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REINTRODUCTION OF HISTORICALLY EXTIRPATED TAXA ON THE CALIFORNIA CHANNEL ISLANDS

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ABSTRACT.—Most invasive alien vertebrate populations on the Channel Islands of California have been eradicated over the past 30 years. Unfortunately, removal of these introduced herbivores or predators came too late for some native flora and fauna, and numerous populations are now extinct. Here, we describe a systematic approach to reintroducing extirpated native taxa as a means for rebuilding natural communities and enhancing the resiliency of island ecosystems. Reintroduction efforts typically focus on a single species or site. In contrast, we propose that if reintroduction is a shared conservation goal of managers across the islands, the associated planning, implementation, and monitoring should be conducted as a cross-island initiative for the archipelago. A coordinated effort based on best practices in reintroduction biology could accrue programmatic efficiencies and economies of scale, more quickly advance ecosystem and species conservation goals, and create unique opportunities to test hypotheses in basic and applied ecology and evolution. The philosophical and technical approaches developed through this program may apply to other island and mainland systems and could be adapted to develop conservation strategies for species that may be candidates for assisted colonization in the face of climate change.

RESUMEN.—La mayoría de las poblaciones invasoras de vertebrados no nativas en las Islas del Canal de California han sido erradicadas durante los últimos 30 años. Desafortunadamente, la eliminación de estos herbívoros o depredadores exóticos llegó demasiado tarde para algunas especies de fauna y flora nativa, y numerosas poblaciones están ahora extintas. Describimos un enfoque sistemático para reintroducir taxa autóctonos eliminados como un medio de reconstruir las comunidades naturales y mejorar la resistencia de los ecosistemas de las islas. Los esfuerzos de reintroducción típicamente se centran en una sola especie o lugar. Por el contrario, nosotros proponemos que si la reintroducción es un objetivo de conservación compartido por los administradores de recursos en todas las islas, la planificación asociada, la implementación y el monitoreo deben ser conducidos como una iniciativa entre islas del archipiélago. Un esfuerzo coordinado, basado en mejores prácticas de biología de reintroducción, podría conjuntar eficiencia del programa y economías de escala, hacer que los objetivos de conservación de los ecosistemas avancen más rápidamente y crear oportunidades únicas de comprobar hipótesis sobre ecología y evolución básica y aplicada. Los enfoques filosóficos y técnicos desarrollados a través de este programa podrían aplicarse a otros sistemas de islas y de continentes, y podrían ser adaptados para desarrollar estrategias de conservación para aquellas especies que pudieran ser candidatas para la colonización asistida en caso de cambio climático.

Advances in the eradication of invasive vertebrates from islands have improved our ability to conserve insular biodiversity (Veitch and Clout 2002, Veitch et al. 2011). Eradication, however, generally represents only the initial phase of an island restoration program. After eradication, managers must decide what desired state they will manage toward over the long term (Hobbs and Norton 1996, Hayward 2009). For example, managers might assess the desirability, feasibility, and priority of reconstituting the full complement of native species that was present on the island prior to the introduction of invasive vertebrates. Reintroducing locally extinct populations on islands free of harmful invasive species can be an important management strategy for restoring island ecosystems and conserving native species (Ewen et al. 2012).

The Channel Islands of California have been the focus of much ecological restoration effort, including invasive species eradication (McEachern et al. in press). The Channel Islands are a loose archipelago of 8 islands that range in size from 260 ha (Santa Barbara Island) to 250 km^2 (Santa Cruz Island) and from 20 km (Anacapa Island) to 120 km (San Nicolas Island) in distance to the mainland.

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Ownership is mostly federal (U.S. Department of Defense, U.S. National Park Service) and nonprofit conservation organizations (The Nature Conservancy [TNC], Catalina Island Conservancy). Although the terrestrial and marine environments of the islands have been affected by human activities for millennia, the 19th and 20th centuries—generally categorized as the "ranching era"—had an especially profound ecological impact (Rick et al. 2014). Introduced herbivores and predators degraded island habitats and imperiled many plant and animal species. Populations of a variety of taxa disappeared (PWC unpublished data), including numerous passerine birds (Table 1). Island managers across the archipelago have implemented numerous projects aimed at eradicating ecologically harmful introduced species (McEachern et al. in press). These efforts over the past 3 decades have contributed to the recovery of some native vegetation communities (e.g., Beltran et al. 2014) and imperiled animal populations (e.g., Whitworth et al. 2005, Coonan et al. 2010, Sillett et al. 2012). Some invasive animal species (e.g., Randall et al. 2011, McEachern et al. in press) and numerous invasive plant species (e.g., Corry and McEachern 2009, Cory and Knapp 2014) remain; but all of the islands are now managed for protection of natural resources, and their ecological trajectories are generally more toward resilience than degradation (Rick et al. 2014). For some Channel Islands species, however, the current "conservation management era" came too late.

