Washington University Law Review

Volume 92 | Issue 4

2015

Going the Way of the Dodo: De-Extinction, Dualisms, and Reframing Conservation

Alejandro E. Camacho

Washington University
Law Review

VOLUME 92 NUMBER 4 2015

GOING THE WAY OF THE DODO: DE-EXTINCTION, DUALISMS, AND REFRAMING CONSERVATION

ALEJANDRO E. CAMACHO[*]

ABSTRACT

De-extinction, a suite of selective breeding or biotechnological processes for reviving and releasing into the environment members or facsimiles of an extinct species, has been the subject of a recent surge of analysis in popular, scientific, and legal literature. Yet de-extinction raises more fundamental questions about the relationship between humans and nature and about the more and less useful ways that the law serves to navigate that relationship. Unfortunately, the endangered species, invasive species, and public land management laws likely to govern the revival and introduction of de-extinct species largely remain premised on an understanding of nature as static and easily divisible from human activity. In these contexts, the law habitually privileges and even actively promotes what it identifies as natural and native over the unnatural and exotic.

Through the example of de-extinction, this article illustrates the limitations of the law's reliance on these crude dualisms. Currently, de-extinct species will often be obstructed as non-native and introduced (even

* Professor of Law and Director, Center for Land, Environment, and Natural Resources, University of California, Irvine School of Law; Member Scholar, Center for Progressive Reform. The author thanks the other participants in conferences, workshops, and meetings at the National Geographic Society, the Stanford Law School, and the National Academy of Sciences for their useful insights. I am indebted to Dan Burk, Michael Robinson-Dorn, and especially Andrew Torrance for helping me work through many of the issues explored in the paper, as well as Ava Azad, Andrew Contreiras, John Frank, and Andrea Ringer for their valuable research assistance.

if they might promote ecological function in a particular area) and may be allowed or promoted in locations they used to exist (even if likely to cause ecological damage). De-extinction illustrates how policymakers need to reformulate natural resources law to be less dependent on these strict dualities. Instead, the article argues in favor of cautious risk assessment that acknowledges the dynamism of nature and humanity's indivisibility from it.

TABLE OF CONTENTS

INTRODUCTION 851
I. THE ECOLOGICAL RISKS AND BENEFITS OF DE-EXTINCTION 856
A. *Potential Ecological Benefits of De-Extinction* 856
B. *Potential Conservation Risks of De-Extinction* 858
II. DUALISM IN ENDANGERED SPECIES LAWS 862
A. *"Species" and a Focus on Natural* 864
B. *"Endangered" and a Focus on Native Range* 867
C. *Captive-Breeding: Preferencing Exotic* 868
D. *Introductions: Preferencing "Natural" and "Native"* 870
III. DUALISM IN OTHER WILDLIFE AND PUBLIC LAND LAWS 876
A. *De-Extinction and the Problem of "Native"* 880
1. *Promoting "Native"* 880
2. *De-Extinction with "Native" as Pre-existing* 883
3. *De-Extinction with "Native" as Natural* 884
B. *De-Extinct Species as "Exotic" and "Invasive"* 885
1. *Suppressing "Exotic" and "Invasive"* 885
2. *De-Extinction and Defining "Invasive"* 886
C. *Problems with the Native/Exotic and Artifactual/Wild Dualities* 888
IV. REJECTING STRICT DUALITIES: A RISK ASSESSMENT APPROACH ... 890
A. *Native/Exotic and Nature/Human as False Dichotomies* 893
B. *Risk-Based Adaptive Ecosystem Management* 897
1. *Risk Assessment and Adaptive Management* 898
2. *Potential Default Rebuttable Presumptions* 902
CONCLUSION 905

INTRODUCTION

The Dodo (*Raphus cucullatus*), that object of the leading idiom about permanent obsolescence,[1] might not be gone.[2] In 1598, at the behest of Dutch Vice-Admiral Wybrandt Warwijck, who had rediscovered the island of Mauritius and claimed it for the Netherlands,[3] Heyndrick Dircksz Jolinck led an expedition to reconnoiter the island during which he encountered what became known as the Dodo.[4] Flightless and fearless, the Dodo was driven to extinction by about 1698, likely a victim of the combined onslaught of human hunting, habitat loss, and invasive rats, pigs, goats, dogs, and cats.[5] There is no reason to assume that the Dodo—now known to have been, in evolutionary terms, essentially a giant, flightless pigeon[6]—any less well adapted to the ecosystems it inhabited than any other species indigenous to Mauritius.[7] Nevertheless, it has become a potent symbol of silliness and futility.[8]

---

1. To "go the way of the dodo" commonly means to become extinct or obsolete, to fall out of common usage or practice, or to become a thing of the past. *See* ERROL FULLER, DODO: FROM EXTINCTION TO ICON 13 (2002).

2. The Dodo may soon be a target for de-extinction. *Scientists Want to Bring 24 Animals Back from Extinction (Dodos Make the List . . . but Dinosaur DNA Is So Old, Jurassic Park Isn't an Option)*, MAIL ONLINE (Mar. 25, 2013, 8:58 AM), http://www.dailymail.co.uk/sciencetech/article-2298805/Scientists-want-bring-24-animals-extinction-Dodos-make-list--dinosaur-DNA-old-Jurassic-Park-isnt-option.html, *archived at* perma.cc/VPZ2-CEYW.

3. Julian P. Hume, *The History of the Dodo* Raphus Cucullatus *and the Penguin of Mauritius*, 18 HIST. BIOLOGY 65, 67 (2006). It appears that Mauritius had been visited earlier by Arab sailors and even settled briefly by the Portuguese in the early 16th Century. *Id.* at 66. However, it was uninhabited by humans when the Dutch first arrived. *Id.*

4. *See* P.J. MOREE, A CONCISE HISTORY OF DUTCH MAURITIUS, 1598–1710, at 12 (Paul van der Velde et al. eds., 1998) ("[W]e also found large birds, with wings as large as of a pigeon, so that they could not fly and were named penguins by the Portuguese. These particular birds have a stomach so large that it could provide two men with a tasty meal and was actually the most delicious part of the bird.").

5. *See* JOLYON C. PARISH, THE DODO AND THE SOLITAIRE: A NATURAL HISTORY 50 (2013) (stating that "[b]y 1698 no dodos were to be seen") (internal citations omitted).

6. Beth Shapiro et al., *Flight of the Dodo*, 295 SCIENCE 1683, 1683 (2002) (concluding based on genetic analysis that the dodo belongs to the pigeon family, despite substantial morphological differences).

7. *E.g.*, FULLER, *supra* note 1, at 25; *Dodo Bird a Resilient Island Survivor Before the Arrival of Humans, Study Reveals*, SMITHSONIAN SCI. (Sept. 26, 2011), http://smithsonianscience.org/2011/09/dodo-bird-was-a-resilient-island-survivor-before-the-arrival-of-humans/, *archived at* perma.cc/C9SB-QVED; *Theory of Evolution: Extinction*, BBC, http://www.bbc.co.uk/schools/gcsebitesize/science/21c_pre_2011/evolution/theoryevolutionrev8.shtml (last visited Nov. 1, 2014), *archived at* perma.cc/B9BF-KWM7.

8. Contemporaneous verbal accounts and pictorial representations clearly indicate that the Dodo was viewed as awkward, silly, and rather pathetic. With its oddly proportioned body that appeared to be a concatenation of parts, its unnatural appearance inspired English explorer Peter Mundy to speculate about whether it had arisen "by Mixture off kindes producing straunge and Monstrous formes." Hume, *supra* note 3, at 68 (citing 5 PETER MUNDY, THE TRAVELS OF PETER MUNDY IN

Yet "going the way of the Dodo" may soon take on new meaning. Though until now a symbol of permanent extermination, emerging technologies of de-extinction may make the Dodo the ultimate example of the inevitably dynamic character of ecological phenomena and the inextricable relationship of humans with nature. Unfortunately, the various conservation laws likely to govern the revival and introduction of the Dodo largely remain premised on outdated assumptions of nature as static and firmly divisible from human activity.

While established legal dualisms such as native versus alien or natural versus introduced may offer a clear organizing principle, strict adherence may ignore nuances and complexities.[9] More crucially, legal dualisms based on erroneous premises—such as a nature that is (and should be) unchanging and divisible from humanity—likely will result in distorted or harmful policy outcomes.[10] Just as aphorists may be forced to reconsider a common adage, and scientists obliged to reevaluate the permanency of extinction, de-extinction illustrates how policymakers need to reformulate legal frameworks governing natural resources to be less dependent on simplistic dualisms in favor of cautious risk assessment that recognizes the dynamism of nature and humanity's indivisibility from it.

De-extinction is the process of reviving members or facsimiles of an extinct species through a variety of selective breeding or biotechnological methods, as well as the release of such organisms into existing ecological systems.[11] *Functional de-extinction* would not involve genetic engineering but rather selectively breeding organisms exhibiting the phenotypic or functional characteristics of extinct target organisms with the intent of aggregating those desired characteristics into individual organisms over several generations.[12] More controversially, de-extinction *via genetic*

EUROPE AND ASIA 353 (Richard C. Temple ed., 1914)). Even the etymology of the name "Dodo" foreshadowed its fate. Derived, as it probably was, from the word "doudo," Portuguese for simpleton or fool, the description "Dodo" has come to be understood as a synonym for stupid. Dodo *Definition*, OXFORD ENG. DICTIONARY, *available at* http://www.oed.com/view/Entry/56392 (last visited July 29, 2014).

9. *See infra* notes 202–06 and accompanying text.

10. *See, e.g.*, Jody Freeman, *The Private Role in Public Governance*, 75 N.Y.U. L. REV. 543, 564–71 (2000); Duncan Kennedy, *Form and Substance in Private Law Adjudication*, 89 HARV. L. REV. 1685 (1976).

11. Norman F. Carlin et al., *How to Permit Your Mammoth: Some Legal Implications of "De-Extinction"*, 33 STAN. ENVTL. L.J. 3, 7–17 (2013).

12. For example, it might be possible to breed cattle in a conventional manner to recapture some of the characteristics and functions of aurochs. The fruits of such a breeding program would not be aurochs *per se*, but ecologically functional approximations of aurochs. *The Tauros Programme: The Search for a New Icon for European Wilderness*, STICHTING TAURUS, http://www.taurosproject.com/ (last visited Nov. 1, 2014).

engineering[13] would include a suite of technologies in which the DNA segments from extinct and extant species are combined to make a new "recombinant" DNA.[14] For example, efforts to construct a viable Dodo might rely on inserting preserved fragments of Dodo genomic DNA into its closest living relative, an existing, complete Nicobar pigeon (*Caloenas nicobarica*) genome.[15] The result would be a genomic hybrid Dodo/Nicobar pigeon. Through multiple generations of such a process, DNA from extinct target species would make up increasing proportions of genomes of de-extinct individuals—eventually resulting in the genomes of de-extinct species being derived entirely, and with high fidelity, from the genomes of their extinct relatives.

The possibility of "bringing back" extinct species like the Dodo has been the subject of a recent outpouring of discussion in popular[16] and

13. BRUCE ALBERTS ET AL., MOLECULAR BIOLOGY OF THE CELL G:15 (5th ed. 2008) (defining genetic engineering (or recombinant DNA technology) as a "[c]ollection of techniques by which DNA segments from different sources are combined to make a new DNA, often called a recombinant DNA").

14. *See* Carlin et al., *supra* note 11, at 11–13 (describing de-extinction through genetic engineering).

15. Beth Shapiro & Michael Hofreiter, *A Paleogenomic Perspective on Evolution and Gene Function: New Insights from Ancient DNA*, 343 SCIENCE 1236573, 1236573–75 (2014).

16. *E.g.*, Dominic Basulto, *De-Extinction Is the Mind-Blowing Idea of the Year*, WASH. POST (Mar. 19, 2013, 1:05 PM), http://www.washingtonpost.com/blogs/innovations/post/de-extinction-is-the-mind-blowing-idea-of-the-year/2013/03/19/cbbce3b8-908e-11e2-9173-7f87cda73b49_blog.html, *archived at* perma.cc/3953-Z5H5; Stewart Brand, *Back From the Brink: Should We Use Cloning to Save Endangered Species?*, SLATE (June 4, 2014, 12:47 PM), http://www.slate.com/articles/technology/future_tense/2014/06/cloning_wildlife_carrie_friese_s_book_on_using_tech_to_save_endangered_species.html, *archived at* perma.cc/K8YZ-E7WX; Virginia Gewin, *Laws Lag Behind Science in De-Extinction Debate*, DISCOVER (June 5, 2013, 9:39 AM), http://blogs.discovermagazine.com/crux/2013/06/05/laws-lag-behind-science-in-de-extinction-debate/#.VAjjFleNauT, *archived at* perma.cc/5HXT-RXGB; Liza Gross, *De-Extinction Debate: Should Extinct Species Be Revived?*, KQED (June 5, 2013), http://blogs.kqed.org/science/2013/06/05/deextinction-debate-should-extinct-species-be-revived/, *archived at* perma.cc/JV6W-VBCM; Gina Kolata, *So You're Extinct? Scientists Have Gleam in Eye*, N.Y. TIMES (Mar. 18, 2013), http://www.nytimes.com/2013/03/19/science/earth/research-to-bring-back-extinct-frog-points-to-new-path-and-quandaries.html?_r=0, *archived at* perma.cc/DSJ4-A8V5; Lisa M. Krieger, *Extinct Species Revival Raises Hopes, Fears*, SAN JOSE MERCURY NEWS (May 31, 2013, 6:05 PM), http://www.mercurynews.com/science/ci_23365591/reviving-extinct-species-raises-hopes-and-fears, *archived at* perma.cc/9P7B; Jackson Landers, *Can Scientists Bring Mammoths Back to Life by Cloning?*, WASH. POST (Feb. 9, 2015), http://www.washingtonpost.com/national/health-science/can-scientists-bring-mammoths-back-to-life-by-cloning/2015/02/06/2a825c8c-80ae-11e4-81fd-8c4814dfa9d7_story.html; Tanya Lewis, *De-Extinction Experts See Benefits in Resurrecting Extinct Animals, but Critics Abound*, HUFFINGTON POST (Aug. 26, 2013, 9:05 AM), http://www.huffingtonpost.com/2013/08/26/de-extinction-extinct-animals-life_n_3816271.html, *archived at* perma.cc/LLL5-9A6H; Frank Swain, *Don't Bring Back the Saber-Toothed Tiger: How De-Extinction Could Derail the Conservation Movement*, SLATE (Mar. 18, 2013, 1:58 PM), http://www.slate.com/articles/health_and_science/future_tense/2013/03/de_extinction_isn_t_a_good_idea.html, *archived at* perma.cc/76F8-WCNC; John Roach, *Back from the Dead: Why De-Extinction May Save Humanity*, NBC NEWS (July 24, 2014), http://www.nbcnews.com/science/environment/back-dead-why-de-extinction-may-save-humanity-n164226; Andy Roast, *De-Extinction: Mammoth*

scientific[17] literature, and a number of active initatives are under way to revive facsimiles of the extinct passenger pigeon,[18] bucardo,[19] gastric brooding frog,[20] woolly mammoth,[21] and auroch.[22] Even legal scholarship recently has touched on the applicability of certain laws to the revival of a de-extinct species.[23] Yet de-extinction raises more fundamental questions about the relationship between humans and nature,[24] and the more and less useful ways that the law serves to navigate that relationship.

Unfortunately, resource conservation laws are replete with dualisms as awkward and unsustainable as the stereotypical Dodo.[25] How the law may

---

Prospect, or Just Woolly?, BBC NEWS (Aug. 19, 2013, 7:31 PM), http://www.bbc.co.uk/news/science-environment-23602142, *archived at* perma.cc/NPT4-NFVK; Adam Welz, *De-Extinction Critics at Scientific American Have Missed the Point*, THE GUARDIAN (June 7, 2013, 11:18 AM), http://www.theguardian.com/environment/nature-up/2013/jun/07/deextinction-critics-scientific-american, *archived at* perma.cc/V5NY-OO7S; Carl Zimmer, *Bringing Them Back to Life*, NAT'L GEOGRAPHIC, Apr. 2013, *available at* http://ngm. nationalgeographic.com/2013/04/125-species-revival/zimmer-text, *archived at* perma.cc/U63N-JC4N.

17. *E.g.*, C. Josh Donlan, *De-Extinction in a Crisis Discipline*, 6 FRONTIERS BIOGEOGRAPHY 25 (2014); Lesley Evans Ogden, *Extinction Is Forever . . . Or Is It?*, 64 BIOSCIENCE 469 (2014); Matthew J. Heard, *De-Extinction: Raising the Dead and a Number of Important Questions*, 6 FRONTIERS BIOGEOGRAPHY 1 (2014); AMY LYNN FLETCHER, MENDEL'S ARK: BIOTECHNOLOGY & THE FUTURE OF EXTINCTION (2014); Carrie Friese & Claire Marris, *Making De-Extinction Mundane?*, PLOS BIOLOGY, Mar. 2014, at 1; Nader Heidari, *Reviving the Dead*, 91 CHEM. & ENG'G NEWS 34 (2013), *available at* http://cen.acs.org/articles/91/i14/Reviving-Dead.html; Kate Jones, *From Dinosaurs to Dodos: Who Could and Should We De-Extinct?*, 6 FRONTIERS BIOGEOGRAPHY 20 (2014); Dolly Jørgensen, *Reintroduction and De-Extinction*, 63 BIOSCIENCE 719 (2013); Ronald Sandler, *The Ethics of Reviving Long Extinct Species*, 28 CONSERVATION BIOLOGY 354 (2013); Jacob S. Sherkow & Henry T. Greely, *What If Extinction Is Not Forever?*, 340 SCIENCE 32 (2013); Philip J. Seddon et al., *Reintroducing Resurrected Species: Selecting DeExtinction Candidates*, 29 TRENDS ECOLOGY & EVOLUTION 140 (2014), *available at* http://dx.doi.org/10.1016/j.tree.2014.01.007.

18. *See* David Biello, *Ancient DNA Could Return Passenger Pigeons to the Sky*, SCI. AM. (Aug. 29, 2014), http://www.scientificamerican.com/article/ancient-dna-could-return-passenger-pigeons-to-the-sky, *archived at* perma.cc/U2AE-CYDT; Todd McGrain, *Can Science Bring Back the Passenger Pigeon?*, WALL ST. J. (Aug. 28, 2014, 7:50 PM), http://wsj.com/articles/todd-mcgrain-can-science-bring-back-the-passenger-pigeon-1409269840.

19. *See* Kai Kupferschmidt, *Can Cloning Revive Spain's Extinct Mountain Goat?*, 344 SCIENCE 137 (2014).

20. *See* Nicky Phillips, *Extinct Frog Hops Back into the Gene Pool*, SYDNEY MORNING HERALD (Mar. 15, 2013), http://www.smh.com.au/environment/animals/extinct-frog-hops-back-into-the-gene-pool-20130315-2g68x.html.

21. *See* Jason Koebler, *The Plan to Turn Elephants into Woolly Mammoths is Already Underway*, MOTHERBOARD (May 21, 2014, 2:14 PM), http://motherboard.vice.com/en_us/read/the-plan-to-turn-elephants-into-woolly-mammoths-is-already-underway.

22. *See* Stephan Faris, *Breeding Ancient Cattle Back from Extinction*, TIME, Feb. 12, 2010, *available at* http://content.time.com/time/health/article/0,8599,1961918,00.html.

23. *See* Carlin et al., *supra* note 11.

