Broadening the concept of success in animal and plant translocations

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Abstract

Translocations are commonly used to conserve or manage organisms. Generally, the success of such translocations is based exclusively on the establishment of viable populations of organisms. Yet, translocations are conducted for diverse reasons including conservation, economics, scientific advancement, and to restore ecosystem function and ecosystem services. Conservation-based translocations may not require long-term viable populations; moreover, all translocations have inherit effects on source and release communities and populations. A definition of success that only considers population viability may be restrictive of the diverse reasons for conducting translocations or of the novel ways that conservation can be achieved through translocations (e.g., ecosystem functions). We suggest that the definition of success for translocations be broadened to accommodate diverse goals that include, but are not solely restricted to establishing viable populations. Success should be predicted on *a priori* goals that are designed to achieve specific outcomes or to reduce risks including those to release ecosystems. Implementing a broader definition of success allows projects to judge success and failure on multiple project goals and to conceptualize success as a continuum rather than a simple binary outcome. Further, encouraging a broader definition of success that accommodates different perspectives, and for different types of goals, encourages those designing translocations to think seriously about both positive and negative outcomes that are potentially unrelated to the focal population(s). We discuss an example for considering success and failure through the reintroduction of fishers (*Pekania pennanti*) released in northern California.

Keywords: augmentation, ecological restoration, ecosystem services, establishment, introduction, population success, project success, reintroduction, source population

Highlights

- Translocations are considered successful if they result in viable populations.
- Translocations are important and valuable beyond achieving population viability.
- Including the negative attributes of translocations allows a broad evaluation.
- Conservation through translocations may not require viable populations.
- Broadening the definition of success of translocations is warranted and important.

1. Introduction

The concept and practice of translocating organisms have advanced significantly in recent decades (Armstrong and Seddon 2008; Griffith et al. 1989; IUCN/SSC 2013; Seddon et al. 2007a). Motivations for translocating animals include conservation of single species, restoration of ecological function, and preservation of ecosystem services (Hodder and Bullock 1997; Irvine et al. 1964; Seddon et al. 2012). Experience and research have offered new insights and methodologies for successfully establishing viable populations via translocation (Armstrong and Seddon 2008; Fischer and Lindenmayer 2000; Griffith et al. 1989). Translocation success, however, remains narrowly defined and one-dimensional. .

Translocations are the intentional or unintentional movements of organisms from one location to another Translocations are subdivided into three types: *Reintroductions* are the movements of organisms into places they historically occurred but are presently extinct, *Introductions* are movements of organisms to places where they are not known to ever have existed, and *Augmentations* are movements of organisms into places with known populations of conspecifics (IUCN/SSC 2013; Seddon et al. 2012). Historically, translocations in the context of conservation were undertaken for the conservation of single species (CITE).Awareness about ecological function and ecosystem services have provided new motivations to move organisms in scientifically interesting and important ways (Armstrong and Seddon 2008; Donlan 2005; Harris et al. 2006; McAlpine et al. 2016; Svenning et al. 2015; van Andel and Aronson 2012). Contemporary translocations are planned for varied reasons that include ecosystem rehabilitation, ecosystem services, conservation, and even human aesthetics (e.g., Hodder and Bullock 1997; Irvine et al. 1964; Seddon et al. 2012). Removing organisms for release elsewhere has the potential to alter ecosystems and, therefore, is included in the design and evaluation of translocations (Berger et al. 2008; Green et al. 2018; McLoughlin et al. 2003; Pérez et al. 2012; van Wieren 2006).

Translocation research has greatly improved our understanding of how to move organisms and establish viable populations (Armstrong and Seddon 2008; Fischer and Lindenmayer 2000; Griffith et al. 1989). The number of founding individuals, habitat quality, and timing of release have been found to influence the outcomes of translocations (Armstrong and Seddon 2008; Facka et al. 2016; Powell et al. 2012; Seddon et al. 2014). . Similarly, diseases, random catastrophes, and demographic stochasticity can affect outcomes of translocations (Hodder and Bullock 1997; Miller et al. 1999; Sarrazin and Barbault 1996).

The success of translocations, however, is based, almost universally, on a definition presented by Griffith et al. (1998) that "*A translocation is a success if it results in a self-sustaining population*". Nearly all translocation projects and analyses since have adopted this defining principle for planning and evaluation (Anderson et al. 2014; Guerrant Jr and Kaye 2007; Powell et al. 2012; Sarrazin and Barbault 1996; Seddon et al. 2007b). Individual translocation programs often do not define success explicitly because of this convention (Pavlik 1996). Indeed, the International Union for Conservation of Nature guidelines for translocations and nearly all published reports that discuss success refer to this definition either explicitly or implicitly (IUCN/SSC 2013).

