BIODIVERSITY ON THE BRINK: THE ROLE OF "ASSISTED MIGRATION" IN MANAGING ENDANGERED SPECIES THREATENED WITH RISING SEAS

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Coastal areas in the United States are already experiencing the effects of sea-level rise, and the best available science predicts significant additional sea-level rise this century. In addition to sea-level rise, storm intensity and storm surge are also increasing. In some coastal areas, continuing population growth is compounding the threats of climate change and sea-level rise.

At the same time, one in six of the federally listed endangered and threatened species in the United States is threatened by sea-level rise. Coastal species face displacement, extirpation, and even extinction due to loss of habitat. They are at risk of being trapped between rising sea levels and human development. This threat is exacerbated by unyielding human-made coastal fortifications. This coalescence of factors leads to the phenomenon known as "coastal squeeze"—the loss of transitional habitat between land and sea.

For coastal areas this means that some of the most imperiled species will be pushed closer to the brink of extinction. "Assisted migration" refers to one policy prescription to address this problem. The federal government, through the U.S. Fish and Wildlife Service, has the authority—and responsibility—to consider active and passive assisted migration under the Endangered Species Act in managing species threatened with habitat loss due to sea-level rise. The federally protected Florida panther, loggerhead sea turtle, Key tree-cactus, and Lower Keys marsh rabbit inhabit critically imperiled habitat in south Florida and are analyzed to examine this issue from the perspective of species from differing taxa, habitat types, and natural histories. This Article concludes that assisted migration, coupled with preserve and corridor protection and dramatic reductions in greenhouse gas emissions, are necessary for the conservation of imperiled species threatened with sea-level rise.

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Introduction

The best available science predicts significant impacts from sea-level rise in the coastal United States within this century. The Atlantic and Gulf of Mexico coasts of the United States have already experienced higher rates of sea-level rise than the global average during the last fifty years.[1] In addition, frequency of storm surges and storm intensity are predicted to continue to rise.[2]

Compounding the threats of climate change and sea-level rise is continuing population growth in already crowded coastal communities. For example, Florida's population density along the coast is three times greater than in inland counties.[3] All counties in south Florida are expected to continue to grow; some coastal counties will run out of room and development will spill into neighboring inland counties.[4] Coastal species are at risk of being trapped between rising sea levels and human development. This threat is exacerbated by unyielding, human-made coastal fortifications. This coalescence of factors leads to the phenomenon known as "coastal squeeze"—the loss of transitional habitat between the land and the sea. For coastal species, this means that some of the most imperiled species will be pushed closer to the brink of extinction.

"Assisted migration," which includes passively or actively moving species to areas outside their currently occupied ranges, is one policy prescription to address this problem. This Article focuses on the U.S. Fish and Wildlife Service's responsibility under the Endangered Species Act ("ESA") to consider assisted migration as a tool in managing species threatened by climate change.

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[1] U.S. Global Change Research Program, Global Climate Change Impacts in the United States 37 (Thomas R. Karl, Jerry M. Melillo & Thomas C. Peterson eds., 2009), https://perma.cc/Q3UY-FG3S?.

[2] *See generally* Morris A. Bender et al., *Modeled Impact of Anthropogenic Warming on the Frequency of Intense Atlantic Hurricanes*, 327 Science 454 (2010); James B. Elsner, James P. Kossin & Thomas H. Jagger, *The Increasing Intensity of the Strongest Tropical Cyclones*, 455 Nature 92 (2008); Aslak Grinsted, John C. Moore & Svetlana Jevrejeva, *Homogeneous Record of Atlantic Hurricane Surge Threat Since 1923*, 109 Proc. Nat'l Acad. Sci. U.S. 19601 (2012) [hereinafter Grinsted et al., *Homogeneous Record*]; C. M. Kishtawal et al., *Tropical Cyclone Intensification Trends During Satellite Era (1986–2010)*, 39 Geophysical Res. Letters L10810 (2012).

[3] Judith Kildow, Nat'l Ocean Econ. Program, Phase I: Facts and Figures: Florida's Ocean and Coastal Economies 13 (2006), http://perma.cc/B7XX-B96U.

[4] Paul D. Zwick & Margaret H. Carr, GeoPlan Ctr. at the Univ. of Fla., Florida 2060: A Population Distribution Scenario for the State of Florida 13–14 (2006), http://perma.cc/M2ZH-9HFK.

This Article does not address considerations such as the ethics of assisted migration,[5] limits of liability,[6] or how wildlife management agencies should prioritize aid to species.[7]

The federally protected Florida panther, loggerhead sea turtle, Key tree-cactus, and Lower Keys marsh rabbit are analyzed to examine this issue from the perspectives of species from differing taxa, habitat types, and natural histories. This Article concludes that through the ESA, the Service has the responsibility to consider utilizing assisted migration, manifested as active or passive aid—through its authority to implement recovery plans, create experimental populations, and designate unoccupied critical habitat—to help imperiled species survive a rapidly changing environment.

I. Sea-Level Rise Impacts and the Need for Assisted Migration

A. *Coastal Impacts from Sea-Level Rise on Imperiled Species*

The best available science predicts significant impacts from climate change and global sea-level rise in the coming century, including species extinctions.[8] The United States' Atlantic and Gulf of Mexico coasts have already experienced high rates of sea-level rise.[9] In addition to sea-level rise, the inten-

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[5] *See generally* Ben A. Minteer & James P. Collins, *Move It or Lose It? The Ecological Ethics of Relocating Species Under Climate Change*, 20 Ecological Applications 1801 (2010); Mark W. Schwartz et al., *Managed Relocation: Integrating the Scientific, Regulatory, and Ethical Challenges*, 62 BioScience 732 (2012) [hereinafter Schwartz et al., *Managed Relocation*]; Mark W. Schwartz, Jessica J. Hellmann & Jason S. McLachlan, *The Precautionary Principle in Managed Relocation is Misguided Advice*, 24 Trends Ecology & Evolution 474 (2009).

[6] *See generally* Karrigan Bork, Note, *Listed Species Reintroductions on Private Land—Limiting Landowner Liability*, 30 Stan. Envtl. L.J. 177 (2011).

[7] *See generally* Alejandro E. Camacho, *Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change*, 27 Yale J. on Reg. 171 (2010); J. J. Hellmann & M. E. Pfrender, *Future Human Intervention in Ecosystems and the Critical Role for Evolutionary Biology*, 25 Conserv. Biology 1143 (2011); Malcolm L. Hunter, Jr., *Climate Change and Moving Species: Furthering the Debate on Assisted Colonization*, 21 Conserv. Biology 1356 (2007); Ian D. Lunt et al., *Using Assisted Colonisation to Conserve Biodiversity and Restore Ecosystem Function Under Climate Change*, 157 Biological Conserv. 172 (2013); David M. Richardson et al., *Multidimensional Evaluation of Managed Relocation*, 106 Proc. Nat'l Acad. Sci. U.S. 9721 (2009); Anthony Ricciardi & Daniel Simberloff, *Assisted Colonization is Not a Viable Conservation Strategy*, 24 Trends Ecology & Evolution 248 (2009); Pati Vitt et al., *Assisted Migration of Plants: Changes in Latitudes, Changes in Attitudes*, 143 Biological Conserv. 18 (2010).

[8] *See generally* Aslak Grinsted, J. C. Moore & S. Jevrejeva, *Reconstructing Sea Level from Paleo and Projected Temperatures 200 to 2100 AD*, 34 Climate Dynamics 461 (2010); James Hansen et al., *Global Temperature Change*, 103 Proc. Nat'l Acad. Sci. U.S. 14288 (2006); S. Jevrejeva, J. C. Moore & A. Grinsted, *How Will Sea Level Respond to Changes in Natural and Anthropogenic Forcings by 2100?*, 37 Geophysical Res. Letters L07703 (2010); W. T. Pfeffer, J. T. Harper & S. O'Neel, *Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise*, 321 Science 1340 (2008); Stefan Rahmstorf, *A Semi-Empirical Approach to Projecting Future Sea-Level Rise,* 315 Science 368 (2007); Martin Vermeer & Stefan Rahmstorf, *Global Sea Level Linked to Global Temperature*, 106 Proc. Nat'l Acad. Sci. U.S. 21527 (2009); Nat'l Research Council of the Nat'l Acads., Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future (2012), http://perma.cc/6RMX-32S8.

[9] U.S. Global Change Research Program, *supra* note 1, at 37.

sity of high-severity storms appears to be increasing in the Atlantic,[10] as are the frequency of storm-generated large surge events[11] and wave heights.[12] When combined with the effects of sea-level rise, there may be increased cumulative impacts from future storms. As the seas rise, storm surge will push water farther inland and flood coastal habitats.[13] When storm surges coincide with high tides,[14] the impact is even greater.[15]

With rising seas comes additional coastal fortification in the form of seawalls and breakwaters.[16] Beaches naturally migrate in response to seasonal changes—using the dune system as a reservoir to store sand for times of high erosion.[17] When big waves crash on a beach, the energy is dispersed through the upper beach depositing sand while the water seeps back into the ocean.[18] In contrast, when a wave hits an armored beach, much more energy is reflected outward, which causes sand to be moved away from the shoreline rather than deposited on higher parts of the beach.[19] The dune is no longer able to replenish sand on the beach nor can it be used as a reservoir to store sand during the seasons when excess sand is deposited on the coast. Seawalls literally draw a line in the sand—severing all interaction between what remains of the dune system and the beach. The end result is a net loss of beach width, year after year, until there is no beach at all—just a rocky shoreline abutting steel seawalls. Therefore, these coastal hardening structures can actually increase erosion and prevent species' landward migration, catching species in a "coastal squeeze."[20]

As a low-lying, densely populated peninsula, Florida is particularly vulnerable to sea-level rise, and its species to coastal squeeze. Currently, more than half of the ESA-listed species in Florida are threatened by sea-level rise.[21] This will likely worsen as sea-level rise projections for coastal Florida counties, such as Monroe, Miami-Dade, Broward, and Palm Beach, are estimated at three

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[10] *See generally* Bender et al., *supra* note 2. *See also* Elsner et al., *supra* note 2, at 92; Kishtawal et al., *supra* note 2, at L10810.
[11] Grinsted et al., *Homogeneous Record*, *supra* note 2, at 19601.
[12] Paul D. Komar & Jonathan C. Allan, *Increasing Hurricane-Generated Wave Heights Along the U.S. East Coast and Their Climate Controls*, 24 J. Coastal Res. 479, 479 (2008).
[13] Claudia Tebaldi, Benjamin H. Strauss & Chris E. Zervas, *Modelling Sea Level Rise Impacts on Storm Surges Along US Coasts*, 7 Envtl. Res. Letters 1, 1 (2012).
[14] Joseph Park et al., *Storm Surge Projections and Implications for Water Management in South Florida*, 107 Climatic Change 109, 111 (2011).
[15] Daniel R. Cayan et al., *Climate Change Projections of Sea Level Extremes Along the California Coast*, 87 Climatic Change S57, S71 (2008).
[16] *See generally* Niki L. Pace, *Wetlands or Seawalls? Adapting Shoreline Regulation to Address Sea Level Rise and Wetland Preservation in the Gulf of Mexico*, 26 J. Land Use & Envtl. L. 327 (2011).
[17] *See* Omar Defeo et. al, *Threats to Sandy Beach Ecosystems: A Review*, 81 Estuarine, Coastal & Shelf Sci. 1, 2, 6 (2009); *see also* Shawn W. Kelly, The Utilization of Seawalls in Response to Shoreline Erosion 2 (2000), http://perma.cc/4DUH-BLCL.
[18] *See* Defeo et al., *supra* note 17, at 2.
[19] *See id.* at 6.
[20] Matthew M. Linham & Robert J. Nicholls, Technologies for Climate Change Adaptation 5 (Xianli Zhu ed., 2010), http://perma.cc/9SKP-J4LM.
[21] Ctr. for Biological Diversity, Deadly Waters: How Rising Seas Threaten 233 Endangered Species 4–5 (2013), http://perma.cc/BG3E-WUH6.

