12-6-2017

Managed Relocation: Reducing the Risk of Biological Invasion

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FINAL · APPROVED DECEMBER 6, 2017

INTRODUCTION

Managed relocation is the intentional relocation of populations of native wildlife to habitats that they do not now live in as a hedge against hypothetical changes in their current ranges. This proposed scheme has been proposed as one tactic to perhaps minimize the risk of extinctions of species owing to changing climate (cf. Aitken and Bemmels 2016; Fordham et al. 2012; Gallagher et al. 2015; Loss et al. 2011; Vitt et al. 2009).[1] This contrasts with the relocation of wildlife to locations whose habitat has been degraded or destroyed (Miller et al. 2012; Seddon et al. 2014a; Seddon et al. 2014b). Although intended to advance conservation goals, there are substantive concerns about the ethical foundation, social acceptability, ecological wisdom, and practical capacity of engaging in management relocation (Maier and Simberloff 2016; Ricciardi and Simberloff 2009a; Schwartz et al. 2012). The feasibility concerns are largely governed by limits on ecological knowledge and legal and funding constraints. Thus, although increasingly popular in concept, managed relocation will not be practical as a broadly exercised extinction mitigation strategy (Maier and Simberloff 2016).

A key concern about the managed relocation scheme is the risk of ecological damage that might be caused by the translocation of species to novel ecosystems (Maier and Simberloff 2016; Ricciardi and Simberloff 2009b). Intentional introductions of non-native species have often resulted in unexpected and adverse outcomes (Mack et al. 2000), potentially amounting to billions of dollars in damages and other losses (Pimentel et al. 2001). These impacts may become readily evident, subtly accumulate over time, or emerge suddenly following a long, apparently benign lag time (Simberloff 2009). The current understanding of ecological systems has provided weak evidence for gauging the risk of translocated organisms to the recipient ecosystems (Ricciardi and Simberloff 2009a).

Invasive species are defined by the United States government to mean "with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health."[2] Any organism that is relocated to a novel ecosystem is thereby non-native, has the potential to become an invasive species, and/or spread "hitching" invasive species (e.g., pathogens, parasites, or propagative material).

Regardless of the how often the introduction of non-native species cause ecological harm, the degree of harm suggests that introducing them poses sufficient ecological risk to the integrity of natural systems that local, national, and international governing bodies need to establish policies that constrain species introductions (Lodge et al. 2006). However, there is not now any cohesive policy at any level of governance to guide the conditions under which managed relocation might be acceptable or what might be the consequences of interested parties engaging in unsanctioned managed relocation efforts (Klenk and Larson 2015; Kostyack et al. 2011; Schwartz et al. 2012; Shirey and Lamberti 2010).

Recognizing the risks posed by invasive species to national security, federal assets, and the well-being of the American public, Section 4(d) of Executive Order (E.O.) 13112[3] called for the National Invasive Species Council (NISC) to:

Develop, in consultation with the Council on Environmental Quality (CEQ), guidance to Federal agencies pursuant to the National Environmental Quality Act (NEPA) on prevention and control of invasive species, including the procurement, use, and maintenance of native species as they affect invasive species.

The *2016-2018 NISC Management Plan*[4] thus called for the following actions:

Action 4.1: In keeping with NEPA requirements, develop a general introductory document and associated annexes that provide

1 The scientific literature generally refers to intentional translocation of species outside a species' historic range for the purpose of conservation as managed relocation (Richardson et al. 2009), assisted migration (McLachlan et al. 2007), or assisted colonization (Hoegh-Guldberg et al. 2008). For consistency, "managed relocation" is used throughout this paper.

2 https://www.doi.gov/invasivespecies/management-plan-and-executive-order

3 https://www.doi.gov/invasivespecies/management-plan-and-executive-order

4 https://www.doi.gov/invasivespecies/management-plan-and-executive-order

effective guidance for the prevention, eradication, and control of invasive species, as well as the restoration of impacted habitats. Each annex will provide guidance on a specific aspect of the invasive species issue. The first annexes are to be developed within the scope of this NISC Management Plan, but annexes may be included as needed dictate and resources permit. The initial annexes include:

Action 4.1.1: Use of native seed/plants in habitat restoration; Action 4.1.2: Movement of watercraft among water bodies; and Action 4.1.3: Reducing the risk of biological invasion via managed relocation