24. *See* Sandler, *supra* note 17, at 354; THE ETHICS OF ANIMAL RE-CREATION AND MODIFICATION: REVIVING, REWILDING, RESTORING (Markku Oksanen & Helena Siipi eds., 2014).

25. *Cf.* Christine A. Klein, *Preserving Monumental Landscapes Under the Antiquities Act*, 87 CORNELL L. REV. 1333, 1337 (2002) (analyzing and rejecting reliance on a rigid nature/human legal dualism in interpreting the Antiquities Act, Endangered Species Act, and Wilderness Act).

relate to de-extinction brings the limitations of these dichotomies into high relief. These simplistic and problematic dualisms include divisions between those phenomena deemed natural and those considered artificial or unnatural, as well as between the native and the exotic. In a variety of different regulatory programs, the law habitually privileges and even actively promotes what it identifies as natural and native over the unnatural and exotic.

De-extinction illustrates the limitations of the law's reliance on these simplistic dichotomies. Existing endangered species, invasive species, and public land laws and policies as applied to the revival of extinct species demonstrate the problems with a primarily dualistic approach to managing dynamic natural systems. Endangered species laws focus on protecting de-extinct species primarily where they used to be, not where they may promote ecological function now and in the future; other wildlife laws might perversely allow introduction of a de-extinct species where it is incompatible with an area's current conditions but bar it in circumstances where it could provide substantial ecological benefits. The effectiveness and coherence of laws in each of these doctrinal areas have been undermined by the privileges (and even stimuli) accorded to just one side of a dualistic pair.

Accordingly, this Article offers an alternative approach that provides for a more appropriate assessment and adaptive management of the benefits and risks of de-extinction and other human manipulations of, or intervention in, ecology. I do not suggest that differently situated species or organisms should be treated equivalently. To the contrary, there may be circumstances in which it is valuable to privilege certain types of species over others. In particular, there may be important reasons to build into the legal framework a rebuttable presumption that a species or organism that already exists in a particular ecological niche is valuable and less risky. In contrast, the potential arrival of a new species or organism to a preexisting ecological community may be reasonably presumed to be less valuable and raise unknown risks. Other circumstances may not justify such initial presumptions and instead would default to full and particularized risk assessments. The article submits that either a case-by-case risk assessment or a default rebuttable presumption is more likely to lead to sound and justifiable legal and policy decisions than a simplistic reliance on dualisms that treats preexisting biota as categorical virtues and new arrivals—particularly those involving human intervention—as vices.

The article proceeds in four Parts. Part I provides a brief summation of the potential ecological benefits and risks of reviving, as well as introducing, de-extinct organisms. Parts II and III engage in a detailed

exploration of the ways in which the emphasis on dualisms in natural resources law largely fails to integrate a clear and coherent methodology for parsing through these various risks and benefits. Part II examines endangered species preservation laws, which largely focus on protecting historically present species in pre-existing environments while ignoring the inevitability of dynamic change in ecological systems and the unavoidable influence of humans in these areas. Similarly, Part III explores how invasive species and other wildlife management laws seek to resist species' movement, especially human-aided movement, while promoting previously present biota and ecological inertia as incontrovertible assets. Part IV then explains how de-extinction reveals the flaws in legal categories grounded in erroneous conceptions of nature as static and detached from human activity. Finally, it proposes a provisional risk-based adaptive management framework more likely to lead to sensible assessments of the risks and benefits of novel conservation strategies.

I. THE ECOLOGICAL RISKS AND BENEFITS OF DE-EXTINCTION

The availability of de-extinction technologies does not only provide the possibility for reviving extinct species in a laboratory setting. At least according to de-extinction proponents, the process of de-extinction may not end with the successful revival of a single organism or population of organisms *ex situ*.[26] De-extinction may—and some would argue should—include the eventual introduction of recovered populations into existing biotic communities.[27] Such efforts may have ecological benefits, but they also raise potentially significant risks.

A. Potential Ecological Benefits of De-Extinction

There is a range of possible benefits from engaging in de-extinction for efforts to conserve existing ecological resources. The revival and introduction of members of a de-extinct species could serve to directly improve the integrity and function for ecosystems that have declined due to the loss of the constituent species. This would be particularly beneficial for recently extinct species (such as a keystone species[28]) that had

26. Seddon et al., *supra* note 17, at 140.

27. *Id*.

28. The loss of a keystone species from an ecosystem can create significant ecological disruptions. *See* L. Scott Mills, Michael E. Soulé & Daniel F. Doak, *The Keystone-Species Concept in Ecology and Conservation*, 43 BIOSCIENCE 219, 219 (1993) (arguing that the term *keystone species* "is broadly applied, poorly defined, and nonspecific in meaning," but nonetheless delineating "two

occupied an important ecological niche that remains unfilled since the extirpation of the species. As with reintroduction efforts of extant endangered species,[29] a strategic introduction of members of a revived species could provide benefits not only for the introduced species but also other components of the ecological community.[30] In this sense, the introduction of revived species into the habitat of which it previously was a constituent might be considered a form of (or at least analogous to) re-wilding or restoration ecology.[31]

In addition, a number of proponents of de-extinction contend that technologies developed in the pursuit of de-extinction may have considerable co-benefits for efforts to recover critically endangered populations. Advances in knowledge achieved through cloning efforts for extinct species could be used to engage in cloning for extant endangered species, particularly for species that have declined to only a few or single non-reproducing individuals.[32] Furthermore, technological advances in genetic manipulation achieved through de-extinction efforts—such as the use of cryopreserved gametes[33] (or even ancient DNA from preserved

---

hallmarks of keystone species. First, their presence is crucial in maintaining the organization and diversity of their ecological communities. Second, it is implicit that these species are exceptional, relative to the rest of the community, in their importance.").

29. *See* Sherkow & Greely, *supra* note 17, at 33 (suggesting that re-wilding with existing species, locally extinct in certain habitats, can help restore extinct or threatened ecosystems). Such ecological benefits may be direct or indirect. *See, e.g.*, Welz, *supra* note 16 (explaining how re-wilding the California condor shed light on lead poisoning, thus resulting in lead reduction efforts in Arizona and calls to ban the use of lead bullets in California); *but cf.* Seddon et al., *supra* note 17, at 141 (referencing existing guidelines for extant species "on the justification, design, and implementation of any conservation translocation" that can provide a starting point for selecting de-extinction candidates).

30. Some suggest, for example, that the woolly mammoth as a grazing species in the Arctic may help return the grassy steppes to the now "less ecologically rich tundra," and reintroducing extinct plants could result in pharmaceutical advancements. Sherkow & Greely, *supra* note 17, at 33. On the other hand, the longer the species has been absent from the community, the greater the risk that its return could, much like an invasive species, have a negative impact on a community that has moved on and established a new dynamic equilibrium. *See* Julian Savulescu & Russell Powell, *Mammoth Cloning: The Ethics*, THE CONVERSATION (July 24, 2013, 9:39 AM), http://theconversation.com/mammoth-cloning-the-ethics-16183 (discussing the issue of habitat disruption), *archived at* perma.cc/U6W6-ARQZ.

31. *See, e.g.*, Josh Donlan et al., *Re-Wilding North America*, 436 NATURE 913, 913–14 (2005) (advocating "the restoration of large wild vertebrates into North America" through "a series of carefully managed ecosystem manipulations using closely related species as proxies for extinct large vertebrates").

32. *See* Ferris Jabr, *Will Cloning Ever Save Endangered Animals?*, SCI. AM. (Mar. 11, 2013), http://www.scientificamerican.com/article/cloning-endangered-animals, *archived at* perma.cc/8DWX-FUDP.

33. *See* Jonathan D. Ballou, *Potential Contribution of Cryopreserved Germ Plasm to the Preservation of Genetic Diversity and Conservation of Endangered Species in Captivity*, 29 CRYOBIOLOGY 19 (1992).

materials) to obtain and introduce new beneficial alleles into an existing population—might be useful if employed to increase the genetic diversity of existing endangered species populations or to engage in "genetic rescue" for endangered species that are genetically depauperate.[34] Genetic-engineering technologies might also be used to insert new genes into the genome of a vulnerable species to enhance its fitness in the face of threats such as introduced pathogens or parasites.[35]

Finally, some also suggest that successful de-extinction of a species may serve to awaken interest in, and even action on behalf of, ecological conservation by providing a concrete illustration of the capacity of humans to shape and repair past and ongoing anthropogenic damage to ecosystems.[36] These proponents of de-extinction argue that the reconstruction of previously extinct species will help the public realize that humans indeed can shape their environment, and such influence may be galvanized to actively try to develop solutions that cultivate ecological health.[37] De-extinction's use as an example of the capacity for ecological manipulation is thus posited as a way to combat resignation in some quarters that humans are incapable of mending past and continuing harm to ecological resources.[38]

B. Potential Conservation Risks of De-Extinction

On the other hand, de-extinction efforts raise several costs, and potentially significant risks, for existing biotic communities and conservation efforts in general. The most obvious costs are the direct

34. *See, e.g.*, Philip W. Hedrick & Richard J. Fredrickson, *Genetic Rescue Guidelines with Examples from Mexican Wolves and Florida Panthers*, 11 CONSERVATION GENETICS 615 (2010).

35. *See, e.g.*, Katherine F. Smith et al., *Evidence for the Role of Infectious Disease in Species Extinction and Endangerment*, 20 CONSERVATION BIOLOGY 1349 (2006); Jonathan M. Adams et al., *The Case for Genetic Engineering of Native and Landscape Trees against Introduced Pests and Diseases*, 16 CONSERVATION BIOLOGY 874 (2002). For example, researchers announced in November 2014 that they have successfully altered the genome of the American chestnut to increase blight resistance to the introduced pathogenic fungus *Cryphonectria parasitica*. *See* Andrew E. Newhouse, et al., *Transgenic American Chestnuts Show Enhanced Blight Resistance and Transmit the Trait to T1 Progeny*, 228 PLANT SCI. 88 (2014).

36. *See* Sandler, *supra* note 17, at 3.

37. *See* Welz, *supra* note 16 ("People are strongly drawn to miraculous stories of resurrection (Jesus of Nazareth has quite a few fans) and de-extinction could, if framed and conducted correctly, bring new awareness to extinction and habitat protection."); Seddon et al., *supra* note 17, at 140 ("The prospect of being able to resurrect extinct species captures the imagination of many scientists and the general public alike.").

38. *But see* Sandler, *supra* note 17, at 355–56 (arguing that appropriate methods of mending past harm should be forward-looking and seek to minimize future extinctions, and as such de-extinction can be detrimental).

economic expenses of managing the laboratory revival and subsequent introduction effort. A number of scientists have identified the considerable administrative expenditures from active reintroduction interventions for existing species.[39] Beyond the substantial outlay for captive breeding efforts,[40] monitoring and adaptive management sufficient to support successful introduction and minimize negative effects on the receiving area will often be extensive and possibly decades long.[41]

The direct costs of captive breeding and introduction efforts for revived species are likely to be at least as high as those for the translocation of existing species. The expense of developing yet unproven de-extinction technologies to cultivate a viable organism and breed a population are likely to be significant.[42] Additional costs include those incurred for planning, implementation, and long-term monitoring of introductions, including the costs of any initial failures to establish a de-extinct species (though empirical assessments of the likelihood of successfully establishing an introduced population vary).[43]

Perhaps of even greater concern are the potential risks of harm from the introduction of organisms to existing ecological systems of which these organisms have either never been a constituent or from which they have been absent for a substantial period of time. Rather than contributing ecological benefits, then, such introductions may serve to erode biodiversity, disrupt ecosystems, and contribute to extinctions at receiving sites.[44] These risks mirror concerns raised in response to proposals for assisted migration—non-native, planned introductions to facilitate species

39. Jason S. McLachlan et al., *A Framework for Debate of Assisted Migration in an Era of Climate Change*, 21 CONSERVATION BIOLOGY 297, 299–300 (2007)

40. *See* Noel F.R. Snyder et al., *Limitations of Captive Breeding in Endangered Species Recovery*, 10 CONSERVATION BIOLOGY 338, 343-44 (1996) ("The costs of captive breeding programs for recovery of endangered species sometimes run on the order of a half-million dollars per year per species").

41. *See* McLachlan et al., *supra* note 39, at 299; Anthony Ricciardi & Daniel Simberloff, *Assisted Colonization Is Not a Viable Conservation Strategy*, 24 TRENDS ECOLOGY & EVOLUTION 248, 251 (2009).

42. One such cost is the welfare of organisms throughout the revival process, as well as the risks of harm to revived organisms that are introduced. Sherkow & Greely, *supra* note 17, at 32.

43. Some studies have found that only five to twenty percent of planned introductions result in the successful establishment of a population of the introduced species. *See* Mark Williamson & Alastair Fitter, *The Varying Success of Invaders*, 77 ECOLOGY 1661, 1662 (1996). Others have found a success rate of about fifty percent. *See* Jonathan M. Jeschke & David L. Strayer, *Invasion Success of Vertebrates in Europe and North America*, 102 PROC. NAT'L ACAD. SCI. 7198, 7198 (2005); M. Jake Vander Zanden, *The Success of Animal Invaders*, 102 PROC. NAT'L ACAD. SCI. 7055, 7055–56 (2005).

44. *See generally* Jeff McNeely, *Invasive Species: A Costly Catastrophe for Native Biodiversity*, LAND USE & WATER RESOURCES RES., 2001; INVASIVE SPECIES IN A CHANGING WORLD (H.A. Mooney & R.J. Hobbs eds., 2000).

movement as an adaptation strategy for managing the effects of climate change.[45] The history of natural resources management is rife with notorious examples of non-native introductions—some even intended to minimize other human effects on ecological resources—that nonetheless led to extensive unintended ecological harm to receiving areas.[46] As such, introductions risk disrupting receiving biological communities and, rather than increase biodiversity or ecological function, may serve to decrease it.[47] In particular, the intentional introduction of a revived species into a biotic community of which it was never a constituent might be regarded as necessarily a degradation of native biotic communities and natural ecosystems, akin to an invasive species that makes the existing community ostensibly less authentic.

In addition to anticipated risks, however, are the possible unanticipated harms of introductions of revived species. Scholars have raised various uncertainties that inhibit the capacity to evaluate, anticipate, and minimize the harms of intentional introductions for existing species on receiving ecosystems.[48] Retrospective empirical studies of circumstances in which certain species became invasive, while others did not, do not yield clear answers.[49] Even species that were vulnerable in their native range have become invasive elsewhere, as "the biological traits that promote endangerment are not simply the opposite of those that favor invasiveness."[50] The uncertainties that accompany climate change are likely to further hinder the ability to assess and manage any introductions effectively.[51] As a result, assessing the risks of planned introductions even

45. *See* Ricciardi & Simberloff, *supra* note 41, at 248–50.

46. Prominent examples are the introduction of the kudzu vine (*Pueraria lobata*) for erosion control in the southeastern United States, *Specific Profiles: Kudzu*, USDA NAT'L INVASIVE SPECIES INFO. CENTER, http://www.invasivespeciesinfo.gov/plants/kudzu.shtml (last visited July 2, 2013), *archived at* perma.cc/CMY2-E992, and the introduction in Australia of the cane toad (*Bufo marinus*) to control growth of the cane beetle (*Dermolepida albohirtum*). Margarita Lampo & Giulio A. De Leo, *The Invasion Ecology of the Toad* Bufo marinus*: From South America to Australia*, 8 ECOLOGICAL APPLICATIONS 388, 388–89 (1998).

47. Ricciardi & Simberloff, *supra* note 41, at 250.

48. *Id.* at 251.

49. *See* I.M. Parker et al., *Impact: Toward a Framework for Understanding the Ecological Effects of Invaders*, 1 BIOLOGICAL INVASIONS 3, 3 (1999).

50. Ricciardi & Simberloff, *supra* note 41, at 251.

51. Alejandro E. Camacho, *Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change*, 27 YALE J. ON REG. 171, 186–87 (2010). In light of changing climate conditions, information on the localized effects of climate change on particular biotic communities or species is vital for assessing the potential benefits and risks of an introduction, yet there is considerable uncertainty about such effects for most ecosystems. *See* McLachlan et al., *supra* note 39, at 300–01. Additionally, existing climate models do not attempt to predict how an introduced species will interact with its new biotic community, or how that community will otherwise be altered by climate change.

for existing species is rife with uncertainty.[52] Yet the uncertainties for any introduction of a de-extinct species are likely to be even greater than those for existing species. For most candidates for de-extinction, scientists typically have even less knowledge about the species—including its behavior, adaptations, and compatibility with existing biota and abiotic conditions—than about extant species.[53] This is particularly likely to be the case the more time that has elapsed since a revived species has been extinct.

There are also potential opportunity costs to de-extinction efforts. Some conservationists are concerned that already scarce research and management resources will be diverted from conserving endangered species and existing ecological systems toward more expensive, less proven, and possibly harmful efforts to revive extinct ones.[54] Notably, certain prominent efforts for a few more charismatic endangered species already draw resources from less alluring and arguably more worthy species,[55] and de-extinct efforts might exacerbate this trend.

Relatedly, some raise concerns that the availability of de-extinction technologies might reduce the sense of urgency for preventing extinctions, which has served as a rare effective catalyst for regulatory efforts toward endangered species conservation.[56] Those who are unsympathetic or hostile to conservation efforts might rely on the hope of unproven de-extinction technologies to undermine conservation mandates. The availability of captive breeding of existing endangered species, for instance, comparably has been used to avoid or delay activities that seek to prevent extinctions *in situ*.[57] De-extinction thus might unwittingly erode resources dedicated to endangered species preservation or the protection of existing ecological resources more generally.[58]

See id. (explaining that there is a lack of understanding about community interactions when a range shift is driven primarily by climate change and the potential for invasiveness of species).

52. *See* Ricciardi & Simberloff, *supra* note 41, at 252.

53. *See* Sandler, *supra* note 17, at 356.

54. *See id.* at 358; Donlan, *supra* note 17, at 914.

55. *See* Benjamin M. Simon et al., *Allocating Scarce Resources for Endangered Species Recovery*, 14 J. POL'Y ANALYSIS & MGMT. 415 (1995) (examining the relationship between FWS spending on endangered species recovery and priority rankings assigned by the FWS, in part determining that the likelihood of receiving FWS recovery funding was greater for mammals, birds, and fish); Berta Martín-López et al., *What Drives Policy Decision-Making Related to Species Conservation?*, 142 BIOLOGICAL CONSERVATION 1370, 1370, 1376 (2009) (describing how government conservation funding in the United States and Spain are heavily influenced by public opinion of the species).

56. *See* Sandler, *supra* note 17, at 4–6.

57. *See* Snyder et al., *supra* note 40, at 344.

58. *See* Sandler, *supra* note 17, at 358.

One might reasonably anticipate that legal rules governing whether a species can or should be revived and introduced would be based on an analysis that carefully considered, or at least generally reflected, these potential ecological benefits and risks. Unfortunately, as detailed in Parts II through IV, the various laws and policies governing wildlife management are actually anchored in a set of dualisms that primarily seek to divide biological phenomena between those deemed natural and those deemed manmade, and/or between those labeled native and others labeled exotic. As demonstrated below, these dichotomies largely fail to integrate a coherent methodology for evaluating the various risks and benefits of relying on biotechnologies, like de-extinction, to advance ecological conservation.

II. DUALISM IN ENDANGERED SPECIES LAWS

International, federal and state endangered species conservation laws provide broad prohibitions that may be applicable to both revival activities and those involving potential introductions. The federal Endangered Species Act (ESA)[59] is jointly administered by the Secretary of the Interior through the U.S. Fish and Wildlife Service (FWS) and the Secretary of Commerce through the National Marine Fisheries Service (NMFS), with the FWS managing terrestrial and freshwater species and the NMFS managing marine species.[60] The ESA prohibits the harm, transport, or sale of listed species absent a permit.[61] Most notably, the ESA prohibits any "take" of a listed fish or wildlife species,[62] defined very broadly to include

59. 16 U.S.C. §§ 1531–1544 (2012).