to seven inches by 2030, nine to twenty-four inches by 2060, and nineteen to fifty-seven inches by 2100, relative to 2010 levels.[22]

Sea-level rise is already affecting south Florida ecosystems. It is accelerating erosion and increasing saltwater intrusion to ground and surface water in the Everglades.[23] It is affecting freshwater plant communities in the southern Everglades by producing ideal conditions for salt-loving plants, which crowd out freshwater plants.[24] Increased salinity in the Florida Keys due to nearly six inches of sea-level rise has also reduced pine rockland habitat.[25] Mangrove coverage in the Ten Thousand Islands area has increased 35% between 1927 and 2005, which is partially attributable to sea-level rise.[26]

Compounding the threats of climate change and sea-level rise in south Florida is population growth. Florida's population density along the coast is three times greater than in inland counties.[27] Inland counties Hardee, DeSoto, and Osceola are predicted to experience tremendous growth in the coming decades due to the spillover from significant population growth in nearby coastal counties Brevard, Hillsborough, Manatee, Charlotte, and Indian River.[28] Lee and Collier counties' populations are expected to exceed their available space and spill over into Glades and Hendry counties.[29] In the Florida Keys, nearly all currently vacant land will be filled by projected population growth.[30]

B. *Assisted Migration as a Management Tool to Respond to Sea-Level Rise*

Climate change, including changes in global temperatures and precipitation, ocean acidification, and sea-level rise, will directly impact species, forcing many toward extinction by eliminating vital habitat. Climate change will also limit habitat quality and availability; prey quality and availability; and increase predation, competition, and disease.[31] These and other threats will affect species

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[22] Technical Ad Hoc Work Grp., SE. Fla. Reg'l Climate Change Compact, A Unified Sea Level Rise Projection for Southeast Florida 2 (2011) (relying on data from the U.S. Army Corps of Engineers), http://perma.cc/Y222-VV5T.

[23] Barry Heimlich & Frederick Bloetscher, *Effects of Sea Level Rise and Other Climate Change Impacts on Southeast Florida's Water Resources*, Fla. Water Resources J., Sept. 2011, at 36.

[24] Douglas O. Fuller & Yu Wang, *Recent Trends in Satellite Vegetation Index Observations Indicate Decreasing Vegetation Biomass in the Southeastern Saline Everglades Wetlands,* 34 Wetlands 67, 67–68 (2014); *see also* Amartya K. Saha et al., *Sea Level Rise and South Florida Coastal Forests*, 107 Climatic Change 81, 83 (2011).

[25] Fla. Natural Areas Inventory, Guide to the Natural Communities of Florida 63 (2010), http://perma.cc/E7KC-Z6XC.

[26] Ken W. Krauss et al., *Sea-Level Rise and Landscape Change Influence Mangrove Encroachment onto Marsh in the Ten Thousand Islands Region of Florida, USA*, 15 J. Coastal Conserv. 629, 632 (2011).

[27] Kildow, *supra* note 3, at 13.

[28] Zwick & Carr, *supra* note 4, at 12.

[29] *Id.* at 13.

[30] *Id.* at 14–15.

[31] Erin E. Seney et al., *Climate Change, Marine Environments, and the U.S. Endangered Species Act*, 27 Conserv. Biology 1138, 1140 (2013); *see also* Abigail E. Cahill et al., *How Does Climate Change Cause Extinction?*, Proc. Royal Soc'y B, Nov. 2012, at 1–2, http://perma.cc/763R-2YR9; The Wildlife Soc'y., Global Climate Change and Wildlife in North America 4, 8–9 (2004).

abundance, distribution, phenology, reproductive success, survival, and genetic diversity.[32] Studies predict widespread extinctions: based on mid-range climate change scenarios, 15–37% of species will be committed to extinction by 2050;[33] 20–30% of species face an increased risk of extinction with a 2–3 degrees Celsius rise,[34] and 40–70% with a 3.5 degree rise;[35] and 58% of plants and 35% of animals will lose more than half of their current climatic range by the 2080s under the current greenhouse-gas emissions scenario.[36] It is predicted that vertebrate species would need to evolve at a rate 10,000 times faster than they have historically in order to adapt to the climate change that is projected for the upcoming 100 years.[37]

South Florida species will be particularly vulnerable as coastal elevations are low and urban populations are dense in coastal areas. Studies show that in south Florida, sea levels have changed dramatically over the last 6,000–7,000 years, and that these changes corresponded to shifts in species composition—where the migration of vegetation zones have tracked sea-level changes.[38] However, historic changes in the climate and sea levels occurred at much slower rates and absent built environments that restrict species' movements; studies suggest that some species may not be able to move their ranges quickly enough to keep pace with contemporary sea-level rise and climate change.[39]

Active and passive assisted migrations are tools to help species respond to a changing climate. "Managed relocation," which is a form of active assisted migration, is "the intentional act of moving species, populations, or genotypes (the *target*) to a location outside a target's known historical distribution for the purpose of maintaining biological diversity or ecosystem functioning as an adaptation strategy for climate change."[40] Passive assisted migration will also be important in helping to provide areas for species retreat. Protecting existing corridors and reserves will help species as they seek new habitats to evade sea-level rise, as will modifying management regimes of other types of land to be

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[32] Cahill et al., *supra* note 31, at 2.
[33] Chris D. Thomas et al., *Extinction Risk from Climate Change*, 427 NATURE 145, 145 (2004).
[34] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 48 (2007), http://perma.cc/ZEB7-KSSV.
[35] *See id.* at 54.
[36] Rachel Warren et al., *Increasing Impacts of Climate Change upon Ecosystems with Increasing Global Mean Temperature Rise*, 106 CLIMATIC CHANGE 141, 141–77 (2011).
[37] *See* Ignacio Quintero & John J. Wiens, *Rates of Projected Climate Change Dramatically Exceed Past Rates of Climatic Niche Evolution Among Vertebrate Species*, 16 ECOLOGY LETTERS 1095, 1102 (2013).
[38] *Project Work Plan: Sea-Level Rise and Climate: Impacts on the Greater Everglades Ecosystem and Restoration*, U.S. GEOLOGICAL SURV., http://perma.cc/UQM5-AYZV; G. LYNN WINGARD, JOEL W. HUDLEY & FRANK E. MARSHALL, U.S. GEOLOGICAL SURVEY, ESTUARIES OF THE GREATER EVERGLADES ECOSYSTEM: LABORATORIES OF LONG-TERM CHANGE (2010), http://perma.cc/6VN2-A5UT.
[39] *See generally* Carrie A. Schloss, Tristan A. Nuñez & Joshua L. Lawler, *Dispersal Will Limit Ability of Mammals to Track Climate Change in the Western Hemisphere*, 109 PROC. NAT'L ACAD. SCI. U.S. 8606 (2012).
[40] Schwartz et al., *Managed Relocation*, *supra* note 5, at 733 (citation omitted). *See also* Jason S. McLachlan, Jessica J. Hellmann & Mark W. Schwartz, *A Framework for Debate of Assisted Migration in an Era of Climate Change*, 21 CONSERV. BIOLOGY 297, 297 (2007).

more supportive of biodiversity.[41] For those species that cannot migrate to suitable habitat, assisted migration provides wildlife managers a valuable management tool. This Article analyzes the Florida panther, loggerhead sea turtle, Key tree-cactus, and Lower Keys marsh rabbit to examine the assisted migration regulatory framework from the perspectives of listed species from differing taxa, habitat types, and natural histories.[42]

II. Managing Wildlife Under the Endangered Species Act in a Changing Climate

The ESA is the nation's premier environmental statute designed to protect fish, wildlife, and plants, and the ecosystems upon which they depend. Congress passed the ESA in 1973 in response to growing concern over the extinction of species in the United States,[43] and intended for it to provide "a program for the conservation of . . . endangered species and threatened species."[44] Congress enacted it, in part, to provide a "means whereby the *ecosystems* upon which endangered species and threatened species depend may be conserved."[45] The overarching purpose of the ESA is to recover species to the point at which the Act's protections are no longer needed.[46]

Several provisions of the ESA make clear that species protection is a national priority. Section 2(c) of the ESA establishes that it is "the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act."[47] The ESA defines "conservation" to mean "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."[48] Similarly, section 7(a)(1) of the ESA directs the U.S. Fish and Wildlife Service ("Service"), Na-

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[41] *See* John Kostyack et al., *Beyond Reserves and Corridors: Policy Solutions to Facilitate the Movement of Plants and Animals in a Changing Climate*, 61 BioScience 713, 717 (2011).

[42] In *A Vulnerability Assessment of 300 Species in Florida*, Reece catalogues 300 species threatened by sea-level rise and climate change. *See generally* Joshua S. Reece et al., *A Vulnerability Assessment of 300 Species in Florida: Threats from Sea Level Rise, Land Use, and Climate Change*, 8 PLoS ONE 1 (2013). The study argues that "conservation efforts should target species and assemblages that are most highly imperiled and of greatest ecological, evolutionary, or other value, while also being feasible to save (salvageable)." *Id.* at 2. Of the 300 species, 28 are endangered under the ESA (another 92 are listed under the Florida ESA), and 15 are threatened under the federal ESA (and 20 are threatened under the Florida ESA). *Id.* at 4. Reece identifies the Florida panther, loggerhead sea turtle, Key tree-cactus, and Lower Keys rabbit as being of the highest ranked species in their taxonomic groups. *Id.* at 6, 10.

[43] *See* 16 U.S.C. § 1531(a)(1) (2012).

[44] *Id.* § 1531(b).

[45] *Id.* (emphasis added).

[46] *Id.* § 1532(3).

[47] *Id.* § 1531(c)(1).

[48] *Id.* § 1532(3).

tional Marine Fisheries Service, and other federal agencies to use their programs and authorities to conserve endangered and threatened species.[49]

For the protections of the ESA to apply to a species, the Service must list it as endangered or threatened. An "endangered" species is one "in danger of extinction throughout all or a significant portion of its range,"[50] and a "threatened" species is "likely to become endangered in the near future throughout all or a significant portion of its range."[51] The ESA requires that the Service list a species if any one, or a combination, of the following factors is met: "(A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence."[52] The Service's analysis of the status of the species and the five listing factors must be based on the "best scientific and commercial data available."[53] Where the threats or status of the species is not well known or understood the agency must give the benefit of the doubt to the species.[54]

Once a species is listed, the ESA provides a variety of procedural and substantive protections to ensure not only the species' continued survival, but also its ultimate recovery. "Congress has spoken in the plainest words, making it clear that endangered species are to be accorded the highest priorities."[55] As evidence of this priority, section 9 prohibits any "person" from "taking" or causing a "take" of any member of an ESA-listed species.[56] The term "take" means to "harass, harm, pursue, shoot, wound, kill, trap, capture, or to attempt to engage in any such conduct."[57] "Harm" includes "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering."[58] "Harass" is "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering."[59]

In order to fulfill the substantive purposes of the ESA, federal agencies are required to engage in consultation with the Service to "insure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize

[49] *Id.* § 1536(a)(1).
[50] *Id.* § 1532(6).
[51] *Id.* § 1532(20).
[52] *Id.* § 1533(a)(1).
[53] *Id.* § 1533(b)(1)(A).
[54] *See* Conner v. Burford, 848 F.2d 1441, 1454 (9th Cir. 1988).
[55] Tenn. Valley Auth. v. Hill, 437 U.S. 153, 155 (1978).
[56] 16 U.S.C. § 1538; *see also* 50 C.F.R. § 17.42(b) (2014) (take prohibition for sea turtles).
[57] 16 U.S.C. § 1532(19).
[58] 50 C.F.R. § 17.3; Babbitt v. Sweet Home Chapter of Cmtys. for a Great Or., 515 U.S. 687, 715 (1995).
[59] 50 C.F.R. § 17.3.