In order to further Action 4.1.3, a Managed Relocation Task Team was established under the auspices of ISAC.[5] This paper reflects the work of that task team, including internal group discussions, expert consultations, and literature review. The Task Team considered two parallel bodies of science to inform the analysis: a) the species translocation literature (Schwartz and Martin 2013; Seddon 2010), particularly as it relates to changing climates[6] and b) a parallel, more empirically rich and much larger[7] literature on the harmful consequences of invasive species on ecosystems (Mack et al. 2000) and on prediction and management of the risks of invasion (Hulme 2009; Kolar and Lodge 2002; Simberloff 2009; Thuiller et al. 2005). See Annex I for examples of managed relocation scenarios, Annex II for a list of referenced literature, and additional citations for further reading.

The task team offers the following key finding and recommendation to strengthen federal capacities to reduce the risk of biological invasion being facilitated through managed relocation practices.

KEY FINDING

Any organism that is relocated to a novel ecosystem has the potential to become an invasive species or spread "hitching" invasive species, or both. Managed Relocation is not congruent with Executive Order 13112 to the extent that it might facilitate "economic or environmental harm or harm to human, animal, or plant health." Consequently, the actions by federal agencies or those entities supported by federal funding to engage in managed relocation need to be addressed in a manner consistent with E.O. 13751 Section 3 (3), which compels Agencies to:

Refrain from authorizing, funding, or implementing actions that are likely to cause or promote the introduction, establishment, or spread and invasive species in the United States, unless pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with these actions.

RECOMMENDATION

Develop a clear national policy for managed relocation consistent with agency duties as set forth in E.O. 13751. This may be best accomplished through a Presidential Memorandum or CEQ-published NEPA guidance document that is further supported by agency-specific guidance.[8,9]

The actions taken in response to this recommendation should be standardized and streamlined among all federal agencies even though perhaps challenging at department and agency levels. Proposals for managed relocation are likely to vary substantially in goals, locations, species, relevant authorities, agency jurisdictions, and available management resources. Public resource managers might propose actions that range from translocating genotypes across portions of species ranges (e.g., tree seed zones) to transferring suites of species in an effort to migrate ecosystems. Similarly, the rationale for such actions may range from reducing extinction risk among endangered species to altering forest composition for timber production or adjusting the composition of zooxanthellae to increase resilience of coral to bleaching.

Good governance requires that the evidence presented by the proponent of managed relocation is evaluated by a qualified, neutral third-party. Therefore, any evaluation and approval actions made in accordance with national or agency-specific policies, or both, should be conducted through an external review process.

At a minimum, the national policy and any supporting policies should:

A. *Limit the use* of managed relocation to extra-ordinary circumstances;

5 ISAC Members: Edward E. Clark, Jr. (Wildlife Center of Virginia), Dan Simberloff (University of Tennessee), Mark Schwartz (University of California – Davis), Brent Stewart (Hubbs-SeaWorld Research Institute), and John Peter Thompson (Maryland Nursery and Landscape Association). The NISC Secretariat and task team members are grateful to the National Park Service for enabling the participation of technical experts on the ISAC Managed Relocation Task Team.

6 An ISI Web of Science search on the terms "assisted migration" or "assisted colonization" or "managed relocation" on 28 April 2017 returned 539 peer reviewed journal articles, 444 since 2010.

7 An ISI Web of Science search on the terms "invasion" or "invasive" or non-native" and "threat" and "species" or "ecosystem" or "biodiversity" conducted on 28 April 2017 returned 3,496 papers, 2,358 since 2010.

8 It is particularly important that the U.S. Fish and Wildlife Service develop explicit guidelines for when and how species listed under the Endangered Species Act or Migratory Bird Treaty Act may be the focus of managed relocation. Since migratory birds are not typically range-limited, the national guidelines should preclude them for managed relocation.

9 Although this paper is necessarily focused on federal policy, coordination with state, territory, and tribal governments is strongly encouraged. In the context of native species management, non-federal agencies frequently have authorities that exceed those of the federal government.