60. *See id.* § 1532(15) (defining "Secretary"); *Id.* § 1533(a)(2); 50 C.F.R. § 424.01 (2005) (FWS/NMFS joint regulations implementing the ESA).

61. 16 U.S.C. § 1538(a).

62. *Id.* § 1538(a)(1)(B). Endangered plants would be subject to fewer restrictions, but nonetheless regulated. For listed plants, the ESA makes it unlawful to (1) import or export, or engage in interstate or foreign commerce; (2) "remove and reduce to possession . . . [or] maliciously damage or destroy," any plant on federal land; or (3) "remove, cut, dig up, or damage or destroy" any listed plant, if in knowing violation of any state law. *Id.* § 1538(a)(2). Accordingly, if a de-extinct plant remains on non-federal land, the ESA likely will not limit the activity that can be undertaken unless state law provides restrictions. *See, e.g.*, Charles B. McDonald, *The Regulatory and Policy Context*, *in* RESTORING DIVERSITY: STRATEGIES FOR REINTRODUCTION OF ENDANGERED PLANTS 87, 90 (Donald A. Falk, Constance I. Millar, & Margaret Olwell eds., 1996); Kevin E. Regan, *The Need for a Comprehensive Approach to Protecting Rare Plants: Florida as a Case Study*, 44 NAT. RESOURCES J. 125, 142 (2004). Various states do, however, provide further limits on activities pertaining to state and/or private lands. *See, e.g.*, California Desert Native Plants Act, CAL. FOOD & AGRIC. CODE § 80002 (2013); Linda McMahan, Comment, *Legal Protection for Rare Plants*, 29 AM. U. L. REV. 515, 545–46 (1980) (noting that a number of states provide greater protection than the ESA). Iowa and

"harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[63] As revival and introduction efforts may often involve confinement, experimentation, and harm to organisms, unless an exception or exemption applies,[64] further revival and introduction efforts could potentially be heavily restricted. Many states[65] and an international treaty[66] have adopted analogous rare species protection laws.

However, as detailed in this Part, the existing ESA and its state and international analogues are fundamentally ill-fitted for providing a comprehensive framework for both revival and introduction of de-extinct species. This is because these laws are fundamentally premised on overly simplistic dichotomies between humans and nature, and between native and non-native, that lead to incongruous results when humans inevitably affect ecological processes or when ecological conditions necessarily shift. Current endangered species preservation laws were largely designed to preserve existing species in their historical and existing habitat, while minimizing those resources deemed to be artificial or artifactual.

Michigan have provisions that provide a broad definition of plants, as well as automatic protections and prohibitions on taking for plants listed under the federal ESA. *Id.* at 546 n.173.

63. 16 U.S.C. § 1532(19). *See also* 50 C.F.R. § 10.12 (2013). Agency regulations and courts have emphasized the breadth of these restrictions. *See, e.g.*, 50 C.F.R. § 17.3 (2013) (defining "harm" to include modification or degradation of habitat that impairs "essential behavioral patterns, including breeding, feeding or sheltering"); Babbitt v. Sweet Home Chapter of Cmtys. for a Great Or., 515 U.S. 687, 697–701 (1995). If a federal agency is involved in managing, funding, or permitting any activities that might affect a listed species, section 7 would require such agency to consult with the FWS, ensure that their activities do not jeopardize the continued existence of any listed species, and ensure that no adverse modification of a listed species' critical habitat would occur. 16 U.S.C. § 1536(a)(2).

64. In addition to the exceptions explored more fully in this section, any individual fish or wildlife member of a de-extinct species that "was held in captivity or in a controlled environment" at the time the species was listed is exempt from the ESA's prohibitions on import/export and any FWS regulations adopted pursuant to the ESA, though any continued use of the fish or wildlife may not be in the course of a commercial activity. 16 U.S.C. § 1538(b). All other statutory restrictions under the ESA would still apply. *See* Am. Soc'y for the Prevention of Cruelty to Animals v. Ringling Bros. & Barnum & Bailey Circus, 502 F. Supp. 2d 103, 109–10 (D.D.C. 2007).

65. Though they differ in their specifics, most state endangered species laws follow the federal ESA template, prohibiting taking an endangered species without a permit. *See* Camacho, *supra* note 51, at 200.

66. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provides "particularly strict regulation" for the "trade"—defined in Article I(c) as "export, re-export, import and introduction from the sea"—of specimens of species that are "threatened with extinction." Convention on International Trade in Endangered Species of Wild Fauna and Flora, art. II(1), Mar. 3, 1973, 27 U.S.T. 1087, 993 U.N.T.S. 243 [hereinafter CITES]. Such trade may be permitted only in exceptional circumstances. *Id.* Moreover, permits for import or introduction may only be granted if "the specimen is not to be used for primarily commercial purposes." *Id.* art. III(3), (5).

When an ecological component is categorized under these laws as a product of human activity (e.g., experimental, exotic), it is treated as tainted and provided less legal protection. Various states, for example, expressly refuse to afford protections under their endangered species laws to species deemed to be exotic.[67] Similarly, endangered species conservation laws focus on promoting resources primarily where they are deemed native, while seeking to minimize the existence of these resources where non-native. In short, these laws primarily seek to protect static pre-existing environments, while ignoring the inevitability of dynamic change in ecological systems and the unavoidable influence of humans in these areas.

Unfortunately, the prevailing focus of these regulatory regimes on preserving existing endangered species, minimizing human development (rather than active recovery of species and habitat), and preserving historical landscapes (or alternatively wild unmanaged land) does not map particularly well with the possible revival and introduction of extinct species. This is unsurprising, as these regulatory regimes were not designed with de-extinction in mind. Nonetheless, it might make the introduction of many revived species difficult, even if such an introduction were expected to have significant ecological benefits. More importantly, de-extinction exposes the problems with adopting these simplistic dualities for endangered species conservation.

A. "Species" and a Focus on Natural

Under the existing ESA, a species could potentially be listed as endangered shortly after revival. A range of issues are triggered by revival, however, beyond the typical scientific questions[68] and political controversies raised by listing a species.[69] In addition to peculiar questions regarding whether a de-extinct organism would be a "species," any

67. *See, e.g.*, ARIZ. REV. STAT. ANN. § 17-296 (2014); FLA. STAT. ANN. § 379.2291 (West 2014); NEV. REV. STAT. ANN. § 503.584(2)(a) (West 2014); N.C. GEN. STAT. § 113-331(2) (2014).

68. Of course, what constitutes a species is contested in the scientific community. *See, e.g.*, Michael J. Donoghue, *A Critique of the Biological Species Concept and Recommendations for a Phylogenetic Alternative*, 88 BRYOLOGIST 172 (1985); Ernst Mayr, *The Ontological Status of Species: Scientific Progress and Philosophical Terminology*, 2 BIOLOGY & PHIL. 145 (1987). However, the category of "species" under the ESA is fundamentally a legal question, not a scientific one.

69. *See, e.g.*, Holly Doremus, *The Purposes, Effects, and Future of the Endangered Species Act's Best Available Science Mandate*, 34 ENVTL. L. 397, 401–02 (2004) (discussing legal, scientific, and political issues in the listing process); J.R. DeShazo & Jody Freeman, *The Congressional Competition to Control Delegated Power*, 81 TEX. L. REV. 1443, 1468 (2003) (finding institutional identities of Congressional committee members had a more significant effect on ESA listing decisions than the ESA's evidentiary requirements).

population of a recently revived organism defined as a species would also need to qualify as "endangered" under the ESA to be subject to the ESA's restrictions. On the face of it, such a determination might seem straightforward, as there initially would only be one or a few organisms of its kind. However, the ESA's fundamental reliance on native range for determinations of endangerment muddies the analysis.

The ESA defines a "species" to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature."[70] Federal law, as does international law,[71] thus relies on a liberal definition of species that expressly treats any subspecies or distinct population segment (DPS) as a separately protected entity, regardless of whether it can breed with other population segments or not.[72] Agency interpretations have defined a DPS as an "evolutionary significant unit,"[73] which is further defined to have two necessary features—discreteness and significance.[74] A de-extinct species would likely satisfy the discreteness condition, as the key factor is a separation from any other populations.[75] All of the relevant factors for significance[76] also appear to suggest a revived species would qualify: (1) the population's *ex situ* existence undoubtedly would qualify as an "unusual ecological setting;" (2) if the revived population subsequently perished, the loss of the population would certainly "result in a significant gap in the range of the taxon;" (3) the de-extinct organism would be the

70. 16 U.S.C. § 1532(16) (2012).

71. Internationally, CITES provides a similar definition for regulated "species" that includes "any species, subspecies, or geographically separate population." CITES, *supra* note 66, art. I(a). CITES also uses the phrase "any readily recognizable part or derivative thereof" to describe a "specimen." *Id.* art. I(b).

72. *Cf.* Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act, 61 Fed. Reg. 4722, 4724 (Feb. 7, 1996) ("The Services do not consider it appropriate to require absolute reproductive isolation as a prerequisite to recognizing a distinct population segment.").

73. Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon, 56 Fed. Reg. 58612, 58618 (Nov. 20, 1991).

74. Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act, 61 Fed. Reg. at 4724. The Services also can consider related factors that are not explicitly listed in the policy. *Id.* at 4725.

75. "Discreteness" is explained as "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors." *Id.* at 4725. If an extinct organism were revived, it would be the species' only specimen, and thus it would necessarily be separated from any other populations.

76. Determinations of whether an organism is "significant" must consider: (1) whether the population inhabits a "unique or unusual" setting; (2) evidence that the loss of the population would result in a "significant gap" in the range of a taxon; (3) whether the population represents the "only surviving natural occurrence of a taxon;" and (4) whether the population "differs markedly from other populations." *Id.*

only surviving occurrence of its kind, though the detail of human involvement in its revival would likely lead to its occurrence not being construed as "natural;" and (4) its existence as a result of genomic engineering marks it as substantially different from any other populations that might be deemed similar. These factors all thus strongly suggest that a de-extinct population would be considered a DPS and a "species" under the ESA.[77]

On the other hand, the fact that a de-extinct species would be, at least in part, an artifact of human action raises questions about the ESA's applicability. Though the express text of the ESA may support protection for human-generated novel species, the ESA, according to some scholars, is implicitly embedded with an assumed human/nature dualism that such species are not covered and only natural species should be protected.[78] De-extinction, however, serves to muddle the line between natural and artifactual; a de-extinct species is at least partially a product of human action even though it previously existed in nature. One scholarly attempt to make sense of this dualism but provide for ESA protection of de-extinct species simply maintains the rigid bifurcation by essentially pushing de-extinct species into the natural category because they "once existed in nature" and are planned for reintroduction "into the wild."[79] Other controversies in interpreting the scope of "species" under the ESA have similarly blurred the human/nature divide, most notably when hatchery fish were initially excluded from consideration by the NMFS in making listing determinations for steelhead salmon.[80]

---

77. *See* Carlin et al., *supra* note 11, at 21 ("[B]oth a textualist and a purposive analysis of the statute seem to demand inclusion of de-extinct species within its scope.").

78. *See id.* at 22 ("The text of the statute might seem to justify ESA listing, but, in our view . . . the ESA was not intended to provide protection for new organisms invented by human beings *ab initio*.").

79. *See id.* (distinguishing de-extinct species as having "once existed in nature, and that the proponents of de-extinction hope and expect eventually to reintroduce them into the wild," while "GMOs engineered as food or pets never existed before and were never intended to be introduced and established in the wild, even though they may be released accidentally").

80. *See* Interim Policy on Artificial Propagation of Pacific Salmon Under the Endangered Species Act, 58 Fed. Reg. 17,573, 17,575 (Apr. 5, 1993) (determining that "in general, [hatchery] fish will not be included as part of the listed species"). NMFS subsequently reversed its approach in its final policy. *See* Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead, 70 Fed. Reg. 37,204, 37,215 (June 28, 2005); Trout Unlimited v. Lohn, 559 F.3d 946, 957 (9th Cir. 2009) (upholding the NMFS decision to include hatchery fish in making listing decision for steelhead salmon). *See also* Andrew Long, *Defining the "Nature" Protected by the Endangered Species Act: Lessons from Hatchery Salmon*, 15 N.Y.U. ENVTL. L.J. 420 (2007).

B. "Endangered" and a Focus on Native Range

Similarly, factors that the Services must consider when evaluating whether to list a species as "endangered" or "threatened" cut both ways for de-extinct species. Under the ESA, a species might be listed as endangered or threatened. The law defines "endangered species" to generally mean "any species which is in danger of extinction throughout all or a significant portion of its range."[81] A "threatened species" includes "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."[82] The ESA's strict protections automatically apply to all listed endangered species; in contrast, after listing a species as threatened, the Service adopts customized regulations under section 4(d) that detail which of these general protections apply to that particular species.[83]

On the one hand, most (but not all) of the factors required for consideration of listing as endangered[84] focus on the existence of human-induced threats to the species or its range. For that reason, a number of them appear to suggest the listing of a de-extinct species as endangered could be appropriate. These factors include (1) the likelihood (without listing) of over-utilization (in light of past human over-utilization); (2) clear manmade factors affecting the species' continued existence (by virtue of the fact that any revived organism would be "manmade" and fully under human possession); and (3) inadequate existing regulatory mechanisms absent listing (as continued existence would be left fully to the discretion of the possessor).[85] Furthermore, courts have found that when determining whether a species is endangered, "the Secretary must determine that a species is exposed to the harm of no longer existing."[86] If only one or a few individuals exist, it is likely those individuals will be

81. 16 U.S.C. § 1532(6) (2012).

82. *Id.* § 1532(20).

83. *Id.* § 1533(d).

84. The ESA requires consideration of the following factors: "(A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence." *Id.* § 1533(a)(1).

85. Courts have found that voluntary actions or actions with no "tangible requirements for improving habitat or reducing threats" are evidence of inadequate regulations. Greater Yellowstone Coal., Inc. v. Servheen, 672 F. Supp. 2d 1105, 1114 (D. Mont. 2009), *aff'd in part and rev'd in part*, 665 F.3d 1015 (9th Cir. 2011).

86. United States v. Hill, 896 F. Supp. 1057, 1062 (D. Colo. 1995).

exposed to harm that could leave the species in a state of no longer existing.

On the other hand, the ESA's conception of endangerment for purposes of listing is fundamentally reliant on an evaluation of the species by reference to its historical and existing native range, making its applicability to de-extinct species confounding. For a species to be "endangered," the ESA expressly requires it to be "in danger of extinction throughout all or a significant portion of its range."[87] However, as a captive laboratory population, a revived de-extinct species would have no discernable current (or even historical) range throughout which it could be considered endangered. Accordingly, this emphasis on a species' range for determining whether the ESA's prohibitions and protections apply makes little sense when applied to a de-extinct species. It is fairly clear that the ESA's listing regime does not contemplate the revival of an extinct species,[88] and the tethering of endangerment to existing range inextricably links value under the ESA to historical conditions and purported naturalness.[89]

C. Captive-Breeding: Preferencing Exotic

Similarly, the ESA's captive-bred wildlife regulations[90]—probably the most directly relevant exception to the ESA's strict prohibitions for revival of de-extinct listed species—are largely premised on simplistically dividing species between those deemed exotic and native. These

87. 16 U.S.C. § 1532(6). The statute's listing factors also require consideration of the "present or threatened destruction, modification, or curtailment of its habitat or range." *Id.* § 1533(a)(1).

88. The Services have relisted species under the ESA from extinct to endangered, which would be the closest analogue to listing a de-extinct species. However, they have done so only when the species was never extinct in the first place. For example, the long-legged thicketbird (warbler) was thought to be extinct until 2003 when it was rediscovered and listed as endangered. *See* Endangered and Threatened Wildlife and Plants; Final Rule To List Six Foreign Birds as Endangered, 73 Fed. Reg. 3146, 3179 (Jan. 16, 2008).

89. Though the standard listing process is elaborate and often time consuming, 16 U.S.C. §§ 1533(b)(3)–(6); 50 C.F.R. § 424.14 (2013); Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 Fed. Reg. 43098 (Sept. 21, 1983) (providing guidelines for ranking species for listing priority), the ESA does include a potentially applicable fast-track listing process if there is an emergency that poses a "significant risk to the well-being" of a species. 16 U.S.C. § 1533(b)(7). *See also* City of Las Vegas v. Lujan, 891 F.2d 927, 933 (D.C. Cir. 1989) (stating that the only restriction on the Services when making an emergency listing decision is to not disregard scientific evidence that is better than the evidence relied upon in making the decision).

90. 50 C.F.R. § 17.21(g) (2013).

regulations provide a federal permitting process[91] for activities involving fish or wildlife that are held or bred in captivity.[92] Among the various requirements, the activity must "enhance the propagation or survival" of the species,[93] and the species must either be not native to the United States or determined to be well protected in the wild.[94] Under such a permit, behavior that would normally constitute harassment nonetheless would not violate the ESA.[95] As such, these regulations serve to authenticate the disparate treatment of captive-bred organisms that are considered a human artifact (and thus for which human manipulation is acceptable) from those wild populations that are deemed natural.[96] Indeed, the FWS has often made this distinction more explicit by developing separate listing decisions for captive-bred populations and their wild counterparts, in which the restrictions on the captive populations are significantly less restrictive than those for wild populations.[97]

---

91. Applicants must qualify through a registration process in which the FWS must find that "the expertise, facilities or other resources available to the applicant appear adequate to enhance the propagation or survival of the affected wildlife." *Id.* § 17.21(g)(3).

92. 16 U.S.C. § 1538(b); 50 C.F.R. §17.21(g) (allowing, provided certain conditions are met, any person to "take; export or re-import; deliver, receive, carry, transport or ship in interstate or foreign commerce, in the course of a commercial activity; or sell or offer for sale in interstate or foreign commerce any endangered wildlife that is bred in captivity").

93. 50 C.F.R. §17.21(g)(1)(ii). *See also id.* § 17.3 (defining "enhance the propagation or survival" as including certain management of populations and animal husbandry; accumulation, holding and transfer of wildlife; and exhibition of living wildlife for conservation education). As such, commercial activities unrelated to conservation, for example, would be impermissible.

A number of states also expressly allow permits to enhance the propagation or survival of the species. KAN. STAT. ANN. § 32-961 (2009); LA. REV. STAT. ANN. § 56:1904 (2009); ME. REV. STAT. ANN. tit. 12, § 12808 (2009); MD. CODE ANN., NAT. RES. § 10-2A-05(f) (West 2010); MINN. STAT. ANN. § 84.0895 (West 2010); NEB. REV. STAT. ANN. § 37-806(11) (LexisNexis 2010); N.H. REV. STAT. ANN. § 212-A:7 (2010); VT. STAT. ANN. tit. 10, § 5408 (2010).

94. 50 C.F.R. § 17.21(g). Other conditions include that the activity does not involve interstate or foreign commerce with respect to non-living wildlife, and that any specimens are uniquely identified. *Id.*

95. *Id.* § 17.3 (specifically noting that the definition of "harass" does not include generally accepted husbandry practices, breeding procedures, or veterinary care). Similarly, under CITES, an animal specimen that is bred in captivity for commercial purposes, or a plant specimen artificially propagated for commercial purposes, that is otherwise listed as threatened is regulated as potentially threatened. *See supra* note 66, art. VII(4).