the continued existence of any endangered species or threatened species or result in the adverse modification of habitat of such species . . . determined . . . to be critical."[60] The action agency must assess the effects of its actions on endangered species where the species may be present. When an agency determines that its proposed action "may affect listed species or critical habitat," it must engage in formal consultation with the federal resource agency responsible for the species at issue, known as the expert agency.[61]

At every turn, the ESA provides imperiled species with both a safety net from extinction and a roadmap to recovery. The ESA does not discriminate—its purpose is to protect listed species from all threats, including climate change. Indeed, climate change and sea-level rise present several threats to many coastal species. Species' habitat and range are impacted by rising seas and storm surge (listing factor A), the stress of climate change can increase threats from disease and predation (listing factor C), and additional human-made factors such as coastal hardening against sea-level rise can affect species' continued existence (listing factor E).[62]

The Service has already listed species under the ESA due to climate change. Elkhorn and staghorn coral were the first species to be listed due to impacts from climate change in 2006.[63] The Biological Review Team identified climate variability and climate change as sources of stress that threatened the coral with extinction.[64] Not long after, the Service listed the polar bear in 2008—the first species to be listed with climate change as its primary threat.[65] The Service found that "both the cumulative effects of multiple stressors and the rapid rate of climate change today create a unique and unprecedented challenge for present-day polar bears . . . ."[66]

The Service has also listed or proposed to list several south Florida species due to impacts from climate change and sea-level rise. For example, on October 2, 2013, the Service listed the Florida bonneted bat as endangered under the ESA, finding that roughly half of the site locations known for the bat are in extremely low-lying areas and are highly vulnerable to sea-level rise.[67] On October 24, 2013, the Service listed as endangered the Cape Sable thoroughwort (*Chromolaena frustrata*), Florida semaphore cactus (*Consolea corallicola*), and aboriginal prickly-apple (*Harrisia aboriginum*), three plants that live at or just

[60] 16 U.S.C. § 1536(a)(2) (section 7 consultation).
[61] 50 C.F.R. § 402.14(a).
[62] *See* 16 U.S.C. § 1533(a)(1).
[63] *See* Endangered and Threatened Species: Final Listing Determination for Elkhorn Coral and Staghorn Coral, 71 Fed. Reg. 26,852, 26,852 (May 9, 2006) (to be codified at 50 C.F.R. pt. 223).
[64] *Id.* at 26,857.
[65] *See* Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Polar Bear (*Ursus maritimus*) Throughout Its Range, 73 Fed. Reg. 28,212, 28,241 (May 15, 2008) (to be codified at 50 C.F.R. pt. 17).
[66] *Id.* at 28,239.
[67] Endangered and Threatened Wildlife and Plants; Endangered Species Status for the Florida Bonneted Bat, 78 Fed. Reg. 61,004, 61,028 (Oct. 2, 2013) (to be codified at 50 C.F.R. pt. 17).

above mean sea level.[68] In its proposed rule the Service found that the protection of "unoccupied habitat may be necessary for the recovery" of the cactus and the prickly-apple.[69] The Service also recently listed the Florida leafwing and Bartram's scrub-hairstreak, two butterflies directly threatened by sea-level rise.[70] It found that sea-level rise will initially convert habitat and then eventually inundate habitat for the species on Big Pine Key in particular.[71] The Service designated unoccupied critical habitat to facilitate "[r]eintroduction or assisted migration to reduce the vulnerability of the subspecies to sea-level rise and storm surge."[72] The Service also listed the Florida brickell-bush (*Brickellia mosieri*) and Carter's small-flowered flax (*Linum carteri var. carteri*), two plants that are vulnerable to sea-level rise.[73]

In addition to listing species threatened by climate change, the Service has started strategically planning for managing species in a changing climate. The purpose of the Service's Strategic Plan for Responding to Accelerating Climate Change ("Strategic Plan") is to lay out a vision for carrying out its mission in light of climate change, and to provide direction for its employees in defining their roles within the Department of Interior and the broader conservation community.[74] It identifies adaptation, mitigation, and engagement as its three major strategies for responding to climate change.[75] It acknowledges that climate change represents "the greatest challenge to fish and wildlife conservation in the history of the Service,"[76] and that some species will only survive climate change "through direct and continuous intervention" by wildlife and fisheries managers.[77] The Strategic Plan states the Service will review whether the Service needs to develop new policies or revise existing policies to "support effective adaptation and mitigation responses to climate change," and specifically

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[68] *See* Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for *Chromolaena frustrata* (Cape Sable thoroughwort), *Consolea corallicola* (Florida semaphore cactus), and *Harrisia aboriginum* (Aboriginal prickly-apple), 78 Fed. Reg. 63,796, 63,796 (Oct. 24, 2013) (to be codified at 50 C.F.R. pt. 17).

[69] Endangered and Threatened Wildlife and Plants; Endangered Species Status for Cape Sable Thoroughwort, Florida Semaphore Cactus, and Aboriginal Prickly-Apple, and Designation of Critical Habitat for Cape Sable Thoroughwort, 77 Fed. Reg. 61,835, 61,857 (proposed Oct. 11, 2012) (to be codified at 50 C.F.R. pt. 17).

[70] *See* Endangered and Threatened Wildlife and Plants; Endangered Status for the Florida Leafwing and Bartram's Scrub-Hairstreak Butterflies, 79 Fed. Reg. 47,222, 47,226 (Aug. 12, 2014) (to be codified at 50 C.F.R. pt. 17) [hereinafter Butterfly Endangered Status]; Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Florida Leafwing and Bartram's Scrub-Hairstreak Butterflies, 79 Fed. Reg. 47,180, 47,192 (Aug. 12, 2014) (to be codified at 50 C.F.R. pt. 17) [hereinafter Butterfly Designation of Critical Habitat].

[71] Butterfly Endangered Status, *supra* note 70, at 47,233.

[72] Butterfly Designation of Critical Habitat, *supra* note 70, at 47,188.

[73] Endangered and Threatened Wildlife and Plants; Endangered Species Status for *Brickellia mosieri* (Florida Brickell-bush) and *Linum cartero var. carteri* (Carter's Small-Flowered Flax), 79 Fed. Reg. 52,567, 52,567 (Sept. 4, 2014) (to be codified at 50 C.F.R. pt. 17).

[74] U.S. Fish & Wildlife Serv., Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change 18–26 (2010), http://perma.cc/C5GF-88TK.

[75] *Id.* at 14.

[76] *Id.* at 2.

[77] *Id.* at 5.

mentions managed relocation as an example of a policy that might need to be developed.[78]

The goals of the Appendix for Implementing the Climate Change Strategic Plan ("Appendix") mostly focus on reorganizing and educating Service staff rather than on specific management regimes.[79] While the Strategic Plan and Appendix provide a helpful policy framework, they do not expressly identify the existing tools the Service has at its disposal under the ESA to aid species in surviving climate change, such as implementing recovery plans, designating unoccupied critical habitat, and releasing populations outside their current occupied range.

Recovery plans help the Service prioritize conservation actions, including the acquisition or protection of habitat. The designation of unoccupied critical habitat allows the Service to safeguard areas that will become necessary for species conservation. The release of populations of species outside their current, occupied range gives the Service flexibility and the species a buffer in reacting to climate change. These tools allow the Service to proactively identify and protect species habitat that will become essential for surviving climate change.

A. Section 4: Recovery Plans and Blueprints for Assisted Migration

Recovery plans are the blueprints for species recovery; they outline the steps required to move the species past survival and toward recovery. The purpose of the ESA is to bring a species to a point where the Act's protections are no longer necessary.[80] In furtherance of that goal, the ESA mandates that the Service develop and implement a recovery plan for every listed species, unless it determines that a plan would "not promote the conservation of the species."[81] Recovery plans must include a description of the actions necessary for the recovery of the species,[82] and should contain "objective, measurable criteria, which, when met, would result in a determination . . . that the species should be removed from the list."[83] Recovery plans are important tools to ensure scientific and logistical decision-making throughout the recovery process.[84] In fact, species with recovery plans are more than twice as likely to be improving than species without recovery plans.[85]

In the last decade, the Service has increasingly incorporated climate change into its recovery plans. Fifty-nine percent of recovery plans completed

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[78] *Id.* at 22.
[79] *See generally* U.S. Fish & Wildlife Serv., Appendix: 5-Year Action Plan for Implementing the Climate Change Strategic Plan (Draft) (2009), http://perma.cc/3MVZ-FWXQ.
[80] 16 U.S.C. §§ 1531(b), 1532(3) (2012).
[81] *Id.* § 1533(f)(1).
[82] *Id.* § 1533(f)(1)(B)(i).
[83] *Id.* § 1533(f)(1)(B)(ii).
[84] Nat'l Marine Fisheries Serv., Interim Endangered and Threatened Species Recovery Planning Guidance Version 1.3, 1.1-1 (2010), http://perma.cc/4BG9-DKTZ.
[85] Martin F. J. Taylor, Kiernan F. Suckling & Jeffrey J. Rachlinski, *The Effectiveness of the Endangered Species Act: A Quantitative Analysis*, 55 BioScience 360, 360 (2005).

between 2005 and 2008 addressed climate change, while less than 5% of recovery plans completed prior to 2005 did so.[86] Approximately 60% of recovery plans call for the restoration or active management of habitat,[87] and more than two-thirds recommend the use of translocation or captive breeding and release.[88] Some recovery plans call expressly for reintroduction as well.[89] Notable in the context of assisted migration, the U.S. Fish and Wildlife Service Manual states, "we do not introduce species . . . outside their historic range . . . unless such introduction is essential for the survival of a species and prescribed in an endangered species recovery plan . . . ."[90] Therefore, the development and implementation of recovery plans will continue to be essential to the Service as it navigates species management in rising seas.

Several experts have written on the role of recovery plans. In *Conserving Endangered Species in an Era of Global Warming*, Kostyack and Rohlf recommend that in light of climate change, future recovery plans should include information regarding:

> (1) corridors for species movement that allow transitions to more hospitable areas; (2) measures particularly aimed at managing and protecting vulnerable resources such as water availability and specialized habitat needs; (3) better use of population and habitat availability projections; (4) stronger adaptive management programs for long-term operations such as dams; (5) protection and acquisition of northerly or higher elevation portions of species' ranges; and (6) targeted population supplementation and reintroduction.[91]

Including information on such topics could result in more comprehensive planning for moving a species closer to recovery.

Meanwhile, Ruhl, in his 2008 *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, suggests that where the Service determines that species are "doomed," funds should not be "wasted" in developing recovery plans.[92] He argues that because the ESA permits the agency to not develop a recovery plan where it finds a plan would not promote the conservation of the species, "the Service could justifiably reach such a finding and avoid expending agency resources developing a plan for the species."[93]

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[86] Anthony Povilitis & Kiernan Suckling, *Addressing Climate Change Threats to Endangered Species in U.S. Recovery Plans*, 24 Conserv. Biology 372, 373 (2010).
[87] Bork, *supra* note 6, at 192.
[88] Timothy H. Tear et al., *Status and Prospects for Success of the Endangered Species Act: A Look at Recovery Plans*, 262 Science 976, 977 (1993).
[89] *See, e.g.*, U.S. Fish & Wildlife Serv., Multi-Species Recovery Plan for South Florida 4-166 (1999) [hereinafter Multi-Species Recovery Plan], http://perma.cc/TVH6-D8FX; U.S. Fish & Wildlife Serv., U.S. Fish & Wildlife Service Manual (2001) [hereinafter U.S. Fish & Wildlife Service Manual], http://perma.cc/6LAC-7TZW (at question 3.14, answer F).
[90] U.S. Fish & Wildlife Service Manual, *supra* note 89 (at question 3.14, answer F).
[91] John Kostyack & Dan Rohlf, *Conserving Endangered Species in an Era of Global Warming*, 38 Envtl. L. Rep. (Envtl. Law Inst.) 10,203, 10,208 (Apr. 2008).
[92] J. B. Ruhl, *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 B.U. L. Rev. 1, 61 (2008).
[93] *Id.* at 38.

