NOTES

PROTECTING EVOLUTIONARY POTENTIAL: CAN THE ENDANGERED SPECIES ACT SAVE SPECIES BEFORE THEY EXIST?

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As popularly conceived, environmental conservation is a backward-looking exercise that aims to restore and protect the biodiversity of our parents and grandparents. But this static view of nature is a fiction. Scientists have grown increasingly aware that species are still evolving and, in some cases, doing so rapidly. What's more, scientists are beginning to be able to make predictions about when and how evolution will occur. This Note argues that such nascent biodiversity is worthy of protection. Furthermore, the text and purpose of the Endangered Species Act require protecting populations likely to evolve in the foreseeable future. Without changing the administrative criteria for implementing the Act, agencies could protect nascent biodiversity under the statutory provisions covering threatened "distinct population segments." Finally, this Note responds to some possible difficulties with this approach. As scientific understanding of evolution and biodiversity continues to advance, agencies must consider that their statutory mandate is not to recreate the past, but to enrich the future.

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INTRODUCTION

In the time it takes students to finish law school, some species will have evolved.[1] Take, for example, the green anole, a bright, slender Southeastern lizard whose whole body could fit on a piano key.[2] Life got hard for green anoles in the 1940s, when an invasive brown anole from Cuba began spreading through Florida and outcompeting green anoles for territory on tree trunks.[3] In 1995, a team of biologists made two predictions. First, they guessed that if brown anoles colonized islands off the Florida coast, the resident green anoles would move higher into the trees, the better to avoid their Cuban competitors. Second, they predicted that as a result, subsequent green anole generations would evolve larger toe pads, the better to adhere to precarious

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[1] *See* JOHN N. THOMPSON, RELENTLESS EVOLUTION 3 (2013) (discussing how microbial species can evolve in a matter of days). There are plenty of examples of rapid evolution. *See* Philipp W. Messer et al., *Can Population Genetics Adapt to Rapid Evolution?*, 32 TRENDS GENETICS 408, 409–11 (2016) (discussing several examples of rapid evolution, including Darwin's finches and cichlid fishes); Shyril O'Steen et al., *Rapid Evolution of Escape Ability in Trinidadian Guppies (*Poecilia reticulata*)*, 56 EVOLUTION 776, 782 (2002) (reporting evolutionary divergence within twenty years); Devon E. Pearse et al., *Over the Falls? Rapid Evolution of Ecotypic Differentiation in Steelhead/Rainbow Trout (*Oncorhynchus mykiss*)*, 100 J. HEREDITY 515, 522 (2009) (discussing evolution of trout separated by a waterfall that most likely occurred within less than one hundred years); Y. E. Stuart et al., *Rapid Evolution of a Native Species Following Invasion by a Congener*, 346 SCIENCE 463, 464 (2014) (reporting lizards changing perch height mere months after introduction of a negatively interacting species).

[2] *See* Stuart et al., *supra* note 1, at 463 (discussing range in the Southeastern United States); *Green Anole* (Anolis carolinensis), SAVANNAH RIVER ECOLOGY LABORATORY: HERPETOLOGY PROGRAM, https://srelherp.uga.edu/lizards/anocar.htm (last visited Jan. 8, 2019) (providing photos and length estimates).

[3] *See* Jason J. Kolbe et al., *Genetic Variation Increases During Biological Invasion by a Cuban Lizard*, 431 NATURE 177, 177 (2004) (discussing brown anole invasion); Thomas W. Schoener & Amy Schoener, *Intraspecific Variation in Home-Range Size in Some* Anolis *Lizards*, 63 ECOLOGY 809 (1982) (specifying that both green and brown anoles inhabit tree trunks); Stuart et al., *supra* note 1, at 464 (outlining the range on trees where green anoles typically live).

treetop branches.[4] After brown anoles were introduced to the islands, the biologists found their predictions were correct. Within three years,[5] green anoles began to inhabit higher perches.[6] When the biologists examined the green anoles, they found the anoles had also evolved bigger toe pads.[7]

Although evolutionary biology was once regarded as a strictly retrospective study, that perspective is no longer correct.[8] Though scientists and the lay public traditionally believed evolution to be a slow process playing out over millennia, biologists are discovering more and more evidence of rapid evolution. In addition, they are increasingly able to make predictions about when evolution will occur over these short timeframes.[9]

But even if biologists can identify populations with the potential to diversify, it is not clear what legal protections, if any, such nascent diversity deserves. A population may be likely to evolve in the near future, but if the population is vulnerable, it may die off before it has the chance to evolve.[10] Conservation measures like habitat protection could therefore make the difference in whether a population evolves or not.

This Note argues that the Endangered Species Act (ESA) requires protecting potential biodiversity, although the agencies implementing the Act have not yet used the statute to do so.[11] One of the strongest statutory frameworks for conservation in the world,[12] the ESA was first passed in 1973 to protect biodiversity. The framers of the Act believed protection was critical to preserving biodiversity as a reservoir for future scientific, commercial, medical, educational,

4 *See* Stuart et al., *supra* note 1, at 464 (referring to "Collette's prediction" with regard to perch height and a second prediction about toe pads).

5 *See id.* (depicting change from 1995 to 1998).

6 *See id.* ("*A. carolinensis* on treatment islands already showed a significant perch height increase relative to controls, which was maintained through the study.").

7 *See id.* at 464–65 (observing an increase in toepad size, "suggesting genetically based divergence in nature").

8 *See infra* Section II.A (discussing rapid evolution).

9 *See infra* Sections II.A, II.B (providing examples of rapid evolution and explaining scientists' increased predictive abilities).

10 *See* Alan R. Templeton et al., *Disrupting Evolutionary Processes: The Effect of Habitat Fragmentation on Collared Lizards in the Missouri Ozarks*, 98 PROCEEDINGS NAT'L ACAD. SCI. 5426, 5427–30 (2001) (discussing how human activity fragmented lizard populations in the Ozark Mountains, therefore decreasing genetic diversity and placing the lizards at risk of extinction).

11 *See infra* Section I.B (explaining how Agencies implement the ESA today).

12 FRED W. ALLENDORF & GORDON LUIKART, CONSERVATION AND THE GENETICS OF POPULATIONS 381 (2007) ("The ESA of the United States is one of the most powerful pieces of conservation legislation in the world.").

and aesthetic resources for future generations of humans.[13] To do so, the ESA offers protection for species, subspecies, and distinct population segments.[14] The last category, distinct population segments (DPS)—discrete, evolutionarily significant populations—offers a particularly promising means of protecting nascent biodiversity. As the criteria for DPS listing are quite similar to traits of populations beginning to evolve, there is a strong argument to be made that protections available to DPSs should be extended to nascent populations.[15] Preserving these nascent populations would protect what they're evolving into: fully distinct organisms. Such protection is supported by both the purpose and text of the ESA. This Note is the first piece of legal scholarship to examine whether distinct population segments can and should be used to protect biodiversity that does not yet exist. Though other legal scholars have critiqued the ways distinct population segments are delineated,[16] this is the first effort to incorporate predictive evolutionary biology into the analysis and propose an approach to protection.

This Note proceeds in three parts. Part I discusses what the ESA currently protects. Part II explains how scientific advances are enabling us to predict potential diversity and makes the case for protecting nascent biodiversity. Finally, Part III describes how the ESA could be used to protect this biodiversity. Part III's conclusion addresses some possible concerns about extending protection to nascent biodiversity.

It is easy to misinterpret the idea of conservation as a strictly backward-looking exercise, designed to preserve the current level of diversity or return animals to more plentiful numbers of bygone years. But biodiversity is not a museum diorama to be dusted off and fussed over by scientists and policymakers. This conception ignores that evolution is a constant, dynamic process. If nature were a museum diorama, it would be one that changed every evening and surprised curators the next morning. Nature does not stand still. The ESA

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13 *See infra* Section II.C (elaborating on the reasons for protecting biodiversity).

14 Endangered Species Act of 1973, 16 U.S.C. § 1532(16) (2012).

15 *See infra* Section III.B (discussing the promise of distinct population segments (DPS) for protecting nascent diversity).

16 *See, e.g.*, Holly Doremus, *Listing Decisions Under the Endangered Species Act: Why Better Science Isn't Always Better Policy*, 75 Wash. U. L.Q. 1029, 1100–02 (1997) (discussing the subjective nature of delineating between different species, subspecies, and DPSs); Daniel J. Rohlf, *Section 4 of the Endangered Species Act: Top Ten Issues for the Next Thirty Years*, 34 Envtl. L. 483, 513–15 (2004) (arguing that defining DPSs is a subjective, policy-driven exercise, and that it has been used to advance the "museum piece" view of biodiversity); J.B. Ruhl, *The Battle over Endangered Species Act Methodology*, 34 Envtl. L. 555, 576 (2004) (discussing the methodological uncertainty of defining species, subspecies, and DPSs).

demands a conception of protection that accommodates the march of evolution.

I
The ESA's Protection of Biodiversity

To understand the structure of the Endangered Species Act, it helps to appreciate the context in which it was passed in 1973. The ESA was not blazing trails—several previous statutes had tentatively ventured into wildlife protection before.[17] Instead, the ESA is special because of the ways it reinforced legal paths of protection and paved over the cracks in former statutes. This Part first discusses the structure of the Act, including key advances in protection. Then, in Section B, it discusses how agencies currently wield the Act today.

A. Structure of the Endangered Species Act

The ESA is structured to grant broad permission to the Secretary of the Interior, who oversees the U.S. Fish and Wildlife Service (USFWS), and the Secretary of Commerce, who oversees the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), to list plants[18] and animals under the Act for protection.[19] The Act provides a widely permissive suite of causes for listing, ranging from present or threatened habitat destruction, to disease or predation, to "inadequacy of existing regulatory mechanisms."[20]

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17 *See Origins of Federal Wildlife Laws and Enforcement*, USFWS: Nat'l Conservation Training Ctr., https://training.fws.gov/history/TimelinesLawEnforcement.html (last updated Feb. 21, 2014) (listing the various conservation statutes of the United States). For example, the Lacey Act, enacted in 1900, prohibited interstate shipping of illegally taken wildlife; the Federal Migratory Bird Act, enacted in 1913, regulated bird hunting; and the Bald Eagle Protection Act, enacted in 1940, prohibited taking bald eagles. *Id.*

18 Listing plants was an advance over previous statutes, which only protected animals. *Laws and Regulations to Protect Endangered Plants: The Convention on International Trade in Endangered Species of Wild Fauna and Flora*, USDA: Forest Serv., https://www.fs.fed.us/wildflowers/Rare_Plants/conservation/lawsandregulations.shtml (last visited Oct. 22, 2018) ("Prior acts of Congress had protected some wildlife, but the Endangered Species Act of 1973 was the first Federal legislation to protect endangered plants.").