Several authors have recognized that success of a translocation depends on the stated goals of a project (Guerrant Jr and Kaye 2007; Hayward et al. 2007; Kleiman 1989; Pavlik 1996). A definition that emphasizes the viability of populations is pertinent when the main goal of a translocation is to ensure long-term persistence of a population, metapopulation, or a species (Figure 1). Perhaps because the goals of most projects ostensibly are related only to viability of populations, the stated or unstated goals, seem consistently to pertain to viable, self-sustaining populations. Continued scrutiny of biological processes that affect establishment and persistence of populations remains a critical aspect of planning and implementing future translocations (Armstrong and Seddon 2008; Seddon et al. 2007b; Seddon et al. 2014). Nevertheless, the definition of Griffith et al. may be restrictive when translocations are undertaken for reasons that may not rely on creating self-sustaining populations, such as moving animals to test a specific method or hypothesis (Facka 2016; Phillips et al. 2003). A definition that focuses solely on the population-related outcome of a translocation ignores effects to the source ecosystems, which are scientifically interesting and pertinent to population and ecosystem management, (Armstrong and Seddon 2008; Green et al. 2018; Packer et al. 2013; Phillips et al. 2003; van Wieren 2006). Researchers, managers and agencies should not be encumbered by a singular definition of success that is predicated only on viable populations and should be able to consider translocations successful under a variety of criteria (Figure 1). Though, collectively, we may think of success in biological terms; ultimately, human societal values and desires, are, effectively the main determination for all successful translocations (Pavlik 1996; Pérez et al. 2012).

Here we discuss the success of translocation projects in terms of both goals that are specific to establishing self-sufficient populations and goals that do not require a self-sufficient population. We highlight these goals through an example from a reintroduction of fishers (*Pekania pennanti*) in northern California. Others researchers have noted that success can be defined in different ways based on different specific goals and taxa (e.g., plants; Guerrant Jr and Kaye 2007; Hayward et al. 2007; Pavlik 1996), but often alternative goals are simply means to achieving a viable population. We posit a more a general treatment is useful and needed.

We propose that translocation goals can be divided logically into a minimum of two categories: (1) *Population Success* pertains to establishing and sustaining a viable population and (2) *Non-Population Success* pertains to a goal or goals that do not require the creation of a viable population. Collectively, achieving stated *Population* and *Non-Population Success* goals would determine the cumulative success of a project (hereafter *Project Success*; e.g., Pavlick 1996; Figure 1). Thus, if the only goal of a project is to have a self-sustaining population, the *Project* success reduces to *Population* success (Figure 1- Project A). *Population* or *Non-Population* goals (or both) can be divided into multiple sub-goals. Identifying multiple goals expressly acknowledges that a project meets some degree of success if some subgoals are met (Figure 1 – Projects D and E).

2. **Are definitions important?**

The definition espoused by Griffith et al., and by others, appears to have been motivated primarily by a need to quantify successful and unsuccessful translocation for analyses that could identify and improve future translocations (Fischer and Lindenmayer 2000; Griffith et al. 1989; Sarrazin and Barbault 1996; Wolf et al. 1996). So long as *Population* success strictly equates to *Project* success, this definition poses no issues. The reintroductions of prominent North American animals such as bison (reviewed in Kleiman 1989), black-footed ferret (*Mustela nigripes*; CITE), red wolves (*Canis rufus*; CITE), and California condors (*Gymnogyps californianus*; CITE) had few goals beyond creating viable populations; thus, a definition focused on population objectives was appropriate and valuable (Miller et al. 1994; Phillips et al. 2003; Toone and Wallace 1994). If, however, translocations are designed to accomplish goals other than, or in addition to, establishing a new population, they could be falsely identified as completely successful if a new population is created but other goals are not met, or conversely, a failure if no population was established but other goals were met. For example, a global analyses of fisher and marten translocations (*Martes* spp.) identified success based on the determination of the agencies or researchers that conducted the translocations (Powell et al. 2012). Generally, those definitions of success were roughly equivalent to Griffith et al., but for some augmentations in the Union of Soviet Socialists Republics success was based on improvement of fur quality of native sable (*Martes zebellina*) populations (Powell et al. 2012). Powell et al. accounted for these differences within their analyses but this example illustrates that goals set out for different projects can be equally successful, but "success" represents different biological processes.