While courts have interpreted the ESA to afford the agency discretion in implementing recovery plans,[94] recovery plans provide a critical role in guiding the Service in its implementation of measures that, when successful, can lead to the delisting of species.[95] Given the unequivocal purpose of the ESA to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved" and that the Service must use "all methods and procedures . . . necessary" to recover species, it would be challenging for the Service to conclude that a species is beyond saving and therefore not entitled to the full life-saving measures of the ESA.[96]

B. Critical Habitat Designation and Passive Assisted Migration

To achieve the ESA's purpose, section 4 requires the Service to protect species by listing them as "endangered" or "threatened."[97] In addition to requiring the Service to list endangered or threatened animals or plants, it must also, at the time of listing, to the maximum extent prudent[98] and determinable,[99] designate any habitat of the species, which is considered to be critical habitat.[100] Critical habitat is defined as those "specific areas within the geographical area occupied by the species," which contain physical or biological features "essential to the conservation of the species" and that "may require special management considerations or protection."[101] This designation must be based on "the best scientific data available and after taking into consideration the economic impact" of the designation.[102]

In making the designation, the agency must consider such physical and biological features as:

> (1) [s]pace for individual and population growth, and for normal behavior; (2) [f]ood, water, light minerals, or other nutritional or physiological requirements; (3) [c]over or shelter; (4) [s]ites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and generally; (5) [h]abitats that are protected from disturbance or are

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[94] Fund For Animals v. Babbitt, 903 F. Supp. 96, 105–09 (D.D.C. 1995); *but see* Sw. Ctr. for Biological Diversity v. Bartel, 470 F. Supp. 2d 1118, 1136–37 (S.D. Cal. 2006) (holding the Service must consider a species' recovery plan in evaluating an incidental take permit to take the species).
[95] 16 U.S.C. §§ 1533(c)(2)(B)(i)–(iii), (f)(1)(B)(ii) (2012).
[96] *Id.* §§ 1531(b), 1532(3).
[97] *Id.* §§ 1532(6), (20).
[98] Designation of critical habitat is not prudent when either "[t]he species is threatened by taking or other human activity, and identification of critical habitat can be expected to increase the degree of such threat to the species," or when "[s]uch designation of critical habitat would not be beneficial to the species." 50 C.F.R. § 424.12(a)(1) (2014).
[99] Critical habitat is not determinable when either "[i]nformation sufficient to perform required analyses of the impacts of the designation is lacking," or "[t]he biological needs of the species are not sufficiently well known to permit identification of an area as critical habitat." *Id.* § 424.12(a)(2).
[100] 16 U.S.C. § 1533(a)(3); 50 C.F.R. § 424.12(a).
[101] 16 U.S.C. § 1532(5)(A).
[102] *Id.* § 1533(b)(2).

> representative of the historic geographical and ecological distributions of a species.[103]

In addition to these features, the agency must pay particular attention to "primary constituent elements" ("PCEs") such as nesting grounds, feeding sites, wetlands, and vegetation in designating occupied critical habitat.[104] Once the agency designates critical habitat, it must delineate the habitat on a map.[105]

The ESA also expressly allows the Service to designate critical habitat "outside the geographical area occupied by the species . . . upon a determination . . . that such areas are essential for the conservation of the species."[106] Service regulations further clarify that "the Secretary shall designate as critical habitat areas outside the geographical area presently occupied by a species only when a designation limited to its present range would be inadequate to ensure the conservation of the species."[107] The designation of unoccupied critical habitat does not require that the Service identify physical and biological features essential to the conservation of the species or which may require special management considerations or protection, only that it is essential for the conservation of the species.[108]

The designation of critical habitat protects those areas for species that are or will be necessary for their continued survival. Habitat loss is the most significant threat to listed species.[109] Climate change is a major source of habitat loss.[110] To protect species' habitats, the ESA requires that the Service designate critical habitat for listed species.[111] Critical habitats are those specific areas, within and outside the geographical areas occupied by the species, which are essential for the conservation of the species.[112] This ensures that the habitat needed for the recovery of a species is protected from destruction and adverse modification through ESA section 7 interagency consultations.[113] Indeed, species with designated critical habitat are more than twice as likely to be improving than species without designated critical habitat.[114]

As climate change forces species' habitats to shift, it will be imperative to protect habitat areas outside of species' current ranges in order to facilitate spe-

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[103] 50 C.F.R. § 424.12(b)(1)–(5).
[104] *Id.* § 424.12(b).
[105] *Id.* §§ 424.12(c), 424.18(a)(1).
[106] 16 U.S.C. § 1532(5)(A)(ii).
[107] 50 C.F.R. § 424.12(e).
[108] Courts have found that unoccupied critical habitat need not contain all of the relevant PCEs. *See* Fisher v. Salazar, 656 F. Supp. 2d 1357, 1368 (N.D. Fla. 2009); Markle Interests, LLC v. U.S. Fish & Wildlife Serv., No. CIV.A. 13-234, 2014 WL 4186777, at *2 (E.D. La. Aug. 22, 2014).
[109] David S. Wilcove et al., *Quantifying Threats to Imperiled Species in the United States*, 48 BioScience 607, 607 (1998).
[110] Thomas S. Hoctor et al., *Land Corridors in the Southeast USA: Connectivity to Protect Biodiversity and Ecosystem Services*, 4 J. Conserv. Planning 90, 116 (2008); Camille Parmesan, *Ecological and Evolutionary Responses to Recent Climate Change*, 37 Ann. Rev. Ecology, Evolution, & Systematics 637, 653 (2006).
[111] 16 U.S.C. § 1533(b)(2). The ESA requires that the Service designate critical habitat at the time a species is listed unless the designation is not prudent or determinable. *Id.* § 1533(a)(3)(A).
[112] *Id.* § 1532(5)(A)(i)–(ii).
[113] *Id.* § 1536(a)(2).
[114] Taylor et. al, *supra* note 85, at 360.

cies' movements.[115] The designation and protection of unoccupied habitat will facilitate the eventual assisted migration, and perhaps will allow some species to retreat on their own to habitats that are more suitable. The Service has already designated the unoccupied habitats of several species as critical habitat in anticipation of climate change, including the western snowy plover, Quino checkerspot butterfly, dusky gopher frog, and three mountain plant species.[116]

The western snowy plover is a small Pacific coast shorebird that nests along California, Oregon, and Washington shores, peninsulas, islands, bays, rivers, and estuaries.[117] In revising the critical habitat designation for the western snowy plover, the Service determined that sea-level rise and hydrological changes associated with climate change would continue to have significant impacts on the imperiled shorebird.[118] It found that combined with projected sea-level rise due to climate change, including more frequent El Niño Southern Oscillations leading to increased storms, California's already significant tidal fluctuations would negatively impact available habitat.[119] It found that sea-level rise would cause inundation of low-lying areas by high tides; flooding of coastal areas during storm events; acceleration of erosion of coastal bluffs; and move the mean high water line landward.[120]

The Service designated unoccupied habitat for the western snowy plover because it found that certain areas served an essential role in conservation by connecting other habitat, that they would play an important role as sea-level rise inundates other sites, and in some instances, the sites had been identified in the western snowy plover's recovery plan as a recovery site.[121] The Service determined how habitat should be extended to compensate for habitat loss due to sea-level rise, and it proposed to restore habitat to increase the amount of

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[115] Kostyack and Rohlf argue this as well: "the Services should immediately end this unwritten policy of failing to recognize the importance of currently unoccupied habitat for the recovery of some species . . . . [U]noccupied portions of species' habitat in the United States to the north and upslope from where they now exist are essential for conservation of many listed species." Kostyack & Rohlf, *supra* note 91, at 10,208; *see also* Seney et al., *supra* note 31, at 1141 fig.1.

[116] *See* Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Pacific Coast Population of the Western Snowy Plover, 77 Fed. Reg. 36,728, 36,728 (June 19, 2012) (to be codified at 50 C.F.R. pt. 17) [hereinafter Final Plover Rule]; Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Quino Checkerspot Butterfly (*Euphydryas editha quino*), 74 Fed. Reg. 28,776, 28,776 (June 17, 2009) (to be codified at 50 C.F.R. pt. 17) [hereinafter Revised Quino Checkerspot Determination]; Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Dusky Gopher Frog (Previously Mississippi Gopher Frog), 77 Fed. Reg. 35,118, 35,118 (June 12, 2012) (to be codified at 50 C.F.R. pt. 17) [hereinafter Dusky Gopher Habitat Designation]; Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for *Ipomopsis Polyantha* (Pagosa Skyrocket), *Penstemon Debilis* (Parachute Beardtongue), and *Phacelia Submutica* (DeBeque Phacelia), 77 Fed. Reg. 48,368, 48,368 (Aug. 13, 2012) (to be codified at 50 C.F.R. pt. 17) [hereinafter Pagosa Skyrocket, Parachute Beardtongue, and DeBeque Phacelia Habitat Designation].

[117] Final Plover Rule, *supra* note 116, at 36,746.

[118] *Id.* at 36,729.

[119] *Id.*

[120] *Id.*

[121] *See generally id.*

suitable habitat for plovers to offset losses from sea-level rise and other threats.[122]

The Quino checkerspot butterfly, a colorful orange and white checker butterfly, was once one of the most common butterflies in Southern California.[123] Due to habitat destruction and fragmentation, the Service listed this Southern California species as endangered.[124] The Service found that there would be pronounced future upslope range shifts due to climate change.[125] The Service designated unoccupied northern, higher-elevation habitat for the Quino checkerspot butterfly to facilitate movement in response to hotter, more arid conditions due to climate change.[126] It determined that the protection of unoccupied habitat was essential for the conservation of the species in light of the range shift.[127]

The dusky gopher frog inhabits the burrows left in the ground by gopher tortoises in the forested longleaf pine uplands of Mississippi. It crawls out of its burrow in winter to breed in temporary ponds before returning upland.[128] Due to habitat degradation, this frog that once spanned several states is now only found in three small Mississippi ponds.[129] The Service found that climate change will continue to affect the amount and timing of rain, which will impact ephemeral breeding ponds.[130] The Service determined that "[t]he designation of critical habitat, and the creation of new populations of dusky gopher frogs through reintroductions, should give the species better odds of survival and recovery given the threats posed by climate change."[131] The Service designated unoccupied habitat for the dusky gopher frog to help reestablish a population to buffer it from climate change.[132]

The Pagosa skyrocket (*Ipomopsis polyantha*), Parachute beardtongue (*Penstemon debilis*), and DeBeque phacelia (*Phacelia submutica*) are beautiful, extremely rare flowers found only in Colorado.[133] The Service designated unoc-

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[122] *See generally id.*

[123] Rudi Mattoni et al., *The Endangered Quino Checkerspot Butterfly,* Euphydryas Editha Quino *(Lepidoptera: Nymphalidae),* 34 J. Res. Lepidoptera 99, 100, 104–05 (1997).

[124] Endangered and Threatened Wildlife and Plants; Proposed Determination of Critical Habitat for the Quino Checkerspot Butterfly, 66 Fed. Reg. 9,476, 9,478 (Feb. 7, 2001) (to be codified at 50 C.F.R. pt. 17).