19 *See* 16 U.S.C. §§ 1532(15)–(16), 1533(a) (defining "Secretary" and "species," and delegating authority); *see also Endangered Species*, USFWS, https://www.fws.gov/endangered/improving_esa/index.html (last updated June 6, 2018) (discussing how the Agency administers the ESA); *Endangered Species Act Guidance, Policies, and Regulations*, NOAA Fisheries, https://www.fisheries.noaa.gov/national/endangered-species-conservation/endangered-species-act-guidance-policies-and-regulations (last visited Jan. 7, 2019) (listing policies, guidance, and regulations the Agency uses to administer the ESA). As a note, NOAA Fisheries is also referred to as the National Marine Fisheries Service. *About Us*, NOAA Fisheries, https://www.fisheries.noaa.gov/about-us (last visited Feb. 27, 2019).

20 16 U.S.C. § 1533(a)(1).

These findings must be made "on the basis of the best scientific and commercial data available,"[21] and listing is subject to notice-and-comment rulemaking procedures.[22] An Agency might consider a species's status because the Agency independently begins reviewing the species or, more commonly, because the Agency is petitioned to do so by members of the public.[23] In making its decision, the Agency may consider its own scientific research as well as scientific research offered by petitioners and by the public during the commenting process.[24]

The listing categories of the ESA make clear that the Agencies can protect multiple levels of evolutionary diversification. To understand this, it is helpful to visualize a three-by-two matrix. Listings are composed of a determination about the evolutionary group in question—a species, subspecies, or distinct population segment—and a determination of the level of risk the group faces—reflected in the categories "endangered" or "threatened." These classifications determine what proportion of a species receives protection and what kinds of protection the listed group receives.

Deciding which evolutionary groups to protect involves complex, scientific tradeoffs, and the Act defers to Agencies in these decisions. The original Endangered Species Act of 1973 protected species and subspecies.[25] Biologists had not reached a consensus about how to define species at the time, and they still have not reached a consensus today.[26] Species may be determined based on whether members interbreed to produce fertile offspring, how similar they are to each other genetically, or how closely they relate to each other on an evolu-

[21] *Id.* § 1533(b)(1)(A).

[22] *See id.* § 1533(b)(3)–(6).

[23] *See* Ctr. for Sci. & Democracy, Advancing Science in the Endangered Species Act 4, 8–9 (2017), https://www.ucsusa.org/sites/default/files/attach/2017/07/esa-toolkit-ucs-july-2017.pdf (discussing the "two main paths" of listing).

[24] *See* Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that Are Candidates or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Recycled Petitions; and Annual Description of Progress on Listing Actions, 64 Fed. Reg. 57,534, 57,535 (Oct. 25, 1999) (codified at 50 C.F.R. pt. 17) ("[W]e rely on information from status surveys conducted for candidate assessment and on information from State Natural Heritage Programs, other State and Federal agencies . . . knowledgeable scientists, public and private natural resource interests, and comments received in response to previous notices of review.").

[25] Endangered Species Act of 1973, Pub. L. No. 93-205, § 3(11), 87 Stat. 884, 886 (codified at 16 U.S.C. § 1532(16) (2012)).

[26] *See* Jody Hey, *The Mind of the Species Problem*, 16 TRENDS Evolution & Ecology 326 (2001) (discussing, throughout the entirety of the article, the "species problem," or the inability of biologists to agree on how to define species).

tionary tree, to name a few prominent methods.[27] There was and is even more scientific uncertainty about identifying subspecies,[28] and the Act offers no explanation of how to determine subspecies beyond the definition of species above. In general, a subspecies is a group within a species, differentiated from the rest of the species geographically and genetically.[29] If given enough time, subspecies may evolve further apart, eventually diverging enough to become separate species.[30] In this sense, conserving subspecies protects an earlier phase in the evolutionary process than protecting species alone would.[31]

In 1978, Congress amended the ESA to allow protection of biodiversity at an even earlier stage in evolution: "distinct population segments."[32] Agencies had special flexibility in defining this group for two reasons. First, distinct population segments were defined nowhere in the ESA.[33] Second, unlike species and subspecies, which were part of scientific parlance, the phrase "distinct population segment" had no preexisting scientific meaning.[34] Congress incorporated the phrase into the definition of "species" without additional explanation in the statute or congressional subcommittee reports, defining "species" as including "any subspecies of fish or wildlife or plants, and any *distinct population segment* of any species of vertebrate fish or wildlife which

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27 *See* DOUGLAS J. FUTUYMA, EVOLUTION 354–55 (2005) (discussing the "biological species concept," the genetically based "phylogenetic species concept," and the relationally and historically based "evolutionary species concept"). The Act seemingly embraced a version of the first method, defining species as including "any subspecies of fish or wildlife or plants and any other group of fish or wildlife of the same species or smaller taxa in common spatial arrangement that interbreed when mature." Endangered Species Act § 3(11).

28 *See Endangered Species Conservation Act of 1972: Hearing on S. 249, S. 3199, and S. 3818 Before the Subcomm. on the Env't of the S. Comm. on Commerce*, 92d Cong. 255 (1972) [hereinafter *S. Comm. on Commerce 1972*] (letter from Seymour H. Levy, conservationist) (emphasizing the subjectivity of delineating subspecies); RICHARD FRANKHAM ET AL., INTRODUCTION TO CONSERVATION GENETICS 371 (2002) ("The concept of sub-species is more subjective than that of species.").

29 *See* FRANKHAM ET AL., *supra* note 28, at 371 (defining subspecies); FUTUYMA, *supra* note 27, at 552 (same).

30 *See* John L. Gittleman, *Species*, BRITANNICA ONLINE ENCYCLOPEDIA, https://www.britannica.com/science/species-taxon (last updated Dec. 4, 2018) (calling subspecies "groups at the first stage of speciation").

31 *See id.* (describing speciation from subspecies with graphics illustrating the evolution of new species).

32 *See* Endangered Species Act Amendments of 1978, Pub. L. No. 95-632, § 5, 92 Stat. 3751, 3752 (codified as amended at 16 U.S.C. § 1532(16) (2012)).

33 Kate Geoffrey & Thomas Doyle, *Listing Distinct Population Segments of Endangered Species: Has It Gone Too Far?*, 16 NAT. RESOURCES & ENV'T 82, 83 (2001).

34 *See* ALLENDORF & LUIKART, *supra* note 12, at 381 (noting that biologists have "vigorously debated criteria for identifying DPSs" since Congress protected the group without offering guidelines).

interbreeds when mature."[35] Congress offered little additional guidance to Agencies, though it did suggest that, in general, species listing be undertaken "sparingly."[36] As of 2005, roughly six percent of listed vertebrates—seventy-one populations—were designated distinct population segments.[37] Notably, Congress's definition limited distinct population segments to vertebrates, or animals with backbones.[38] Because this Note focuses on the DPS classification as the clearest path toward protecting inchoate biodiversity, and DPS only applies to vertebrates, this Note will focus on vertebrates.

Taxonomic permissiveness was not the Act's only innovation. The ESA also sought to intervene sooner in conservation crises than former statutes allowed. The Act protects groups facing two levels of risk, termed "endangered" and "threatened." "Endangered species" are defined as "any species which is in danger of extinction throughout all or a significant portion of its range."[39] If a Secretary lists a taxonomic group as endangered, the group is entitled to numerous protections. The Secretary must designate critical habitat for the group, which may in turn require federal agencies to consult the Secretary before conducting projects or issuing permits in critical habitat areas.[40] Importing or buying the animal is forbidden by the Act, as is any kind of "taking" within the United States or the high seas.[41] The Act explicitly defines "take" as including harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting the animal.[42] Those who knowingly violate the law may face civil charges and accompanying fines, or criminal

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35 Endangered Species Act Amendments of 1978 § 5 (emphasis added).

36 S. Rep. No. 96-151, at 7 (1979). The Senate was responding to a concern that species listing could be used any time a population was geographically isolated, such as the listing of a squirrel population in a particular city park. *See id.* at 6–7 (discussing this squirrel concern).

37 J. Michael Scott et al., *By the Numbers*, *in* The Endangered Species Act at Thirty 16, 20 (Dale D. Goble et al. eds., 2005). At the time of writing, the implementing Agencies list 132 DPS entries in their searchable public database, ECOS. *FWS & NOAA-Fisheries Species Listed as Distinct Population Segments (DPS)*, U.S. Fish & Wildlife Servs.: ECOS, https://ecos.fws.gov/ecp/report/table/species-listed-as-distinct-population-segments.html (last visited Feb. 27, 2019) [hereinafter ECOS].

38 *See* Endangered Species Act Amendments of 1978 § 5 (defining "species" as including "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").

39 Endangered Species Act of 1973, 16 U.S.C. § 1532(6) (2012).

40 *See id.* § 1533(a)(3)(A) (providing that the Secretary designate critical habitat); *id.* 1536(a)–(b) (describing circumstances under which Federal Agencies must consult with the Secretary, along with the relevant procedures).

41 *See id.* § 1538(a)(1).

42 *Id.* § 1532(19). The Supreme Court has also allowed a Secretary's interpretation of "take" which included indirect harm through habitat alteration. *See* Babbitt v. Sweet Home Chapter of Cmtys. for a Great Or., 515 U.S. 687, 696 (1995).

charges followed by fines or imprisonment for up to one year[43]—another conscious departure from earlier, feebler attempts at legal protection.[44] Once a protected group reaches the point "where it is secure in the wild and no longer needs the protection of the ESA," the Agency may delist the group.[45]

Protecting species when they are threatened, rather than waiting until they're endangered, allows Agencies to intervene in a conservation crunch before the situation becomes dire. A group is considered threatened if it is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."[46] Although certain protections like designating critical habitat are mandatory,[47] the Secretary has significantly more discretion when regulating threatened groups than when regulating endangered ones. The required protections for endangered populations serve as a menu for threatened populations, and the Secretary can choose to apply whichever protections she believes would fit the situation best.[48] For example, the Secretary might prohibit taking the threatened animal within the United States, but allow importing the animal. In this sense, protections for threatened animals are more customizable than those for endangered animals.

Protecting populations not yet on the brink of extinction was a priority for legislators drafting the ESA.[49] Congressional reports for the bill quoted President Nixon criticizing the inadequacy of previous legal protections that only applied to species on the verge of extinction and therefore did too little too late.[50] Congress extended protections to animals at risk in "the foreseeable future," but left the

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43 16 U.S.C. § 1540(a)–(b).

44 *See* S. REP. NO. 92-1136, at 3 (1972) (asserting that the effectiveness of the program rested on the bill's making "the taking of an endangered animal by any person within the jurisdiction of the United States a Federal criminal act for the first time").

45 USFWS, OUR ENDANGERED SPECIES PROGRAM AND HOW IT WORKS WITH LANDOWNERS 1 (2009), https://www.fws.gov/endangered/esa-library/pdf/landowners.pdf.

46 16 U.S.C. § 1532(20).

47 *See id.* § 1533(a)(3)(A) (saying that concurrently with listing a species, the Secretary shall "designate any habitat of such species which is then considered to be critical habitat").