Translocations are often closely scrutinized for their ability to meet goals associated with establishing a population and their cost effectiveness (Kleiman 1989; Packer et al. 2013; Pérez et al. 2012). Yet, well designed and well executed translocations may be useful and important investments of money and time even if they fail to establish a persistent population (Facka 2016; Guerrant Jr and Kaye 2007; Pavlik 1996). Translocation failures may promote conservation by identifying important threats and causes of population failure. For example, Short et al. (1992) demonstrated that the presence of exotic predators caused the population failures of 6 reintroductions of wallabies (macropods). These data in combination with the results from other reintroductions demonstrated that islands without predators had a high proportion of population successes. Identification of the causal mechanisms that limited reintroductions provided information useful to future translocations as well as other restorations.

Translocations that are concerned primarily with restoring a population of a single species have effectively become a sub-branch of biology (e.g., Armstrong and Seddon 2008; Seddon et al. 2007a). Many subfields of ecology and conservation including ecological restoration, invasive species biology, and pest control have relevant literature and results that should be incorporated in these varied, but related, branches of science (Lipsey and Child 2007; McAlpine et al. 2016; Polak and Saltz 2011). Even among researchers that do reintroductions, divisions apparently exist within the literature because some are focused exclusively on plants (Guerrant Jr 2012) or animals (Seddon et al. 2007a) but few that study the interactions between translocated or restored plants and animals (McAlpine et al. 2016). Plant and animal translocations have fundamental principles tied to population biology, as do other fields of study mentioned. Important differences in the life histories of plants and animals do exist that require specialization of knowledge and approaches and, therefore, are less useful to researchers from other specialties. Nonetheless, these differences can be overcome by common concepts and definitions of translocation success. Thus, a definition that is shared and understood among diverse research fields is important, but a definition exclusive to viable populations may lack the flexibility to be valuable across different fields of study or with diverse goals.

Defining success in a broad and comprehensive framework may increase the rigor and thoroughness of translocation design. The definition of success used on a particular project affects the ideas of appropriate or important goals held by stakeholders. Labeling success only from a population perspective may give some researchers or managers a reasonable excuse to think that population processes are the only aspects of a translocation that are important. A broad concept of success necessitates the incorporation, or at least the consideration, of diverse goals and positive and negative outcomes into translocations. A broadening of success, and the goals that determine success, can facilitate researchers and managers to think critically about core functions of translocations, benefits and potential effects (Figure 2). Thus, we posit that a broad definition of success that accommodates a wide range of goals and successwill XXXXXXXXXX.

Beyond a population-specific view of success

Van Andel and Aronson (2012) argued that restoration of ecological processes and ecological services should be integrated into as many translocation projects as possible (van Andel and Aronson 2012). If definitions of success do not accommodate, or promote, ecological restoration, planners that are focused on establishing a viable population may not consider potential ecosystem benefits of a translocation project (Figure 2). For example introducing native predators can lead to control of native herbivores (Earle and Kramm 1982; Powell 1981; Powell 1993). Translocations of ecological surrogates may restore communities and increase their overall function (Donlan 2005; Svenning et al. 2015). Such translocations also increase biodiversity (Hodder and Bullock 1997) and ecosystem services should be considered a central goal contributing to project success. Some biologists have even advocated using translocations as actions that create communities proactively in the face of new or accelerated threats (e.g., climate change; Aitken and Whitlock 2013; Seddon 2010; Seddon et al. 2014). For such translocations, population success is more complex than for standard translocations and understanding and accounting for this complexity belongs in the goals of projects (Polak and Saltz 2011). The reintroduction of a predator may alter the local community in ways that humans perceive as beneficial such as the trophic cascade in Yellowstone National Park (Berger et al. 2008; Beschta et al. 2018; Beschta and Ripple 2009; Ripple and Beschta 2012); however, the complex interactions of new predators with new communities often is negative (Chipman et al. 2008; Jones et al. 1997; Letnic et al. 2009; Roemer et al. 2009).