[125] Revised Quino Checkerspot Determination, *supra* note 116, at 28,779.

[126] *See generally id.*

[127] *Id.* at 28,785.

[128] John A. Tupy, Terrestrial Habitat Selection by the Dusky Gopher Frog (*Rana sevosa*) 9–10 (Nov. 2012) (unpublished M.S. thesis, Western Carolina University), http://perma.cc/KC3G-X76P.

[129] *Id.* at 11; Dusky Gopher Habitat Designation, *supra* note 116, at 35,130.

[130] Dusky Gopher Habitat Designation, *supra* note 116, at 35,124.

[131] *Id.*

[132] *Id.* This designation was recently upheld. *See* Markle Interests, LLC v. U.S. Fish & Wildlife Serv., No. CIV.A. 13-234, 2014 WL 4186777 (E.D. La. Aug. 22, 2014).

[133] Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for *Ipomopsis Polyantha* (Pagosa Skyrocket) and Threatened Status for *Penstemon Debilis* (Parachute Beardtongue) and *Phacelia Submutica* (DeBeque Phacelia), 76 Fed. Reg. 45,054, 45,057, 45,062, 45,068 (July 27, 2011) (to be codified at 50 C.F.R. pt. 17); *see also* Pagosa Skyrocket, Parachute Beardtongue, and DeBeque Phacelia Habitat Designation, *supra* note 116, at 48,372.

cupied habitat for them to facilitate upslope and downslope movement in response to climate change.[134]

It is unlikely that species will undergo rapid evolutionary changes to adapt to climate change.[135] However, there is evidence that species are reacting to climate change by moving to new areas.[136] Therefore, the designation of unoccupied critical habitat provides a less intrusive approach to assisted migration by making new habitat available.[137] In general, courts have upheld the Service's decision to designate unoccupied critical habitat.[138]

In *Fisher v. Salazar*,[139] the Northern District of Florida upheld the Service's designation of unoccupied critical habitat for the Perdido Key beach mouse, a coastal species with dune habitat. The Service had designated 1,300 acres comprising five land units; the Perdido Key beach mouse did not occupy four of the units at the time of listing.[140] The Service had determined that the four units were still essential for the conservation of the species because they connected adjacent habitat units and provided habitat needed for storm refuge, expansion, natural movements, and re-colonization.[141] The plaintiffs argued that the Service failed to identify the primary constituent elements of the unoccupied habitat.[142] The court concluded that the Service was not required to identify these elements, and instead was only required to make a finding that the areas are essential for the conservation of the species.[143] The court upheld the Service's determination, concluding that the Service met its burden in finding that the areas are essential for the conservation of the species.[144]

In *Markle Interests v. U.S. Fish & Wildlife Service*,[145] the Eastern District of Louisiana upheld the Service's designation of unoccupied critical habitat for the dusky gopher frog. The plaintiffs in *Markle* challenged the Service's failure to define "essential."[146] The court found that Congress did not define essential and had delegated the authority to define it to the Service.[147] The Service determined the habitat was essential after reviewing the high risk of extinction due

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[134] *See* Pagosa Skyrocket, Parachute Beardtongue, and DeBeque Phacelia Habitat Designation, *supra* note 116, at 48,378, 48,381, 48,385.
[135] *See* P. Gienapp et al., *Climate Change and Evolution: Disentangling Environmental and Genetic Responses*, 17 MOLECULAR ECOLOGY 167, 168 (2008).
[136] Parmesan, *supra* note 110, at 648.
[137] *See* Julie Lurman Joly & Nell Fuller, *Advising Noah: A Legal Analysis of Assisted Migration*, 39 Envtl. L. Rep. (Envtl. Law Inst.) 10,413, 10,422 (May 2009); *but see* Ruhl, *supra* note 92, at 36 (describing this approach as aggressive and suggesting that "not prudent" determinations under the statute would be a more passive approach to species management).
[138] *But see* Cape Hatteras Access Pres. Alliance v. U.S. Dep't of the Interior, 344 F. Supp. 2d 108, 125 (D.D.C. 2004) (holding that "Service regulation prohibits designation of unoccupied lands unless designation of occupied lands is insufficient. This finding and reasoning to back it up is made nowhere in the record.").
[139] 656 F. Supp. 2d 1357, 1375 (N.D. Fla. 2009).
[140] *Id.* at 1366.
[141] *Id.*
[142] *Id.* at 1368.
[143] *Id.*
[144] *Id.*
[145] No. CIV.A. 13-234, 2014 WL 4186777, at *1 (E.D. La. Aug. 22, 2014).
[146] *Id.* at 10.
[147] *Id.* at 11.

to habitat threats and scientific information on the frog's habitat needs, as well as on the basis of a peer reviewer's recommendation.[148] Finding the Service's interpretation reasonable and supported by the administrative record, the court upheld the Service's designation.[149]

1. *When Designating Critical Habitat is Not Determinable*

With species becoming increasingly threatened by sea-level rise and climate change, the Service will need to list them under the ESA, and "to the maximum extent prudent and determinable" concurrently designate critical habitat to protect the places they currently occupy and might retreat to.[150] The ESA requires that the Service use "the best scientific data available,"[151] and permits the Service to extend the time for designating critical habitat if it is "not then determinable."[152] Critical habitat is not determinable if "information sufficient to perform required analyses of the impacts of the designation is lacking" or where "the biological needs of the species are not sufficiently well known to permit identification of an area as critical habitat."[153]

It is conceivable that the Service may struggle to determine what is suitable unoccupied habitat. However, the agency must err on the side of providing protection for the species. According to the ESA's legislative history, it is expected that the Service will make "the *strongest attempt possible* to determine critical habitat within the time period designated for listing . . . ."[154] Where critical habitat is not determinable, the Service has one additional year to designate critical habitat. At or before the end of the one-year extension, "the Secretary must publish a final regulation, based on *such data as may be available at that time* . . . ."[155]

2. *When Designating Critical Habitat is Not Prudent*

The ESA requires that the Service designate critical habitat—at the time that it finds the species to be endangered or threatened—"to the maximum extent prudent and determinable."[156] The imprudence exception to the designation of critical habitat should only be invoked "in rare circumstances where the specification of critical habitat concurrently with the listing would not be bene-

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[148] *Id.* at 11–13.
[149] *Id.* at 11.
[150] 16 U.S.C. § 1533(a)(3)(A)(i) (2012).
[151] *Id.* § 1533(b)(2).
[152] *Id.* § 1533(b)(6)(C)(ii); *see also* 50 C.F.R. § 424.17(b)(2) (2014) (if critical habitat is not determinable, the Service "may extend the 1–year period specified in paragraph (a) of this section by not more than one additional year").
[153] 50 C.F.R. § 424.12(a)(2)(i)–(ii).
[154] H.R. Rep. No. 97-567, at 20 (1982), *as reprinted in* 1982 U.S.C.C.A.N. 2807, 2820 (emphasis added).
[155] 16 U.S.C. § 1533(b)(6)(C)(ii) (emphasis added).
[156] *Id.* § 1533(a)(3)(A)(i).

ficial to the species."[157] Under Service regulations, critical habitat designation would be imprudent based upon the risk of unauthorized collection or other taking, or where the designation would not be beneficial to the species.[158]

Ruhl believes that the Service "could justifiably conclude that designation of critical habitat for species doomed by climate change fails to meet the 'prudent' standard, as the designation will provide no benefit. Indeed, for a doomed species, arguably there is no habitat 'essential to the conservation of the species' as conservation of the species is not possible."[159] However, the Service would also have to conclude that the designation of unoccupied critical habitat would not be essential for the conservation of the species. Indeed, the designation of unoccupied critical habitat is contemplated specifically for situations where "a designation limited to its present range would be inadequate to ensure the conservation of the species."[160]

Ruhl also argues that the Service "could put together a credible case that a designation of critical habitat for some climate-threatened species might so extensively impede human adaptation to climate change as to warrant exercise of its discretion not to act. . . ."[161] However, while the Service may exclude areas from critical habitat where it determines that the benefits of such exclusion outweigh the benefits of designating critical habitat, the Service must designate critical habitat if it determines that, based on the best scientific and commercial data available, the failure to designate critical habitat will result in the extinction of the species concerned.[162] The ESA makes no exception to this rule for the designation of unoccupied critical habitat.

As climate change continues to impact species' habitats and outpace their ability to adapt, the Service should prioritize identifying potentially suitable upland, inland, or more northerly habitat for Florida's imperiled species.

C. *Experimental Populations and Active Assisted Migration*

As sea-level rise and climate change threaten coastal and southerly habitat, the Service should consider whether a new population of an impacted species should be relocated to suitable habitat outside its current, occupied range. Section 10(j) of the ESA authorizes the Service to release species outside their current range if it determines that the "release will further the conservation of [the] species" and that the released population is wholly geographically separate from other original populations.[163] This provision was included in the 1982 amendments to the ESA, and by that time, the Service had already engaged in

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[157] H.R. Rep. No. 95-1625, at 17 (1978), *as reprinted in* 1978 U.S.C.C.A.N. 9453, 9467. *See also* Enos v. Marsh, 769 F.2d 1363 (9th Cir. 1985); N. Spotted Owl v. Lujan, 758 F. Supp. 621, 625 (W.D. Wash. 1991).
[158] *See* 50 C.F.R. § 424.12(a)(1).
[159] Ruhl, *supra* note 92, at 36.
[160] 50 C.F.R. § 424.12(e).
[161] Ruhl, *supra* note 92, at 37.
[162] *See* 16 U.S.C. § 1533(b)(2) (2012).
[163] *See id.* § 1539(j)(2)(A).

several species reintroductions.[164] Congress may have added section 10(j) to the ESA in an effort to bring greater flexibility to the ESA in the hope that relaxed protections for populations of certain species would minimize public resistance to their reintroduction.[165] In *From Population Segregation to Species Zoning: The Evolution of Reintroduction Law Under Section 10(j) of the Endangered Species Act*, Cheever found that "Congress intended [this amendment] to facilitate reintroduction by providing assurances to those people who might be burdened by the reintroduction and, therefore, might oppose it."[166]

This released population is known as an "experimental population."[167] In order to establish an experimental population, the Service must first issue regulations for a specific species population that include a finding that designating the species as an experimental population will "further the conservation of the species."[168] In making this finding, the Service must consider the possible adverse effects of removing individuals from the current population, the likelihood that the experimental population will survive, the impact the experimental population will have on the recovery of the species, and how much the experimental population will be affected by current and future activities in and around its area of release.[169]

The Service is required to list the "actual or proposed location, actual or anticipated migration, number of specimens released or to be released, and other criteria appropriate to identify the experimental population(s)."[170] Other necessary elements of the regulation include a list of "[m]anagement restrictions, protective measures, or other special management concerns of that population, which may include but are not limited to, measures to isolate and/or contain the experimental population . . . from natural populations."[171] The regulation must describe the process by which the success or failure of the experimental population may be measured.

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[164] Federico Cheever, *From Population Segregation to Species Zoning: The Evolution of Reintroduction Law Under Section 10(j) of the Endangered Species Act*, 1 Wyo. L. Rev. 287, 305 (2001). Despite the reintroductions that had occurred at the time of the amendments, nothing in the legislative history indicates that these were illegal. *Id.* In fact, since the time section 10(j) was added to the ESA, the Service has reintroduced several species without utilizing the experimental population provision, including the California condor and the peregrine falcon. *Id.*

[165] H.R. Rep. No. 97-567, at 33 (1982), *as reprinted in* 1982 U.S.C.C.A.N. 2807, 2833 (stating that section 10(j) is "intended to give greater flexibility to the Secretary in the treatment of populations of endangered or threatened species that are introduced into areas outside their current range"); *see also* Cheever, *supra* note 164, at 300 (discussing the legislative history of the 1982 amendments in detail).