48 *See id.* § 1533(d) (stating that the Secretary shall issue "such regulations as he deems necessary and advisable" to protect threatened species). Contrast this leeway with the strict requirements that go along with endangered species listing. *See id.* § 1538(a)(1) (cataloguing unlawful acts with respect to species listed as endangered, including transporting or selling the species in interstate or foreign commerce).

49 *See* H.R. REP. NO. 93-412, at 2 (1973) (listing protection for "animals which may become endangered" as the first of nine "principal changes" in the new legislation).

50 S. REP. NO. 93-307, at 3 (1973) (quoting President Nixon, who critiqued contemporary law for not allowing early enough conservation action, to explain the need for legislation); S. REP. NO. 92-1136, at 2–3 (1972) (same).

definition of "foreseeable future" to Agencies and courts, to which this Note turns next.

B. How Agencies Interpret and Use the ESA

As discussed above, Congress left significant room for interpretation by USFWS and NOAA Fisheries in implementing the Act. Most importantly for the purposes of this Note, the Agencies have developed interpretations of what constitutes distinct population segments and what constitutes the "foreseeable future" for the purpose of identifying threatened species.

USFWS and NOAA Fisheries have developed a definition of distinct population segments that depends on a three-part test.[51] First, the population has to be "discrete" from the rest of its subspecies or species.[52] This discreteness can be proven through geographic isolation, quantified genetic differentiation, or behavioral or physical differentiation.[53] Second, the population must be ecologically or biologically "significant."[54] The Agencies have declined to create a comprehensive list of what determines significance but offer four possible factors: (1) The population exists in an unusual ecological setting different from the rest of its species or subspecies; (2) the population's loss would create a significant gap in the species or subspecies's range; (3) the population is the "only surviving natural occurrence" in the species's historic range; (4) the genetics of the population "differ markedly" from others in the species.[55] These elements, according to the Agencies, bear a connection to whether a population represents "an important component in the evolutionary legacy of the species."[56]

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[51] *See, e.g.*, Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act, 61 Fed. Reg. 4722, 4725 (Feb. 7, 1996) [hereinafter DPS Definition Policy] ("Three elements are considered in a decision regarding the status of a possible DPS . . . .").

[52] *Id*.

[53] *See id.* (listing conditions for "discreteness"). Discreteness may also be met by relevant international boundaries, but that is not the focus of this Note.

[54] *Id.*

[55] *See id.* (explaining that the significance consideration "may include, but is not limited to" these traits).

[56] *See id.* at 4722. This was part of the Agencies' definition of "evolutionarily significant units" (ESU). *See id.* (explaining the National Marine Fisheries Service's approach to ESU, which depended on two criteria: isolation and evolutionary legacy). The term "ESU" existed before the promulgated policy and has been used by different scholars in different ways. *See* Allendorf & Luikart, *supra* note 12, at 407–08 ("It can be difficult to provide a single concise, detailed definition of the term ESU because of the controversy and different uses and definitions of the term in the literature."); Craig Moritz, *Defining 'Evolutionarily Significant Units' for Conservation*, 9 Trends Ecology & Evolution 373, 373 (1994) ("[T]he ESU remains poorly defined, both conceptually and operationally.").

The final step in the three-part test is that, if treated as an independent species, the population would be considered either endangered or threatened.[57]

The pygmy rabbit offers a fairly typical example of a DPS listing. Weighing roughly a pound, the pint-sized pygmy rabbit is the smallest rabbit in North America.[58] Although pygmy rabbits can be found in a few western states,[59] as of 2003, an isolated population concentrated in Washington State numbered fewer than thirty individuals.[60] The Washington population was deemed distinct because it was geographically isolated from all other pygmy rabbit populations, had genetics that were "markedly different" and less diverse than other populations, and occupied an ecosystem with different types of plant species.[61] Because its small population size made it imminently vulnerable to extirpation from predation, disease, or natural disaster,[62] the population qualified as endangered and was listed as such in 2003.[63]

The Agencies have defined the foreseeable future differently from one taxonomic group to the next, but they have embraced regulatory horizons as far as one hundred years in the future.[64] Courts have declined to offer a bright-line rule in cabining foreseeability, instead suggesting that the determination is heavily context specific.[65]

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57 DPS Definition Policy, *supra* note 51, at 4725.

58 *See* Endangered and Threatened Wildlife and Plants; Final Rule to List Columbia Basin Distinct Population Segment of the Pygmy Rabbit (*Brachylagus idahoensis*) as Endangered, 68 Fed. Reg. 10,388, 10,388 (Mar. 5, 2003) (codified at 50 C.F.R. pt. 17) (providing the weight of this rabbit, its dimensions, and calling it "the smallest Leporid in North America").

59 *See id.* at 10,395, 10,397 (describing DNA samples taken from pygmy rabbits of Washington, Montana, Idaho, and Oregon, and contrasting the Columbia Basin ecosystem with ranges in central and southern Oregon).

60 *Id.* at 10,392–93.

61 *See id.* at 10,395 ("The Columbia Basin pygmy rabbit has been physically discrete from the remainder of the taxon for several millennia . . . ."); *id.* at 10,395–97 (discussing differences in elevation, soil, and plant life between the ecosystems of Columbia Basin rabbits and other species populations).

62 *See id.* at 10,393 (calling the Columbia Basin pygmy rabbit "at risk of extirpation").

63 *See id.* at 10,388.

64 *See, e.g.*, Alaska Oil & Gas Ass'n v. Pritzker, 840 F.3d 671, 674 (9th Cir. 2016) (finding reasonable an Agency's decision to list a DPS as threatened when that Agency determined that the population would be endangered by the "end of the century"); W. Watersheds Project v. Foss, No. CV 04–168–MHW, 2005 WL 2002473, at *14–15 (D. Idaho Aug. 19, 2005) (disagreeing with the Agency's conclusion that a sixty-four percent chance that a population will be extinct within one hundred years is beyond the foreseeable future).

65 *See, e.g.*, *Pritzker*, 840 F.3d at 681 (upholding a one hundred-year projection on the part of the National Marine Fisheries Service to designate a DPS); Otter v. Salazar, No. 1:11–cv–00358–CWD, 2012 WL 3257843, at *18–19 (D. Idaho Aug. 8, 2012) (requiring that the meaning of "foreseeable future" be determined in a species-specific manner); Ctr. for

In general, courts defer to the Agencies' decisions not to list species when the Agency reasonably demonstrates a threat is too remote to be foreseeable.[66] If an Agency decides to list a species as threatened based on risks decades in the future, the Agency need not prove the data are ironclad, but only reasonable, in order for a court to uphold listing a population as threatened.[67]

In some cases, the Agencies eschew defining "foreseeable future" altogether. For example, when NOAA Fisheries listed a Mexico-distinct population of humpback whales as threatened, the Agency simply referenced a "moderate threat" to the population—entanglement in fishing gear—and rather low population numbers.[68] Based on these facts in the present, the Agency determined the DPS "likely to become endangered throughout its range within the foreseeable future."[69] The Agency did not present any time horizon for what it considered the foreseeable future.

The circumstances surrounding listings of threatened distinct population segments range widely, but there's at least one consistency: Agencies currently use the ESA to protect distinct population segments that are likely *already* evolutionarily distinct. At the time of listing, the pygmy rabbit, the Mexican humpback whale, and scores of other listed populations were already discrete from the rest of their species, according to a mix of criteria. They were listed because their

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Biological Diversity v. Lubchenco, 758 F. Supp. 2d 945, 967 (N.D. Cal. 2010) ("Plaintiffs concede that the length of time that constitutes the 'foreseeable future' for listing purposes may vary depending on the species and the threats it faces.").

66 *See, e.g.*, *Lubchenco*, 758 F. Supp. 2d at 964–67 (finding that a decision not to rely on modeling data beyond 2050 to extend the "foreseeable future" was satisfactorily explained by the Agency); *cf.* W. Watersheds Project v. Ashe, 948 F. Supp. 2d 1166, 1174 (D. Idaho 2013) (declaring deference to the Agency's technical expertise as appropriate if a reasonable basis exists for the Agency's decision).

67 The Ninth Circuit, for example, upheld a decision to list a distinct population segment of bearded seal as threatened based on projections through 2100 that climate change would lead to significant loss of the seals' ice habitat. *See Pritzker*, 840 F.3d at 674, 681. The ESA, the court explained, did not require predictions to be "ironclad and absolute," but rather required the Agency to provide a reasonable and scientifically supported methodology for the prediction while disclosing an approach's shortcomings. *Id.* at 680. This view runs through other "foreseeable future" cases as well. *See, e.g.*, Safari Club Int'l v. Salazar (*In re* Polar Bear Endangered Species Act Listing & Section 4(d) Rule Litig.), 709 F.3d 1, 14–16 (D.C. Cir. 2013) (upholding a listing that treated the "foreseeable future" as forty-five years in the future); *Ashe*, 948 F. Supp. 2d at 1178–80, 1184 (upholding a decision not to list a population when the Agency did not have a scientifically sound way to determine the range of years that constituted the "foreseeable future"); *see also Foss*, 2005 WL 2002473, at *15–16 (striking down an FWS decision regarding foreseeability because, in part, the FWS failed to explain its methodology).

68 *See* Endangered and Threatened Species; Identification of 14 Distinct Population Segments of the Humpback Whale (*Megaptera novaeangliae*) and Revision of Species-Wide Listing, 81 Fed. Reg. 62,260, 62,305–06 (Sept. 8, 2016).

69 *Id.* at 62,306.

numbers were projected to dwindle in the foreseeable future. All of this seems straightforward enough.

What's less clear is whether Agencies could protect another type of animal; those who have not yet diverged but are likely to do so in the foreseeable future. Consider Table 1, which lays out three different populations and their potential treatment under the ESA.

TABLE 1.
VARIABLE TREATMENT OF POPULATIONS UNDER THE ESA

	Scenario Description	Treatment Under ESA
Population 1	A vulnerable population that is not isolated from the rest of its species and has not genetically differentiated from the rest of the species.	Ineligible for protection
Population 2	A vulnerable population that is isolated from the rest of its species and has significantly genetically differentiated from the rest of the species.	Eligible for protection as DPS
Population 3	A vulnerable population that is isolated from the rest of its species and is likely to significantly genetically diverge from the rest of its species but has not yet done so.	Unclear

Currently, the Agencies are not protecting Population 3. This Note argues the Agencies could and, indeed, ought to protect this type of population. The criteria the Agencies currently use to identify distinct population segments and the timeframe the Agencies consider to identify "threatened" status lay the foundations for a different kind of protection: populations that have not yet diverged evolutionarily but are likely to do so in the foreseeable future. This type of biodiversity and the reasons it merits protection are the subject of the next Part.

II
NASCENT BIODIVERSITY: WHAT IT IS AND WHY IT MATTERS

Part I discussed how the ESA functions and what it protects. This Part discusses a type of biodiversity the ESA presently fails to preserve: nascent biodiversity. Two trends in the study of evolution are making the protection of burgeoning biodiversity more possible. The first is a new appreciation for so-called "rapid evolution" occurring over time periods frequently shorter than the human lifespan. Rapid evolution is much more common than scientists once believed.[70] The second advance is an improved ability on the part of scientists to predict evolution before it happens. Sections A and B will briefly explore each of these phenomena in turn.