Here, we discuss reintroducing taxa that were historically extirpated from the Channel Islands. We review potential benefits of reintroduction, as well as some of the risks managers need to address in planning. Further, we suggest that if reintroduction is indeed a conservation goal across the archipelago, planning, implementing, and monitoring the translocations as a coordinated cross-island research and management initiative, rather than as a series of discrete single-species projects, could reduce overall cost, accelerate ecosystem restoration, and improve learning outcomes. We use passerine birds as a model, but the principles we present could apply across taxa. Although the focus here is on reintroduction, we also discuss an instance where the extinct population is considered an extinct form, and so an ecological surrogate taxon would need to be identified (Parker et al. 2010). Developing experience not only in the science and practice but also in the philosophy and policy of conservation translocations may become increasingly important because, with climate change, managers will face decisions about assisting the colonization of species outside of their indigenous range to facilitate adaptation (Seddon 2010, IUCN/SSC 2013).

WHY REINTRODUCE EXTINCT POPULATIONS?

Reintroducing populations on the California Islands would be elective and therefore warrants articulating reasons for reintroduction to help prioritize it as a management action. Below, we discuss potential reasons to reintroduce extirpated taxa, which include considerations of ecological function, species viability and adaptation, as well as ethical considerations, such as a desire to undo perceived damage caused by humans. Potential reasons *not* to reintroduce populations include opportunity costs of diverting limited conservation resources from other conservation management priorities, and risks (e.g., of the translocation causing harm to the relocated species or to other species on the destination island). Such risks should be addressed in planning, which we discuss in the subsequent section.

Societal Values and Precedent

A general management goal for many of the islands is a return to conditions that existed prior to the ranching era. This goal stems from an awareness that relatively recent human activities resulted in the loss of diversity on the islands and that restoration of historical conditions may still be feasible. Indeed, undoing the damage of human impacts to the archipelago was an implicit rationale for some of the reintroduction programs already implemented on the Channel Islands: these were actions intended to contribute to recovery of species that at the time were listed as endangered by the U.S. federal government. Bald Eagles (*Haliaeetus leucocephalus*) were extirpated from the archipelago in the early 1960s due to pesticide contamination in the food web; a reintroduction program was initiated on Santa Catalina Island in 1980 (Garcelon 1988) and on Santa Cruz Island in 2002 (Dooley et al. 2005). The Peregrine Falcon (*Falco peregrinus*), also extirpated due to

TABLE 1. Extirpated passerine bird populations on the California Channel Islands. Listed are purported endemic forms of birds that likely have experienced recent population-level extinction. X indicates presence; M, a mainland subspecies; E, an extinct island population; and E? indicates that historic or prehistoric specimens suggest the possible prior occurrence of a breeding population. For species with multiple purported subspecies on the islands, if one population is extinct, we list all the members of that species. Table compiled by PWC based on review of literature, historical records, and museum collections; sources available on request.

	Island								
Species	San Miguel	Santa Rosa	Santa Cruz	Anacapa	Santa Barbara	San Nicolas	Santa Catalina	San Clemente	Status[a]
Island Scrub-Jay (*Aphelocoma insularis*)	E?	E?	X						USFWS : BCC
Island Loggerhead Shrike (*Lanius ludovicianus anthonyi*)	E	X	X	E	E?		X		CDFG : SSC
San Clemente Loggerhead Shrike (*Lanius ludovicianus mearnsi*)								X	CDFG : SSC; USFWS : FE
Island Horned Lark (*Eremophila alpestris insularis*)	X	X	X	E	X	X	X	X	None
Catalina Bewick's Wren (*Thryomanes bewickii catalinae*)							X		None
San Clemente Bewick's Wren (*Thryomanes bewickii leucophrys*)								E	CDFG : SSC
Santa Cruz Island Bewick's Wren (*Thryomanes bewickii nesophilus*)		X	X	X					None
San Clemente Spotted Towhee (*Pipilo maculatus clementae*)	E	X	M				X	E	CDFG : SSC; USFWS : BCC
Santa Cruz Rufous-crowned Sparrow (*Aimophila ruficeps obscura*)			X	X			E?		CDFG : SSC
San Clemente Island Song Sparrow (*Melospiza melodia clementae*)		X	X	X				E	None
Santa Barbara Island Song Sparrow (*Melospiza melodia graminea*)					E				USFWS : FE (delisted, extinct)
San Miguel Island Song Sparrow (*Melospiza melodia micronyx*)	X								None
San Clemente House Finch (*Carpodacus mexicanus clementis*)	M	M	M	M	E	X	X	X	None