B. *Delineate conditions* that constitute legitimate exceptions to E.O. 13571 (e.g., imminent extinction of a keystone species), recognizing that the national need may supersede the caution imposed by the executive order;[10]

C. Develop a clear and consistent *definition of actions* and *definition of reasonable expected benefit* that, among other things, address the need for enacting this extreme management measure;

D. Require a *standardized risk assessment* that evaluates the potential:[11]
   1. degradation of recipient ecosystems caused by the introduced species ;
   2. losses of other native species or diminishment of valued ecosystem services;
   3. degradation of adjoining ecosystems caused by the introduced species expanding its distribution resulting in losses of other native species or diminishment of valued ecosystem services;
   4. degradation of the recipient ecosystem caused by associated pests or pathogens accidentally moved with the deliberately introduced species, resulting in unwanted disease or damage to resident native species;
   5. risk that moving individuals of a species further degrades the potential of that species to persist within its historic distribution; and
   6. risk that moving individuals of non-local genotypes drives undesirable evolutionary trajectories through mixing with local genotypes;

E. Require a *monitoring and safeguard plan* that establishes protocols that evaluates each of the six risk factors (above) in addition to the success or failure of the action on the target species. The safeguard component should address containment, or elimination of the translocated species in the event that the prescribed monitoring demonstrated that risk factors were larger than originally estimated and that ecosystem damage exceeds the benefits gained through the translocation. The critical nature of this policy component means that funding must be established and dedicated to support post-release monitoring and enacting safeguard measures. The temporal delimitation for enacting monitoring and safeguarding practices should be context-specific and articulated clearly in the plan; and

F. Identify measures to be taken if the guidelines are violated.

10 It is clear from this literature that there are several opinions among biologists regarding the need, the criteria by which to judge a project supportable, and the likely consequences of engaging in managed relocation (Javeline et al. 2015).

11 There are models for managing risks associated with introducing species to novel ecosystems. These risk management strategies mostly deal with decisions to release biocontrol agents. This literature provides a foundation to guide decisions where compelling need suggests managed relocation despite the risk (see Annex II for relevant literature).

ANNEX I

Scenarios

Meeting Public Land Management Objectives

Public agencies and their partners might engage in managed relocation to meet various public land management objectives. Fish introductions into fishless montane lakes were sponsored by many state fish and game agencies during the 20th century (Casal 2006). From a federal perspective, the practice has been endorsed, or at least tolerated, throughout the National Park System to the extent that numerous parks now contain non-native trout in formerly fishless lakes. The ecological cost of these introductions has been high (Eilers et al. 2007), and those same agencies are now spending limited conservation resources removing non-native fish from lakes to restore their former fishless nature (Hoffman et al. 2004) and protect amphibians and reptiles from fish-transmitted diseases (Hoffman et al. 2004). Despite lessons learned regarding the harm caused by introducing fish into fishless lakes, bull trout were moved into a fishless lake, for the purpose of bull trout conservation, by Glacier National Parks as recently as 2015 (Galloway et al. 2016).

Private Landowner Effects on Public Lands

Private land managers have the capacity to affect public lands by introducing non-native species to their property with little or no ecological justification. These species may spread onto federal lands creating a potential need for land managers to either declare the species an invasive species or of conservation value. The Torreya Guardians began a program to actively spread *Torreya taxifolia* more than a decade ago (http://www.torreyaguardians.org). The group began with an effort to expand this species' range from northern Florida and southern Georgia over 600 km northward to North Carolina. The group has continued the spread of *T. taxifolia* as far north as Michigan and New Hampshire and west to Oregon with apparently no effort for ecological justification. In all cases the group has endorsed private plantings of this federally listed endangered tree species on private lands in a manner that is ecologically unjustified and risky, though they have not violated any rules or guidelines adopted by any governing body.

Advancing Commercial Interests

Natural resource-based industries (especially horticulture, forestry, and aquaculture/commercial fisheries) are engaging in mass relocation of species for economic gains (Benito-Garzon et al. 2013; Dumroese et al. 2015; Fady et al. 2016; Fontaine and Larson 2016; Klenk and Larson 2015; Pedlar et al. 2011; Pedlar et al. 2012; Williams and Dumroese 2013; Winder et al. 2011). When biological invasion results from these translocations, the economic benefits to a relative few may result in substantial, long-term costs to the public. Federal partnership with private land managers are needed to help minimize the risk of managed relocation activities by private sector groups on neighboring public lands and, more broadly, the well-being of Americans.

ANNEX II

Citations and Further Reading

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