A. *Rapid Evolution*

In the past, evolution was believed to be a slow-moving process. When Charles Darwin first proposed the theory of evolution in *On the Origin of Species*, he suggested that evolution was an incremental process of small changes driven by natural selection that took place over long periods of time.[71] Since then, the view of evolution as unfolding over thousands or millions of years has predominated in scholarly and public discourse.[72] The idea that current actions could protect potential biodiversity might have seemed implausible.

But beginning in the 1980s, scientists began to uncover evidence that sometimes evolution occurs at a much brisker pace.[73] One of the earliest proofs of concept was demonstrated by a biologist, David Reznick, who wanted to test how the presence of predators could affect the speed with which Trinidadian guppies matured.[74] He found that introducing big, wide-mouthed predator fish to ponds led to guppies reaching maturity at an earlier age—leaving them better able to

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70 *See* Thompson, *supra* note 1, at 3–4 (referencing the misconception of the past that "evolutionary processes happened slowly"); Joachim Mergeay & Luis Santamaria, Editorial, *Evolution and Biodiversity: The Evolutionary Basis of Biodiversity and Its Potential for Adaptation to Global Change*, 5 Evolutionary Applications 103, 103 (2012) ("Until a decade or so ago, evolutionary change was broadly assumed to happen on a vastly longer time scale than ecological change."); Messer et al., *supra* note 1, at 409 (referencing the "paradigm of slow molecular evolution" and contrasting it with studies showing evolution in action).

71 Charles Darwin, On the Origin of Species 151–52, 172, 310–11 (The Floating Press 2009) (6th ed. 1872) (describing evolution as taking place over "millions of years"); *see* Thompson, *supra* note 1, at 45; Messer et al., *supra* note 1, at 408 ("Charles Darwin thought of evolution as an innately slow process . . . ."). Darwin's view was likely shaped in part by previous findings about the timescales of geological phenomena, like the formation of canyons. *See* Thompson, *supra* note 1, at 45 (stating that Charles Lyell's geological theory "based on slow and continuous changes caused by slow-acting physical processes acting over long periods of time" influenced Charles Darwin).

72 Messer et al., *supra* note 1, at 408 ("[Darwin's view] still runs deep in modern population genetics."). This view did not include macromutations, which scientists appreciated could create rapid change in a population. *See* Thompson, *supra* note 1, at 45–46 (discussing the work of Gregor Mendel on peas).

73 *See* Thompson, *supra* note 1, at 3 (noting that the days of only having a few examples of rapid evolution are over).

74 The view of evolution as a glacial process was so entrenched that Reznick faced significant skepticism. Says Reznick: "People thought my thesis was cute, but doubted I would live long enough to see the results." Jane B. Little, *Rapid Evolution Changes Species in Real Time*, Discover (Jan. 22, 2015) (quoting David Reznick), http://discovermagazine.com/2015/march/19-life-in-the-fast-lane.

reproduce before being eaten.[75] This evolutionary change took place within four years.[76] An ever-growing number of studies have demonstrated examples of rapid evolution, both induced experimentally and occurring naturally.[77] To quote one evolutionary biologist: "Well-studied examples of ongoing evolution within our lifetimes are being published in professional journals at such a fast rate that it is hard to keep up with them."[78]

Climate change is likely to put more pressure on animals and make rapid evolution even more common. The journal *Evolutionary Applications* dedicated an entire issue to the subject of rapid evolution and biodiversity in 2012. In the issue's introduction, the editors declared, "The closer we look at adaptive evolution, often with the aid of new biological insights and technological advances, the faster it seems to happen. . . . This knowledge profoundly affects our thinking on how evolution affects patterns of biodiversity, especially in the face of global change."[79]

Rapid evolution is relevant to conservation choices because it places evolutionary events in "the foreseeable future." It is all very well to discuss protecting a species's ability to evolve, but it is hard to determine what such protection looks like when the timeframe is millions of years.[80] The realization that evolution can take place quickly makes protecting the ability to evolve more tenable under the ESA.

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[75] *Id.*

[76] *Id.*

[77] *See* THOMPSON, *supra* note 1, at 8–9 (providing a table with examples of rapid evolution); *see also, e.g.*, Ross A. Alford et al., *Comparisons Through Time and Space Suggest Rapid Evolution of Dispersal Behavior in an Invasive Species*, 36 WILDLIFE RES. 23, 26–27 (2009) (documenting the rapid evolution of cane toads, as observed by a study in nature and a study of specimens removed to a specific site). Certain populations of cane toads evolved longer legs to move more quickly, but the adaptation wasn't without cost: The population also suffered higher rates of spinal arthritis. *See id.* at 23; *see also, e.g.*, Pearse et al., *supra* note 1, at 522–23 (observing that within one hundred years a population of trout evolved different migration strategies when moved from below a waterfall to above the waterfall); Douglas Quenqua, *Things Looked Bleak Until These Birds Rapidly Evolved Bigger Beaks*, N.Y. TIMES (Nov. 28, 2017), https://www.nytimes.com/2017/11/28/science/birds-beaks-evolution-snails.html?_r=0 (reporting that North American snail kites evolved bigger beaks to eat invasive snails within eleven years, less than two generations for this population).

[78] THOMPSON, *supra* note 1, at 3. For a sample list of examples of rapid evolution, see *id.* at 8–9.

[79] Mergeay & Santamaria, *supra* note 70, at 103.

[80] That said, population geneticists and wildlife managers have tried to calculate the minimum number of individuals needed in a population in order to protect the potential to evolve. *See* FRANKHAM ET AL., *supra* note 28, at 341–44 (discussing the "range of estimates" on population sizes needed to retain evolutionary potential, and noting that most agree that at least five hundred units are required).

B. Predictive Evolution

If rapid evolution moves prospective biodiversity from the distant future to the foreseeable future, predictive evolution offers a means of estimating how and when such evolution is happening or is likely to happen. Scientists making predictions about potential biodiversity can make their predictions based on two aspects of evolution: natural selection and genetic drift.

The first way scientists can make forecasts about evolution is to predict how natural selection will act on a population. Genes, the chunks of DNA code that parents pass onto their offspring,[81] experience random mutations.[82] The forces of natural selection—environmental pressures[83]—work upon these mutations. If a mutation is disfavored by natural selection because the mutation hurts the individual's chance of surviving and reproducing viable offspring, the mutation will likely be kept at only low frequencies in the population.[84] If a mutation is favored by natural selection, mutant individuals are more likely than their non-mutant peers to survive, reproduce, and cause the mutation to spread through a population and perhaps even become ubiquitous.[85] When species evolve a trait thanks to natural selection, the change is called an "adaptation."[86]

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[81] *See* Scott Freeman & Jon C. Herron, Evolutionary Analysis 146 (4th ed. 2007) (describing genes as stretches of DNA that code for protein products); Futuyma, *supra* note 27, at 179–80, 548 (explaining the heredity of genes and defining "gene," respectively).

[82] *See* Futuyma, *supra* note 27, at 178 (describing genetic mutation).

[83] This is a necessarily simplistic description of "natural selection." Douglas J. Futuyma offers a more nuanced definition: "The differential survival and/or reproduction of classes of entities that differ in one or more characteristics. To constitute natural selection, the difference in survival and/or reproduction cannot be due to chance, and it must have the potential consequence of altering the proportions of the different entities." *Id.* at 550.

[84] *See* Freeman & Herron, *supra* note 81, at 254 (describing mutation rates); Futuyma, *supra* note 27, at 251–52 (describing fitness, or reproductive success, of biological entities).

[85] *See* Freeman & Herron, *supra* note 81, at 90 (describing how mutations spread); Futuyma, *supra* note 27, at 251–52 (same). Consider the example of peppered moths, which covered nineteenth century Great Britain's forests with their gray, speckled wings. *See* Jonathan B. Losos, Improbable Destinies: Fate, Chance, and the Future of Evolution 112–13 (2017) (relating the story and appearance of peppered moths). The moths blended into the mottled bark of trees, so when the occasional genetic mutation led to different colors, the moth mutants generally fell victim to predators and failed to pass on their genes. *Id.* However, the Industrial Revolution covered the trees in soot, and as a result, suddenly dark-winged mutants were better camouflaged than their speckled counterparts. *Id.* at 113–14. As a result, the initially rare dark-colored mutants reproduced rapidly, and by the 1950s, constituted the majority of populations in industrialized areas. *Id.*

[86] *See* Freeman & Herron, *supra* note 81, at 364 (explaining adaptation); Futuyma, *supra* note 27, at 247–48 (same).

As the anole example from the Introduction demonstrates, evolutionary biologists have begun making successful predictions about how environmental pressures—an invasive species, for example—will drive evolutionary change.[87] In some cases, they have ways of verifying these predictions quite early by identifying genes that seem to be under selection.[88] Imagine a small population geographically separated from the rest of its abundant species. Although it has not yet genetically diverged, the population has recently become exposed to a new invasive animal competing for similar resources and is therefore experiencing unique pressures that the rest of its species is not. This population would likely be of interest to scientists, who might expect the population to evolve in order to survive despite the presence of a new, invasive competitor.

The second way scientists can predict evolution is by identifying situations in which genetic drift is likely to occur. Genetic drift is the phenomenon of mutations being eliminated or fixed in a population by chance.[89] Sudden decreases in population can accelerate this process.[90] For example, imagine a forest has fifty speckled salamanders

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87 *See supra* notes 1–8 and accompanying text (describing scientists' correct prediction of how the invasion of a Cuban brown anole drove changes in native green anoles).

88 *See* THOMPSON, *supra* note 1, at 13–14 (describing how health officials can detect evolution in influenza strains by observing rates of mutation in certain proteins); Francesco Angeloni et al., *Genomic Toolboxes for Conservation Biologists*, 5 EVOLUTIONARY APPLICATIONS 130, 134 (2012) (describing how to find early signals of selection). One means of determining which genes are under selection is to estimate mutation rate, something else scientists are increasingly able to do. *See id.* at 140 (examining the mutation rate of the Z chromosome in ten non-model bird species); Randy W. DeYoung & Rodney L. Honeycutt, *The Molecular Toolbox: Genetic Techniques in Wildlife Ecology and Management*, 69 J. WILDLIFE MGMT. 1362, 1370 (2005) (summarizing the mutation rates at different kinds of loci); Hanna Panagiotopoulou et al., *Microsatellite Mutation Rate in Atlantic Sturgeon (*Acipenser oxyrinchus*)*, 108 J. HEREDITY 686, 690 (2017) (calculating mutation rates of Atlantic sturgeon).

89 *See* FRANKHAM ET AL., *supra* note 28, at 537 (defining genetic drift); FREEMAN & HERRON, *supra* note 81, at 232–34 (same). A recent, if unnerving, example of genetic drift was found in New York City rat populations. Because of relative isolation between populations, downtown, midtown, and uptown rats have genetically diverged from one another. Matthew Combs et al., *Spatial Population Genomics of the Brown Rat (*Rattus norvegicus*) in New York City*, 27 MOLECULAR ECOLOGY 83, 91 (2018). Evidently, you can take the rat out of the downtown, but you can't take the downtown out of the rat. This all happened on a relatively short time scale too; brown rats first arrived in New York between 1750 and 1780. *Id.* at 93.