Many translocations are motivated entirely or in part by economics (Hayward et al. 2007; Spear and Chown 2009). Thousands of translocations occur for human recreation, including stocking fish and game for sport-fishing and hunting (Chipman et al. 2008; Hodder and Bullock 1997; Thorne and Williams 1988). Animals are often translocated to mediate the impacts of urbanization or development (Germano et al. 2015) or to alleviate human-animal conflicts caused by predation or destruction of human property (Fritts et al. 1984; Miller and Ballard 1982; Stüwe et al. 1998; Walsh and Whitehead 1993). In these instances, the central goal of moving animals is to alleviate problems without killing animals directly. Such economically motivated translocations may be more common than conservation-based projects and their goals may be emphasized in spite of the usual emphasis of the Griffith et al. definition (Germano et at. 2015). Less information on biological processes or ecological services, or damage, may be associated with these types of translocations without consideration for their specific goals.

In some circumstances, translocated populations may exist only when humans intervene for an extended time. Such interventions may include supplemental feeding, predator removals or continuous augmentation with new individuals (Chauvenet et al. 2012; Oro et al. 2008). These populations will become self-sufficient or go extinct without human intervention. Translocations that result in non-viable populations and that go extinct may offer important temporary conservation benefit that was an expected outcome of the translocation. For example, colonies of black-tailed and Gunnison's prairie dogs (*Cynomys ludovicianus* and *gunnisoni*) that were reintroduced to the southwestern United States were predominantly not self-sustaining (Davidson et al. 2014; Facka et al. 2010). Prairie dog populations could be maintained with augmentations that could benefit the ecosystem even if they ultimately went extinct. The presence of prairie dogs, through their burrowing and herbivory, had positive effects on burrowing owls (*Athene cunicularia*) and soil invertebrates (Duval and Whitford 2009; Duval and Whitford 2012). Additionally, the burrows provided an important resource if future reintroductions where attempted after the mechanisms that limited prairie dogs were overcome. In such instances, non-viable populations may be important to consider partially successful in terms of their non-population goals.

Some translocations have important conservation benefits but their success emerges via the elimination of populations. Certain methods of genetic pest control (e.g., Sterile Male Technique) use translocated, genetically modified organisms that express characteristics that reduce or eliminate populations of pest species (Figure 2) (Klassen and Curtis 2005; Knipling 1955). Recently, these methods have been developed as conservation measures for the purpose of eliminating or reducing invasive organisms or disease vectors from localized areas (Gould 2008).. Currently, these types of translocations are not considered within our concept of successful translocations because their goal is not conservation of the organisms being translocated. Reconsidering success of these translocations based on diverse goals allows assessment of these projects within the context of the specific population biology associated with translocation as well their contribution to conservation or restoration.

Conservation-based translocations that move individuals may re-establish local populations but still be insufficient to improve the overall (range-wide?) status of imperiled organisms. Such translocations can be evaluated in the context of their immediate outcomes at the individual population as well as their effectiveness toward improving conservation. Yet, if the definition and conception of success *a priori* is focused only on individual reintroductions, there may be less motivation to consider the big picture contribution of individual projects. Slotow and Hunter (2009) concluded that dozens of successful reintroductions in South Africa made little impact on the conservation status of African lions (*Panthera leo*) because they had not re-established a viable metapopulation. In this specific case, consideration for success at both the population and metapopulation level may help to guide conservation in an expedient way. Meeting multiple goals may demand more integrated and collaborative planning of conservation actions beyond single independent translocation efforts.

3. Incorporating negative impacts into success

Even if re-establishing a population is the only goal for a translocation, researchers, managers, and the general public may wish to incorporate effects of the new organisms on the release environment and the effects of removing organisms from source populations and communities. Reintroduced flora or fauna may be ill-adapted to, or cause severe perturbations at, their release locations (Figure 2) (Caro 2007, Caro et al. 2012). Consequently, "reintroduction" of a species to a portion of its range where it has long been absent may be functionally equivalent to an introduction (Osborne and Seddon 2012; Thorpe and Stanley 2011). In these instances, a translocation that yields a viable population may have unintended consequences that are not the designed or desired outcomes. Comprehensive success is only achieved if the population persists and adds value to the ecosystem to which it is introduced. If a translocation hinders current species or services, then the project should not be fully considered a success.

An overlooked aspect of assessing success in translocating organisms is the impact that a translocation has on source populations or source communities (Armstrong and Seddon 2008; Swiers 2013). Source populations are often chosen to provide genetic diversity within the new population (Jamieson 2011; Weeks et al. 2011). Yet, rarely are negative effects of removing many individuals, or the timing of those removals, on the source population incorporated or reported relative to *Project* success (Armstrong and Seddon 2008). We know of only one study that has actively monitored a source population, of fishers, and documented little impact to population numbers during or after removing animals (Green et al. 2017). Creating a new population at the cost of damaging an established, naturally-occurring population is counterproductive. Monitoring and reducing impacts on source populations could often be one of the stated goals for translocations and incorporated into the evaluation of *Project* success.