[166] Cheever, *supra* note 164, at 292.

[167] The Service could also authorize the assisted migration of a listed species, as opposed to acting as the wildlife manager that creates an experimental population. Section 10(a)(1)(A) authorizes the Service to permit a take "for scientific purposes or to enhance the propagation or survival of the affected species, including, but not limited to, acts necessary for the establishment and maintenance of experimental populations." 16 U.S.C. § 1539(a)(1)(A).

[168] 50 C.F.R. § 17.81(b) (2014).

[169] *Id.* § 17.81(b)(1)–(4).

[170] *Id.* § 17.81(c)(1).

[171] *Id.* § 17.81(c)(3).

The Service manages forty-six species with experimental populations.[172] The gray wolf experimental population in Yellowstone best highlights both the benefits and the flaws that the added flexibility of section 10(j) provides.[173] In contrast to the typical ESA prohibition against the take of a listed species, Service regulations for the gray wolf allow for its take in certain circumstances including the killing of wolves that harass livestock and a management plan for "problem" wolves.[174] While this flexibility partially pacified local stakeholders who resisted the reintroduction of the wolf, it has also resulted in much conflict over the wolf.

1. Essential Population

The experimental population designation can provide additional layers of protection beyond passive assisted migration. The Service must also determine whether an experimental population is "essential to the continued existence of an endangered species or a threatened species."[175] The Service deems a population "essential" if its "loss would be likely to appreciably reduce the likelihood of the survival of the species in the wild."[176] The primary importance of this classification is that an "essential" population of a threatened or endangered species has ESA protections equivalent to that of threatened species: section 9 take prohibitions may be applied to the population at the Service's discretion, section 4 critical habitat may be designated, and section 7 consultation is required for actions by federal agencies.[177] "Nonessential" populations are—unless they are found within a National Wildlife Refuge or a National Park—treated as only a proposed species for section 7 consultation purposes, and section 4 critical habitat designation is not permitted.[178] However, the Service may still prohibit take of members of the nonessential population by special rule.[179]

The Service has stated that it will not deem a population "essential" unless the loss of that population would reduce the probability of the species' survival as a whole below what it was before the experimental population was released.[180] Thus, the Service may designate an experimental population as nonessential even if that population comprises the only members of that species in the wild, as is the case with the Guam rail.[181] The Guam rail is a bird that

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[172] *Environmental Conservation Online System*, U.S. Fish & Wildlife Serv., http://perma.cc/G7WFE62C.
[173] *Id.*
[174] Joly & Fuller, *supra* note 137, at 10,423.
[175] 16 U.S.C. § 1539(j)(3) (2012).
[176] 50 C.F.R. § 17.80(b).
[177] 16 U.S.C. § 1539(j)(2)(C).
[178] *Id.* § 1539(j)(2)(C)(ii); 50 C.F.R. § 402.10(a).
[179] *See* 50 C.F.R. § 17.82.
[180] Endangered and Threatened Wildlife and Plants; Experimental Populations, 49 Fed. Reg. 33,885, 33,888 (proposed Aug. 27, 1984) (to be codified at 50 C.F.R. pt. 17).
[181] Endangered and Threatened Wildlife and Plants; Determination of Experimental Population Status for an Introduced Population of Guam Rails on Rota in the Commonwealth of the Northern Mariana Islands, 54 Fed. Reg. 43,966, 43,966 (proposed Oct. 30, 1989) (to be codified at 50 C.F.R. pt. 17) [hereinafter Guam Rail Determination] .

originally inhabited only Guam, but was completely extinct in the wild when the Service decided to introduce it to Rota, a small island near Guam.[182] Even though the population on Rota comprised the only surviving members of the species in the wild, the Service still determined it was nonessential.[183] Indeed, to date, the Service has not deemed any experimental populations of any species essential.[184]

2. *Historic Range*

As species are forced out of their currently occupied habitat, they may need to retreat to other areas outside of their historic range. Service regulations currently prohibit the transplantation of an experimental population outside of the species' historic range unless "the primary habitat of the species has been unsuitably and irreversibly altered or destroyed."[185] The Service has moved only two experimental populations out of their likely historic ranges: the Guam rail and the red wolf (*Canis rufus*).[186] The Service moved the Guam rail to the nearby island of Rota after finding that the bird's habitat was "irreversibly altered," and that there was no effective method for controlling its primary threat, the brown tree snake.[187] The Service temporarily introduced red wolves within their probable historic range, but on islands that likely never supported red wolves, to acclimate them prior to moving them to areas within their historic range.[188]

It has been suggested that future standards for assisted migration address this regulatory restraint and instead focus on "the translocation's feasibility, the species' ecological significance, and its compatibility with future climatic conditions at a site."[189] A more modest approach might be to modify the regulation with a verb tense change from "has been" to "will be." This would provide the Service with a proactive approach, permitting the agency to release a species outside its probable historic range before its habitat is rendered entirely unsuitable. Even without that minor regulation change, the ESA itself provides ample direction that the Service consider active and passive assisted migration in protecting our nation's most imperiled species.

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[182] *Id.*
[183] *Id.* at 43,969.
[184] *See Environmental Conservation Online System*, *supra* note 172.
[185] 50 C.F.R. § 17.81(a) (2014).
[186] *See* Guam Rail Determination, *supra* note 181, at 43,966; *see also* U.S. Fish & Wildlife Serv., Red Wolf Recovery/Species Survival Plan 15 (1990) [hereinafter Red Wolf Recovery Plan], http://perma.cc/6S6F-JC9L.
[187] Guam Rail Determination, *supra* note 181, at 43,967.
[188] *See* Red Wolf Recovery Plan, *supra* note 186, at 12–13.
[189] Camacho, *supra* note 7, at 239.

III. South Florida Case Studies Applying Concepts of Assisted Migration

A. Florida Panther Recovery Planning

The Florida panther is managed by the Service and has a recovery plan that, if implemented, could save it from extinction driven historically by habitat fragmentation and degradation.[190] The Florida panther is a large predatory cat that has been characterized as its own species (*Felis coryi*), a subspecies of the puma (*Puma concolor coryi*), and as a population of the pan-North American subspecies of puma (*Puma concolor couguar*).[191] There is no consensus in the scientific community regarding the genetic status of the Florida panther, and in 1995, the Service temporarily introduced eight female pumas from Texas to address symptoms of inbreeding depression.[192] The primary threat to the Florida panther's long-term recovery is habitat loss. Historic and ongoing habitat degradation and fragmentation due to land-use practices are currently the leading threats against the panther.[193] Habitat destruction and fragmentation has led to intraspecific aggression, which accounts for 42% of all mortalities among radio-collared panthers, and limits the panthers' breeding capacity.[194]

Florida panthers likely originally spanned throughout much of the Southeast. Today the only known breeding population of Florida panthers is on less than 5% of its original range, in the Big Cypress National Preserve and Everglades National Park region, south of the Caloosahatchee River.[195] However, individual Florida panthers have been confirmed north of the Caloosahatchee River in Flagler, Glades, Highlands, Hillsborough, Indian River, Okeechobee, Orange, Osceola, Polk, Sarasota, and Volusia counties in Florida, and in west-central Georgia.[196] Within these regions, Florida panthers appear to prefer forested cover, including cypress swamps, pinelands, hardwood swamps, and upland hardwood forests.[197]

Panthers need a lot of space to successfully hunt, breed, and raise offspring. Dispersal, the process by which juveniles leave their mothers and establish their own home range, is vital in reproduction, population growth, and range expansion. When juveniles disperse, their mothers are more likely to mate again, and the juveniles themselves may also then be able to mate.[198] Male juveniles travel an average of 25 miles (but up to over 100 miles) to establish

[190] *See* Native Fish and Wildlife: Endangered Species, 32 Fed. Reg. 4001, 4001 (Mar. 11, 1967) (listing the Florida panther as threatened with extinction).
[191] U.S. Fish & Wildlife Serv., Florida Panther Recovery Plan (3d Revision) 8, 11–12 (2008) [hereinafter Panther Recovery Plan 2008], http://perma.cc/G27N-S5UK.
[192] *Id.* at 6, 70.
[193] *Id.* at 35–36.
[194] *Id.* at 17.
[195] *Id.* at 13, 35.
[196] *Id.* at 15.
[197] *Id.* at 28.
[198] *See id.* at xi, 18.

new home ranges.[199] Female juveniles travel just under one home-range width from their natal range.[200] Male home ranges are 140–250 square miles and female home ranges are 69–153 square miles.[201] Most of the dispersal occurs south of the Caloosahatchee River, with only males traveling north.[202] The river itself does not appear to be a significant barrier to northerly migration, but development and roads do.[203] Ultimately, the size of the home range depends on habitat quality and prey density—which typically includes white-tailed deer (*Odocoileus virginianus*) and feral hogs (*Sus scrofa*), and to a lesser extent raccoons (*Procyon lotor*), nine-banded armadillos (*Dasypus novemcinctus*), marsh rabbits (*Sylvilagus palustris*), and alligators (*Alligator mississippiensis*).[204] Unfortunately, south Florida has run out of space and, due to habitat destruction and fragmentation, current "[s]uccessful male recruitment appears to depend on the death or home-range shift of a resident adult male."[205]

The Service has identified three zone types as necessary for the Florida panther's survival. The Primary Zone, where the existing breeding population lives, is 3,548 square miles.[206] Seventy-three percent of these lands are public lands, and are mostly forest and freshwater marsh.[207] The Secondary Zone, which offers potential for expansion, is 1,269 square miles.[208] Thirty-eight percent is public land, and is mostly freshwater marsh and agriculture.[209] The Dispersal Zone, the only area that currently contemplates panthers dispersing north of the Caloosahatchee River, is 44 square miles, with a mean width of 3.4 miles, and is all privately owned.[210] Combined, the three zones total 3,110,619 acres, or 4,860 square miles.

Much of the panther's current habitat is concentrated mere feet above sea level in south Florida, which means the impending threat of sea-level rise will further diminish the panther's south Florida habitat. Ten percent of current panther habitat would be inundated under conservative estimates of just under two feet of sea-level rise by 2100,[211] and 33% would be lost with six feet of sea-level rise.[212] It is projected that the Florida panther will lose 23% of its primary, secondary, and dispersal habitat with three feet of sea-level rise, 59% with nine feet, and 83% with thirty-six feet.[213] Moreover, the panther will be competing

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[199] *See id.* at 18.
[200] *Id.*
[201] *See id.* at 19–20.
[202] *Id.* at 19.
[203] *Id.*
[204] *Id.* at 19, 21–22.
[205] *Id.* at 17 (quoting D. S. Maehr, E. D. Land & J. C. Roof, *Social Ecology of Florida Panthers*, 7 NAT'L GEOGRAPHIC RES. & EXPLORATION 414 (2001)).
[206] *Id.* at 27.
[207] *Id.* at 27–28.
[208] *Id.*
[209] *Id.* at 28.
[210] *Id.* at 27–28, 30.
[211] Songlin Fei, John Cox & Andrew Whittle, *A Perfect Storm May Threaten Florida Panther Recovery*, 9 FRONTIERS ECOLOGY & ENV'T 317, 317 (2011).
[212] *Id.*
[213] THE NATURE CONSERVANCY & U.S. FISH & WILDLIFE SERV., SEA LEVEL RISE ADAPTATION IN THE FLORIDA KEYS 9 (2012), http://perma.cc/QJ6Q-FRPQ.

with human populations, which will be vying for the same available habitat, and prey will also likely be impacted by the quality of their habitats.