90 *See* ALLENDORF & LUIKART, *supra* note 12, at 123–26 (describing genetic bottlenecks); R. Bijlsma & Volker Loeschcke, *Genetic Erosion Impedes Adaptive Responses to Stressful Environments*, 5 EVOLUTIONARY APPLICATIONS 117, 118, 122 (2012) (discussing how "small relatively isolated populations become increasingly subject to genetic drift" and describing the effects of that genetic drift). "Genetic bottlenecks," in which populations drastically decrease in number, or "founder events," in which a few individuals colonize an area previously uninhabited by the larger population, are phenomena that both accelerate genetic drift and can make the small population's future

and fifty solid-colored salamanders of the same species, with neither color meaningfully influencing survival or reproduction. Then a road splits the forest, leaving ten salamanders isolated from the rest of their species. One of the ten is speckled, and nine happen to be solid-colored. If the ten salamanders are left alone to reproduce, it is likely that a greater proportion of their progeny will be solid-colored than speckled. Genetic frequencies among the population could change dramatically within one generation, from 50:50 to 90:10. Although the population has not yet evolutionarily diverged from the rest of its species, scientists would expect the proportions of future generations to look significantly different from the original population because of the unusual founding population, which was selected by chance.[91] Perhaps this population would eventually become completely solid-colored.

Biodiversity is thus a mosaic composed of tesserae placed by natural selection and chance. Evolutionary biologists can make predictions[92] based on natural selection or genetic drift to guess how the mosaic will change.

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genetics more predictable, as the salamander example in the text shows. *See* Hongye Li & Marilyn J. Roossinck, *Genetic Bottlenecks Reduce Population Variation in an Experimental RNA Virus Population*, 78 J. VIROLOGY 10,582, 10,582 (2004) ("Genetic bottlenecks are stochastic events that limit genetic variation in a population and result in founding populations that can lead to genetic drift."); D.R. Matute, *The Role of Founder Effects on the Evolution of Reproductive Isolation*, 26 J. EVOLUTIONARY BIOLOGY 2299, 2299 (2013) ("Events in which a small group of individuals colonize a new environment are known as founder events."); *see also* Benjamin M. Peter & Montgomery Slatkin, *The Effective Founder Effect in a Spatially Expanding Population*, 69 EVOLUTION 721, 722–23 (2015) (developing a genetically predictive model based on founder effects and testing the model using simulations). Because this paper focuses on small, discrete populations, these phenomena are the most relevant examples of genetic drift to this Note, and therefore the subject of the text above. This Note does not claim that all genetic drift results from such phenomena, or that all genetic drift is predictable.

91 Scientists have made observations of genetic drift in the past, but this has not yet reliably led to protection by an Agency. *See* Nw. Ecosystem All. v. USFWS, 475 F.3d 1136, 1149–50 (9th Cir. 2007) (upholding USFWS decision declining to list a DPS, despite evidence of genetic drift).

92 *See* FRED W. ALLENDORF ET AL., CONSERVATION AND THE GENETICS OF POPULATIONS 382–85 (2013) (ebook) (discussing and listing predictions about population changes based on selective harvesting); Michael E. Soulé & Bruce A. Wilcox, *Preface to* CONSERVATION BIOLOGY: AN EVOLUTIONARY-ECOLOGICAL PERSPECTIVE, at vii (Michael E. Soulé & Bruce A. Wilcox, eds., 1980) (referencing predictive theories concerning rates of extinction); Jane M. Reid, *Predicting Evolutionary Responses to Selection on Polyandry in the Wild: Additive Genetic Covariances with Female Extra-Pair Reproduction*, 279 PROC.: BIOLOGICAL SCI. 4652, 4653 (2012) (describing "a quantitative genetic approach to predicting per-generation evolutionary responses to selection"); David L. Stern & Virginie Orgogozo, *Is Genetic Evolution Predictable?*, 323 SCIENCE 746, 750 (2009) ("[G]ene function, gene structure, and the roles of genes and gene products in genetic networks all influence whether particular mutations will contribute to phenotypic evolution. . . . The genetic basis of phenotypic evolution thus appears to be somewhat predictable.").

C. Why Protect Nascent Biodiversity?

Even if biologists are getting better at anticipating evolution before it happens, it's another question whether such nascent evolution deserves protection. This Section presents reasons we ought to care about nascent biodiversity.

To begin, protecting future biodiversity would be consistent with values espoused by wildlife managers and conservationists. Biologists may have multiple goals at once: conserving ancient isolated lineages, protecting current diversity patterns, and preserving genetic variation for future biodiversity.[93] All three are important, yet a guide to conservation genetics notes, "one can argue that the most important temporal component to consider is future biodiversity"[94] because of its importance to future generations.

Encouraging the development of genetic diversity helps make present populations more robust, ultimately contributing to overall species health.[95] In this sense, protecting the ability to genetically diversify is part of ensuring present populations continue into the future, despite misfortunes like disease or natural disasters. This is beneficial, because biodiversity serves as a well of resources for medical and commercial discovery, educational value, ecological maintenance, and aesthetic enjoyment.[96] Protecting the ability of a population to evolve thus not only benefits that population, but could benefit future human generations by passing on a greater bounty of potential resources.[97]

Moreover, humans may derive a good—aesthetic, educational, or otherwise—from observing the process of evolution itself. Evolu-

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93 *See* ALLENDORF & LUIKART, *supra* note 12, at 382 (outlining types of biodiversity that can be protected).

94 *See* ALLENDORF ET AL., *supra* note 92, at 319.

95 *See* ALLENDORF & LUIKART, *supra* note 12, at 361 (describing how homozygosity in corn, for instance, decreases yield, while heterozygosity increases yield); FRANKHAM ET AL., *supra* note 28, at 344–45 (outlining the dangers of a lack of genetic diversity).

96 For an overview of ecosystem services, see generally *Ecosystem Services*, NAT'L WILDLIFE FED'N, https://www.nwf.org/Educational-Resources/Wildlife-Guide/Understanding-Conservation/Ecosystem-Services. Biodiversity seems to be positively correlated with well-functioning ecosystem services. Patricia Balvanera et al., *Quantifying the Evidence for Biodiversity Effects on Ecosystem Functioning and Services*, 9 ECOLOGY LETTERS 1146, 1155 (2006).

97 There is a well-established philosophical literature arguing that future generations of humans have moral standing when present generations make decisions affecting them. *See, e.g.*, David Boonin, *How to Solve the Non-Identity Problem*, 22 PUB. AFF. Q. 129, 129, 154 (2008) (offering a solution to how to reconcile future rights with the fact that future generations lack identity, the "non-identity problem"); Derek Parfit, *Future People, the Non-Identity Problem, and Person-Affecting Principles*, 45 PHIL. & PUB. AFF. 118, 124 (2017) (same); Jeffrey Reiman, *Being Fair to Future People: The Non-Identity Problem in the Original Position*, 35 PHIL. & PUB. AFF. 69, 92 (2007) (same).

tionary biologists are one obvious example of such a group, but the pool of beneficiaries is likely wider and deeper. The reason is that studying evolution in one instance sheds light on how the evolutionary process works in other instances.[98] Thus, understanding how an obscure population of moths evolves may help us understand how well-known agricultural pests evolve, or—even closer to home—how we humans change over time. Populations identified to be on the precipice of evolutionary change offer an intriguing opportunity to study evolution in real time.

The above are reasons nascent biodiversity merits protection on its own terms. But just as importantly for the purposes of this Note, protecting nascent biodiversity where possible seems to be mandated by the Endangered Species Act. Part III will discuss how the ESA's text and legislative history support protecting nascent biodiversity. The best way to do this is through protecting threatened discrete population segments discussed in Part I—discrete, evolutionarily significant vertebrate populations facing danger in the foreseeable future.

III
The ESA's Promise of Protecting Potential Biodiversity

The text and purpose of the Endangered Species Act necessitate protecting potential biodiversity if possible. This Part first discusses how the text and purpose of the ESA support such an endeavor. Next, this Part discusses what such a protective scheme could look like. Finally, this Part discusses possible lingering concerns and objections to protecting nascent biodiversity through the ESA.

A. The ESA's Text and Legislative History Mandate Protecting Future Biodiversity

This Section discusses the ESA's temporally flexible focus, embrace of scientific advances, and broad legislative regard for protecting ongoing evolution. Taken together, these features suggest nascent biodiversity must be protected under the ESA.

1. The ESA Does Not Condition Conservation on History

One might expect that upon inspection, the ESA's text emphasizes current or historical diversity to the exclusion of biodiversity that

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98 *See, e.g.*, Diana Kenney, *How Mapping a Fish's Genome Can Teach Us About Human Evolution*, U. Chi. News (Aug. 17, 2018), https://news.uchicago.edu/story/how-mapping-fishs-genome-can-teach-us-about-human-evolution (discussing the link between understanding genes regulating the width of skate fins and human disease).

could evolve in the future. But in fact, this is not so. Multiple aspects of the Act argue against an exclusive focus on a particular time period, past or present.

The structure of the ESA argues against a view that the Act was envisioned solely to protect historical or existing diversity. If the only way a vulnerable population could merit protection under the Act were historical or current presence in a given habitat, then one would expect the Act to define some kind of temporal baseline to be conserved. The reason is that evolution is an ongoing process, in which populations and ecosystems change over time. For example, New England was once heavily forested, but was dominated by farmland during much of the nineteenth century.[99] This farmland ecosystem decreased the abundance of many animals, but increased the abundance of many species of songbirds.[100] Thus, protecting species in New England implicates significantly different approaches depending on whether one is protecting the region's sixteenth-century ecosystem, its nineteenth-century ecosystem, or its current ecosystem. Without establishing a historical baseline for conservation, it is impossible to know what kinds of populations ought to be protected, and what abundance should be targeted. Targeting a historical period before European colonization might seem reasonable. But that approach could necessitate reintroducing species long gone from the continent—the cheetah, for example.[101] On the other hand, protecting colonial diversity or even present-day diversity would involve a careful balance of preserving patches of forest while maintaining significant clearings for animals that flourish in open spaces. The point is that choosing any baseline involves managerial effort and conservation tradeoffs, and the ESA provides no guidance on this issue.

Language in the ESA acknowledges history as a reason to protect biodiversity, but does not suggest that historical significance is a required factor to make biodiversity worth protecting. Section 2 lists

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99 *See* DAVID S. WILCOVE, THE CONDOR'S SHADOW: THE LOSS AND RECOVERY OF WILDLIFE IN AMERICA 34 (1999) (explaining that "[t]he conversion of forests to farmland during the eighteenth and nineteenth centuries [in New England] was a disaster for some species and a bonanza for others"); *Landscape History of Central New England*, HARV. FOREST, http://harvardforest.fas.harvard.edu/diorama-series/landscape-history-central-new-england (last visited Mar. 1, 2018) (saying the peak of deforestation in New England occurred from 1830 to 1880).