Translocating diseased, parasitized, or immuno-compromised organisms may lead to reduced vigor of a new population (Cabezas et al. 2011; Sainsbury and Vaughn-Higgins 2012; Sepúlveda et al. 2014). Additionally, unintentional translocations of diseases and parasites to areas where they are novel can decimate local populations and ecosystems (Ewen et al. 2012; Gaughan 2001; Kock et al. 2010). Translocation efforts that damage the local community should be considered unsuccessful, or only partially successful, even when translocated populations are established. Few translocation efforts appear to monitor diseases actively after organisms are released (Kock et al. 2010).

Released organisms can be either novel food for extant consumers or are themselves novel consumers with which novel foods have no experience (Biggins et al. 2011; Frair et al. 2007). Often translocated organisms are both the consumers of some local organisms and the food of another. Released animals may be prey for native predators (Figure 2) (Anson and Dickman 2013; Cabezas and Moreno 2007; Moseby et al. 2011; Shier and Owings 2006). Conversely, prey at a release site may be naïve and highly susceptible to novel, though native, predators. Predators and prey may alter their behaviors in response to the translocated animals, leading to cascades through the community (Gittleman and Gompper 2001). Even over short timeframes, these interactions can reduce the resiliency of that ecosystem to recover in the long-term (Lundberg et al. 2000).

Disease and predation are only two examples of community effects that influence *Project Success* for translocations. Mladenoff et al. (1997) argued that species-specific management must be placed in the context of ecosystem health and function. Long-term ecosystem effects are part of the total success of a translocation. Minimally, the benefits of a translocation on the recipient community should offset any damage done

4. Recommendations

A broad view of success for an intentional movement of organisms promotes diverse goals, motivations, and approaches to restoration and conservation (Guerrant Jr and Kaye 2007; Thorpe and Stanley 2011). We recommend that intentional translocations be designed and evaluated based on diverse goals that include population viability, ecosystem function, and scientific advancement that is identified *a priori* (also see Pavlik 1996). We also recommend that translocation projects formally incorporate monitoring and report negative outcomes that relate to overall *Project Success*. Monitoring known possible effects should be incorporated into translocation plans and, if possible, be capable of noting unanticipated outcomes. Ideally, conservation translocations should not commence until the factors that led to their necessity are ameliorated (IUCN/SSC 2013; Morrison 2012; Stoskopf 2012). Thus, all projects should evaluate conditions before translocating any organisms, making identification of changes in communities post release not an onerous task.

Armstrong and Seddon (2008) suggested that translocated populations exist in two distinct phases: establishment and persistence (also see; David et al. 2013). This distinction increases the precision of defining population success. The establishment phase comes during and soon after the release of individuals. In this phase the incipient population is small and reliant on the founding individuals. Hence, we suggest that the establishment phase concludes when normal population processes (e.g., breeding and recruitment) are ongoing and independent of augmentation from further releases. In the persistence phase, populations of sufficient size experience smaller effects from environmental or demographic stochasticity (Armstrong and Seddon 2008). Nevertheless, if populations are relatively small or live in poor habitat they may still be prone to extinction. We recommend that projects identify important milestones for the persistence phase rather than specific, nebulous, and generally arbitrary end dates. Identification of these milestones, *a priori,* is crucial for projects and populations, though they may be revisited throughout the life of the project (Morrison 2009).

5. An example of a broader concept of success: Fisher reintroduction for science

Fishers XXXXXXXX. In the mid-2000s, Sierra Pacific Industries, a company that owned and managed >2 million acres in California for timber production, proposed a reintroduction of fishers onto one of five of their properties in the southern Cascade mountains and the northern Sierra Nevada (Callas and Figura 2008). Most forests where fishers live in the western portion of their range are also valuable private and public timberlands with intensive logging (Haynes 2003; Morgan et al. 2012; Shaw et al. 2011). Yet, the functional relationships between fisher populations and logging were unknown but important, for both future management and regulatory decisions (USDI 2014; USDI Fish and Wildlife Service 2004). We reasoned that using robust scientific theory and methodology, a reintroduction project could provide answers about fishers and their habitat requirements in the presence of logging. We estimated that the benefit of a better understanding these complex relationships was greater than the cost of the reintroduced population failing to establish. Thus, after a feasibility assessment was made to choose an appropriate reintroduction site, fishers were translocated to the Stirling Management Area, owned and managed for commercial timber production by Sierra Pacific Industries (Fig 3; Callas and Figura 2008).