96. 50 C.F.R. § 17.3.

97. *See, e.g.*, Endangered and Threatened Wildlife and Plants; Reclassification of Ranched Nile Crocodile Populations in Zimbabwe from Endangered to Threatened, 52 Fed. Reg. 23,148 (June 17, 1987); Endangered and Threatened Wildlife and Plants; Revised 12-Month Finding to List the Upper Missouri River Distinct Population Segment of Arctic Grayling as Endangered or Threatened, 75 Fed. Reg. 54,708, 54,712–13 (Sept. 8, 2010); Endangered and Threatened Wildlife and Plants; Final Rule to List the Arkansas River Basin Population of the Arkansas River Shiner (*Notropis girardi*) as Threatened, 63 Fed. Reg. 64,772 (Nov. 23, 1998); Endangered and Threatened Wildlife and Plants; Endangered Status for Chimpanzee and Pygmy Chimpanzee, 55 Fed. Reg. 9129 (Mar. 12, 1990).

Accordingly, the ESA's captive-bred wildlife regulations might provide a potential pathway for certain genetic-engineering activities related to the continued propagation of a listed de-extinct species. No mention is made in the captive-bred wildlife regulations regarding genetic engineering or other genetic technologies yet. However, activities carried out pursuant to the captive-bred wildlife regulations certainly parallel those involved in the revival of extinct species. In this regard, the ESA does anticipate the possibility of some human management of listed species, which might serve as a reference for de-extinction revival activities.

Nevertheless, these regulations appear to create anachronistic distinctions in light of the advent of de-extinction technologies. As stated earlier, FWS regulations provide that, in general, permits can only be granted for species whose natural geographic distribution is *not* in the United States.[98] The only exception—allowing for species native to the United States to be captively bred—is if the FWS Director determines that the species is eligible because (1) there is low demand for taking wild populations, and (2) wild populations "are effectively protected from unauthorized taking as a result of the inaccessibility of their habitat to humans or as a result of the effectiveness of law enforcement."[99] Accordingly, the ESA's captive breeding program appears to require species to be exotic or well protected in the wild. Of course, any recently de-extinct species is not going to be protected in the wild, as there would be no wild population. As such, a revival program for native extinct species would be very difficult under the ESA's existing framework for captive-bred wildlife.[100]

D. Introductions: Preferencing "Natural" and "Native"

Like those provisions governing breeding activities, the ESA's provisions likely to govern the introduction of revived species into ecological systems rely on simplistic dualisms that make little sense in

98. 50 C.F.R. § 17.21(g)(1)(i).

99. *Id.* § 17.21(g)(5). The Laysan duck (*Anas laysanensis*) is the only native species to date ever granted eligibility under this provision. *See id.* § 17.21(g)(5)(iii); U.S. FISH & WILDLIFE SERV., CAPTIVE-BRED WILDLIFE REGISTRATION UNDER THE U.S. ENDANGERED SPECIES ACT 1 (2012), *available at* http://www.fws.gov/international/pdf/factsheet-captive-bred-wildlife-and-endangered-species-act-2012.pdf.

100. As these captive-bred wildlife regulations only are available for wildlife species, not plants, the likely avenue for cultivation of revived plants listed as endangered is through permits for scientific purposes or for enhancement of propagation or survival. *Id.* § 17.62. See *infra* note 130 for more detailed analysis of scientific permits.

light of de-extinction. First, these regulations create distinctions that disfavor introduced populations over "natural" ones. Second, in emphasizing historical range, these provisions heavily focus on a dichotomy between native and non-native. In direct contrast to the captive-bred regulations' primary focus on propagating exotic species, however, those regulating introduction heavily favor introductions of historically native species—regardless of the species' compatibility with existing conditions. De-extinction again demonstrates the incongruity of this approach.

ESA section 10(j) allows the re-introduction of any endangered animal or plant[101] species through a permitting process for "experimental populations."[102] Importantly, this introduction program is fundamentally grounded in treating populations that are introduced and actively managed by humans differently from those that are deemed to be wild or natural. Section 10(j) allows "experimental population" introductions "only when, and at such times as, the population is wholly separate geographically from nonexperimental populations of the same species."[103] In addition, FWS regulations allow required protective management measures for experimental populations to include measures that isolate and/or contain the experimental population from natural populations.[104] Thus, FWS regulations actively seek to keep wild populations distinct from experimental populations. FWS accordingly has engaged in active population segregation efforts, including capturing and controlling reintroduced animals to keep populations apart.[105]

Moreover, the ESA and FWS regulations establishing this division include various provisions that treat experimental populations as less

101. If derived from non-public stock and proposed for non-federal land, an introduction of a listed plant may occur without a permit or listing the plant as an experimental population. *See, e.g.*, Holly Doremus, *Restoring Endangered Species: The Importance of Being Wild*, 23 HARV. ENVTL. L. REV. 1, 22 (1999) ("It has also been reported that 'plant reintroductions are occurring regularly without formal listing as experimental populations.'").

102. 16 U.S.C. § 1539(j) (2012). Before authorizing any release of an experimental population, FWS "must find that the release will further the conservation of the species." 50 C.F.R. § 17.81(b). When making this determination, the Secretary must consider (1) "possible adverse effects on extant populations," (2) "the likelihood that [the] experimental population will become established and survive," (3) the potential effects of the population's establishment on the species' recovery, and (4) "the extent to which the introduced population may be affected by [other] activities within or adjacent to the experimental population." *Id.*

103. 16 U.S.C. § 1539(j); 50 C.F.R. § 17.80(a).

104. 50 C.F.R. § 17.81(c).

105. *See* Federico Cheever, *From Population Segregation to Species Zoning: The Evolution of Reintroduction Law Under Section 10(j) of the Endangered Species Act*, 1 WYO. L. REV. 287, 294 (2001).

valuable. As a consequence of being designated as experimental, members of a species that is listed as endangered nonetheless receive significantly less protection than analogous wild populations.[106] "Essential experimental populations,"[107] and any experimental populations on a National Park or National Wildlife Refuge, are generally only subject to the less-stringent restrictions imposed on activities related to threatened species.[108] Nonessential experimental populations are even less protected; they generally are subject only to a portion of the restrictions on species proposed to be (but not yet) listed as threatened or endangered.[109] In practice, the FWS always designates an experimental population as nonessential, affording them the least protection under the ESA.[110]

The purpose of establishing this division may have been to facilitate reintroduction efforts "by providing assurances to those people who might be burdened by the reintroduction and, therefore, might oppose it."[111] However, it nevertheless reinforces a fallacious duality between those biological resources that are human managed and those that are not.[112] In doing so, it enshrines in the legal system an ostensibly "natural" ecological baseline of those conditions that existed as of the ESA's enactment in 1973, while treating any ecological enhancements as human artifacts and less valuable. Such a legal fiction can lead to illogical results when applied, particularly when "experimental" and "natural" populations intermingle.[113] Perhaps most importantly, the segregation and discounting serve to frustrate the overriding goals of introduction efforts: promoting the acceptance of introductions, species recovery, and the ecological

106. 16 U.S.C. § 1539(j).

107. FWS regulations further classify experimental populations as essential or nonessential, with an "essential experimental population" defined as an "experimental population whose loss would be likely to appreciably reduce the likelihood of the survival of the species in the wild." 50 C.F.R. § 17.80(b). All other experimental populations are categorized as nonessential. *Id.*

108. 16 U.S.C. § 1539(j)(2)C); 50 C.F.R. 17.83(b).

109. 16 U.S.C. § 1539(j)(2)C)(i); 50 C.F.R. 17.83(a).

110. *See* Cheever, *supra* note 105, at 292 ("[FWS] . . . appl[ies] the lowest level of protection authorized by section 10(j)—the 'experimental non-essential' designation—to every formally reintroduced population.").

111. *Id.*

112. *Cf.* Klein, *supra* note 25, at 1379 ("Once tainted by human intrusion, so-called 'experimental populations' lose many of the protections afforded to their wilder counterparts, creating a dichotomy.").

113. *See id.* at 1379 ("[A]bsurd results might occur when reality confronts the legal fiction that reintroduced populations are distinct from naturally occurring populations.").

health of the reserved land into which a species is introduced. As stated by Professor Cheever:

> This need to prevent overlap can frustrate recovery by encouraging wildlife managers to actively isolate experimental and naturally occurring populations. Preventing population interaction can endanger the genetic health and recovery prospects of the species. Second, the "wholly separate geographically" requirement can frustrate recovery by creating confusing regulatory variation concerning members of the same species, thereby aggravating any burden placed on humans whose activities may be affected by reintroduction. This not only frustrates the long-term goal of recovery by turning people against the protected species, but also frustrates the primary goal of section 10(j), facilitating acceptance of reintroduction among affected human populations.[114]

In addition to this engineered duality between human managed and natural resources, ESA regulations on introduction create a crude duality between native and non-native resources by making it a key division whether or not an introduction is proposed within a species' historical native range. Regulations promulgated by FWS give the Secretary authority to introduce an experimental population "outside the species' current natural range," but "within its probable historic range."[115] The only exception—allowing introduction outside of a species probable historical native range—is in "the extreme case that the primary habitat of the species has been unsuitably and irreversibly altered or destroyed."[116]

The FWS, when it adopted this regulation, emphasized that non-native introductions should be exceptionally rare.[117] It justified this by highlighting the fundamental importance of the native/non-native distinction in the ESA, explaining that the ESA is premised on conserving species in native ecosystems, and expressing that the ESA's purposes would be violated if the FWS regularly allowed "the introduction of listed species into new habitat areas as exotic species."[118] Moreover, the FWS

114. Cheever, *supra* note 105, at 291.

115. 50 C.F.R. § 17.81(a) (2013).

116. *Id.*

117. *See* Endangered and Threatened Wildlife and Plants; Experimental Populations, 49 Fed. Reg. 33,885, 33,890 (Aug. 27, 1984) ("Long-standing Service policy provides that the relocation or transplantation of native listed species outside their historic range will not be authorized as a conservation measure.").

118. *See id.* ("[T]he purposes and policies of the Act would be violated if the Service were to regularly permit the introduction of listed species into new habitat areas as exotic species. Under [the ESA], the Service must commit itself to ecosystem protection . . . . Generally, the transplantation of

emphasized that other federal invasive species laws prohibit "the introduction of exotic, foreign species into the natural ecosystems of the United States."[119] Accordingly, the FWS has been very reluctant to allow non-native introductions, permitting only two cases since the creation of the ESA.[120] Even these cases—the red wolves that were moved to Carolina coastal islands and the Guam rail that was introduced to the island of Rota—were intended to only be temporary translocations, with the FWS paying particular attention to reversing these incursions into non-native areas.[121] Other FWS policies reinforce this emphasis on introductions only within historical native range. The "controlled propagation" policy,[122] which allows the use of genetic engineering techniques and introductions of listed species only as part of a federally approved recovery plan,[123] also restricts any introductions outside the species' "historic" native range.[124]

As de-extinct species have no natural habitat and their ranges will often be at most unclear, their introduction raises a couple of fundamental problems in the application of these native/exotic dualities. First, whether a species would be considered native or non-native for purposes of section 10(j) hinges on whether a revived organism would be considered the same or a different species from previously extinct species. As explored earlier, such a determination is not a straightforward proposition.[125]

Yet the application of this provision is problematic regardless of which interpretation is adopted. If the de-extinct population were to be considered a novel species for the purposes of the ESA, then it could not

---

listed species to non-native habitat abandons the statutory directive to conserve species in native ecosystems.").

119. *See id.*

120. *See* Camacho, *supra* note 51, at 203.

121. *See id.*

122. Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act, 65 Fed. Reg. 56,916 (Sept. 20, 2000).

123. *See id.* at 56,919–20 (stating that any "controlled propagation" activities must occur only when specifically provided for in an adopted recovery plan under the ESA, with a genetics management plan whenever practical). In addition, the FWS has stated that "intercrossing"—"[a]ny instance of interbreeding or genetic exchange between individuals of different species, subspecies, or distinct population segments of a vertebrate species"—"will not be considered for use in controlled propagation programs unless recommended in an approved recovery plan; supported in an approved genetic management plan . . . ; implemented in a scientifically controlled and approved manner; and undertaken to compensate for a loss of genetic viability in listed taxa that have been genetically isolated in the wild as a result of human activity." *Id.*

124. *See id.* at 56,919 (stating activities permitted include "[p]roducing individuals for reintroduction to suitable habitat within the species' historic range"); *see also id.* at 56,920 (stating any controlled propagation activities must be "[c]onducted in a manner that will prevent the escape or accidental introduction of individuals outside their historic range").

125. *See supra* notes 70–77 and accompanying text.

have an historical native range. Furthermore, FWS arguably could not allow introductions of the species because it would have no habitat that could have been irreversibly altered or destroyed. Even if the de-extinct population were not considered a new species—but rather sufficiently similar to justify being treated as part of a pre-existing species—it is nonetheless unclear what to use to determine the appropriate historical range. Under the ESA, "historic range" has typically been analyzed as the range of the species in the recent ecological past, typically the period immediately preceding industrialized human settlement.[126] However, the exact historical baseline under the ESA remains ambiguous; in the context of section 10(j) or otherwise,[127] FWS regulations and guidance do not identify any particular date for determining "historic range."[128] A pre-industrial baseline would be consistent with the approach relied upon in conservation biology and other natural resource management contexts, in which the ecological baseline for evaluating a North American species' historical range routinely has been at or before European settlement.[129]

For any de-extinct species—whether prehistoric or extirpated more recently—it is unclear why a baseline of Columbus' arrival to the Western hemisphere would be defensible. Particularly for the many species being considered for de-extinction whose extinct predecessors perished before

126. *See, e.g.*, Fish and Wildlife Service, Reintroduction of the Mexican Wolf Within Its Historic Range in the Southwestern United States, Final Environmental Impact Statement 1–3, 5–106 (Nov. 1996) (finding the probable historic range of the Mexican Wolf for identification as an experimental population by reference to scientific studies of range before modern settlement and late-nineteenth and early-twentieth century documentation of the species' range).

127. Most of the judicial and regulatory discussion under the ESA about the concept of range focuses on determining whether a species qualifies as an endangered or threatened species "throughout all or a significant portion of its range." 16 U.S.C. § 1532(6) (2012) (defining "endangered species"); *Id.* § 1532(20) (defining "threatened species"). Neither the ESA nor the implementing regulations define "significant portion of its range." Sherry A. Enzler & Jeremy T. Bruskotter, *Contested Definitions of Endangered Species: The Controversy Regarding How to Interpret the Phrase "A Significant Portion of a Species' Range"*, 27 VA. ENVTL. L.J. 1, 8 (2009). The FWS has interpreted this as referring to current range and not historical range. *See* Memorandum from U.S. Dep't of the Interior, Office of the Solicitor to Dir. of U.S. Fish and Wildlife Serv. 7 (Mar. 16, 2007), *available at* http://www.doi.gov/solicitor/opinions/M-37013.pdf.

128. The recovery planning guidelines, upon which introductions under § 10(j) are supposed to be based, do include language that implies the Services should simply use the "best available information" when determining historic range. *See* NAT'L MARINE FISHERIES SERV., INTERIM ENDANGERED AND THREATENED SPECIES RECOVERY PLANNING GUIDANCE VERSION 1.3 §§ 5.1, 6.3 (2010). However, no period is expressly identified for evaluating such range.

129. *See* Donlan, *supra* note 31, at 913 ("North American conservationists routinely turn to the arrival of Columbus in 1492 as a restoration benchmark."); Stephen T. Jackson & Richard J. Hobbs, *Ecological Restoration in the Light of Ecological History*, 325 SCIENCE 567, 567 (2009) ("Restoration targets in the 'New Worlds' of the Americas, Australia, and Oceania are identified as the 'natural' states existing at the time of European discovery and conquest, that is, just before disruptions associated with land clearance, agriculture, grazing, and wildfire control.").

European settlement, such a baseline would provide no historical range. More importantly, this emphasis on preserving or restoring historical locations of species largely ignores the more important issue of an introduction's potential compatibility with the existing biotic community or climatic conditions. As such, de-extinction again provides a vivid demonstration of the limitations of existing endangered species law's myopic focus on advantaging "natural" populations and preserving native, rather than assessing the potential benefits and risks in light of current ecological conditions.[130]

III. DUALISM IN OTHER WILDLIFE AND PUBLIC LAND LAWS

International, national, and state laws managing wildlife and public lands vary considerably in their particular language and scope. In the United States, no federal law has ever comprehensively managed the movement of biota. However, an array of legal provisions and definitions directly affect species migration and introduction, and a variety of governmental bodies have addressed problems that arise from non-indigenous species.[131] Most directly, there are many international, federal, and state invasive species laws that focus on prohibiting, restricting, and/or managing the movement of plants and animals into, out of, or within their jurisdictional borders. These laws vary in scope but often institute a permitting process for importation[132] and/or release[133] of certain

130. Another possible exception to the ESA's restrictive prohibitions might be a permit under section 10(a)(1)(A) "for scientific purposes or to enhance the propagation or survival of the affected species." 16 U.S.C. § 1539(a)(1)(A). *See also* 50 C.F.R. § 17.22(a)(2) (2013) (for endangered fish or wildlife); *id.* § 17.62(b) (for introductions of listed plants on federal land). Most states also provide for similar permits. *See, e.g.*, CAL. FISH & GAME CODE § 2081 (West 2013); N.Y. ENVTL. CONSERV. LAW § 11-0535 (McKinney 2013); OHIO REV. CODE ANN. § 1531.25 (West 2012); LA. REV. STAT. ANN. § 56:1904 (2013). These permits are typically used "to allow for scientific research on a listed species in order to understand better the species' long-term survival needs." U.S. FISH & WILDLIFE SERV., PERMITS FOR NATIVE SPECIES UNDER THE ENDANGERED SPECIES ACT 2 (2013), *available at* http://www.fws.gov/endangered/esa-library/pdf/permits.pdf. As such, a permit under section 10(a)(1)(A) might better fit continued revival activities, though it might be available for introductions as well. However, any subsequent activities that affect populations authorized pursuant to section 10(a)(1)(A) would still be subject to the general restrictions on the take or movement of listed species. As such, the FWS has only relied on this provision to allow proposed introductions in the unusual circumstance that such an introduction would raise little controversy. *See* Camacho, *supra* note 51, at 204. Most efforts to introduce a population of a de-extinct species, however, are likely to be especially contentious.

131. Marc L. Miller, *The Paradox of U.S. Alien Species Law*, 35 ENVTL. L. REP. 10,179, 10,179 (2005).

132. *See, e.g.*, ALASKA STAT. § 16.05.921 (2010); ARIZ. REV. STAT. ANN. § 17-306 (2010); IOWA CODE ANN. § 481A.47 (West 2009).

133. *See, e.g.*, ARIZ. REV. STAT. ANN. § 17-306; CAL. FISH & GAME CODE § 3515 (West 2010)

species, with some regimes developing lists of prohibited species[134] while others elect to generate lists of species not requiring permits.[135]

As approximately twenty-eight percent of all the land in the United States is federally owned and managed,[136] federal and other public land management laws also serve to significantly affect wildlife movement. Each of the major federal and state lands is subject to a different statutory regime, with each administering agency promulgating regulations and guidance further interpreting its authority. At the federal level, these include: (1) the 193 million acres of National Forests managed by the United States Forest Service (USFS) pursuant to the National Forest Management Act;[137] (2) the nearly 248 million acres of Bureau of Land Management (BLM) land managed under the Federal Land Policy and Management Act of 1976;[138] (3) the national park system managed by the National Park Service (NPS), which includes over fifty-two million acres of designated National Parks[139] managed under the National Park Service Organic Act;[140] (4) approximately 89 million acres of terrestrial Federal Wildlife Refuges administered by the FWS pursuant to the National Wildlife Refuge System Improvement Act;[141] and (5) over nineteen million acres of land managed by the Department of Defense (DoD).[142] Moreover, 109 million acres of the above-listed federal lands are specially designated by Congress to be federal wilderness [143] and subject to an additional overlay of regulation pursuant to the Wilderness Act of 1964.[144]

("Exotic nonresident game birds may be released in this State only on prior approval of the commission."); N.C. GEN. STAT. § 113-292 (2009) (requiring a permit from a commission to release non-indigenous wild animals or birds to stock an area for hunting).