[a]CDFG : SSC = Species of Special Concern (CDFG 2011); USFWS : FE = Federally Listed Endangered; BCC = Birds of Conservation Concern (CDFG 2011, USFWS 2008).

pesticide contamination, was reintroduced to multiple islands beginning in 1983 (Latta 2012). Similarly, 2 other island bird taxa listed as State of California Bird Species of Conservation Concern have been recommended for reintroduction once habitat has been sufficiently restored (Collins 2008a, 2008b).

Ecosystem Function and Services

Reintroduction of extirpated species can restore important ecological processes and functions (e.g., Gibbs et al. 2008). For example, one rationale for reintroducing Bald Eagles to the northern Channel Islands was that they might, through agonistic interactions, deter Golden Eagles (*Aquila chrysaetos*), which were not resident on the islands prior to the ranching era, from continuing to settle on the islands. Golden Eagle predation drove island fox (*Urocyon littoralis*) populations on San Miguel, Santa Rosa, and Santa Cruz Islands to near extinction (Coonan et al. 2010). Island Scrub-Jays (*Aphelocoma insularis*), currently restricted to Santa Cruz Island, provide another example of an important ecological role that could be restored by translocation. Jays inhabited Santa Rosa Island at least in prehistoric time and may have been extirpated as recently as the late 1800s, due in part to vegetation destruction by sheep (*Ovis aries;* Collins 2009). *Aphelocoma* jays cache and bury seeds and are important to long-distance dispersal of oaks (*Quercus* spp.) and pines (*Pinus* spp.) (Grinnell 1936). The extent of oak, chaparral, and pine woodland on Santa Rosa Island was greatly reduced during the ranching era. These woodland habitats remain limited, and their recovery is expected to be slow in the absence of a long-distance seed disperser. Reintroducing Island Scrub-Jays to Santa Rosa would return a key ecological process—long-distance seed dispersal—to the island, accelerate recovery of oak and pine ecosystems, and decrease erosion (Morrison et al. 2011). Although the ecological roles of the Bald Eagle and Island Scrub-Jay are better understood than those of other extirpated bird taxa (Table 1), we can assume that all the missing populations affected their ecosystems. Reestablishing these absent ecological relationships should be a management focus on the California Islands (see Post and Palkovacs 2009).

Decreased Risk of Extinction

Reintroduction can increase species viability through the creation of additional distributed populations. For example, the southern sea otter (*Enhydra lutris nereis*), a keystone predator and a federally threatened taxon, was reintroduced to waters off San Nicolas Island in 1987, in part to reduce extinction risk should the subspecies' main population along the central coast of California experience a catastrophic event like an oil spill (Benz 1996). Reintroduction may also enhance viability in the context of climate change if reintroduction facilitates adaptation of the species and contributes to the resiliency of an island's ecosystem. Future viability of the Island Scrub-Jay on Santa Cruz Island, for example, could be jeopardized by epidemic disease, habitat loss, and climate change (Morrison et al. 2011). Santa Rosa and Santa Cruz Islands are in different marine ecoregions (Spalding et al. 2007) and might experience climate change differently. Establishing a second population of *A. insularis* on Santa Rosa Island could therefore reduce extinction risk because it would increase the species' geographic range, population structure, and resilience to future shifts in climate. Reintroducing jays to Santa Rosa Island would also hasten the recovery of oak and pine ecosystems.