100 *See* WILCOVE, *supra* note 99, at 34 (listing several birds that flourished in the farmland ecosystem).

101 *See* Dustin R. Rubenstein et al., *Pleistocene Park: Does Re-Wilding North America Represent Sound Conservation for the 21st Century?*, 132 BIOLOGICAL CONSERVATION 232, 235 (2006) (referring to the long-extinct American cheetah and noting that pumas might be the better option for re-wilding, because of closer genetic relatedness to American cheetahs than African cheetahs).

many sundry benefits of protecting diversity, asserting species have "esthetic, ecological, educational, *historical*, recreational, and scientific value to the Nation and its people."[102] There is no reason to assume nascent biodiversity will possess any of these values, other than historical significance, in less abundance than existing biodiversity. Thus the offered justifications for protecting existing biodiversity also apply to nascent biodiversity.

Other language that may seem to cut against protecting potential biodiversity does not do so when considered in context. The Act defines "conservation" as "the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary."[103] The phrase "all methods and procedures" should encompass protecting a population whose characteristics suggest it will enrich genetic diversity in the near future. Once this group is sufficiently stable or its promise of diversifying goes away, its protection is "no longer necessary" under the ESA. In the first instance, the population is strong enough that it no longer needs protection in order to evolve. In the second instance, the population is in fact not diverging from the rest of its species and therefore does not represent nascent biodiversity that needs protection.

The ESA's text further suggests that Congress was open to the idea of protecting populations that do not exist, albeit in a different fashion from the nascent biodiversity considered in this Note. Acceptable measures of conservation are defined as including, but not being limited to, "habitat acquisition and maintenance, propagation, live trapping, and transplantation."[104] In addition, the ESA requires the implementing Agencies to designate critical habitat, which may include "areas outside the geographical area occupied by the species at the time it is listed . . . [that] are essential for the conservation of the species."[105] Taken together, these two sections of text show the ESA extends protection to areas that a species does not yet inhabit. Moreover, Agencies have interpreted the Act this way, designating as critical habitat regions in which a given population is not located, but could eventually be.[106] This designation of critical habitat, along with

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[102] Endangered Species Act of 1973 § 2, 16 U.S.C. § 1531(a)(3) (2012) (emphasis added).

[103] 16 U.S.C. § 1532(3).

[104] *Id.*

[105] *Id.* § 1532(5)(A)(ii).

[106] *See, e.g.*, Lisa Heinzerling, *Argument Preview: Justices to Consider Critical-Habitat Designation for Endangered Frog*, SCOTUSBLOG (Sept. 24, 2018), http://www.scotusblog.com/2018/09/argument-preview-justices-to-consider-critical-habitat-

the ESA's express endorsement of translocation, disproves the conception that the ESA is only interested in protecting diversity as it exists. Rather, in the interests of biodiversity, Agencies can and do consider how diversity could be expanded. Although this protection of biodiversity in places it does not yet exist is distinct from protecting biodiversity that has not yet evolved, the two both involve looking beyond diversity as it currently stands. Where legislators knew about the one kind of potential diversity, they expressly chose to protect it.

Another seemingly retrospective feature of the Act—recovery plans[107]—are also not in fact historically focused. Required for each listed species by the Act, recovery plans must lay out a plan for helping the listed species recover enough to eventually be delisted.[108] Such plans may seem like proof of focus on past abundance; after all, the word "recovery" suggests return to a previous baseline. But in practice, recovery plans tend to target populations becoming self-sustaining instead of meeting historical abundance.[109] This approach is consistent with the statutory text. If Congress intended the Act only to protect historical diversity, one might expect reference to a historical baseline in laying out the requirements for a recovery plan. But the ESA does not do this. Instead, the ESA requires that recovery plans describe specific management actions, establish measurable criteria for delisting, and estimate the time and cost of recovery.[110] All of these requirements are consistent with and in fact argue in favor of establishing a plan to nurture a population as it diverges.

2. *The ESA Embraces Scientific Advances*

Congress clearly intended science to dictate or heavily influence decisions made under the Endangered Species Act, suggesting that protection must expand along with scientific ability to identify nascent biodiversity.

designation-for-endangered-frog (discussing the USFWS designation of critical habitat for the dusky gopher frog where the frog does not currently exist).

107 *See* 16 U.S.C. § 1533(f)(1) (introducing recovery plans and outlining requirements).

108 *Id.*

109 *See, e.g.*, NAT'L MARINE FISHERIES SERV., FINAL RECOVERY PLAN FOR THE GULF OF MAINE DISTINCT POPULATION SEGMENT OF ATLANTIC SALMON (*Salmo salar*) viii (2005), https://repository.library.noaa.gov/view/noaa/15982 (defining the population goal not at historical levels, but at self-sustaining levels); USFWS, RECOVERY PLAN FOR THE COLUMBIA BASIN DISTINCT POPULATION SEGMENT OF THE PYGMY RABBIT (*Brachylagus idahoensis*) 58 (2012), https://www.fws.gov/pacific/ecoservices/documents/Columbia_Basin_Pygmy_Rabbit_Final_RP.pdf (same); *Central California Tiger Salamander Recovery Plan: Questions and Answers*, USFWS, https://www.fws.gov/sacramento/outreach/2017/06-14/docs/2017-5-23-Central_California_Tiger_Salamander_Recovery_Plan-QA_FINAL.pdf (last visited Feb. 12, 2018) (same).

110 16 U.S.C. § 1533(f)(1).

The ESA explicitly puts science at the center of listing decisions. Section 4 states that listing decisions must be made "solely on the basis of the best scientific and commercial data available."[111] This emphasis on science was a later, intentional amendment to the Act; by contrast, the original 1973 bill compelled consideration of several non-scientific factors prior to listing.[112] In addition to the best available scientific and commercial data on the species, the initial statute required "consultation, as appropriate, with the affected States, interested persons and organizations, [and] other interested Federal agencies," among other stakeholders.[113] But in 1982, Congress amended the ESA to allow only the consideration of scientific and commercial data.[114] Legislators emphasized that the change was meant to put science front and center in listing decisions: "The principal purpose of these amendments," the conference report reads, "is to ensure that decisions in every phase of the process pertaining to the listing or delisting of species are based solely upon biological criteria and to prevent non-biological considerations from affecting such decisions."[115] Any one of a broad list of findings can justify listing. The criteria include destruction of habitat or range, overuse of the animals themselves, threats posed by disease or predation, inadequacy of existing regulatory mechanisms, and other natural or manmade factors.[116]

The ESA's deference to agency expertise also reflects an interest in allowing Agencies the flexibility to respond to changing science. If lawmakers intended the bill only to be deployed to protect a handful of charismatic animals they deemed valuable at the time of drafting, they could have easily included a list of protected species in the bill.[117] The fact that drafters explicitly exempted insect pests[118] from protection suggests that lawmakers appreciated that the Act could expand protection to a vast array of animals and thus found it necessary to exclude insect pests expressly. Congress deferred to Agencies in expanding protection: Under the Act, the Administrators make the listing decisions,[119] and the criteria for listing are broad.[120]

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[111] Endangered Species Act of 1973 § 4, 16 U.S.C. § 1533(b)(1)(A).

[112] Endangered Species Act of 1973, Pub. L. No. 93-205, § 4(b)(1), 87 Stat. 884, 887 (showing the language of 16 U.S.C. § 1533(b)(1) before the 1982 amendments).

[113] *Id.*

[114] H.R. Rep. No. 97-835, at 2 (1982) (Conf. Rep.).

[115] *Id.* at 19.

[116] 16 U.S.C. § 1533(a)(1).

[117] For example, lawmakers took this approach when listing hazardous air pollutants under the Clean Air Act. 42 U.S.C. § 7412(b) (2012).

[118] 16 U.S.C. § 1532(6).

[119] *Id.* § 1533(b).

Congress deferred to agency expertise, even though it appreciated Agencies would need to make predictions and tradeoffs based on scientific judgment. Speaking to the House Subcommittee on Fisheries and Wildlife Conservation in 1972, NOAA Administrator Dr. Robert M. White acknowledged the difficulty posed by protecting threatened species: "[Y]ou would have to be able to make a judgment as to whether a species was about to become endangered in the foreseeable future. I believe there could be differences of view in such judgments . . . ."[121] William Garner, from the Office of Solicitor of the Department of the Interior, explained in another hearing: "[Y]ou just can not put one pat definition on endangerment. . . . It has to be a flexible definition. . . . It is a large discretionary area, and it is difficult to pin it down."[122] With this understanding, Congress decided to delegate significant freedom and flexibility to Agencies. A Senate report on the Endangered Species Act emphasized the delegation of authority to the Secretary, stating that the Act should strengthen "the Secretary's ability to forecast population trends by permitting him to regulate these animals before . . . danger becomes imminent . . . ."[123] Another Senate report explained the ESA was intended to provide "the Secretary with a wide range of authority . . . while at the same time making it clear that the conservation, protection, restoration or propagation" of species should govern management decisions.[124]

Implicit in Congress's grant of authority to science and implementing Agencies is an understanding that scientific capabilities and conceptions of diversity could and would change. Indeed, between the time of the ESA's enactment in 1973 and the latest amendments to the ESA in 1982, significant advances had been made in genetic engineering.[125] "[A] species must now be viewed as more than just a unique conglomerate of genes," explained one biologist in a hearing before Congress.[126] "It must be viewed also as a depository of genes that are potentially transferrable. . . . The notion that species extinction means the loss of individual utilizable genes must now be

[120] *Id.* § 1533(a)(1).

[121] *Predatory Mammals and Endangered Species: Hearing on H.R. 698 and Related Bills Before the Subcomm. on Fisheries & Wildlife Conservation of the H. Comm. on Merch. Marine & Fisheries*, 92d Cong. 200 (1972) [hereinafter *1972 House Hearings*].

[122] *Id.* at 130.

[123] S. Rep. No. 93-307, at 3 (1973).

[124] S. Rep. No. 92-1136, at 10 (1972).

[125] *See Hearing on Endangered Species Act Reauthorization and Oversight Before the Subcomm. on Fisheries & Wildlife Conservation of the H. Comm. on Merch. Marine & Fisheries*, 97th Cong. 130–31 (1982) (discussing recent advances in organic chemistry and in genetic engineering).

[126] *Id.* at 131.

squarely faced."[127] The parties testifying to these advances did not suggest that the Act needed to be amended to adapt to this new scientific understanding, but rather that the ESA as written incorporated protection of this new conception of biodiversity.[128] Senator John Chafee, chairman of the subcommittee overseeing the 1982 amendments, emphasized in his opening statement to the Senate oversight hearings that genetic engineering illustrated the continued importance of the ESA.[129] In fact, although industry interests argued for changes in the ESA,[130] no party argued the ESA was too narrowly drafted to adapt to science's advances.