The Service's Florida Panther Recovery Plan recognizes that "[r]ange expansion and reintroduction of additional populations are . . . essential for panther recovery."[214] The primary goal of the plan is to "maintain, restore, and expand the panther population and its habitat in south Florida and expand the breeding portion of the population in south Florida to areas north of the Caloosahatchee."[215] Its second goal is to "identify, secure, maintain, and restore panther habitat in potential reintroduction areas within the historic range, and to establish viable populations of the panther outside south and south-central Florida."[216] To accomplish these goals, the Service set a target of establishing three viable populations of at least 240 individuals established and maintained for at least twelve years.[217] The Service defines a viable Florida panther population as one in which there is a 95% chance of persistence for 100 years.[218]

In 1993, the Service released nineteen mountain lions (*Felis concolor stanleyana*), some wild-caught and some captive-raised, in the Osceola-Okefenokee ecosystem to evaluate the prospect of reintroducing Florida panthers into unoccupied areas of their historic range.[219] A study on the experiment found that captive-raised males were more likely to cause human interactions and establish smaller home ranges significantly closer to the release site than wild-caught males.[220] The study also determined that the reestablishment of Florida panther populations was biologically feasible.[221] A more recent habitat feasibility analysis found suitable habitat for the Florida panther in north Florida, Georgia, Alabama, Arkansas, and Louisiana.[222]

The Service has engaged in some implementation of the recovery plan that furthers the plan goals of reintroducing Florida panthers, including securing the dispersal zone through easements, but has not taken concrete steps toward reintroduction, including determining what steps must be taken to facilitate natural expansion or translocation of panthers.[223] On March 21, 2014, Florida State Director for the Service, Larry Williams, articulated the priorities for Florida panther recovery, which included range expansion and reintroduction of Florida panthers.[224] Time is short for the Florida panther—sea levels are rising and

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214 PANTHER RECOVERY PLAN 2008, *supra* note 191, at 88–89.
215 *Id.* at x.
216 *Id.*
217 *See id.* at 99.
218 *Id.* at xi.
219 *See id.* at 72.
220 ROBERT C. BELDEN & JAMES W. MCCOWN, FLA. GAME & FRESH WATER FISH COMM'N, FLORIDA PANTHER REINTRODUCTION FEASIBILITY STUDY 10 (1996).
221 *Id.* at 14.
222 *See* Cindy A. Thatcher, Frank T. van Manen & Joseph D. Clark, *Identifying Suitable Sites for Florida Panther Reintroduction*, 70 J. WILDLIFE MGMT. 752, 760 (2006).
223 *Recovery Plan Action Status: Third Revision of the Florida Panther Recovery Plan*, U.S. FISH & WILDLIFE SERV. ENVTL. CONSERV. ONLINE SYS., http://perma.cc/B5VY-NFDS.
224 Larry Williams, State Supervisor, South Fla. Ecological Servs. Field Office, U.S. Fish & Wildlife Serv., Opening Remarks at Florida Panther Symposium (Mar. 21, 2014).

urban development is encroaching. The Service must act swiftly to expand their habitat and reintroduce them northward and inland, or risk losing them forever.

B. Loggerhead Sea Turtle Critical Habitat Designation

The loggerhead sea turtle (*Caretta caretta*) is a federally managed species under the ESA and is currently situated to have designated critical habitat protective of inland and northward future nesting beaches. The loggerhead sea turtle is one of the longest journeying animals on earth. Its territory spans throughout the Atlantic, Pacific, and Indian Oceans. The Northwest Atlantic population of the loggerhead sea turtle—the one that nests in Florida—is listed as threatened under the ESA and can be found along the Atlantic coast from Cape Cod to Florida and in the Gulf of Mexico from Florida to Mississippi.[225]

Climate change and sea-level rise threaten the recovery of loggerhead sea turtles in a number of ways. Sea-level rise is the primary threat to turtle nesting beaches and nesting success.[226] As sea levels increase, so will inundation and erosion of nesting beaches.[227] Sea-level rise can flood turtle nests from below.[228] Increased storms and storm surge on top of elevated seas can impact sea turtle nests. Nests can be flooded or washed away by surges, wave action, beach erosion, and sand washout events.[229] An increase in storm activity in Dry Tortugas National Park, Florida, has already been noted, and has been directly linked to an increase in flooding of loggerhead nests and a more than 50% reduction in loggerhead hatchling success.[230]

Sea-level rise and increased storm surge will significantly diminish available sea turtle nesting habitat. For example, Tropical Storm Debby, a July 2012 storm, brought high winds and several feet of storm surge on the southwest coast of Florida along loggerhead nesting beaches. The storm inundated thousands of nests with water before wildlife managers and volunteers were

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[225] *See* Endangered and Threatened Species; Determination of Nine Distinct Population Segments of Loggerhead Sea Turtles as Endangered or Threatened, 76 Fed. Reg. 58,868, 58,868, 58,870 (Sept. 22, 2011) (to be codified at 50 C.F.R. pts. 17, 223, 224) [hereinafter Determination of Loggerhead Sea Turtle Population Segments].

[226] *See, e.g.*, Lucy A. Hawkes et al., *Climate Change and Marine Turtles*, 7 Endangered Species Res. 137, 146–47 (2009); M.M.P.B. Fuentes et al., *Vulnerability of Sea Turtle Nesting Grounds to Climate Change*, 17 Global Change Biology 140, 149–50 (2010).

[227] *See, e.g.*, Richard C. Daniels, Tammy W. White & Kimberly K. Chapman, *Sea-Level Rise: Destruction of Threatened and Endangered Species Habitat in South Carolina*, 17 Envtl. Mgmt. 373, 375 (1993); Marianne R. Fish et al., *Predicting the Impact of Sea-Level Rise on Caribbean Sea Turtle Nesting Habitat*, 19 Conserv. Biology 482, 483 (2005).

[228] M. J. Witt et al., *Predicting the Impacts of Climate Change on a Globally Distributed Species: The Case of the Loggerhead Turtle*, 213 J. Experimental Biology 901, 901 (2010); *see also* M.M.P.B. Fuentes et al., *Potential Impacts of Projected Sea-Level Rise on Sea Turtle Rookeries*, 20 Aquatic Conserv. Marine Freshwater Ecosystems 132, 136 (2009).

[229] *See* Fuentes et al., *supra* note 228, at 136; Hawkes et al., *supra* note 226, at 139; Witt et al., *supra* note 228, at 902.

[230] Kyle S. Van Houtan & Oron L. Bass, *Stormy Oceans Are Associated with Declines in Sea Turtle Hatching*, 17 Current Biology R590, R590 (2007).

able to rescue them.[231] With predictions that storms and storm surge will increase in the coming decades,[232] the damage of Tropical Storm Debby is likely just a small and tame sample of what the future holds for sea turtle nesting on Florida's southwest coast. Unfortunately, Florida's east coast nesting sea turtles are not expected to fare much better.

With rising seas comes the human response to it, including coastal armoring and beach renourishment, which can impact nesting, disorient turtles, and block beach access.[233] A study on the effects of seawalls on nesting loggerheads in Florida found that erosion in front of seawalls discourages sea turtles from nesting and that nests in front of seawalls were more likely to be washed away in storms.[234] Beach renourishment may provide unsuitable incubation conditions and change the beach profile.[235] The number of loggerhead hatchlings disoriented by artificial lighting can increase by 600% during the first two years after renourishment.[236] One study found that reproductive output of nesting turtles was reduced by 52.2% the first year after renourishment.[237]

Rising temperatures also threaten sea turtles' long-term survival.[238] In the Southeast, annual average temperatures have risen about 2 degrees Fahrenheit since 1970.[239] Under a low-emissions scenario, average temperatures in the Southeast are projected to rise 4.5 degrees Fahrenheit by the 2080s; however, on our current trajectory, temperatures will rise 9 degrees Fahrenheit, including a 10.5-degree-Fahrenheit increase in summer and a higher heat index.[240] This means that sand temperatures will also increase. Sand temperature determines the sex of the sea turtle; plays a role in embryo development, incubation success, and incubation duration; and influences nesting phenology. Increases in temperature are predicted to skew hatchling sex ratios, change hatchling attributes and survival, and alter timing of nesting.[241] For example, sea turtles typically incubate between about 77 and 95 degrees Fahrenheit.[242] Embryos incubating at the higher range become females and those incubating at lower temperatures become males.[243] Loggerhead hatchling sex ratios in the Atlantic Ocean basin are currently more female-biased the closer they are to the equa-

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[231] Craig Pittman, *Officials Report Near-Record Year for Loggerhead Sea Turtle Nests*, TAMPA BAY TIMES (Oct. 19, 2012), http://perma.cc/TD29-KVEP.
[232] *See, e.g.*, Bender et al., *supra* note 2, at 454; Elsner et al., *supra* note 2, at 92; Grinsted et al., *Homogeneous Record*, *supra* note 2, at 19,603; Kishtawal et al., *supra* note 2, at L10810.
[233] Hawkes et al., *supra* note 226, at 139; Witt et al., *supra* note 228, at 901.
[234] Carol E. Rizkalla & Anne Savage, *Impact of Seawalls on Loggerhead Sea Turtle (*Caretta caretta*) Nesting and Hatching Success*, 27 J. COASTAL RES. 166, 171–72 (2011).
[235] Hawkes et al., *supra* note 226, at 139.
[236] Kelly A. Brock, Joshua S. Reece & Llewellyn M. Ehrhart, *The Effects of Artificial Beach Nourishment on Marine Turtles: Differences Between Loggerhead and Green Turtles*, 17 RESTORATION ECOLOGY 1, 1 (2007).
[237] *Id.*
[238] Witt et al., *supra* note 228, at 902.
[239] U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 1, at 111.
[240] *Id.*
[241] Fuentes et al., *supra* note 226, at 140; Witt et al., *supra* note 228, at 902.
[242] Hawkes et al., *supra* note 226, at 141.
[243] *Id.*

tor.[244] Rookeries in eastern Florida "are estimated to produce nearly 90% female hatchlings . . . while more northerly rookeries in Georgia, South Carolina and North Carolina are thought to produce closer to 55–60% female hatchlings."[245] Already there is a strong possibility that sex ratios will become completely feminized in Florida,[246] with some exceptions at smaller, vegetated beaches in western Florida.[247] The primary concern is that the population will fail because there will not be enough males to mate.[248]

Because loggerheads are long-lived, late-maturing, and have evolved with a climate changing at a much slower rate than projected during this century, their ability to adapt to rapid change is limited. In addition, the genetic capacity for sea turtle adaptation may be lower than for other vertebrates, and with many sea turtle populations already well below their historic population levels, their capacity for selection of key traits may be limited.[249]

Critical habitat designation of unoccupied areas could provide the loggerhead the habitat it needs as our beaches change in response to climate change. On July 10, 2014, the Service designated 685 miles of critical habitat along its nesting beaches from North Carolina to Mississippi, with most of the habitat in Florida.[250] The Florida nesting population is one of the largest aggregations of nesting loggerheads.[251] About 90% of U.S. loggerhead sea turtle nesting occurs in Florida, and most of that occurs in Brevard, Indian River, St. Lucie, Martin, Palm Beach, Broward, and Sarasota counties.[252] Along these beaches, loggerheads require a certain quality and quantity of habitat to successfully reproduce. They prefer narrow, steeply sloped beaches with coarse sand.[253] They require deep, clean sand with high humidity to allow for embryonic development.[254] Loggerheads have high nesting site fidelity, nesting zero to three miles within past nesting sites.[255] These sandy shoreline habitats on the coasts and barrier islands of south Florida are of high ecological importance to the loggerhead, and are severely threatened by intense human use, development, and climate change.