The population, if it became established, would expand the range of fishers (Fig. 3). If, however, the population did not become established, we would be in a position to understand the reasons for that failure and make recommendations for fisher habitat management and reintroduction efforts in other parts of California and in western North America (Lofroth et al. 2010). We outlined 3 primary goals for our project on which to evaluate success: 1) Understanding fisher habitat use and persistence on an industrial timberland, 2) understanding the effects of removing fishers from source locations and monitoring one source population to assess the effect of removal, and 3) establishing a viable population of fishers (Table 1). Were the new population not viable, and we learned why it failed, we would still consider the project successful because the knowledge learned could profoundly influence management of fishers elsewhere (Table 1). Alternatively, if fishers persisted and expanded their new population beyond the Stirling Management Area, but our research failed to elucidate the reasons for their persistence, then the project could not be considered a full success (Callas and Figura 2008).

6. Conclusions

Thinking about success of translocations only through the lens of establishing viable populations fails to include translocations that are undertaken for other diverse purposes. Broadening the concept of success in translocations does not diminish the importance of establishing viable populations or for understanding the mechanisms that lead to viable populations. Rather, a broad definition for translocation success incorporates diverse goals that consider both positive and negative outcomes of moving organisms. Some translocations may be easily defined as successful or unsuccessful based on 1 or few goals but others may be more aptly viewed as a continuum where each goals is weighted equally and contributes to comprehensive success and, thus, modest levels of success are possible. A broad definition of success is a strong motivator for researchers and managers that undertake translocation projects to develop their goals fully and to reflect on the true purpose of their proposed actions. If those planning a project determine that it's only goal is to have a viable population, perhaps they should reconsider other important aspects of their design that include scientific inquiry, effects to source and release ecosystems or to their own human communities.

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Table 1. Goals and sub-goals and their importance to project success in reintroducing fishers to the northern Sierra Nevada and southern Cascade mountains of California. Meeting all goals would signify success to the project whereas only reintroducing a viable population or monitoring a source location would represent failure or partial success.

Major Goals	Sub-Goals	Importance to Project Success†
Understand fisher habitat use on industrial timberland	a. Estimates of survival & reproduction	High
	b. Predicted use of habitat by fishers	High
	c. Predicted placement, sizes, and shapes of home ranges using models of optimal home range choice	Moderate
	d. Predicted patterns of breeding by males from home range placement and familiarity with landscapes	High
	e. Descriptions of natal dens, maternal dens, and rest sites.	Moderate
	f. Causes of fisher mortality and monitor health	High
	g. Use the results of items 1-6 above to provide the foundation for understanding the results of the reintroduction.	High - Ultimate Goal
Reduce and understand impacts to one source location prior to, during, and after removal of fishers	h. Translocation of fishers from diverse locations (reduce the effect to any one location)	Moderate
	i. Annual population estimates from one source location using non-invasive techniques from 2006 to 2017	
	j.	Moderate
	k. Removal of 10 adult fishers in 2009 and 2010	High
	l.	High

Reintroduce a viable population of fishers in northern California	m. Release 40 fishers (24F: 16M) over three years (2009 – 2012)	High
	n. Preferentially translocate adults to increase likelihood of reproduction in first years	High
	o. Translocate from multiple locations in northern California (genetic diversity)	High

† Different cooperators to the project could potentially ranked the importance of these goals modestly differently.

Figure 1. Five hypothetical projects with diverse numbers and types of goals related to establishing viable populations (Population-goals) or to goals unrelated to population viability (Non-Population goals). Project success is met by achieving goals that pertain to either or both types of goals and their relative priority to the specific project. **NOTE: The idea was the bar on the right would be a measure of success for those projects, but in looking at it in at the last minute I'm not sure that comes though. Improving that is important before submitting.**