Although the legislative history of the Endangered Species Act suggests it was created to encompass new understandings of diversity, some might argue that the mandate would be clearer if Congress were to amend the Act to expressly protect these new conceptions of diversity. Fair enough. But Congress's failure to act should not be interpreted as a rejection of scientific advances. Gridlock is a significant problem in today's Congress;[131] it is accordingly dubious that congressional inaction can be taken as evidence of much of anything. The best evidence we have of congressional intent is therefore in the text and the legislative history of the Act from decades ago, when Congress was, arguably, more aerobic.

Congress delegated authority to Agencies so that protection could adjust to scientific understanding. This regard for flexibility suggests that the growing ability to identify potential biodiversity should serve as a new basis for protection under the ESA.

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127 *Id.*

128 *See id.* (stating, after explaining advances in genetic engineering, that "what this Act is really trying to do is to preserve an enormously valuable endowment for ourselves and for future generations"); *id.* at 125–26 (claiming, after explaining the value of genetic diversity, that the traditional conservation position is to protect such diversity in organisms, and that "it is a dangerously radical position to ignore the importance of these organisms to our well-being and that of our grandchildren"); *id.* at 135–36 (citing the importance of the existing ESA to protecting resources for genetic engineering).

129 *See Endangered Species Act Oversight: Hearing Before the Subcomm. on Envtl. Pollution of the S. Comm. on Env't & Pub. Works*, 97th Cong. 267 (1981) (arguing that "feats of genetic engineering illustrate why it is so important to stop the world's accelerating loss of species").

130 *See, e.g.*, *Endangered Species Act Amendments of 1982: Hearings Before the Subcomm. on Envtl. Pollution of the S. Comm. on Env't & Pub. Works*, 97th Cong. 318–19 (1982) (statement by the National Forest Products Association arguing for weakening the statutory definition of "critical habitat").

131 *See* Richard L. Revesz, *Regulation and Distribution*, 93 N.Y.U. L. Rev. 1489, 1522–24 (2018) (explaining, in Part II, reasons Congress has become significantly more gridlocked since the 1970s and 1980s); *id.* at 1520 n.145 (listing articles studying the increase in gridlock over the last forty years).

3. The ESA Demonstrates Congress's Intent for Broad Protection

When legislators passed the ESA, many lawmakers suggested a broad understanding of biodiversity motivated the Act. A report on the statute by the House Committee on Merchant and Marine Fisheries in 1973 compared Congress's role to that of a global librarian and emphasized the importance of protecting the country's collection of genetic diversity.[132]

Congress was not under the impression that evolution was a one-and-done phenomenon, but instead understood that evolution was ongoing. "Throughout the history of the world, as we know it, species of animals and plants have appeared, changed, and disappeared," the House Committee said.[133] While a species's extinction is therefore not "an occasion for terror or panic," the committee explained, it is "an occasion for caution, for self-searching, and for understanding" and for a recognition that "[t]he value of . . . genetic heritage is, quite literally, incalculable."[134]

The word "heritage" might suggest an emphasis on historical biodiversity, but the report does not treat biodiversity as a collection of historical mementos; instead, the report presents genetic diversity as a resource to be maximized because of future usefulness.[135] Says the report: "[I]t is in the best interests of mankind to minimize the losses of genetic variations. The reason is simple: they are potential resources."[136] The Endangered Species bill, the report explains, is the "institutionalization of that caution."[137] The legislators make clear that this protection must be limited to some extent by the bounds of practicality—"it is beyond our capability to acquire all the habitat which is important to those species of plants and animals which are endangered today, without at the same time dismantling our own civilization"[138]—but nonetheless the lawmakers thought genetic diversity of all kinds, even those of unknown usefulness, deserved conservation.

Congressional hearings on the ESA suggest legislators appreciated that they were crafting law compatible with the dynamic process of evolution rather than creating a straightforward museum of the status quo. In rare cases, protecting evolution was specifically men-

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132 *See* H.R. Rep. No. 93-412, at 4–5 (1973) (analogizing legislators to "custodians" of a building full of books).

133 *Id.* at 4.

134 *Id.*

135 The report also seems to nod at the possibility that diversity is valuable beyond its usefulness to humans, describing the focus on usefulness as "the most narrow possible point of view." *Id.* at 5.

136 *Id.*

137 *Id.*

138 *Id.*

tioned and assigned normative importance, as by Senator Alan Cranston of California, a sponsor of one of the ESA draft bills.[139] Cranston described each species as an "irreplaceable genetic reservoir,"[140] which people had an "ethical and moral responsibility to protect,"[141] and which were currently "disappearing faster than new ones [were] evolving."[142] Senator Hatfield of Oregon, who introduced another draft version of the ESA,[143] explained: "The extinction of a species limits our potential for scientific advancement and human enjoyment. . . . Each species is a perishable resource of unpredictable value."[144] Many similar remarks can be found throughout the hearings to show that Congress envisioned protecting biodiversity as an important purpose of the Act, even if its value to humans was not apparent. The House report stated that the hearings proved the "ecologists' shorthand phrase 'everything is connected to everything else' is nothing more than cold, hard fact."[145]

This focus on biodiversity in the ESA was not a mere blip. Other laws enacted after the ESA also stressed the importance of protecting biodiversity. The Antarctic Conservation Act, enacted in 1978, had the purpose to "provide for the conservation and protection of the fauna and flora of Antarctica, and of the ecosystem upon which such fauna and flora depend."[146] The Act limited the removal of Antarctic vertebrates, invertebrates, and plants from their habitat unless authorized by a permit.[147] The Coastal Barriers Resources Act, enacted in 1982, aimed to protect "resources of extraordinary scenic, scientific, recreational, natural, historic, archeological, cultural, and economic importance,"[148] and the Wild Bird Conservation Act, enacted in 1992, sought to promote "the maintenance of biological diversity generally."[149]

In sum, lawmakers behind the Endangered Species Act emphasized that the goal of protecting biodiversity motivated the statute. They stressed that biodiversity should be viewed as a resource to be maximized for the present and future welfare of animals and humans

139 *See 1972 House Hearings*, *supra* note 121, at 480–81 (statement by Senator Cranston in support of S. 249, his draft of the ESA).
140 *Id.* at 482.
141 *Id.* at 484.
142 *Id.* at 481.
143 *See S. Comm. on Commerce 1972*, *supra* note 28, at 9 (recording that Senator Hatfield introduced the bill).
144 *Id.* at 65.
145 H.R. Rep. No. 93-412, at 6 (1973).
146 Antarctic Conservation Act of 1978 § 2, 16 U.S.C. § 2401(b) (2012).
147 *Id.* § 2403(b)(5).
148 Coastal Barrier Resources Act § 2(a)(2), 16 U.S.C. § 3501(a)(2) (2012).
149 Wild Bird Conservation Act § 2(3), 16 U.S.C. § 4901(3) (2012).

alike. Temporal flexibility and an openness to scientific progress combine with this purpose to suggest that the ESA militates for protecting nascent biodiversity. The next Section will lay out what this protection could look like.

B. How the ESA Could Protect Nascent Biodiversity

If science has advanced enough to make predicting future biodiversity sometimes possible, and protecting nascent biodiversity is required by the text and purpose of the Endangered Species Act, the next question is how such protection would function within the regulatory regime underlying the ESA. The best path to protecting such nascent biodiversity is through listing threatened distinct population segments.

Reconsider the three hypothetical populations laid out in Part I. In light of the features of the ESA discussed above, it is clear that the approach to Population 3 most consistent with the text and purpose of the ESA would be to protect the population. Indeed, the ESA seems to require protecting this population.

TABLE 2. OPTIMAL TREATMENT OF POPULATIONS UNDER ESA

	Scenario Description	Treatment Under ESA
Population 1	A vulnerable population that is not isolated from the rest of its species and has not genetically differentiated from the rest of the species.	Ineligible for protection
Population 2	A vulnerable population that is isolated from the rest of its species and has significantly genetically differentiated from the rest of the species.	Eligible for protection as DPS
Population 3	A vulnerable population that is isolated from the rest of its species and is likely to significantly genetically diverge from the rest of its species, but has not yet done so.	***Protected***

Population 3 qualifies as a distinct population because it is geographically isolated from the rest of its species, which is a qualifying criterion under the Agencies' approach to defining discreteness.[150] The population is also evolutionarily significant, because it is likely to diverge evolutionarily from the rest of its population, which is the second part of the Agencies' DPS listing criteria.[151] Finally, if the population is small enough to be vulnerable

150 DPS Definition Policy, *supra* note 51, at 4725.
151 *Id.*

or faces another threat that may eradicate it in the foreseeable future before it can evolutionarily diverge, the population should qualify as "threatened."[152]

Consider a more specific example. A road is built through a forest, separating a small population of voles from the rest of its species. Initially, the two groups of voles are basically identical. But scientists notice that the isolated population happens to be in the northern part of the forest at a significantly higher elevation than the rest of the ecosystem. Because much of this ecosystem is above the tree line, scientists predict that the newly isolated population of voles will evolve in color to camouflage with rock rather than soil. They also predict the voles' fur will grow fluffier to cope with a colder climate. In other words, this population will likely genetically diverge from the rest of its species and increase biodiversity. Because this population has short generation times, the evolution is likely to occur in the foreseeable future. But this evolution will only occur if the population survives long enough to reproduce, evolve, and become self-sustaining. The population is already small, and scientists have learned that the local human community has a passion for vole hunting. Thus, biologists predict there is a decent chance that this population will be in danger of extinction in the foreseeable future if not protected. The population should therefore be listed as a threatened DPS.

That scenario anticipates adaptive evolution, but one could imagine a similar scenario based instead on the founders of the population and genetic drift. Imagine again that a road separated a population of voles from the rest of its species. But in this instance, the ecosystem on either side of the road is virtually identical. Instead, the scientists notice that by chance, the newly isolated population has an unusually high rate of a rare genetic trait: a lack of tail. Assuming for the sake of argument that this trait is adaptively neutral, scientists would expect this population to continue over generations to have many more tailless voles than the rest of the species. In this case, the trait already exists in the larger species. But protecting a different population in which the trait is unusually prevalent is a type of insurance against losing the trait altogether. Protecting the newly isolated population therefore still makes sense in the context of protecting nascent biodiversity. Assuming the same threats that faced the population above, the population should be listed as a threatened DPS.

Under a threatened listing, USFWS would have considerable discretion about which protections to deploy for the northern vole

152 *Id.*

population. For example, the Agency would designate the northern forest segment "critical habitat" and prohibit Federal Agencies' taking the vole in the area.[153] But the Agency could also prohibit private takings to prevent hunting, if it so chose.

Protecting biodiversity need not lock Agencies into protecting a population indefinitely. There are two paths to delisting. First, if after a certain period of time passes, the population fails to show the expected evolutionary divergence, the population no longer has a claim to evolutionary significance. The population should thus be delisted. Second, if after a certain period of time, the population reaches safe, self-sustaining numbers, the population is no longer threatened. Again, the population should be delisted.