APPLICATIONS OF REINTRODUCTION SCIENCE

An extensive literature provides theoretical and practical guidance on how to plan and implement a reintroduction project (e.g., Sutherland et al. 2010, Ewen et al. 2012, IUCN/SSC 2013). That guidance describes best practices in structured decision making, harvest, husbandry, transport, release, disease management, and so on. Here, we highlight some aspects of the planning that may be of particular concern to managers on the California Islands, such as the identification and management of risks and uncertainties. For example, many islands that would provide the source population or be the target of a translocation are generally at the early stages of vegetation succession, with more weed species and less tree and shrub cover than before the ranching era. Indeed, some ecosystems might well be considered "novel" (Ewel et al. 2013). Consequently, some species present on the archipelago in the 19th century may not be able to persist now or could have adverse, community-level effects.

Planning processes should assess whether degraded habitat has sufficiently recovered to support a reintroduced population. In some cases, however, it may be difficult to remove uncertainty about whether that threshold has been met without actually testing it through translocation. For example, when the Bald Eagle and Peregrine Falcon reintroduction programs were launched on the Channel Islands, it was not known if contaminants in the environment had declined enough to allow these species to establish self-sustaining populations. Nevertheless, managers determined that the benefit of having Bald Eagles and Peregrine Falcons on the islands outweighed the uncertainty associated with the initial translocations. The Island Scrub-Jay example illustrates similar risk issues. Santa Rosa Island, a potential jay reintroduction site, has a fraction of the oak, pine, and chaparral vegetation cover that it did prior to the introduction of livestock (Kindsvater 2006); that habitat loss may have been the primary cause of jay extinction (Collins 2009). Plans to reintroduce Island Scrub-Jays to Santa Rosa Island would need to consider whether enough habitat exists to support a population with an acceptable probability of persistence. A reintroduced population may require occasional augmentation of additional individuals and food supplementation (Morrison et al. 2011).

Some islands still have invasive vertebrate populations, and managers would need to consider the degree to which reintroduction could complicate future eradication efforts. For example, managers may decide that reintroducing a ground-foraging, granivorous bird to an island where invasive rodents are still present (e.g., San Miguel Island) should not proceed because the currently available methods to eradicate such pests, if used, could jeopardize the reintroduced population (Howald et al. 2010). Alternatively, managers could decide to proceed with reintroduction ahead of the eradication if they concluded that eradication would not be tractable in the foreseeable future, the pest would not threaten viability of the reintroduced population, and appropriate mitigation measures could be taken if an eradication is attempted (see Howald et al. 2010).

Potential community-level effects also must be identified and evaluated. Some effects could be a desired outcome of reintroduction. For example, if the scatter-hoarding Island Scrub-Jay were to be provided with supplemental food in the early stages of its reintroduction to Santa Rosa Island, managers could provide seeds of oak and pine species they seek to promote as part of that island's vegetation restoration program (Pesendorfer 2014). Other community-level effects of a jay reintroduction could be less desirable. Island Scrub-Jays are nest predators. Populations of predator-naïve songbirds (such as Loggerhead Shrikes [*Lanius ludovicianus*]; Stanley et al. 2012) on Santa Rosa could be adversely affected. However, recent work demonstrates that some Channel Island passerines modify their behavior in the presence of predators, even if they lack experience with that predator (Peluc et al. 2008, Sofaer et al. 2013). Moreover, restoration of predators can enhance ecosystem resiliency (Ritchie et al. 2012). The planning phase of a reintroduction should therefore seek to identify and evaluate potential risks and have in place the monitoring programs necessary to adaptively manage such risks if the reintroduction action is implemented. Managers have faced similar risks and uncertainties in earlier Channel Island reintroductions: Bald Eagles introduced to Santa Cruz Island could have exacerbated predation risk of island foxes on the northern islands (Newsome et al. 2010).

Island populations likely have traits adapted to local conditions that would be important to identify and consider when planning a reintroduction. Channel Island populations of Song Sparrow (*Melospiza melodia graminae*), for example, display variation in bill size that corresponds with island size and temperature (Greenberg and Danner 2012, 2013, Danner et al. 2014). Local adaptation may be an important consideration in identifying a source population or in selecting individuals of the founder population. Such considerations may be especially important when the extirpated population is an extinct form, such as the Song Sparrow subspecies on Santa Barbara Island (Table 1), and a surrogate taxon needs to be identified (Parker et al. 2010).