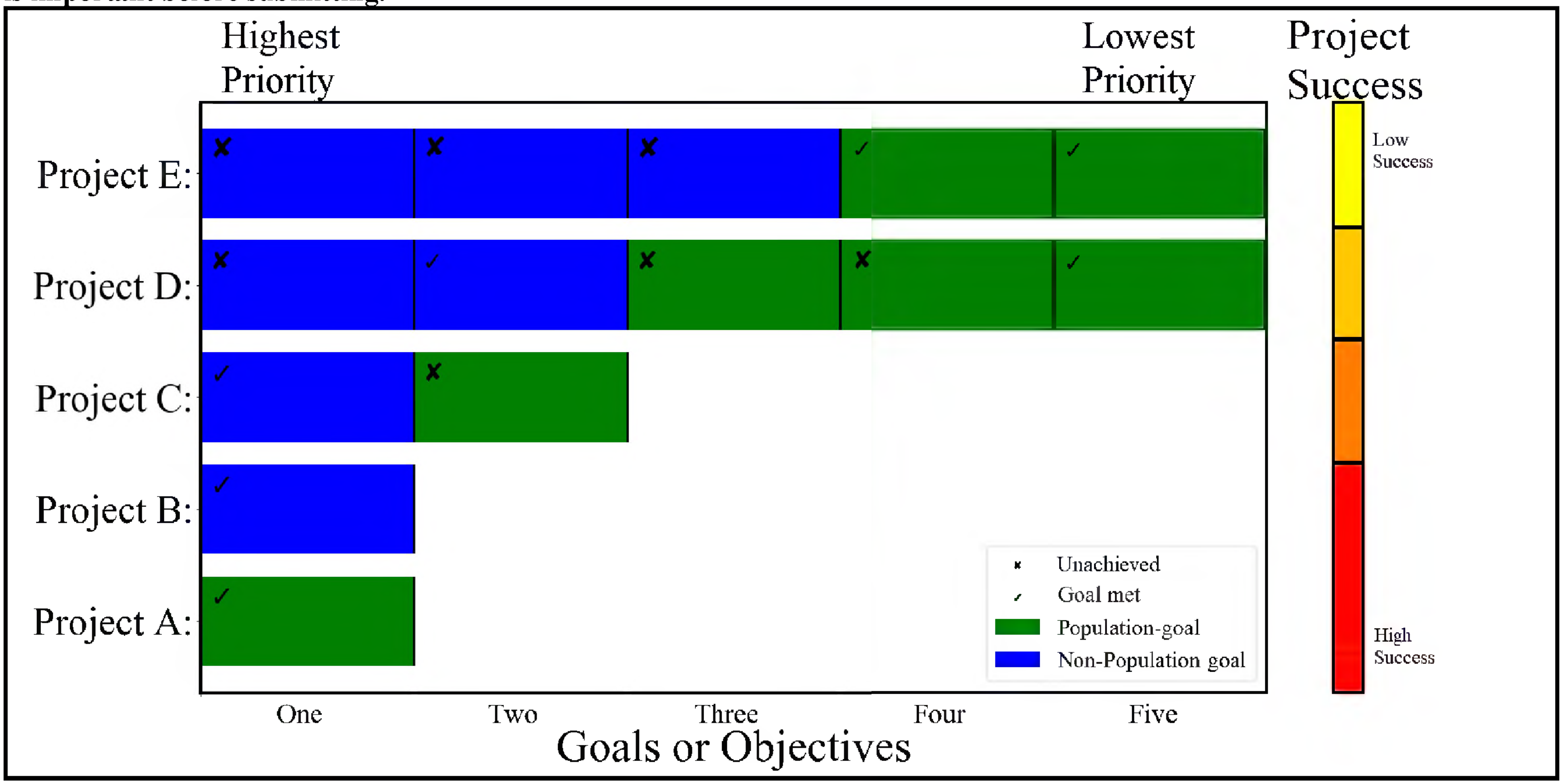

Figure 2. Hypothetical scenarios depicting the outcomes of translocations and their potential for being considered successful or unsuccessful based on criteria associated with changes in population size after the release of organisms. A. Conventional depiction of success and failure in translocations where long-term population stability or increase is related to success (solid lines) whereas long-term decline or extinction is related to failure (dashed lines; each scenario in panel A is shown in a different context in subsequent panels) B. Apparent success of a translocation (solid lines) but with long-term negative consequences to native population or species at the release or source locations, C. Long-term increase in population size of a translocated population but with the accidental introduction of a disease or parasite to the release location D. Long-term decline and likely extinction of a translocated population but with positive effects on a nuisance or pest species E. The extinction of a translocated population that has been genetically altered to simultaneously reduce or eliminate a disease or introduced species or population and F. Extinction of a translocated predator that negatively affects a native or introduced herbivore while present with cascading effects to native plant species while the predator is present.

