some participants commented that these partnerships could be especially difficult to obtain because incorporation of non-native species into conservation efforts has been increasingly discouraged among the Service's peer agencies and some may perceive CI as being antithetical to that focus.

Key recommendation:

Provide clear guidance and explanations for how potential conservation introduction efforts are being assessed and how potential unintended consequences are being identified.

There was also substantial agreement among participants when asked about the risks they were most concerned about, with most participants mentioning perceived risks to recipient ecosystems of translocated species. Nearly half of those participants also tied that concern to the uncertainty associated with moving novel species into an ecosystem outside its normal range. It is not surprising that many of the participants we talked to would be concerned about risks to the recipient ecosystems since this echo's criticism in the literature. Participants in this study were cognizant of difficulty in identifying potential unintended consequences with many commenting that obtaining the necessary understanding to reduce risk is necessary; a small minority were skeptical that it could even be done successfully.

When asked about what qualifies as success in the short-term and the long-term, most participants framed the responses within assisted colonization, rather than ecological replacement. In the short-term, most participants focused on the establishment of the translocated species and evidence for reproduction in the new area. For long-term success many participants also commented on the establishment of the species and reproduction but an area of disagreement for some was the acceptance of conservation-reliant species. Although only a minority of participants commented on it, those that did were split in their views, with some suggesting it should be viewed on a case-by-case basis.

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Appendix I: Codebook

Table A.1 Primary codebook used in analysis of semi-structured interviews. International Union for the Conservation of Nature (IUCN); Endangered Species Act (ESA); National Environmental Protection Act (NEPA); U.S. Fish and Wildlife Service (USFWS); conservation introduction (CI).

Code	Subcode	Description
Interviewee Characteristics	Role in Service	Participant description of their professional background and their duties within the Service
	Experience with translocation	Participants experience with translocation efforts and/or CI
Definition of CI	Their definition	Comments on IUCN definition for CI and potential alternatives
	Not outside native range	Comments specific to movement of species outside indigenous range or ranges in general
	Baseline assumptions	Bassline assumptions for CI that the participant believed were relevant
Perceptions of CI	Perceptions, general	General perceptions and views related to CI
	Benefits of CI	Perceptions that refer to specific benefits of CI
	Legal and Policy framework	Perceptions that refer to legal and policy frameworks (e.g., ESA or NEPA) related to CI
	Species vs Ecosystem-centric	Perceptions that set up an explicit contrast between preserving a species or an ecosystem / habitat
	Endangered species-related	Perceptions of CI that are specifically related to endangered species
	Climate change and CI	Perceptions of how CI relates to Climate change
	Barriers	Perceptions of barriers to conducting CI
	Prerequisites and criteria	Perceptions or views on specific prerequisites or criteria that should be met for conducting CI
	Caveats	Caveats or qualifiers related to specific perceptions of CI
Risk and CI	Risk, general	General perceived risks of conducting CI
	Risk of no action	Risks associated with taking no action or waiting too long to conduct CI
	Risk to source population	Risks to the source population of species being translocated
	Risk to recipient ecosystem	Risks to the recipient ecosystem where species are being translocated
	Socioeconomic risks	Social or economic risks that would result from conducting CI
	Tradeoffs	Comparisons of tradeoffs between risks
	Uncertainty and Confidence	Risks associated with uncertainty and confidence in predicted outcomes of CI
	High profile species	Risks associated with high profile species
Social feasibility		General perceptions or views that relate to the social feasibility of conducting CI
Defining Success	Success, general	General perceptions of markers for success when conducting CI
	Hybridization	Implications of hybridization on success when conducting CI
	Short-term	Views on the markers for short-term success
	Long-term	Views on the markers for long-term success

Code	Subcode	Description
Ethics of CI	Ethics, general	General perceptions of the ethics and morals associated with conducting CI
	Obligations/stewardship	Comments on the obligations for preservation or stewardship of species or ecosystems related to CI
USFWS and CI	Internal Barriers	Barriers to conducting CI specific to operating within the Service
	USFWS Culture and CI	General perceptions of Service culture that relate to CI
	Suggestions for change	Specific suggestions for change within the Service related to conducting CI
	Things working well	Suggestions for things that should not change within the Service related to CI
	Unaware/uncommon	Perceptions of CI being uncommon or of Service personnel being unaware of it