Climate change will affect the species that are candidates for reintroduction, as well as the ecosystems of both donor and recipient islands. A key consideration is whether the destination island for a translocation would be suitable for the species in the future, given current climate projections. However, much uncertainty exists about how climate change will affect coastal southern California, where fog is a major ecological influence (Cayan et al. 2008, Fischer et al. 2009, Carbone et al. 2013). Given that most of the taxa considered here are currently not threatened or endangered (Table 1), the impact on viability of harvesting individuals from source populations or of a failed reintroduction effort may be small. Thus proceeding with a translocation, even in the face of uncertainties, might be precautionary if the costs and risks of doing so are acceptable.

A Coordinated Cross-island, Multitaxa Approach

Cross-island collaboration by managers and scientists is an efficient and effective means of achieving conservation goals (Coonan et al. 2010, Boser et al. 2014). If reintroducing locally extirpated taxa is a priority across the archipelago, developing a plan to conduct the work as a coordinated program rather than as a series of projects, one population at a time, would be an efficient model. The manner in which invasive species eradication projects occurred across the Channel Islands over the past decades illustrates the potential benefit of a programmatic approach. Each invasive population was typically eradicated as an individually planned and implemented effort (McEachern et al. in press). This approach was used for many reasons, including the fact that eradication methods themselves were evolving (Veitch et al. 2011) and that different island managers had competing priorities and constraints on their management prerogatives (Morrison 2007). Given current knowledge, however, if managers today faced the same suite of "ranching era" introduced species across the archipelago, they would certainly achieve some economies of scale by conducting the eradication efforts as a coordinated multitaxa, cross-island initiative (Saunders et al. 2011).

A programmatic approach can reduce costs because of efficiencies in planning, implementation, monitoring, and research. Island managers have many competing and urgent priorities, as well as limited resources and funding. The research program needed to support reintroduction would be similar for many of the taxa and could be coordinated across islands. For example, if both Song Sparrows and House Finches (*Carpodacus mexicanus clementis*) were being considered for reintroduction to Santa Barbara Island (Table 1), the field assessment, baseline monitoring, compliance processes, and postintroduction monitoring needed for each species could be conducted by the same teams. A few well-designed studies that leverage the comparative and experimental potential of the reintroductions to address ecological and evolutionary questions would also provide the genetic, population, and community-level information needed to inform conservation and management goals. Moreover, with sufficient planning and coordination, basic research on the ecological and evolutionary responses postreintroduction could be integrated with a translocation action, and funding could be leveraged from multiple sources (e.g., the National Science Foundation). The linkages between potential source and destination islands of bird taxa (Table 1) highlight the opportunity for a collaborative management and research initiative. Importantly, a coordinated effort could accelerate the attainment of conservation outcomes across the archipelago.

Time and cost efficiency must be secondary considerations to the ecological conditions of the individual islands and to sequencing restoration actions in an ecologically appropriate order (Temperton 2004). Nevertheless, erring on the side of action in getting the new populations established, as a means for enhancing resiliency of Channel Island ecosystems, is prudent. A proactive approach could benefit these systems in the face of climate change and be initiated before future impacts create potentially higher priority demands on limited management funds. Most of the bird species that would be candidates for reintroduction are not federally or state listed, although some are considered species of management concern (Table 1). Thus, initiating reintroductions while donor populations are relatively robust seems wise. If potential donor populations become more imperiled, reintroduction may become biologically, administratively, and ethically more difficult.

The planning and decision-support framework developed for a multitaxa reintroduction initiative in the Channel Islands could be adapted for other island systems, and the collaborative enterprise itself could readily be expanded to include additional islands of the Californias. For example, many taxa have recently gone extinct on Guadalupe Island of Baja California, Mexico, including the Guadalupe Bewick's Wren (*Thryomanes bewickii brevicauda*), Guadalupe Spotted Towhee (*Pipilo maculatus consobrinus*), Guadalupe Caracara (*Polyborus lutosus*), Guadalupe Storm Petrel (*Oceanodroma macrodactyla*), and Guadalupe Ruby-crowned Kinglet (*Regulus calendula obscurus;* Aguirre-Muñoz et al. 2011). Appropriate surrogate taxa would need to be identified (e.g., Hutton et al. 2007) for these extinct populations, and the approaches developed for reintroductions in the Channel Islands (e.g., identifying a surrogate for the Santa Barbara Island Song Sparrow) could potentially inform such planning. Because Guadalupe Island is at a very early stage of vegetation succession following the recent eradication of feral goats (*Capra hircus*), managers would need to be especially cautious in identifying and managing potential risks of any reintroduction effort, including the possibility that reintroduction might (1) distract from other management priorities or prerequisites (e.g., fire management and forest recovery; Oberbauer et al. 2009); (2) adversely affect species of conservation concern on the island (e.g., Laysan Albatross [*Phoebastria immutabilis*], which nests on the island); or (3) complicate invasive species eradication efforts that may be attempted in the future (e.g., feral cats [*Felis catus*] or house mice [*Mus musculus*]).