134. *See, e.g.*, ALA. ADMIN. CODE r. 220-2-.26, 220-2-.93 (2009); GA. CODE ANN. §§ 27-5-4, 27-5-5 (2009); 3 PA. CONS. STAT. ANN. § 4219(a) (West 2008).

135. *See, e.g.*, ILL. ADMIN. CODE tit. 17, § 870.10(a)–(b) (2010).

136. ROSS W. GORTE ET AL., CONG. RESEARCH SERV., FEDERAL LAND OWNERSHIP: OVERVIEW AND DATA 3 (2012), *available at* http://fas.org/sgp/crs/misc/R42346.pdf.

137. 16 U.S.C. §§ 1600–87 (2006). The Forest Service's Organic Administration Act of 1897, 16 U.S.C. § 475 (2006), created the USFS, and the Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. §§ 528–31 (2006), broadened the use objectives of the national forests to include "outdoor recreation, range, timber, watershed, and wildlife and fish purposes." *Id.* § 528.

138. 43 U.S.C. §§ 1701–1785 (2006).

139. U.S. CENSUS BUREAU, STATISTICAL ABSTRACT OF THE UNITED STATES 772 (2012), *available at* https://www.census.gov/compendia/statab/2012/tables/12s1254.pdf.

140. 16 U.S.C. § 1.

141. *Id.* § 668dd.

142. GORTE ET AL., *supra* note 136, at 1, 13.

143. *See The Beginnings of the National Wilderness Preservation System*, WILDERNESS.NET, http://www.wilderness.net/index.cfm?fuse=NWPS&sec=fastfacts (last visited Sept. 22, 2014), *archived at* perma.cc/34C3-K7KU.

144. 16 U.S.C. §§ 1131–36.

These invasive species and public land management laws have much in common in their suppositions and goals for managing ecological systems. As with endangered species laws, invasive species and public land laws treat species' movement—in particular, any human-aided movement—with skepticism, to be resisted. In contrast, previously present biota and ecological inertia are treated as almost undeniable virtues.

Many of these legal provisions are premised on a static, preservationist model of ecology that seeks to preserve species only where they exist or existed. Generally, the predominant motivation of this strain of wildlife law is to protect or promote native preexisting species, combined with seeking to keep exotic species from ecologically significant areas. These provisions draw from the prominent approach in natural resources law that is largely focused on a goal of *historical* preservation: preserving fidelity to historical conditions and preexisting biota, thus setting up a dualism between native and alien resources.[145]

Alternatively (or at times in addition), legal regimes seeking to manage wildlife incorporate a focus on keeping humans separate from, and largely passive in their management of, these resources. The goal of such legal provisions is to avoid or minimize human involvement in species movement or the progression of reserved ecological areas. Such reserved lands and biota are explicitly or implicitly considered valuable in large part because they are deemed wild or natural, separate from humans, and not artificial or an artifact of human activity.[146] Accordingly, the

145. *See, e.g.*, National Park Service Organic Act, 16 U.S.C. § 1 ("[T]o conserve the scenery and the natural and historic objects and the wild life therein . . . unimpaired for the enjoyment of future generations."). This preservation goal mandates that the NPS cannot approve an action if it could lead to the impairment of any preexisting resources or values of a national park. *See, e.g.*, NAT'L PARK SERV., MANAGEMENT POLICIES 2006 § 4.1 (2006) [hereinafter NPS MANAGEMENT POLICIES], *available at* http://www.nps.gov/policy/mp2002.pdf ("[P]reserving park resources and values unimpaired is the core or primary responsibility of NPS managers."); *id.* § 4.4.1 ("The National Park Service will maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems."). *See also* U.S. FISH & WILDLIFE SERV., FISH & WILDLIFE SERVICE MANUAL, 601 FW 3.6D (1992) [hereinafter FWS MANUAL], *available at* http://www.fws.gov/policy/manuals/ (defining historic conditions as "[c]omposition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human related changes to the landscape"); *id.* 3.12.

146. *See, e.g.*, LINDA H. GRABER, WILDERNESS AS SACRED SPACE 11 (1976); HOLMES ROLSTON, ENVIRONMENTAL ETHICS: DUTIES TO AND VALUES IN THE NATURAL WORLD 238 (1988) ("If we come to a landscape on its own terms, sensitive to its integrity, wild is always a positive predicate."); Eric Katz, *Restoration and Redesign: The Ethical Significance of Human Intervention in Nature*, 9 RESTORATION & MGMT. NOTES 90, 92 (1991); Holly Doremus, *The Endangered Species Act: Static Law Meets Dynamic World*, 32 WASH. U. J.L. & POL'Y 175, 205–06 (2010) (stating that traditional conservation strategies, including preserves, assume "that what nature needs most is for people to leave it alone").

Wilderness Act of 1964[147] and other legal provisions principally target a goal of *natural* or *wildness* preservation: preserving the ostensibly natural or wild character of reserved resources.[148]

However, reliance on native/exotic and human/nature dichotomies for invasive species and public lands law and management conflicts with current scientific understanding, disregards the pervasive effects of humans on natural systems, and ultimately fails to foster the effective protection of ecological resources and their services.[149] Ecological systems are widely understood to be dynamic and their constituents not immutable.[150] Furthermore, humans increasingly interact with and shape virtually every ecological system throughout the globe, although the directness and extent of these effects vary.[151] Perhaps more importantly, by cordoning off areas to be reserved for certain pre-existing resources (while keeping out all others), wildlife laws may impair the ecological function of reserved areas if conditions change and make the area inhospitable for the pre-existing resources. Similarly, tying determinations of the value of a species' movement to whether human involvement exists systematically disadvantages human-aided species movement and bars introduction of ecological resources that may well improve ecosystem function.

As further detailed in this Part, de-extinction brings these various incompatibilities into sharp focus. For legal provisions that emphasize historical preservation and the native/non-native divide, the introduction of

147. 16 U.S.C. §§ 1131–36.

148. *Id.* § 1131(a). Though wilderness areas may often provide other value, the defining characteristic and goal of wilderness is that it is "untrammeled, . . . undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions." *Id.* § 1131(c).

149. *See infra* Part IV.A for a detailed discussion of the incompatibility of legal dualisms with ecological dynamics and inescapable human influence on ecological resources.

150. *See* A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV. 1121, 1122–23 (1994) ("[T]he equilibrium paradigm has been rejected in ecology and replaced with a complex, stochastic nonequilibrium one."); Alejandro E. Camacho, *Transforming the Means and Ends of Natural Resources Management*, 89 N.C. L. REV. 1405, 1434 (2011) (stating the equilibrium model of ecology that stresses the natural stability of ecosystems has been widely discredited for failing to reflect the dynamism of ecosystems).

151. *See, e.g.*, MATHIS WACKERNAGEL & WILLIAM REES, OUR ECOLOGICAL FOOTPRINT: REDUCING HUMAN IMPACT ON THE EARTH 4 (1996) ("[T]he human enterprise cannot be separated from the natural world even in our minds because there is no such separation in nature."); BILL MCKIBBEN, THE END OF NATURE (2006) (arguing that the concept of nature as a force independent from humankind is no longer tenable); J.B. Ruhl, *The Pardy-Ruhl Dialogue on Ecosystem Management, Part IV: Narrowing and Sharpening the Questions*, 24 PACE ENVTL. L. REV. 25, 30–31 (2007) (arguing that "naturalness" and the "natural/unnatural dichotomy" are human constructs and therefore subjective).

a de-extinct species might be deemed permissible if initiated in a geographic area in which its previously extinct brethren historically existed, regardless of the harm it might create or its compatibility with the area's conditions. Such an introduction would also be barred in areas in which the species never existed, regardless of its potential ecological benefits to the area or compatibility with existing conditions.

Similarly, as detailed in this Part, for legal provisions that seek to promote wildness preservation and the human/nature dualism, any introduced de-extinct species would be deemed exotic because humans instigated its presence. A subset of such jurisdictions would only bar an introduced de-extinct species if the jurisdiction also concluded that the species would be harmful to current resources. Yet even such a standard would prevent introductions that (though harmful to some existing resources) might still provide net ecological benefit to the area. Moreover, for the subset of wildness preservation provisions that do not require harm for non-native species to be deemed invasive, any introduction of a de-extinct species would be barred, regardless of its benefits—possibly even where the de-extinct species' previously extinct brethren historically existed. As further explained below, continued reliance on these various incongruous distinctions is unlikely to promote the long-term health of ecological resources.

A. De-Extinction and the Problem of "Native"

1. Promoting "Native"

In general, wildlife and public land laws manage biota very differently depending on whether an organism is native to the area in question. In most jurisdictions, native species benefit from a range of proactive measures that seek to protect, promote, and restore native ecosystems and natural processes. Many federal land agencies, for instance, identify their primary ecological goal to be sustaining and enhancing native ecological systems and species. The NPS has long made the core ecological aim in managing National Parks the protection of preexisting ecosystems and species,[152] and engages in active steps to promote or restore historical

152. *See* NPS MANAGEMENT POLICIES, *supra* note 145, § 4.4.1 ("The National Park Service will maintain as parts of the natural ecosystems of parks all plants and animals native to park ecosystems."). *See also* A. Starker Leopold et al., *Wildlife Management in the National Parks*, *in* TRANSACTIONS OF THE TWENTY-EIGHTH NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE 29, 29–44 (James B. Trefethen ed., 1963).

conditions.[153] The DoD provides for the promotion of "native ecosystems."[154] Similarly, the FWS focuses its efforts in managing National Wildlife Refuges on the preservation and restoration of native ecosystems and species to "historic conditions" and the promotion of "natural diversity" on their lands.[155] The USFS's new planning regulations state that a key purpose is to "both maintain the diversity of plant and animal communities and the persistence of native species in the plan area."[156] Other USFS policies provide that active management of native species in national forests is acceptable to avoid extirpation of a rare or poorly distributed species,[157] as is restoration of native species to "minimize or reverse adverse ecosystem effects caused by invasive species."[158] The conservation focus of these federal land provisions thus is not on dividing humans from nature, but on the historical preservationist goal of promoting or restoring native or preexisting conditions.

Even those legal provisions that fortify a dualism between avowed natural conditions and human activity nevertheless tolerate some human intervention on behalf of native resources. As "perhaps the best legislative

153. *See* NPS MANAGEMENT POLICIES, *supra* note 145, § 4.4.2.5 ("In altered plant communities managed for a specified purpose, plantings will consist of species that are native to the park or that are historically appropriate for the period or event commemorated."); *id.* § 4.4.2.3 ("The Service will survey for, protect, and strive to recover all species native to national park system units that are listed under the [ESA] . . . . [T]he Service will inventory other native species that are of special management concern to parks . . . and will manage them to maintain their natural distribution and abundance."); *id.* § 4.4.1.2 ("The Service will strive to protect the full range of genetic types (genotypes) of native plant and animal populations in the parks.").

154. Dep't of Def., *Developing Novel Ecosystems that Enhance Carbon Storage, Native Biodiversity, and Human Mobility in Lowland Hawaiian Forests*, SERDP, http://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/Land-Use-and-Carbon-Management/RC-2117 (last visited Oct. 3, 2013), *archived at* perma.cc/L4WK-7LHS.

155. *See* FWS MANUAL, *supra* note 145, at 601 FW 3.10(B)(1) ("The System's focus is on native species and natural communities such as those found under historic conditions."); *id.* at 601 FW 1.9(A) ("The overarching goal of the Refuge System is to conserve a diversity of fish, wildlife, and plants and their habitats . . . with a focus on native species."); U.S. FISH & WILDLIFE SERV., NATIONAL WILDLIFE REFUGE SYSTEM MANUAL pt. 7, § 8.1 (2008) [hereinafter FWS REFUGE MANUAL]; *id.* pt. 7, § 12.2; FWS MANUAL, *supra* note 145, at 601 FW 3.12; *id.* at 701 FW 1.4(A) ("Natural Diversity: The number and relative abundance of indigenous species which would occur without the interference of man. . . . The attainment of natural diversity . . . should be an underlying consideration for all habitat and populations management activities.").

156. 36 C.F.R. § 219.9 (2012).

157. U.S. FOREST SERV., FOREST SERVICE MANUAL 2070, VEGETATION ECOLOGY (2008), *available at* http://www.fs.fed.us/wildflowers/nativeplantmaterials/documents/FSM_2070.pdf; *U.S.D.A. Forest Service, Huron-Manistee National Forests: Working Together*, U.S. DEP'T OF AGRIC., FOREST SERV., http://www.fs.usda.gov/detail/hmnf/workingtogether/?cid=STELPRDB5143170 (last visited Oct. 3, 2013), *archived at* perma.cc/C3BJ-KUZD.

158. U.S. DEP'T OF AGRIC., FOREST SERV., NATIONAL STRATEGIC FRAMEWORK FOR INVASIVE SPECIES MANAGEMENT 11 (2013), *available at* www.fs.fed.us/publications/invasive/invasive-framework-2013.pdf.

manifestation of the impulse to divide the world into the mutually exclusive spheres of nature and culture,"[159] the Wilderness Act generally subjects native species on the 109 million acres of lands designated as federal wilderness[160] to minimal management activities.[161] Nonetheless, some agency regulations governing federal Wilderness areas specifically allow the restoration of native populations and natural processes to reverse human manipulation.[162] Similarly, some NPS rules stipulate that active management of native species on non-wilderness National Parks is discouraged.[163] In fact, some NPS policies conflate the human/nature and native/non-native dichotomies by purporting to promote native species *through* the minimization of human management.[164] Even so, the NPS affirms its focus is not only on the preservation of existing natural resources in National Parks,[165] but also the affirmative restoration of extirpated native species.[166] Even in such areas, then, defining a species as native generally serves as a way to protect and promote the species.

---

159. Klein, *supra* note 25, at 1374.

160. *See The Beginnings of the National Wilderness Preservation System*, *supra* note 143.

161. A wilderness area must be "protected and managed so as to preserve its natural conditions." 16 U.S.C. § 1131(c) (2006); *see also* Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 353 F.3d 1051, 1067 (9th Cir. 2003) (en banc) ("[T]he Wilderness Act requires that the lands and waters duly designated as wilderness must be left untouched, untrammeled, and unaltered by commerce."); High Sierra Hikers Ass'n v. U.S. Forest Serv., 436 F. Supp. 2d 1117, 1133 (E.D. Cal. 2006) (determining that built river structures did not advance the Wilderness Act's goals); Sierra Club v. Lyng, 662 F. Supp. 40, 42–43 (D.D.C. 1987) (stating agencies bear the burden of proof when proposing measures that infringe on the Wilderness Act's wilderness values).

162. NPS prefers to allow wilderness to recover from "natural" disturbances without human manipulation, but still allows active management to reverse prior human disturbance of natural conditions. NPS MANAGEMENT POLICIES, *supra* note 145, § 4.4.2.4 ("Landscape and vegetation conditions altered by human activity may be manipulated where the park management plan provides for restoring the lands to a natural condition."). *See also id.* § 6.3.7; U.S. BUREAU OF LAND MGMT., BUREAU OF LAND MANAGEMENT MANUAL § 1745.06(H) (1992) [hereinafter BLM MANUAL] ("In designated wilderness areas, native and naturalized species may be augmented or reestablished to: 1) perpetuate and enhance recovery of a listed Threatened or Endangered species, and thus prevent extinction; or, 2) restore a population of indigenous species reduced or eliminated by human influence.").

163. *See, e.g.*, NPS MANAGEMENT POLICIES, *supra* note 145, § 4.4.2 ("Whenever possible, natural processes will be relied upon to maintain native plant and animal species and influence natural fluctuations in populations of these species.").

164. *See id.* § 4.4.1.2 ("The Service will strive to protect the full range of genetic types (genotypes) of native plant and animal populations in the parks by perpetuating natural evolutionary processes and minimizing human interference with evolving genetic diversity.").

165. *See id.* § 4.1 ("[P]reserving park resources and values unimpaired is the core or primary responsibility of NPS managers.").

166. *See id.* § 4.4.2.2 ("Service will strive to restore extirpated native plant and animal species . . . .").

2. De-Extinction with "Native" as Pre-existing

Application of existing rules and policies defining "native" and/or exotic to de-extinct species, however, fails to even faintly track the potential risks and benefits of introduction. Various authorities define native/indigenous (and thus preferred) species as those species that were present historically and non-native/nonindigenous (and thus controlled) as those that were not. For example, the federal National Invasive Species Act of 1996, which seeks to prevent the unintentional introduction and dispersal of nonindigenous species into the United States, defines "nonindigenous species" as "any species or other viable biological material that enters an ecosystem beyond its historic range, including any such organism transferred from one country into another."[167] Similarly, the FWS classifies "indigenous" species as those "[o]riginating in and being produced, growing, or living in a particular region or environment."[168] For these provisions, the critical question appears to be whether the species originated in the area. Such an approach is congruent with other public lands provisions that direct land management toward the preservation and restoration of native ecosystems to "historic conditions."[169] These jurisdictions thus make an essential division between those constituents and resources that existed before a particular historical baseline and those that attempt to arrive after.

Such an historical preservationist definition of native could raise significant problems for the introduction of a de-extinct species. Under such a classification, a de-extinct organism could only be considered native if it previously existed in the area. As detailed earlier,[170] it is possible and even likely that a de-extinct species would be considered a novel species. Under this historically focused definition of "native," a de-extinct species might not be native to *any* area, even if well suited to a particular location's ecological conditions. Even if deemed to be the same as its extinct brethren, such a de-extinct species could at most be considered native to areas in which such extinct brethren previously existed, regardless of its compatibility with the current biotic communities or physical conditions in those or other areas.

167. 16 U.S.C. § 4702(11) (2012).
168. FWS MANUAL, *supra* note 145, at 701 FW 1.4B.
169. *See, e.g.*, *id.* at 601 FW 3.12; *id.* at 601 FW 3.6D; Leopold et al., *supra* note 152, at 29.
170. *See supra* notes 70–77 and accompanying text.

3. De-Extinction with "Native" as Natural

A more common approach to defining a "native" species on federal and state lands raises even clearer difficulties for the introduction of de-extinct organisms. This category ties nativeness to the absence of human assistance or influence in a species' migration to an area. NPS, for example, expressly defines a native species to include "all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system," while exotic species are defined as "those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities."[171] Federal Executive Order 13,112, which binds all federal agencies (including all federal lands),[172] defines a "native" species as "with respect to a particular ecosystem, a species that, other than as the result of an introduction, historically occurred or currently occurs in that ecosystem."[173] An "introduction" is defined as an "intentional or unintentional escape, release, dissemination, or placement of a species into an ecosystem as a result of human activity."[174] Some state authorities also follow the federal practice of defining "native" in terms of whether human intervention caused the species' arrival.[175]

171. NPS MANAGEMENT POLICIES, *supra* note 145, § 4.4.1.3.

172. Federal lands constitute twenty-eight percent of the United States land area. *See* GORTE ET AL., *supra* note 136.

173. Exec. Order No. 13,112, 64 Fed. Reg. 6183, 6183 (Feb. 3, 1999). *Cf.* 50 C.F.R. § 15.3 (1996) (defining "indigenous," for purposes of the Wild Bird Conservation Act of 1992, 16 U.S.C. § 4903, as "a species that is naturally occurring, not introduced as a result of human activity, and that currently regularly inhabits or breeds in the 50 States or the District of Columbia").