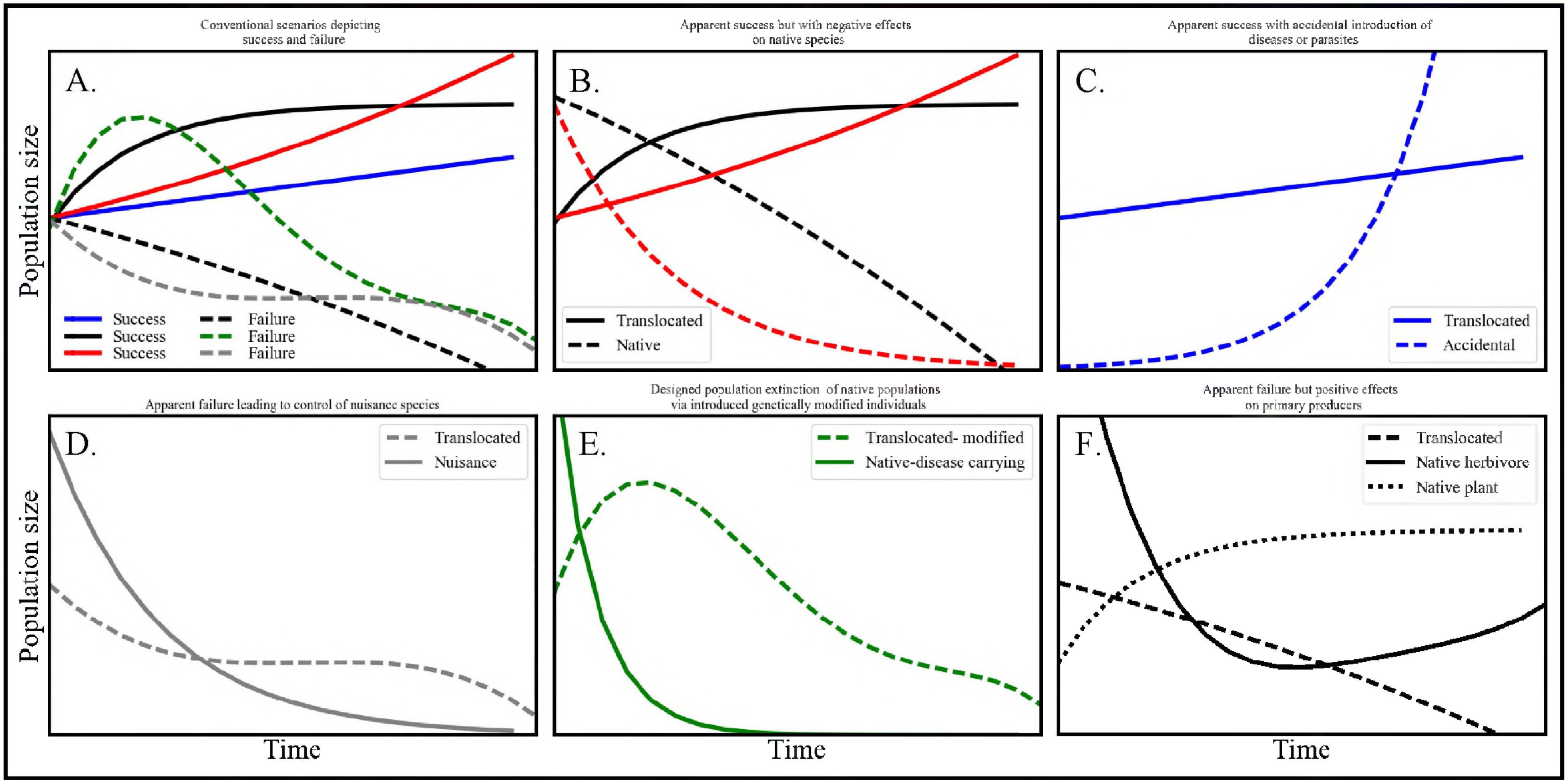
Conventional scenarios depicting success and failure
A.
Success
Success
Success
Failure
Failure
Failure
Apparent success but with negative effects on native species
B.
Translocated
Native
Apparent success with accidental introduction of diseases or parasites
C.
Translocated
Accidental
Apparent failure leading to control of nuisance species
D.
Translocated
Nuisance
Designed population extinction of native populations via introduced genetically modified individuals
E.
Translocated- modified
Native-disease carrying
Apparent failure but positive effects on primary producers
F.
Translocated
Native herbivore
Native plant
Population size
Population size
Time
Time
Time

Figure 3. Historical and current range of fishers, release location (Stirling) and source area (dashed circle) for reintroduction of 40 fishers in northern California from 2009 to 2012.