RESEARCH NEEDS

A multidisciplinary research program would be needed to plan, implement, monitor, and learn from a reintroduction initiative. If designed well, the research program should be efficient, advance science, and inform conservation management—even if the ultimate decision is *not* to implement a given reintroduction. Here, we outline some research needs that could be the initial focus of that program.

First, a list of extirpated taxa is needed for the islands which can serve as a basis for prioritizing reintroductions. Table 1 provides an initial survey of passerine taxa; other taxa should be similarly reviewed. Field surveys may be required to increase certainty of absence for cryptic species. Other taxa that could be candidates for reintroduction include those known to have been historically extirpated (e.g., spotted skunk [*Spilogale gracilis amphiala*] on San Miguel Island) and those known to have been present on an island but for which the time or cause of extinction is uncertain (e.g., gopher snake [*Pituophis catenifer pumilus*] on San Miguel Island; PWC unpublished data). Abandoned seabird nesting colonies (e.g., McChesney and Tershy 1998) could also be reestablished (Jones and Kress 2012). A related project is underway to excavate, identify, and ideally germinate the seed bank of plant species that were present on San Miguel Island prior to the introduction of sheep (J.J. Knapp, TNC, personal communication).

Second, a reintroduction program would benefit from an understanding of the genetic structure of and adaptive differentiation among island populations (Robertson et al. 2014). Some of the extirpated taxa are classified as subspecies, but they are weakly differentiated (Patten and Unitt 2002, Patten and Pruett 2009, Unitt 2012), perhaps based on a limited number of specimens, and may have distributions that appear biogeographically nonintuitive. For example, a form of Spotted Towhee (*P. m. clementae*) is said to be endemic to Santa Rosa Island, yet the mainland taxon (*P. m. megalonyx*) occurs on the neighboring Santa Cruz Island, and both islands were connected as recently as the last glacial period, approximately 10,000 years ago (Collins 2008b). Similarly, it would be helpful to examine time since divergence of taxa, such as for the Rufous-crowned Sparrow (*Aimophila ruficeps obscura*). If genetic studies for this species indicate their presence on the northern islands prior to the last glacial period, then they likely also occurred on what are now Santa Rosa and San Miguel islands even though no physical evidence or other documentation has been found (PWC unpublished data). A systematic survey of species across the islands and adjacent mainland areas using modern genomic approaches can help infer the evolutionary history and phylogenetic relationships of populations (Robertson et al. 2014). That survey could also advance an aforementioned research priority: the need to elucidate patterns of local adaptation that would be important for identifying desired attributes of founder populations.

Third, coordinated demographic and ecological studies of the focal taxa are needed, particularly focusing on habitat requirements and trophic and nontrophic interactions on both source and destination islands, as well as assessments of current habitat quality. This work would establish monitoring baselines and ideally be designed to take advantage of the comparative and experimental research opportunity provided by the management interventions to test hypotheses in population and community ecology and evolution over the long term (Parker et al. 2012). This research effort would also be important for prioritizing and sequencing translocation efforts, as well as predicting, detecting, and managing their potential undesired effects (e.g., Jamieson 2011).

Finally, this initiative will require managers to review the philosophical underpinnings of their conservation goals in the context of ecological novelty and climate change and to reconcile them with conservation policy (Cole and Yung 2010, Morrison 2014). A likely prerequisite of any reintroduction would be legal review to specify how the new population would be treated vis-à-vis regulatory statutes (Shirey and Lamberti 2010). The framework we outline here would require managers to articulate the desired species composition on the islands, recognizing that active and perhaps nontraditional management might be needed to achieve the desired outcomes.