174. Exec. Order No. 13,112, 64 Fed. Reg. at 6183. *See also* BLM MANUAL, *supra* note 162, § 1745 (defining "native species" as "with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem"); 36 C.F.R. § 219.19 (2012) (defining species as "native" for USFS if it "was historically or is present in a particular ecosystem as a result of natural migratory or evolutionary processes; and not as a result of an accidental or deliberate introduction into that ecosystem"). Though judicial interpretations are very rare, at least one federal appellate court interpreted "introduction" in the invasive species context broadly to include not only intentional establishment but also situations where humans have indirectly and unintentionally caused changes to entire habitats that gave rise to the migration of species. *See* Michigan v. U.S. Army Corps of Eng'rs, 667 F.3d 765, 771–72 (7th Cir. 2011) (accepting the allegation that the Chicago Area Waterway System's act of unintentionally allowing non-native invasive Asian Carp access to migrate into the Great Lakes constituted an introduction and importation within the meaning of the Lacey Act, though ultimately denying injunctive relief to Great Lakes states in suit against the owners and operators).

175. *See, e.g.*, Arizona Native Plants Law, ARIZ. REV. STAT. ANN. § 3-903(A) (1989) (defining "protected native plant" as "any plant or part of a plant . . . which is growing wild on state land or public land or on privately owned land *without being propagated or cultivated by human beings* and which is included by the director on any of the definitive lists of protected categories of protected native plants described in this section") (emphasis added); ARIZ. GAME AND FISH DEP'T, ARIZONA'S

These provisions thus allow for the possibility that a species may be native even if it was never present historically, but only if it arrived without human assistance. Accordingly, this type of definition makes human intervention the key factor, establishing a dichotomy between human activity and "natural" movement. Under such a definition of native or exotic that hinges nativeness on the lack of human intervention, however, any de-extinct species proposed to be introduced would almost certainly be considered exotic. NPS in fact expressly states that "[g]enetically modified organisms exist solely due to human activities and therefore are managed as exotic species in parks."[176]

B. De-Extinct Species as "Exotic" and "Invasive"

1. Suppressing "Exotic" and "Invasive"

Being labelled exotic not only causes a de-extinct species to be outside the protection of laws that seek to promote native species, but it also makes them vulnerable to being labelled invasive and subject to control or eradication. Many jurisdictions decline any protections for species deemed exotic.[177] If considered invasive, however, an organism generally also will be vulnerable to laws that seek to minimize, control, or eradicate its species in that jurisdiction. Many state[178] and federal[179] laws prohibit or restrict human-induced movement of exotic or invasive species without a permit. Most public land laws and policies also actively seek to impede, contain, or eliminate invasive species. For example, in exercising its

---

COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY: 2005–2015 (2006) (following the definitions from Federal Executive Order No. 13,112 for "native" and "introduction").

176. NPS MANAGEMENT POLICIES, *supra* note 145, § 4.4.1.3.

177. For example, numerous state endangered species statutes expressly refuse to afford protections to exotic species. *See supra* note 67.

178. *See, e.g.*, ALA. ADMIN. CODE r. 220-2-.26, 220-2-.93 (2014) (promulgating a blacklist of invasive, noxious, or pest species that may not be imported into the state); 3 PA. CONS. STAT. ANN. § 4219(a) (West 2014) (giving the commission the power to determine what "species of fish is allowed in each watershed"); MINN. STAT. ANN. § 84D.04 (West 2014) (placing species in categories with varying degrees of restrictions); ILL. ADMIN. CODE tit. 17, § 870.10(a), (b) (2010) (maintaining "whitelists" of birds and of aquatic species that may be imported and released without a permit, prohibiting importation and release of all others); OR. ADMIN. R. 635-056-0010 (2014) (creating prohibited, noncontrolled, and controlled categories for wildlife, where species that are not categorized are considered prohibited).

179. Lacey Act, 16 U.S.C. §§ 3371−78 (2006); 18 U.S.C. §§ 42−43 (2006); Exec. Order No. 13,112, 64 Fed. Reg. 6183 (Feb. 3, 1999); Plant Protection Act, 7 U.S.C. §§ 7701−02, 7711−21, 7731−36, 7751−61, 7771−71, 7781−86 (2000); National Invasive Species Act of 1996, 16 U.S.C. § 4701−15 (2012). The National Invasive Species Act of 1996, which expired in 2002, regulated invasive aquatic species, with a focus on ballast water as the source of introduction. *Id.* § 4701.

authority under the National Wildlife Refuge System Improvement Act,[180] the FWS seeks to prevent introductions and "control" invasive species on National Wildlife Refuges.[181] The USFS strives to prevent, detect, and control invasive species in National Forests[182] and the DoD requires agents to identify and control invasive species "whenever feasible."[183] Some jurisdictions, such as the BLM, have established extensive eradication programs to not only control but also eliminate invasive species.[184] Though these measures vary, virtually all seek to limit or reduce the presence of invasive species.

2. De-Extinction and Defining "Invasive"

Some jurisdictions embed a requirement of harmfulness for an exotic species to be subject to eradication or control by government authorities. Federal Executive Order 13,112, for example, calls for management of "alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health."[185] Other federal agency policies and laws differ in how harm is characterized.[186] Under such definitions, a de-extinct species might be subject to invasive species controls if proven to be harmful, either to preexisting resources or identified human interests. This would presumably be the case even if the

180. 16 U.S.C. § 668dd (2006).

181. *See* 50 C.F.R. § 35.7 (1971).

182. FOREST SERV., *supra* note 158, at 7–11.

183. DEP'T OF DEF., INSTRUCTION NO. 4715.03: NATURAL RESOURCES CONSERVATION PROGRAM (2011), *available at* http://www.dtic.mil/whs/directives/corres/pdf/471503p.pdf.

184. *See, e.g.*, BLM MANUAL, *supra* note 162, § 1745.06(F) ("Exotic or domesticated species that have reverted to a feral state ('feral species') and that are adversely impacting native species and/or habitats should be controlled and/or removed, unless either their presence is authorized by State or Federal law, or their removal is prohibited by State or Federal law."); *Weed Management and Invasive Species Program*, U.S. DEP'T OF THE INTERIOR: BUREAU OF LAND MGMT., http://www.blm.gov/wo/st/en/prog/more/weeds/blm_program.html (last visited Sept. 28, 2013), *archived at* perma.cc/7YUR-KRMR.

185. Exec. Order No. 13,112, 64 Fed. Reg. 6183, 6183 (Feb. 3, 1999).

186. *See, e.g.*, *What Are Noxious and Invasive Weeds?*, U.S. DEP'T OF THE INTERIOR BUREAU OF LAND MGMT., http://www.blm.gov/wo/st/en/prog/more/weeds/weed_definition.html (last visited Oct. 21, 2012), *archived at* perma.cc/AA5L-A76C (defining "noxious weed" as both "[a] plant that grows out of place and is 'competitive, persistent, and pernicious'" as well as "any plant designated by a Federal, State, or county government as injurious to public health, agriculture, recreation, wildlife or property"); Plant Protection Act, 7 U.S.C. § 7702(10) (2006) (defining "noxious weed" as "any plant or plant product that can directly or indirectly injure or cause damage to . . . interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" and defining "plant pest" as any living stage of, among other things, plants and animals, that can "directly or indirectly injure, cause damage to, or cause disease in any plant or plant product"); Lacey Act, 18 U.S.C. § 42(a) (2000) (prohibiting the importation or shipment of non-domesticated species that are considered harmful).

overall benefits to the biotic community of introducing or maintaining such species were considerable as compared to the harm.

However, numerous jurisdictions provide for the use of suppression management strategies for *any* species considered exotic. Some of these jurisdictions make invasive synonymous with non-native or exotic, while others simply seek to directly control or eradicate non-native species (without labeling them invasive). These jurisdictions thus explicitly or implicitly assume that a non-native species is by default harmful. For example, the California State Park system defines exotic species as those species that "occupy or could occupy [a park] as a result of deliberate or accidental human activities."[187] The California State Park system's resource management policies call for the Park to systematically remove any exotic species found in wildland settings within the park.[188] In contrast, California State Parks' laws forbid the disturbance or destruction of native plants and animals.[189] Other state agencies adopt similar approaches.[190] This expansive definition of invasive exists at the federal level as well. For example, NPS states: "Exotic species are also commonly referred to as non-native, alien, or invasive species. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem at that place."[191]

Importantly for de-extinction, though some federal agencies following Federal Executive Order 13,112 may not engage in active measures to control an exotic species unless harmful, many of these federal land agencies nonetheless make the deliberate *introduction* of an exotic species on public lands impermissible. For example, federal agency regulations restrict or prohibit the introduction of any exotic species in federal

187. *Exotic Species*, CAL. DEP'T OF PARKS & RECREATION, http://www.parks.ca.gov/?page_id=21560 (last visited Nov. 2, 2014), *archived at* perma.cc/N4GY-J48R.

188. *Id.*

189. *Rules and Regulations Summary*, CAL. DEP'T OF PARKS & RECREATION, http://www.parks.ca.gov/default.asp?page_id=21300 (last visited Nov. 2, 2014), *archived at* perma.cc/V3WR-LBWK. Habitat manipulation in natural preserves in the California Park System is only allowed when found to be necessary to preserve the species or associations that constitute the basis for the establishment of the preserve. CAL. PUB. RES. CODE § 5019.71 (West 2001).

190. *See, e.g.*, ARIZONA STATE PARKS POLICY AND PROCEDURES, NATURAL RESOURCE MANAGEMENT § 3(G)(8) (2009) (defining "exotics" as not native to the place where found, and prescribes their removal "where practicable."). The standard turns entirely on whether a species is "endemic," defined as those "native or confined to a certain region," not whether the species is causing any harm. *Id.*

191. NPS MANAGEMENT POLICIES, *supra* note 145, § 4.4.1.3.

wilderness areas.[192] On National Wildlife Refuges, naturally extirpated exotics, exotic birds, or species anticipated to be invasive or cause detrimental effects on the receiving area are similarly not eligible for introduction.[193] Likewise, BLM defines and controls "invasive plants," defined as plants "introduced into an environment where they did not evolve."[194] Other agency regulations and plans prohibit the introduction of exotic species[195] or require the control and/or elimination of exotic species entering their lands.[196] These laws would thus inhibit the introduction of a de-extinct species anywhere it would be deemed exotic.

C. Problems with the Native/Exotic and Artifactual/Wild Dualities

De-extinction thus helps to demonstrate a variety of pathologies in natural resources management that exist due to a reliance on simplistic dichotomies. These dualisms create fundamentally inverse management regimes premised on whether a species historically existed in an area, and/or on whether or not humans were involved in its arrival. Under the various provisions that codify a native/exotic duality, exotic species are treated as detrimental, their introduction prohibited, and their existence subject to a range of management strategies that seek to control or eliminate their presence. This might be the case even if the species appears to be well suited to a particular location's abiotic characteristics or might provide significant value to an existing biotic community. Because de-

192. *See, e.g.*, U.S. FOREST SERV., FOREST SERVICE MANUAL § 2323.34c(1) (2007), *available at* http://www.fs.fed.us/im/directives/dughtml/fsm.html ("Do not stock exotic species of fish in wilderness."); *id.* § 2323.33a ("Reintroduce wildlife species only if the species was once indigenous to an area and was extirpated by human induced events."). *Cf.* BLM MANUAL, *supra* note 162, § 1745.06(J) ("On lands under wilderness review . . . [n]on-native species shall not be introduced, except as biological control agents.").

193. FWS REFUGE MANUAL *supra* note 155, §§ 7-8.6(B), 8.7. *Cf.* FWS MANUAL, *supra* note 145, at 601 FW 3.11(C) ("Unless we determine that a species was present . . . under historic conditions, we will not introduce or maintain the presence of that species for the purpose of biological diversity. We may make exceptions. . . . In such cases, we strive to minimize unnatural effects and to restore or maintain natural processes and ecosystem components to the extent practicable.")

194. U.S. BUREAU OF LAND MGMT., *supra* note 186.

195. *See, e.g.*, 15 C.F.R. § 922.163 (2014) (detailing National Oceanic and Atmospheric Administration policy prohibiting anyone from "introducing or releasing an exotic species of plant, invertebrate, fish, amphibian, or mammals" into the Florida Keys National Marine Sanctuary).

196. *See, e.g.*, SANTA ROSA AND SAN JACINTO MOUNTAINS NAT'L MONUMENT, APPROVED MANAGEMENT PLAN AND RECORD OF DECISION 4 (2004), *available at* http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/pdfs/palmsprings_pdfs.Par.97624.File.dat/SRSJ-ROD-5Feb04.pdf (directing BLM and USFS to design plans for the elimination of non-native species); CAL. DEP'T OF PARKS & RECREATION, MT. SAN JACINTO STATE PARK GENERAL PLAN 41 (2002), *available at* http://www.parks.ca.gov/pages/21299/files/ar_616_284.pdf (requiring the development of control and management plans for exotic species entering park lands).

extinct species will often be considered non-native, a de-extinct species that might promote ecological function in an area often will fail to qualify for native restoration strategies and might even be subject to suppression measures directed at invasive species.

Relatedly, as a result of such a native/exotic partition, a native species is often treated as beneficial even if it is not compatible with existing climactic conditions or it caused substantial ecological or economic harm to the area. Under most jurisdictions, native species cannot be invasive and thus are not subject to the suppression measures applied to invasive species. Federal Executive Order 13,112, for example, provides that invasive species can only be non-native species "whose introduction does or is likely to cause economic or environmental harm or harm to human health."[197] With few exceptions,[198] agencies that categorize a species as native will not consider it invasive[199] and are limited in their ability to actively control it,[200] no matter how much economic loss or damage it caused to other species or ecological functions.[201] Accordingly, legal provisions bifurcating species between native and exotic remarkably would deem a de-extinct species suitable not based on where it is most compatible with existing or future anticipated conditions—or where it might provide the most ecological benefit—but rather on where (if anywhere) it existed before, even if that location's ecology has fundamentally changed.

Legal provisions governing species movement that are premised on a duality between wild nature and humanity likewise delimit categories that make little sense in light of the budding capacity of humans to promote

197. Exec. Order No. 13,112, 64 Fed. Reg. 6183 (Feb. 3, 1999).

198. *See, e.g.*, DEP'T OF DEF., INSTRUCTION 4715.03, *supra* note 183, at Glossary (defining "invasive species" as "with respect to a particular ecosystem, any species . . . whose introduction or presence may cause environmental or economic harm or harm to human health").

199. *See, e.g.*, NAT'L INVASIVE SPECIES COUNCIL, MEETING THE INVASIVE SPECIES CHALLENGE: MANAGEMENT PLAN 2, 10 (2001), *available at* http://www.invasivespeciesinfo.gov/docs/council/mpfinal.pdf (requiring species to be alien or non-native to be considered an invasive species); U.S. DEP'T OF AGRIC., FOREST SERV., NATIONAL STRATEGY AND IMPLEMENTATION PLAN FOR INVASIVE SPECIES MANAGEMENT 7 (Lynn Starr ed., 2004), *available at* http://www.fs.fed.us/invasivespecies/documents/Final_National_Strategy_100804.pdf (same).

200. *See* Michael P. Carey et al., *Native Invaders—Challenges for Science, Management, Policy, and Society*, 10 FRONTIERS ECOLOGY & ENV'T 373, 377, 379 (2012) (explaining how though native species can cause ecological and economic harms that rival those of well-known invasive species, existing management and policy raise significant impediment to addressing these effects).

201. *See, e.g.*, NAT'L INVASIVE SPECIES COUNCIL, INVASIVE SPECIES DEFINITION CLARIFICATION AND GUIDANCE WHITE PAPER 3 (2006), *available at* http://www.doi.gov/NISC/global/ISAC/ISAC_documents/ISAC%20Definititions%20White%20Paper%20%20-%20FINAL%20VERSION.pdf ("While non-migratory populations can cause problems, they are not considered an *invasive species* because they are native.").

ecological conservation through management strategies like de-extinction. First, many of these laws would treat any attempt to introduce a species that had not previously existed in the area as dangerous or problematic—regardless of its ability to promote ecological function for the biotic community. A de-extinct species that might be compatible with the existing ecological conditions of the area and whose introduction might be expected to bring substantial ecological benefits would nevertheless be proscribed in many jurisdictions. In contrast, such provisions would characterize any species movement into an area that was not the result of human activity as categorically acceptable, even if such a migration would be expected to bring substantial ecological, health, or other harms. Paradoxically, deliberate, strategic introductions of a de-extinct species to promote ecological function would be barred while unintentional, unplanned migration would be categorically appropriate.

In short, in most natural resources law provisions governing species movement, direct human intervention in species migration through management strategies like de-extinction leads to an increase in regulatory barriers and a decrease in regulatory protection. This would remain the case even if such a strategy were demonstrated to promote ecological health. De-extinction thus shows how prevailing dichotomies in invasive species and public lands laws can lead to perverse results for the management of ecological systems.

IV. REJECTING STRICT DUALITIES: A RISK ASSESSMENT APPROACH

Reliance on anthropocentric dualisms has a long intellectual history.[202] In any domain of interest, a dualism claims that "there are two fundamental kinds or categories of things or principles."[203] There may be contexts in which adherence to rigid categories can offer a fruitful organizing principle. For example, in the longstanding dialogue in law concerning reliance on rules versus standards, some contend that a strict rule can provide more certainty and be more efficient to administer than a standard that requires a more detailed, case-specific inquiry.[204] On the

202. *See, e.g.*, ARISTOTLE, POLITICS, Bk. 1, Ch. 8, p. 23, 1256b15 (Ernest Barker trans., Oxford U. Press 1995) (concluding that nature makes plants for animals and animals for men); IMMANUEL KANT, LECTURES ON ETHICS 212–13 (Cambridge U. Press 1997); *Genesis* 1:26.

203. Howard Robinson, *Dualism*, STAN. ENCYCLOPEDIA PHIL. (Edward N. Zalta ed., Aug. 19, 2003), http://plato.stanford.edu/archives/win2012/entries/dualism/.

204. *See, e.g.*, Pierre Schlag, *Rules and Standards*, 33 UCLA L. REV. 379, 400 (1985) (stating rules "are said to be appropriate when certainty, uniformity, stability, and security are highly valued"); Colin S. Diver, *The Optimal Precision of Administrative Rules*, 93 YALE L.J. 65, 76–77 (1983)

other hand, rules can be less effective in tailoring decisions that achieve regulatory goals.[205] In this same sense, a slavish adherence to assumptions of dualism may ignore nuances and complexities in phenomena. It is particularly problematic, however, if a dualism is grounded in a fallacious premise, such as failing to recognize that the categorical distinctions being attempted are not binary but more akin to a pluralism, continuum or synthesis.[206] When the law relies on such a dualism, the result may be ineffective or distorted regulation.[207]

(arguing that precision and simplicity are less important and more likely to misallocate resources for "internal" administrative rules addressed to persons charged with the enforcement of the external rules); Isaac Ehrlich & Richard A. Posner, *An Economic Analysis of Legal Rulemaking*, 3 J. LEGAL STUD. 257 (1974). For an overview of the distinction between "rules" and "standards," see generally Schlag, *supra* (questioning the coherence of a distinction between "rules," which draw sharp lines, and "standards," which allow for flexibility). Schlag also discusses an "epistemological twist" to the decision between rules and standards: "standards are most appropriate when we lack knowledge or information about an issue." *Id.* at 424. When we lack the knowledge to assess *facts*, standards may be appropriate, whereas when we lack the knowledge to assess values, rules may be more appropriate. *Id.* at 425.