Although scientific predictions involve some level of uncertainty, this uncertainty is not a reason to ignore potential biodiversity. Most decisions under the Endangered Species Act already involve some level of incertitude. As discussed in Part I, determining what counts as a species, let alone a subspecies or distinct population segment, involves some scientific controversy.[154] Making determinations about whether a population faces extinction or will face extinction in the foreseeable future likewise necessitates uncertain predictions.[155] There is no reason that predictions of potential biodiversity be held to a standard of absolute certainty, when no other prediction under the Act is so constrained.

In summary, the ESA likely requires protecting nascent biodiversity. Furthermore, such protection does not actually seem to require a major upheaval of regulations on the part of Agencies. The Agencies already have established criteria that would allow them to list nascently divergent populations as threatened DPSs. Agencies should use their authority to protect this burgeoning diversity. The next Section addresses some possible concerns with this approach.

C. Concerns About Protecting Nascent Biodiversity

Extending protection to burgeoning biodiversity raises some concerns, but they are not so grave that they justify excluding potential diversity from conservation efforts. Although this Section cannot address all concerns, it identifies and responds to several of the most pressing challenges of conserving potential biodiversity.

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153 *See* Endangered Species Act of 1973, 16 U.S.C. § 1533(a)(3) (2012) (requiring the designation of critical habitats, as defined under § 1532(5)).

154 *See supra* Section I.A.

155 *See supra* Section I.B.

One possible concern is that protecting nascent biodiversity will overwhelm agency capability. The implementing Agencies must already spread their resources to protect more than 700 types of existing animals in the United States.[156] Protecting animals that do not yet exist would expand agency coverage even further and perhaps violate Congress's admonition to use DPS listings "sparingly."[157]

But under current science, the regime this Note envisions would limit the protection of future diversity to a small number of cases. First, such listing would require a significant amount of scientific information, which is unlikely to be readily available for most populations. Scientists would have to identify geographic isolation of such a nature that common genetic exchange with the rest of a species would be unlikely to occur. In addition, scientists would need to estimate the size of a population to determine that it is large enough to be viable at all—a population of two siblings, for example, would likely be doomed for failure and not merit protection—but also vulnerable enough to qualify as "threatened." Scientists would then need to have further reason to believe the species would diverge in the foreseeable future, as opposed to over a longer timescale. Because of the intensive information requirements, DPS listings would remain sparing and would not overwhelm Agencies.

If science advances enough to make evolutionary predictions easier and more widespread, Agencies can tailor their rules to cabin the reach of DPS listings so that such listings remain sparing. USFWS and NOAA Fisheries would likely promulgate regulations about what kind of potential biodiversity is worth protecting with a limited number of listings. For example, the Agencies could decide to protect potential adaptive evolution—evolution driven by natural selection—but not random evolution driven by genetic drift. Regulators could limit how far into the future predictions could reach to merit protection, perhaps discounting the merit of potential diversity as it becomes more remote.[158] Alternatively, with science's new capabilities,

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[156] *See Listed Species Summary (Boxscore)*, U.S. FISH & WILDLIFE SERVS., https://ecos.fws.gov/ecp0/reports/box-score-report (last updated Feb. 27, 2019) (listing total numbers of species protected under the ESA).

[157] S. REP. NO. 96-151, at 7 (1979). The Senate was responding to a concern that DPS listing could be used any time a population was geographically isolated, such as the listing of a squirrel population in a particular city park. *Id.*

[158] This kind of discounting could raise issues related to an ongoing scholarly debate about the appropriateness of discounting future lives. *See, e.g.*, John A. Cairns & Marjon M. Van Der Pol, *Saving Future Lives. A Comparison of Three Discounting Models*, 6 HEALTH ECON. 341, 349 (1997) (suggesting that proportional or hyperbolic discounting rates are more appropriate than a constant discounting rate); Shane Frederick, *Valuing Future Life and Future Lives: A Framework for Understanding Discounting*, 27 J. ECON. PSYCHOL. 667, 677 (2006) (arguing that discounting rates applied to those currently alive

Congress may find there is a need for more DPS listings, and decide DPS protection should no longer be extended sparingly.

Some might raise as a second objection that not all nascent biodiversity deserves equal protection. For example, diversity driven by natural selection helps populations survive and reproduce in a changing environment, while diversity driven by genetic drift is random.[159] Although both types of evolution generate diversity, conservationists might find the first type of diversity to be more valuable than the second. Relatedly, not all genetic mutations equally affect external diversity; some genetic mutations lead to physical changes,[160] others to behavioral changes,[161] and still others to no observable change at all.[162] Agencies might plausibly care about preserving one set of changes more than another.

The proposal to protect nascent biodiversity does not foreclose making value judgments about what kinds of nascent diversity to protect. In fact, USFWS and NOAA Fisheries already make decisions about what kind of differentiation is worth conserving when considering whether to protect extant biodiversity. Agencies currently protect behavioral, physiological, and ecological diversity and seem willing to consider fairly subtle differences along these metrics when making decisions.[163] When considering potential biodiversity, Agencies should decide whether the biodiversity would be worth pro-

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should not be the same as discounting rates applied to those who will be alive in the future); David Weisbach & Cass R. Sunstein, *Climate Change and Discounting the Future: A Guide for the Perplexed*, 27 YALE L. & POL'Y REV. 433, 456–57 (2008) (arguing for a low discounting rate for climate change because its effects are so uncertain and will occur so far in the future). Such a debate is beyond the scope of this Note, but I offer the example to illustrate that Agencies would not be lacking in potential frameworks to limit their DPS listings, even if scientific predictive abilities dramatically improve.

159 *See supra* Section II.B.

160 *See, e.g.*, Georg Halder et al., *Induction of Ectopic Eyes by Targeted Expression of the* Eyeless *Gene in* Drosophila, 267 SCIENCE 1788, 1788 (1995) (exploring gene mutations that affect eye structure and noting loss-of-function mutations can lead to loss of eye structures).

161 *See* Kristin Samuelson, *OCD-Like Behavior Linked to Genetic Mutation*, NW. NOW (Feb. 22, 2017), https://news.northwestern.edu/stories/2017/february/ocd-like-behavior-linked-to-genetic-mutation (describing a mouse study linking gene mutations to obsessive-compulsive disorder).

162 *See The Sound of a Silent Mutation*, SCIENCE (Dec. 22, 2006), http://www.sciencemag.org/news/2006/12/sound-silent-mutation (defining a "silent mutation" as a mutation that does not change the basic sequence of genetic building blocks and does not typically result in a discernible change in the organism's appearance or behavior).

163 For an example of agency receptivity to subtle distinctions, see Nw. Ecosystem All. v. USFWS, 475 F.3d 1136, 1146–47 (9th Cir. 2007). Although the Agency did not find sufficient evidence to support the claim, USFWS took seriously the justification that a population of western gray squirrels was distinct because they were "more shy and secretive" than other western gray squirrel populations. *Id.*

tecting if it already existed. This Note does not minimize the difficulty of these decisions, but rather emphasizes that this difficulty exists independent of protecting nascent diversity.

A final, more theoretical concern might be that a regard for potential biodiversity will obligate Agencies to take proactive steps to create evolutionary opportunities. If we deem future biodiversity worthy of protection, Agencies could be obligated to separate populations and introduce pressures to force evolution. Rather than protecting an isolated population after a highway is built, as in the example from the previous Section, the Agency would need to proactively encourage building highways or other barriers to break up populations and create opportunities for potential diversification. This activity could generate a virtually unlimited amount of agency work.

In fact, such proactivity is not a necessary result of protecting potential biodiversity. First, such an approach would force the Agencies to make tradeoffs between protecting the genetic robustness of an overall species and the potential to divide the species into isolated populations. In general, populations are healthiest when they are in continuous habitat with a diverse gene pool that can intermix through mating.[164] In deciding to isolate a population, an Agency would contribute to habitat fragmentation and could weaken the health of an overall subspecies or species,[165] even while increasing the likelihood that a specific population might diverge. Thus, it's not clear the ESA would permit such action. By contrast, this Note advocates only that Agencies act after isolation has occurred. At that point, the Agency no longer faces a conservation tradeoff because the overall species's habitat has already been fragmented. The decision to protect the isolated population offers the upside of allowing potential divergence with no clear conservation downside.

Furthermore, the Act's emphasis on passive protections, rather than active interventions, cuts against an agency obligation to engineer opportunities for potential diversity. The ESA concerns "prohibited acts," like forbidding transporting or selling animals, not required acts, like enriching a habitat to make it more favorable to a population.[166] This emphasis on passive protection lends itself to conserving populations that have potential to diversify, rather than creating

164 *See* Nusha Keyghobadi, *The Genetic Implications of Habitat Fragmentation for Animals*, 85 CAN. J. ZOOLOGY 1049, 1056 (2007) (summarizing studies that link habitat fragmentation with extinction).

165 *See* Lenore Fahrig, *Effects of Habitat Fragmentation on Biodiversity*, 34 ANN. REV. ECOLOGY, EVOLUTION & SYSTEMATICS 487, 505 (2003) (discussing the possible adverse genetic effects of habitat loss and habitat fragmentation).

166 Endangered Species Act of 1973, 16 U.S.C. § 1538(a)(1) (2012).

populations that have such potential. What's more, because this Note proposes protecting nascent biodiversity as "threatened" rather than "endangered," Agencies are not even required to observe all of the prohibited acts of the ESA.[167] The threatened listing is crafted to avoid overburdening the Agencies with specific obligations regarding their approach to conservation. Given the flexibility the Act preserves with regard to regulating threatened species, Agencies would likely be able to follow their own judgments about how to protect potential diversity, and would likely favor passive protections over proactive efforts to drive evolution.[168]

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Although protecting nascent biodiversity could pose some challenges, they are surmountable. The intent here is not to propose a detailed regulatory framework for implementation. Rather, this Section demonstrates that some seemingly novel difficulties are actually variations on challenges the Agencies already navigate, and that Agencies could retain flexibility in conserving potential evolutionary diversity.

Conclusion

The conventional view of the Endangered Species Act is that it protects historical nature—helping us to return to the biodiversity of our parents and grandparents. Current human generations pass biodiversity in a bucket to the next generation, and their job is to plug any holes that might cause leaks, not to refill the bucket. But this narrow view cheats future animals and humans alike of a more diversified world. As pressures upon animals increase with climate change and human development, rapid evolution will grow more common. The Endangered Species Act was written in a capacious way to generously protect biodiversity. It is time we watered the evolutionary tree.

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167 *See id.* (introducing prohibited acts as relevant to "endangered" species, but not "threatened" species).

168 *See* Nat'l Research Council, Comm. on Sci. Issues in the Endangered Species Act, Science and the Endangered Species Act 139–40 (1995), https://www.ncbi.nlm.nih.gov/books/NBK232376/pdf/Bookshelf_NBK232376.pdf (advising that active measures like captive breeding programs and reintroduction be avoided when possible because of expense). Contrast this view with the approach to the more passive protection of determining critical habitat, which must be designated "to the maximum extent prudent and determinable." *Id.* at 2.