REINTRODUCTION AND THE FUTURE OF HISTORIC CONDITIONS

We have focused on restoring the islands to their preranching condition, but a growing body of literature emphasizes how that state would be an impractical and inappropriate long-term management goal (e.g., Cole and Yung 2010). Managers are sure to face scenarios where an anthropogenic effect, such as climate change, renders an island unsuitable for certain species. In such a situation, a suite of management alternatives are still available, ranging from doing nothing and accepting probable local or global extinction to translocating the species to an area outside of its indigenous range (Schwartz et al. 2012). For example, direct or indirect effects of climate change could render the northern islands inhospitable for Island Scrub-Jay, and the jay may need to be translocated to another island outside of its indigenous range. Managers also may face scenarios in which the island they manage is identified as a candidate location for translocation of a species that may face high risk of extinction in its current range. Although translocating a species outside of its indigenous range requires great caution (Ricciardi and Simberloff 2009), such assisted colonization falls along a continuum of conservation management strategies that includes both reintroduction and taxon substitution (Seddon 2010). Thus, the framework used for planning and implementing a Channel Islands reintroduction initiative could provide a helpful foundation for managers and scientists as they confront more nontraditional management scenarios. Fortunately, managers of the Channel Islands are familiar with how introduced species can have unintended and cascading consequences, and managers can employ that experience when structuring decisions about intentionally introducing species.

To illustrate the questions and challenges likely to come, we consider the endangered California Condor (*Gymnogyps californianus*). A key recovery strategy for the condor is to reintroduce it to several mainland locations, including areas that it may not have occupied for millennia (e.g., near Grand Canyon National Park; Emslie 1987, USFWS 1996). Yet the reintroduced populations continue to be threatened by anthropogenic mortality factors (Rideout et al. 2012). A *Gymnogyps* condor occurred on the northern Channel Islands through the Late Pleistocene (Guthrie 2005). Marine mammal populations are increasing on the Channel Islands (Stewart and Yochem 2000), and that increase could provide food resources for condors (Chamberlain et al. 2005). Managers may need to consider whether the islands should be evaluated as a potential release location for condors, given that some mortality factors difficult to manage on the mainland (e.g., lead bullets, microtrash) are not present on the islands. The possibility that the taxon that occurred on the islands was not *G. californianus* but *G. amplus,* a now extinct species, may affect this decision as well (Syverson and Prothero 2010). Ultimately, managers will need to articulate a conservation management philosophy for the islands that can form an objective basis for such decision making. A reintroduction initiative for the Channel Islands could be a platform for developing the philosophical and policy frameworks, as well as the decision-support tools needed to address these future issues.

CONCLUSION

Following the eradication of many invasive vertebrates that threatened native diversity, an archipelago-wide initiative to reintroduce recently extirpated taxa could be a defining focus of the next chapter of conservation, restoration, and science work on the California Islands. A collaborative effort could accelerate restoration of native flora and fauna and advance theoretical and applied research. This initiative also could foster the development of a vision for the California Islands in which conservation goals for individual islands are set and advanced in the context of maximizing the conservation value of the archipelago as a whole.

In 2006, the first wild-born Bald Eagle chicks on the Channel Islands in a half century were produced in 2 nests on Santa Cruz Island (D.K. Garcelon, Institute for Wildlife Studies, personal communication). The parent birds of those nests were from the reintroduction programs on both Santa Cruz and Santa Catalina islands. Moreover, one of the nests was built on the ground in an area that just months prior had been cleared of feral pigs (*Sus scrofa*) as part of an island-wide eradication program; removal of that potential predator likely benefitted the nest. The 2006 nests illustrate the ecological connectedness of the archipelago and how restoration projects on and across islands can complement one another.

An additional benefit of reintroducing extirpated taxa across the islands is the opportunity to focus public attention on conservation, especially given that the Channel Islands lie just offshore of over 20 million people. Reintroductions (e.g., animal releases) provide a focus for public and media events that can help build community interest and engagement in conservation (Parker 2008). Since 2006, for example, stories about reintroduced Bald Eagles have consistently been among the most visited features on The Nature Conservancy's website, www.nature.org (SAM, unpublished data). Thus, a reintroduction initiative would not only enhance the resiliency of the natural communities of the California Islands but could also fortify much needed public support for conservation.

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