205. *See* Russell B. Korobkin, *Behavioral Analysis and Legal Form: Rules vs. Standards Revisited*, 79 OR. L. REV. 23, 36 (2000) ("[B]ecause rules are specified *ex ante*, even complex rules will sometimes fail to take account of all factual variations that might arise *ex post* which might be relevant to optimal tailoring of legal boundaries."); Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557, 586–96 (1992) (challenging the assumption that standards are categorically more complex than rules). Schlag additionally notes that "standards are seen as more appropriate when flexibility, individualization, open-endedness, and dynamism are important." Schlag, *supra* note 204, at 400.

206. *Cf.* Yeuk-Sze Lo, *Natural and Artifactual: Restored Nature as Subject*, 21 ENVTL. ETHICS 247, 260–61 (1999) (arguing that the moral dualism between wild nature and human-restored nature is based on the fallacious assumption that there is an ontological dualism between independently natural entities and "ontologically dependent" entities). Legal dualisms can be seen, then, as a result of perceived ontological and moral dualisms; legal dualisms should therefore ensure that their foundations are accurate. *See* Dan L. Burk, *Feminism and Dualism in Intellectual Property*, 15 AM. U. J. GENDER SOC. POL'Y & L. 183, 185–86 (2007) (arguing that the dualisms between mind and body, and between nature and culture, are present in intellectual property law). In copyright, the "work that is created and owned by an author in copyright is idealized as an intangible form, which is then embodied or 'fixed' in a tangible medium of expression." *Id.* at 186. It is the "intangible form"—the "platonic form"—that the copyright statute defines as "work" and each fixation is just a copy of that form. *Id.* at 187–88 ("Copyright attaches to the work at the moment of fixation"). Further, Burk notes that "[a]mong the other troublesome dualisms identified and critiqued by feminist scholars is that which opposes the natural world to the results of human activity, a divide between nature and culture." *Id.* at 194. "The failure to recognize this overlap in the law, the attempt to separate these exclusive categories as pristine opposites, the operation of dualistic categories of fact and artifact, signals the presence of an ideological agenda that bears closer scrutiny." *Id.* at 199–200.

207. *See, e.g.*, Jody Freeman, *The Private Role in Public Governance*, 75 N.Y.U. L. REV. 543, 564–71 (2000) (arguing that the public/private distinction in governance is illusory and that the failure to see private and public as interdependent leads to an ineffective preoccupation in administrative law with the accountability of "public actors"). *Cf.* Duncan Kennedy, *The Structure of Blackstone's Commentaries*, 28 BUFF. L. REV. 205, 217 (1979) (describing enormous inequalities masked by the legal dualism between the state and civil society); Freeman, *supra*, at 565 ("The [Critical Legal Studies] project, in large part, was to reveal that seemingly natural dichotomies (public/private,

As revealed in Parts II and III, the application of American wildlife management laws pertinent to de-extinction exposes the flaws in legal categories centered on erroneous conceptions of nature as static and separable from human activity. In the full range of wildlife laws, including laws seeking to protect endangered species and manage invasive species and public lands, a consistent theme is the establishment of conceptual dichotomies—between natural and human-influenced, as well as native and exotic. Unfortunately, each of these dualities regularly leads to inapposite results as exemplified by an application of natural resources laws to the emerging biotechnologies of de-extinction.

In U.S. wildlife management laws, an emphasis on nativity leads to legal categories such as "endangered," "native," and "exotic" that are erroneously premised on ecological stasis and make little sense applied to the management of de-extinct species. Similarly, many wildlife management laws emphasize an inert native/exotic duality, where exotic species are subject to strategies that seek to control or eliminate their presence while native species are treated as *per se* beneficial—often irrespective of the species' compatibility with current conditions or its potential ecological value. Relatedly, under various laws, a focus on promoting "natural" and minimizing human influence leads to species-management regulations that inhibit or prohibit human-directed propagation and movement activities—particularly into new areas—while accepting or promoting unassisted migration, without regard to the particular ecological risks or benefits of such change. As a result of these dichotomies, de-extinct species will often be obstructed as non-native and/or introduced—even if they might promote ecological function in a particular area—and may be allowed or promoted in locations they used to exist—even if likely to cause ecological damage.

This Part suggests replacing such simplistic binary rules with alternatives that seek to link authorizations of potential ecosystem management activities such as de-extinction to a more nuanced assessment of the risks and benefits of the activity. This initial risk assessment should be combined with adaptive management protocols that require systematic monitoring and adjustment of emerging management strategies to periodically assess their efficacy in light of information obtained during the initial implementation process. The Part describes this adaptive risk

---

state/society, contract/property) were artifacts, and that the existing order, while appearing neutral and natural, served some at the expense of others.").

assessment framework, drawing on existing examples that might provide certain features of an adaptive risk analysis alternative. Finally, though the paper rejects the use of a strict binary approach to managing dynamic ecological phenomena with which humans are inextricably intertwined, it nonetheless also outlines how some categorizations, such as native and non-native, can serve a valuable role in shaping rebuttable default presumptions as part of a case-specific, adaptive risk assessment approach.

A. Native/Exotic and Nature/Human as False Dichotomies

De-extinction serves to illuminate the limitations of existing wildlife management laws and regulations that seek to manage the relationship of humans with ecosystems through adherence to dichotomies of natural/human and native/non-native. First, ecological systems and their constituents are widely acknowledged to be dynamic. In contrast to early versions of ecology that are premised on stationarity, "the idea that natural systems fluctuate within an unchanging envelope of variability,"[208] today ecosystems are understood as not inevitably inert or in equilibrium; individual constituents do not stay in one place, and physical conditions change.[209] Every ecosystem has been subject to disturbances such as floods, fire, and drought,[210] and in fact "instability may be responsible for the continued existence of many species."[211] Indeed, anthropogenic climate change is likely to alter ecosystems in fundamental ways, pressuring species to adapt.[212] Some, if not many, species will seek to

208. P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, 319 SCIENCE 573, 573 (2008).

209. *See, e.g.*, DANIEL B. BOTKIN, DISCORDANT HARMONIES: A NEW ECOLOGY FOR THE TWENTY-FIRST CENTURY 9 (1990) (stating ecologists now believe that "at the levels of populations and ecosystems . . . [c]hange now appears to be intrinsic and natural," contrary to the initial views of ecologists who believed they could identify "highly structured, ordered, and regulated, steady-state ecological system[s]"); Donald Worster, *Nature and the Disorder of History*, *in* REINVENTING NATURE 65, 143 (Michael E. Soulé & Gary Lease eds., 1995) ("[T]he science of ecology has been hoist on its own petard by maintaining, as many did during the middle of this century, that natural communities tend toward equilibrium. Current ecological thinking argues that nature at the level of local biotic assemblages has never been homeostatic. Therefore, any serious attempt to define the original state of a community or ecosystem leads to a logical and scientific maze."); C.S. Holling et al., *Science, Sustainability and Resource Management*, *in* LINKING SOCIAL AND ECOLOGICAL SYSTEMS: MANAGEMENT PRACTICES AND SOCIAL MECHANISMS FOR BUILDING RESILIENCE 342, 354 (Fikret Berkis & Carl Folke eds., 1998) ("The linear, equilibrium-centered view of nature no longer fits the evidence, and is being replaced by a non-linear, multi-equilibrium view.").

210. *See* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 35 (Lance H. Gunderson & C.S. Holling eds., 2002).

211. David Farrier, *Conserving Biodiversity on Private Land: Incentives for Management or Compensation for Lost Expectations?*, 19 HARV. ENVTL. L. REV. 303, 325 (1995).

212. *See* Camacho, *supra* note 51, at 179–80.

leave their existing ranges as climatic conditions change and move across landscapes to fill niches in new areas, causing new biotic assemblages to form.[213] Various commenters have questioned the wisdom of relying on "an architecture of laws and management systems that are poorly matched to the challenge of managing ecosystems as complex dynamic systems."[214] Yet preserving native ecological resources on reserved lands, while resisting exotic invasions, remains the fundamental model of wildlife management.[215]

De-extinction demonstrates some of the problems with this approach. Existing laws grounded in a native/non-native duality promote management activities that primarily focus on maintaining or restoring preexisting native species, as well as inhibiting new non-native arrivals. Accordingly, such laws inevitably face significant impediments to their efficacy in advancing historical preservation as physical conditions change and constituents of current biotic assemblages seek to shift. More importantly, because they are designed to keep communities as they were or used to be, laws based on a strict native/non-native duality may not serve to promote ecological function or enhance biodiversity, but rather to inhibit it. Even if changing ecological conditions cause such preservation lands to be inhospitable to native resources, current legal native/non-native dualities will continue to direct managers to maintain native resources even at the expense of ecological function.

---

213. *Id.* at 181–82.

214. Bradley C. Karkkainen, *Collaborative Ecosystem Governance: Scale, Complexity, and Dynamism*, 21 VA. ENVTL. L.J. 189, 196–97 (2002). *See also* Tarlock, *supra* note 150, at 1122–23 ("The underlying ecological justification for the land ethic is the equilibrium paradigm or, as it is crudely and popularly called, the balance of nature. . . . Twenty-five years after this paradigm was incorporated into law, it—and thus the basis for the core of biodiversity protection law—is now unraveling. . . . [T]he equilibrium paradigm has been rejected in ecology and replaced with a complex, stochastic nonequilibrium one."); Reed F. Noss, *Some Principles of Conservation Biology, as They Apply to Environmental Law*, 69 CHI.-KENT L. REV. 893, 893 (1994) ("[C]lassical preservationist approaches to conservation, to the extent that they attempt to hold nature static, do not reflect realities of nature."); Robert B. Keiter, *Public Lands and Law Reform: Putting Theory, Policy, and Practice in Perspective*, 2005 UTAH L. REV. 1127, 1196 ("Ecosystem management acknowledges that resource systems are dynamic and nonequilibrium in character, while traditional resource management has taken a more static and deterministic view of the landscape.").

215. *See* J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363, 393 (2010) ("Legal regimes that formed before the dynamic equilibrium model was well developed, particularly conservation programs such as the ESA, the Wilderness Act, and the National Wildlife Refuge System, to this day depend heavily on the natural stability model of ecosystems and the strategy of setting aside habitat reserves to implement it. Only recently has the discipline of ecosystem management emerged with any concrete policy force to prompt movement toward the dynamic equilibrium model. This newer, more flexible conservation orientation, however, still depends strongly on the stationarity premise and its appeal to "natural" and "native" models of ecosystem dynamics.") (citations omitted).

In addition to illustrating the law's erroneous assumption of ecological stasis embodied in the native/exotic dualism, de-extinction exposes the limitations of a parallel dichotomy between nature and humanity. Laws proscribing active management strategies like introductions help institutionalize a dualism between humans and nature, treating untouched natural systems and undirected species migrations as intrinsically virtuous[216] while resources subject to active human management are artifactual and thus *per se* of diminished value.[217] This natural/human duality presumes that resource management strategies should not seek to actively manipulate ecological communities.[218]

However, it is evident that nature is increasingly indivisible from human activity, assuming it ever was separable. Human activities throughout the earth have measurably large effects on every ecosystem, from the Arctic to the tropics, and from the highest altitude mountaintop to the deepest ocean trench. The substantial and widespread ecological effect of humanity has been discernible, and growing, for decades,[219] most pervasively with anthropogenic climate change.[220] Human activities have had an overwhelming effect on global ecology that continues to increase in scope and intensity, so much so that it is evident to at least some eminent scientists that "we live on a human-dominated planet."[221] With many

---

216. *See* Rolston, *supra* note 146, at 238; Michael McCloskey, *Changing Views of What the Wilderness System is All About*, 76 DENV. U. L. REV. 369, 375 (1999) ("[T]he key idea of what wilderness is all about is to make sure that humans do not hinder the development of that 'community of life,'—the flora and fauna that grow there.").

217. *See, e.g.*, Katz, *supra* note 146, at 92 ("Natural individuals were not designed for a purpose. They lack intrinsic functions, and so they are different from human-created artifacts. . . . Depending on the adequacy of our technology, these restored and redesigned natural areas will appear more or less natural, but they will never be natural—they will be anthropocentrically designed human artifacts.").

218. Some proponents of the nature/human duality have contended that active human management of ecological resources may be appropriate in exceptional circumstances, such as restoration to reverse prior human disturbance. *See, e.g.*, Andrew Light, *Ecological Restoration and the Culture of Nature*, *in* ENVIRONMENTAL ETHICS: WHAT REALLY MATTERS, WHAT REALLY WORKS 178, 181 (David Schmidtz & Elizabeth Willott eds., 2002). However, others still strongly criticize restoration efforts. *See* Eric Katz, *The Problem of Ecological Restoration*, 18 ENVTL. ETHICS 222, 222 (1996). In any event, even advocates of human/nature dualism who might make an exception for restoration would contend that resource management to promote human-centered values would be inappropriate. Light, *supra*, at 181.

219. *See, e.g.*, Peter M. Vitousek et al., *Human Appropriation of the Products of Photosynthesis*, 36 BIOSCIENCE 368 (1986) (concluding that humans are appropriating a huge proportion of the products of photosynthesis upon which almost all ecosystems rely); Stuart Rojstaczer et al., *Human Appropriation of Photosynthesis Products*, 294 SCIENCE 2549 (2001) (providing an updated appraisal that concluded similarly).

220. *Cf* Robert R.M. Verchick, *Steinbeck's Holism: Science, Literature, and Environmental Law*, 22 STAN. ENVTL. L.J. 3, 16–17 (2003) (stating every ecosystem has been affected by direct or indirect human conduct such as genetic manipulation, pollution, farming, and climate change).

221. *See* Peter M. Vitousek et al., *Human Domination of Earth's Ecosystems*, 277 SCIENCE 494,

scientists dubbing the current ecological era the "anthropocene,"[222] ecology has come to view the natural and human worlds as substantially interrelated.[223] So closely intertwined have these two spheres become that they resemble a synthesis more than a dualism.[224]

Establishing a rigid legal dualism between the wild and artifactual can lead to perverse results, as it has in the Wilderness Act.[225] Moreover, whether or not human effects on the biosphere have been beneficial or harmful, the fact that they have been inescapable and significant certainly defines the reality within which conservation law and management decisions will have to be made for the foreseeable future. The nature/human legal dualism can divert attention from this more realistic view, and, in so doing, undermine sound conservation policy.[226] As exemplified through the lens of de-extinction, making the fundamental ecological goal minimizing human influence on ecological resources necessarily obstructs active management measures (such as the introduction of a species) even if they were likely to improve ecological function. Likewise, ignoring the effects of unassisted wildlife migrations

494 (1997) ("Human alteration of Earth is substantial and growing. Between one-third and one-half of the land surface has been transformed by human action; the carbon dioxide concentration in the atmosphere has increased by nearly 30 percent since the beginning of the Industrial Revolution; more atmospheric nitrogen is fixed by humanity than by all natural terrestrial sources combined; more than half of all accessible surface fresh water is put to use by humanity; and about one-quarter of the bird species on Earth have been driven to extinction.").

222. *See* Paul J. Crutzen, *Geology of Mankind*, 415 NATURE 23 (2002); Paul J. Crutzen & Christian Schwägerl, *Living in the Anthropocene: Toward a New Global Ethos*, YALE ENV'T 360 (Jan. 24, 2011), http://e360.yale.edu/feature/living_in_the_anthropocene_toward_a_new_global_ethos/2363/ ("It's a pity we're still officially living in an age called the Holocene. The Anthropocene—human dominance of biological, chemical and geological processes on Earth—is already an undeniable reality."), *archived at* prima.cc/3H60-YWP8; Marion Glaser et al., *New Approaches to the Analysis of Human-Nature Relations*, in HUMAN-NATURE INTERACTIONS IN THE ANTHROPOCENE: POTENTIALS OF SOCIAL-ECOLOGICAL SYSTEMS ANALYSIS 3, 3 (2012).

223. *See* Eric W. Sanderson et al., *The Human Footprint and the Last of the Wild*, 52 BIOSCIENCE 891 (2002).

224. *See* Jill M. Fraley, *The Jurisprudence of Nature*, 63 CATH. U. L. REV. 917, 920–21 (2014) (asserting that the reliance on a man-nature dualism in defining nature, natural and organic in various regulatory areas does more harm than good because human interaction with nature exists on a more complicated continuum); Peter Kareiva et al., *Domesticated Nature: Shaping Landscapes and Ecosystems for Human Welfare*, 316 SCIENCE 1866 (2007).

225. Klein, *supra* note 25, at 1378 ("[T]he deliberate destruction of wild areas . . . illustrates the perverse, unintended consequences of legislation such as the Wilderness Act that relies upon a rigid, unrealistic dichotomy between nature and civilization. . . . [T]he inflexible nature-culture distinction employed by the Wilderness Act threatens to transform thoughtful discussions about the best use of a tract of land into a trivial search for roads and other indicia of a human presence that can disqualify federal lands from wilderness protection.").

226. *Cf. id.* at 1337 ("As legislators have struggled to define the appropriate role of nature in a civilized society, they have relied perhaps overmuch upon rigid, objective boundaries between nature and culture as a substitute for a messy, subjective dialogue about the proper use of wild lands.").

as seemingly natural, without inquiry into such a migration's potential benefits and harms, raises significant risks of ecological degradation.

Strict reliance on such a human/nature duality is particularly alarming in the increasingly dynamic ecological landscape likely to be wrought by global climate change. Absent active human management, both damaging unaided migrations[227] and extinctions[228] are expected to significantly increase. Existing legal dualisms of native/non-native and nature/human that emphasize historical conditions and averting human interaction with other ecological components may have made sense initially as a crude but effective heuristic to prevent direct human harms to precious but increasingly vulnerable ecological resources.[229] Creating reserve networks has helped address conventional ecological stressors such as over-exploitation and habitat loss because the harm could largely be minimized through segregation.[230] Yet intentionally cordoning off lands to quarantine ecological resources from long-term climatic change and human activity was always a difficult proposition, and now increasingly problematic. Though certainly not without risk, the potential benefits of introductions to help reserved lands adapt to and flourish in changing ecological conditions have never been greater, and the advantages of barring such assistance have never been more questionable.[231]

B. Risk-Based Adaptive Ecosystem Management

Accordingly, sound de-extinction policy, and wildlife management laws in general, should reflect the dynamic and human-influenced character of modern ecosystems. As stated by one scholar, "[c]hange is

---

227. *See, e.g.*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SUMMARY FOR POLICYMAKERS: CLIMATE CHANGE 2007: IMPACTS, ADAPTATION, AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 247 (M.L. Parry et al. eds., 2007) ("Climate change is likely to increase opportunities for invasive alien species because of their adaptability to disturbance."); *id.* at 230–31 ("Some colonisers might ultimately need to be considered 'invasive' species . . . such as presently-restricted populations of southern shrub species that are likely to spread in a warmer climate").

228. *See* Camacho, *supra* note 51, at 181.

229. *See id.* at 234–35.

230. *Id.*; *see also* Frank J. Rahel et al., *Managing Aquatic Species of Conservation Concern in the Face of Climate Change and Invasive Species*, 22 CONSERVATION BIOLOGY 551, 557 (2008) ("A dominant management paradigm for species of conservation concern is to isolate them in a reserve and hope that the species will prosper in the absence of human disturbances.").

231. *See* Camacho, *supra* note 51, at 181–83, 188; Emma Marris, *Moving on Assisted Migration*, 2 NATURE REP. CLIMATE CHANGE 112, 113 (2008), *available at* http://www.nature.com/climate/2008/0809/pdf/climate.2008.86.pdf ("Humans have dominated the landscape to such an extent that natural dispersal cannot take place in many areas.").

inevitable, and what matters is not the false choice of preservation versus change, but the real choice of which changes are benign and which are adverse."[232] Laws managing whether to encourage, allow, restrict, or prohibit the establishment or introduction of biota, de-extinct or otherwise, should focus the inquiry on whether the management strategy (as compared to alternative strategies) will promote ecological health in light of current and reasonably foreseeable ecological conditions.[233]

1. Risk Assessment and Adaptive Management

A sensible risk-based approach should incorporate into relevant wildlife management laws both (1) a provisional assessment of the risks and benefits for an introduction and (2) adaptive management that incorporates a framework for periodic monitoring and adjustment of such provisional decisions to account for new information and changes in conditions. Akin to what I and others have articulated elsewhere in the context of other controversial resource management strategies,[234] a risk-based assessment for introduction of a de-extinct speciesshould evaluate: (1) the administrative costs and feasibility of managing the introduction; (2) the potential risks of introduction to the target species; (3) the species' ecological significance (including factors such as its relative rareness, taxonomic distinctiveness, functional uniqueness, future evolutionary potential, and ecological role); and (4) the potential contribution of the species to the ecological health of the target area, including its compatibility with reasonably foreseeable physical conditions at the site and relative ecological value of the target species to other possibly competitive or vulnerable biota in the target location. The assessment should compare these costs and benefits to those of alternative management strategies,[235] such as abstention from introduction or the introduction of another species.

Furthermore, any permitted introduction should be required to include concrete measures that seek to minimize the negative and maximize the positive consequences of the strategy, as determined by the initial risk assessment. Because of the considerable uncertainty involved in such a

232. Jonathan Baert Wiener, *Beyond the Balance of Nature*, 7 DUKE ENVTL. L. & POL'Y F. 1, 14 (1996).

233. *See* Camacho, *supra* note 51, at 247.

234. *See id.* at 236–38 (discussing a possible standard for assessing assisted migration as a strategy for managing the effects of climate change); David M. Richardson et al., *Multidimensional Evaluation of Managed Relocation*, 106 PROC. NAT'L ACAD. SCI. 9721, 9722 (2009) (same).

235. *See* Richardson et al., *supra* note 234, at 9724.

determination, such risk assessments always should be treated as provisional and accompanied by thorough adaptive management measures that mandate sustained and concrete monitoring, reexamination, and periodic adjustment procedures.[236] Such a program should include sufficient resources and incentives for managers to reduce uncertainty and adjust decisions over time.[237]

Though the FWS's current approach to planned introductions of listed species under the ESA is both impermissibly dualist and incomplete, it encouragingly does mandate an initial assessment of some of the release's costs and benefits as well as continued monitoring of the release. When the FWS makes its determination of whether the release of an experimental population "will further the conservation of the species,"[238] the FWS is directed to consider (1) "possible adverse effects on extant populations of [the listed] species," (2) the likelihood that the introduced population will survive and become established, (3) potential effects of the population's establishment on the species' recovery, and (4) potential effects of other adjacent activities on the introduced population.[239] In addition, any approved introduction must provide protective management measures for the population and periodic evaluation of the release's success and its contribution to the species' recovery.[240]

While this particular approach by the FWS provides some features of a sensible risk assessment, it is important to point out its limitations. First, the regulation narrowly focuses its assessment on the harm to the listed species. Thus, it does not require consideration of other significant factors likely to affect the ecological risks and benefits of an introduction: the potential ecological value of the introduced species; the introduction's potential effects on other species at the target site; or the compatibility of the introduction with existing physical conditions at the target site. The approach's monitoring requirement also does not mandate concrete adaptive-management measures that manage the uncertainty associated with the introduction by requiring periodic changes in species

236. For an overview of the scientific literature on adaptive management, see GEORGE H. STANKEY, ROGER N. CLARK & BERNARD T. BORMANN, U.S. DEP'T OF AGRIC., FOREST SERV., ADAPTIVE MANAGEMENT OF NATURAL RESOURCES: THEORY, CONCEPTS, AND MANAGEMENT INSTITUTIONS 31–33 (2005).

237. For a thorough discussion of successful use and misuse of adaptive management in environmental law and management, see HOLLY DOREMUS ET AL., CTR. FOR PROGRESSIVE REFORM, MAKING GOOD USE OF ADAPTIVE MANAGEMENT (2011), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1808106.

238. 50 C.F.R. § 17.81(b) (2013).

239. *Id.*

240. *Id.* § 17.81(c).

management based on new information or changes in conditions over time. Of course, most problematic is FWS's continued linking of authorization of an introduction to the species' historical native range (rather than its compatibility with current and projected ecological conditions).[241] In contrast, some states do allow introductions of rare species outside their historical native range under certain conditions.[242]

Crucially, the risk-based approach to de-extinct introductions suggested herein would not be premised on a duality that categorical bars introductions of exotic de-extinct species. Nor would it permit or encourage the introduction of a native de-extinct species simply because it previously existed in the area, or ignore migrations simply because the arrival lacked direct human assistance. Rather, the framework would focus on the value and compatibility of the de-extinct species with the receiving location and the relative merit of introduction as assessed against other possible strategies.

As such, it makes the central inquiry determining what strategy is expected to maximize current and future ecosystem function or health. Though undoubtedly utilitarian, the inquiry proposed herein would thus seek to focus on promoting ecological health as the central goal, rather than an analysis that might emphasize broader consumptive, economic, aesthetic, or historical preservation considerations.[243] This framework would be a significant departure from a reliance on strict dualist treatments of ecological resources that bifurcate management options according to whether or not a species is deemed native, or whether or not it is an artifact of human intervention.

The most prominent regulatory approach that rejects a strict duality between natural and human-engineered products is embedded in the Coordinated Framework for the Regulation of Biotechnology Products ("Coordinated Framework"), the principal policy framework for synchronizing federal oversight of commercial biotechnology processes and products in the U.S.[244] Under the Coordinated Framework, when a statute leaves an agency latitude regarding whether or not to exercise its

241. *See supra* notes 115–24 and accompanying text.

242. Hawaii, for example, has a statute that expressly allows for the release of certain non-native species. HAW. REV. STAT. ANN. § 195D-29 (LexisNexis 2013). Oregon allows the transplant of non-native vulnerable species. OR. ADMIN. R. 603-073-0110 (2013).

243. *See* Camacho, *supra* note 51, at 247.

244. Coordinated Framework for Regulation of Biotechnology, 51 Fed. Reg. 23,302 (June 26, 1986). The Coordinated Framework was intended to harmonize and efficiently allocate the efforts of the various federal statutes and agencies responsible for regulating the processes and products of genetic engineering. *Id.* at 23,303.

authority to regulate such products or processes, determinations of whether to regulate must be made based on the product's particular characteristics and expected environmental and health effects.[245] The Coordinated Framework expressly states that such assessments (including decisions on whether to restrict a planned introduction of a product) should not be grounded in the methods used to produce them, but rather on the potential risks and advantages posed.[246] Decisions on whether regulatory action is warranted in a particular case must be based on whether the risk is unreasonable, defined as "where the environmental benefits achieved by oversight measures to reduce the risk are greater than the social cost of those oversight measures."[247] In this sense, the Coordinated Framework similarly rejects a duality between human-engineered and conventional or natural products. It purports to subject commercial biotechnology processes and products to the same regulatory regime as more conventional commercial processes and products, ostensibly focusing on the potential advantages and disadvantages of regulation.

Undoubtedly, the Coordinated Framework is only limited to the regulation of commercial biotechnology processes and products. Even in this context, it has been the subject of various credible criticisms, including that it relies on a fragmented and inefficient regulatory patchwork[248] and perpetuates yet another overly formalistic dualism between products and processes.[249] Some have argued that the regulatory

245. *Id.* at 23,305.

246. *Id.*; Exercise of Federal Oversight Within Scope of Statutory Authority: Planned Introductions of Biotechnology Products into the Environment, 57 Fed. Reg. 6753, 6756 (Feb. 27, 1992) ("Federal government regulatory oversight should focus on the characteristics and risks of the biotechnology product—not the process by which it is created. Products developed through biotechnology processes do not *per se* pose risks to human health and the environment; risk depends instead on the characteristics and use of individual products.").

247. Exercise of Federal Oversight Within Scope of Statutory Authority, 57 Fed. Reg. at 6757.

248. *See, e.g.*, Gregory N. Mandel, *Gaps, Inexperience, Inconsistencies, and Overlaps: Crisis in the Regulation of Genetically Modified Plants and Animals*, 45 WM. & MARY L. REV. 2167, 2231–42 (2004) (discussing Coordinated Framework's regulatory gaps, inconsistencies, inexperience, and duplication); PEW INITIATIVE ON FOOD & BIOTECHNOLOGY, ISSUES IN THE REGULATION OF GENETICALLY ENGINEERED PLANTS & ANIMALS 10–13, 18 (2004), *available at* http://www.pewtrusts.org/~/media/legacy/uploadedfiles/phg/content_level_pages/reports/foodbiotechregulation0404pdf.pdf (discussing Coordinated Framework issues of legal uncertainty, regulatory gaps, inconsistency, and lack of coordination).

249. *See, e.g.*, Douglas A. Kysar, *Preferences for Processes: The Process/Product Distinction and the Regulation of Consumer Choice*, 118 HARV. L. REV. 526, 529, 533–34 (2004) (arguing that the conceptual distinction conventionally made in various legal areas between product- and process-related information is "too thin and formalistic of a conceptual device to address those policy disputes in a stable or satisfying manner").

regime has resulted in regulatory passivity as agencies have equated providing similar treatment for conventional and biotechnological products with limited regulation,[250] with some critics calling for a more precautionary regulatory approach.[251] Finally, the regime fails to incorporate any of the essential adaptive management protocols proposed in this article that would treat initial assessments as provisional and require periodic evaluation and revision of decisions to promote agency learning over time.[252] Even so, in a limited way the Coordinated Framework serves as an important example of how the valuation of a potentially risky activity need not turn on a binary choice but can be based rather on a more detailed analysis of the potential merits and risks. An approach for assessing and managing the revival and introduction of de-extinct species—or indeed novel conservation strategies more generally—could adopt a careful risk-based assessment centered on the particular characteristics and ecosystem risks of revival and introduction.[253]

2. Potential Default Rebuttable Presumptions

Of course, rejecting dependence on rigid categories such as native and exotic or natural and artificial for wildlife management leaves open the question of whether default presumptions in favor of unassisted or preexisting wildlife remain valuable. Though this risk-based adaptive approach rejects a reliance on rigid native-exotic dualities, whether members of a species currently exist or previously existed in an area nonetheless will frequently be very relevant to an assessment of the potential risks and benefits of an introduction. Past and current conditions are likely to be invaluable in determinations of what might advance

250. Mandel, *supra* note 248, at 2243 ("The Coordinated Framework's conclusions that genetically modified products should not be regulated based on the process by which they are created, and that no new statutory authority is necessary to regulate them, have led regulators to believe that there are no new risks posed by transgenic products, and perhaps to believe that they are not significantly risky at all. These conclusions also have led to an agency culture of passivity in regulation.").

251. Thomas O. McGarity, *Seeds of Distrust: Federal Regulation of Genetically Modified Foods*, 35 U. MICH. J.L. REFORM 403, 491–94 (2002).

252. *Id.* at 487–88.

253. It is important to note that a rejection of rigid categories such as native and exotic or natural and artificial for wildlife management is not inconsistent with the reliance on a precautionary regulatory approach. Deciding not to categorically accept unassisted migrations and reject assisted movement, for example, is not incompatible with a regulatory regime that presumes wildlife movement, in general, is barred absent sufficient evidence of safety and the adoption of appropriate mitigation measures. Similarly, subjecting preexisting and non-preexisting species to the equivalent risk assessment regime is not inconsistent with a presumption that species introductions generally are barred absent adequate proof of safety.

ecological health. For example, if a species is currently a constituent of an ecosystem, it is much more likely to be compatible with existing physical and ecological conditions. Even if a species were historically present but is currently not, more information is likely to be available about the species' likely value to the biotic community. On the other hand, there is undoubtedly more uncertainty about the ecological costs and benefits of an introduction if an organism has never before been present in a particular location, such as how well suited are a location's biotic and abiotic conditions to the species' successful establishment, as well as the likelihood and extent of harm of an introduction to the location.

Accordingly, such factors might give rise to rebuttable default presumptions in favor of native introductions. For example, a management rule might state that a native species is presumed compatible, or that introductions of that species are permitted, unless the species is assessed to be incompatible with current conditions.[254] Conversely, an introduction of a species that is not native to an area might be barred unless assessed to be compatible with current conditions.

While most legal provisions regulating wildlife management in the United States are grounded in promoting a strict native/non-native duality, a few provisions do provide useful examples of how exotic species might be integrated into land management regimes under a rebuttable presumption in favor of native species. For instance, the FWS has adopted a default presumption against the introduction of non-native plants on Federal Wildlife Refuges unless it determines there is no feasible alternative.[255] The BLM similarly is considering the adoption of a policy that establishes a default rebuttable presumption for the introduction of native plants and against non-native plant species.[256]

---

254. An analogous example of a default that presumes the desirability of preexisting resources exists in the context of food regulation. Under the Federal Food, Drug, and Cosmetics Act, for some food ingredients "generally recognized as safe," there exists a default assumption of safety. *E.g.*, 21 U.S.C. § 346a(k)(1) (2012). Ingredients can be so designated as a result of general recognition of safety through substantial past history of consumption or use in food by a significant number of consumers. 21 C.F.R. § 170.30(c), (f) (2013). Safety need not be affirmatively proven prior to the ingredient's inclusion in a commercial food product. 21 U.S.C. § 348 (2012). However, if the Food and Drug Administration has grounds for believing such an ingredient may not be safe, the agency has the authority to institute regulatory action to overturn such status. *See, e.g.*, United States v. An Article of Food, 752 F.2d 11 (1st Cir. 1985); Fmali Herb, Inc. v. Heckler, 715 F.2d 1385 (9th Cir. 1983).

255. *See* FWS MANUAL, *supra* note 145, 601 FW 3.15C. The FWS also allows exotic species to continue to exist on Federal Wildlife Refuges only if elimination is no longer practicable or the exotic species has become established and maintained on a non-augmented basis for at least 25 years and does not conflict with refuge objectives. FWS REFUGE MANUAL, *supra* note 145, pt. 7, § 8.1.

256. The BLM has proposed a policy for plant introductions that presumes native species will be used unless (1) suitable native species are unavailable, (2) biological diversity of the proposed

A similar default rebuttable presumption could be developed that tracks the human/natural duality, though the argument for such a presumption is appreciably weaker. A regulatory framework could presume that ecological shifts are valuable if not the direct consequence of human activity. Correspondingly, it could presume that alterations to an ecosystem are harmful if directly the result of human action, such as an introduction. Such a presumption might be more appropriate in circumstances in which a key (but not absolute) management goal remains the intrinsic benefit of minimizing direct human manipulation of the ecological resource, regardless of its effects on ecological function.[257] It also might be suitable where the harms from management interventions are habitually greater than the harms from inaction.

However, in light of the pervasive influence of humans in reserved lands and the biosphere more generally, the intrinsic benefit of minimizing additional human interaction with what are already disturbed or "unnatural" biotic communities is more suspect.[258] Moreover, the benefits of making inaction a default management objective are increasingly likely to be less favorable when considered against the costs in ecological health of presuming management inaction. Unfortunately, absent direct human intervention in protected areas, such ecological harms (including ecosystem degradation, loss of genetic diversity, and species extinction) are expected to increase for the foreseeable future as a result of global climate change.[259] As climate change results in pressures for range shifts, the costs of inaction are likely to increase and the benefits of active measures (whether barring or inducing the movement of species) are likely to increase.[260]

In other words, existing evidence does not support a general presumption either in favor of declining to regulate unassisted ecological shifts (especially as such changes are likely to be at least partially attributable to anthropogenic factors) or against active interventions such as introductions (particularly as species that would otherwise have migrated without assistance are obstructed by human-induced dispersal

management area will not be diminished, (3) non-native species can be confined, (4) the site will not support native introductions, and (5) native species will not meet the resource management objective. BLM MANUAL, *supra* note 162, § 1745.06.

257. For example, as a tiebreaker, where all costs and benefits are equal, human inaction might be considered a preferred strategy to active management.

258. *See* Camacho, *supra* note 150, at 1432–33.

259. *See* Camacho, *supra* note 51, at 179–81.

260. *See* Camacho, *supra* note 150, at 1436.

barriers).[261] Undoubtedly, there often will be substantial reasons to minimize human-induced effects on ecological systems, and/or to adopt management alternatives that are less interventionist.[262] Though a presumption against active strategies might make sense in certain circumstances, it frequently will not be preferable to a detailed risk assessment that neither favors nor disfavors direct or indirect human interventions.

CONCLUSION

As with other nascent approaches to conservation policy, de-extinction's value remains far from clear. Though it might be a thought-provoking strategy that galvanizes interest and hope in conservation, there are many reasons to question whether de-extinction of species, such as the Dodo, will be an effective tool for restoring or advancing ecological health. Even so, de-extinction should not be categorically dismissed as a conservation strategy based on a premise that it is inherently unnatural. Nor should its introduction into the environment be primarily focused on the resurrection of historical conditions untethered to the promotion of existing ecological function. Rather, de-extinction reinforces the need to reformulate legal frameworks for assessing new biotechnological and resource management strategies to make careful risk assessment and adaptive management their foundation.

As an examination of their applicability to de-extinction makes clear, the dominant reliance in wildlife laws on dualist treatments of ecological resources distorts conservation management. Native/exotic dualisms establish ecological value primarily predicated on whether or not the resource previously existed in an area, while natural/human dualisms focus on whether or not its presence was a consequence of human influence. Yet the promotion of stasis and a divisible nature is increasingly unachievable, and attempts to do so often will be inconsistent with ecological productivity and health. Though nativity or human involvement may sometimes be quite relevant in assessing a resource's current ecological value or a management strategy's likely feasibility, neither should be the primary focus of conservation policy.

---

261. *See* Camacho, *supra* note 51, at 233.

262. These include, for example, that the administrative costs and risks of harm to the target species may be higher for more active strategies (such as a translocation) than less active strategies (such as a migration corridor). *See id.* at 184–85.

Undoubtedly, there is substantially more uncertainty in evaluating ecological health, and the relative value of the various current and potential constituents of an ecological community is quite contestable.[263] Reducing and managing these uncertainties, and developing processes and tools for assessing value, should be the primary focus of ecology, conservation management, and natural resources laws.[264] By proposing a reorientation toward adaptive risk assessment and management, this Article seeks to push conservation laws to make assessments and deliberations about the relative value of ecological constituents the central enterprise.

---

263. For an exploration of the difficulties in developing standards and assessing goals in natural resources law untethered to historical or wildness preservation, see Alejandro E. Camacho et al., *Perspectives: Reassessing Conservation Goals in a Changing Climate*, ISSUES IN SCI. & TECH. (Summer 2010), http://issues.org/wy-4/p_camacho/, *archived at* perma.cc/65QG-P3XE; Camacho, *supra* note 51, at 245–48.

264. *See* Camacho, *supra* note 51, at 254–55.