[244] Witt et al., *supra* note 228, at 904–05.
[245] *Id.* at 905 (citations omitted).
[246] L. A. Hawkes et al., *Investigating the Potential Impacts of Climate Change on a Marine Turtle Population*, 13 GLOBAL CHANGE BIOLOGY 1, 8 (2007).
[247] Witt et al., *supra* note 228, at 905.
[248] Hawkes et al., *supra* note 246, at 8.
[249] Hawkes et al., *supra* note 226, at 143.
[250] Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northwest Atlantic Ocean Distinct Population Segment of the Loggerhead Sea Turtle, 79 Fed. Reg. 39,756, 39,756 (Jul. 10, 2014) (to be codified at 50 C.F.R. pt. 17) [hereinafter Final Designation of Atlantic Ocean Population Segment].
[251] *See* Determination of Loggerhead Sea Turtle Population Segments, *supra* note 225, at 58,869.
[252] *See Loggerhead Nesting in Florida*, FLA. FISH & WILDLIFE CONSERV. COMM'N, http://perma.cc/H677-UWEH.
[253] Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Northwest Atlantic Ocean Distinct Population Segment of the Loggerhead Sea Turtle (*Caretta caretta*), 78 Fed. Reg. 18,000, 18,007 (proposed Mar. 25, 2013) (to be codified at 50 C.F.R. pt. 17) [hereinafter Proposed Designation of Atlantic Ocean Population Segment].
[254] *Id.*
[255] *Id.*

The Service's critical habitat proposal acknowledged climate change and sea-level rise as threats to loggerhead habitat, summarizing the climate change threats as including "beach erosion from rising sea levels, repeated inundation of nests, skewed hatchling sex ratios from rising incubation temperatures, and abrupt disruption of ocean currents used for natural dispersal during the complex life cycle."[256] It acknowledges that it cannot fully address all the harms of climate change, but that it can respond to climate change by protecting nesting sites from other human-induced habitat modification (i.e. coastal armoring and beach renourishment).[257] However, the Service's final designation of ninety units of habitat of 685 linear miles only included beaches up to coastal construction or the toe of the second dune.[258] This is despite the fact that development and coastal armoring block upslope retreat at many current nesting sites, and despite the fact that the Service identifies climate change as a threat to occupied habitat in all but one of the units of proposed critical habitat.[259] It did not propose or finalize designating any unoccupied habitat for the loggerhead.[260]

The Service should have considered additional critical habitat units in occupied and unoccupied areas to buffer the loggerhead from the impacts of climate change. It could have designated unoccupied inland habitat as well as occupied and unoccupied nesting habitat in the northern edge of its range to allow beaches and nesting turtles to migrate in response to sea-level rise and rising temperatures. Given the Service's own finding that nearly all of the proposed critical habitat units are threatened by climate change, "designation limited to its present range [is] inadequate to ensure the conservation of the species."[261] Proactively identifying, designating, and restoring potential inland habitat in undeveloped areas is essential to facilitate inland movement and to compensate for increasing habitat loss and degradation due to climate change. The Service should exercise its discretion to revise the critical habitat designation to include unoccupied critical habitat to protect beaches that may become important for nesting loggerheads.

C. Key Tree-Cactus and Lower Keys Marsh Rabbit Reintroduction

The Key tree-cactus and Lower Keys marsh rabbit are two species that may benefit from the Service designating experimental populations. They are

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[256] *Id.* at 18,012.
[257] *Id.* at 18,012–13.
[258] Final Designation of Atlantic Ocean Population Segment, *supra* note 250.
[259] *See* Proposed Designation of Atlantic Ocean Population Segment, *supra* note 253, at 18,020–40. Recovery unit LOGG-T-FL-08 inexplicably omits climate change from the list of threats. *Id.* at 18,030.
[260] *Id.* at 18,001; *see also* Final Designation of Atlantic Ocean Population Segment, *supra* note 250, at 39,763. Instead of designating unoccupied habitat, the Service instead found that "[a]s more specific forecasts become available in the future, a revision of critical habitat may be required to more effectively provide for the conservation of the species. At this time, however, such forecasts are unavailable." *Id.* at 39,674.
[261] 50 C.F.R. § 424.12(e) (2014).

both restricted to rapidly disappearing south Florida habitat and both lack the ability to relocate to areas protected from sea-level rise on their own.

The Key tree-cactus (*Pilosocereus robinii*) is a multi-branched, tree-like cactus that grows thirty feet tall and produces large white flowers and purple fruit.[262] Its historic range was throughout the Florida Keys, though it currently occurs only in Cuba and in tropical hammocks in the Florida Keys.[263] It grows on coral rock and thrives on well-drained sites with little or no soil development.[264] It tends to occupy sites within highland hardwood hammocks that are higher in elevation and less prone to flooding.[265] The Key tree-cactus reproduces primarily through vegetative offshoots, which are genetic clones created when branches produce their own root systems.[266] Because of this inclination towards vegetative reproduction, the tree-cactus tends to grow in small, isolated clumps.[267] Disturbance of this cactus by the Key deer, another endangered species, may play an important role in its vegetative dispersal.[268] Reproduction through seeds is very limited,[269] and the pollinators of this species are unknown.[270] Indeed, only four plants in the Keys produced fruits between 2007 and 2010.[271] Therefore, long-range dispersal of the cactus is limited.[272]

The Key tree-cactus was already approaching extinction in the early 1900s and has probably always been rare due to its reproductive capacity and narrow habitat requirements.[273] Negative impacts on the few, widely separated populations of the cactus, in combination with its low rate of reproduction, prompted the Service to list it as endangered in 1984.[274] Despite its listing, the cactus experienced rapid die off in the 1990s.[275] Eighty-four percent of the population disappeared between 1994 and 2007.[276] One population on Big Pine Key, which previously represented 80% of the total number of individuals of this species, lost 99% of individuals between the 1990s and 2010.[277]

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[262] MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1111.
[263] *Id.* at 4-1112.
[264] *Id.* at 4-1114.
[265] *Id.* at 4-1113–14.
[266] Joie Goodman et al., *Differential Response to Soil Salinity in Endangered Key Tree Cactus: Implications for Survival in a Changing Climate*, 7 PLoS ONE 1, 2 (2012), http://perma.cc/7VYD-VJUH; MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1114.
[267] *See* Goodman et al., *supra* note 266, at 2; MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1114.
[268] MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1115.
[269] Goodman et al., *supra* note 266, at 2; MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1114.
[270] MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1114.
[271] Goodman et al., *supra* note 266, at 2.
[272] *See id.;* MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1114.
[273] Goodman et al., *supra* note 266, at 2; MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1115.
[274] Goodman et al., *supra* note 266, at 2; MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1115.
[275] Goodman et al., *supra* note 266, at 1.
[276] *Id.*
[277] *Id.* at 6.

The cactus is already impacted by sea-level rise.[278] Sea-level rise may intensify storm surge in cactus habitat, raising soil salinity, which stresses or kills cacti if raised beyond their tolerance level.[279] Under current projections for sea-level rise, most of the Key tree-cactus's habitat will be destroyed within the next century.[280]

The Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*), also known as the Lower Keys rabbit, is a subspecies of marsh rabbit endemic to the Florida Keys.[281] Mainland marsh rabbits are found throughout southeastern North America.[282] The Lower Keys marsh rabbit has likely inhabited the Lower Keys area for 12,000 to 40,000 years, since it became isolated from other rabbit populations due to sea-level rise around 10,000 years ago.[283]

The Lower Keys marsh rabbit was once common in the Keys,[284] with its original range likely including all islands from Big Pine Key to Key West, however, it currently only occupies the larger islands within the Keys and the smaller islands that surround them.[285] It prefers primarily grassy marshes and prairies close to large bodies of water.[286] From 1959 to 2006, the rabbit lost 64% of its habitat.[287] This was partially due to a dramatic increase in development within the Keys between 1970 and 2000.[288] However, sea-level rise has also been cited as a primary driver of habitat destruction, accounting for 48% of habitat loss.[289] This has left the rabbit with small, fragmented areas of viable habitat. One study has predicted the extinction of the Lower Keys marsh rabbit before 2040.[290]

The Service designated the Lower Keys marsh rabbit as endangered in 1990 due to population decline from habitat loss, fragmentation, and mortality from automobiles and predatory cats.[291] The pressures of development and habitat degradation from off-road vehicles and invasive exotics have been especially detrimental to the rabbit population because it is so reliant on dispersal,[292] which makes fragmentation of wildlife corridors significantly harmful to its viability.

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[278] *See id.* at 8.
[279] *See id.* at 2, 10.
[280] U.S. Fish & Wildlife Serv., Key Tree-cactus (*Pilosocereus robinii*) 5-Year Review: Summary and Evaluation 19–20 (2010), http://perma.cc/3U9R-LQJS.
[281] Jason A. Schmidt et al., *Impacts of a Half Century of Sea-Level Rise and Development on an Endangered Mammal*, 18 Global Change Biology 3536, 3537 (2012).
[282] Multi-Species Recovery Plan, *supra* note 89, at 4-152.
[283] *Id.*
[284] Schmidt et al., *supra* note 281, at 3537.
[285] Multi-Species Recovery Plan, *supra* note 89, at 4-152.
[286] *Id.* at 4-152–53.
[287] Schmidt et al., *supra* note 281, at 3539.
[288] *Id.* at 3537.
[289] *Id.* at 3539.
[290] *See* Elizabeth A. Forys & Stephen R. Humphrey, *Use of Population Visibility Analysis to Evaluate Management Options for the Endangered Lower Keys Marsh Rabbit*, 63 J. Wildlife Mgmt. 251, 258–59 (1999); *see also* Multi-Species Recovery Plan, *supra* note 89, at 4-156.
[291] Multi-Species Recovery Plan, *supra* note 89, at 4-157.
[292] *See id.* at 4-157–58.

The Lower Keys marsh rabbit relies on dispersal to ensure successful breeding. It lives in small, isolated groups with no overlapping territory between adults of the same sex.[293] Adults have permanent home ranges, but successful propagation of the Lower Keys marsh rabbit depends on the dispersal of juveniles and their establishment in previously uninhabited areas.[294] Most rabbits make a long journey at the time of sexual maturity, with males moving significantly longer distances than females.[295] This may mean leaving their habitat patch if it is small. Upon leaving their natal habitat patch, rabbits establish a new range that they will occupy as adults.[296]

The impacts of climate change present a particularly dire situation for the Lower Keys marsh rabbit because the migration of populations to alternative viable habitats may require movement across long distances through urban or dangerous terrain.[297] The greater the distance between suitable patches the less likely a successful migration will be.[298]

Sea-level rise will also reduce the availability of fresh water for the rabbit.[299] While the rabbit requires relatively low amounts of water for survival, probably needing only dew and brackish water to survive,[300] sea-level rise is likely to diminish the availability of fresh water.[301] Sea-level rise is predicted to be a major threat to the rabbit because of its use of low-lying habitats in combination with a lack of inland migration of coastal ecosystems.[302] Available suitable habitat exists on mainland Florida, however, relocation there would expose the rabbit to hybridization with the more fecund subspecies *Sylvilagus palustris palustris*.[303]

The recovery plans for the Key tree-cactus and Lower Keys marsh rabbit call for the reintroduction of the species. The Key Tree-Cactus Recovery Plan prescribes studying "the feasibility of translocating propagules into historically appropriate and protected natural habitats," identifying "potential reintroduction sites," and "[m]onitoring of reintroduced plants."[304] It also calls for identification of "suitable sites for experimental outplantings."[305] The Lower Keys Marsh Rabbit Recovery Plan includes a goal to conduct marsh rabbit rein-

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293 *Id.* at 4-154–55.
294 *Id.*
295 Elizabeth A. Forys & Stephen R. Humphrey, *Home Range and Movements of the Lower Keys Marsh Rabbit in a Highly Fragmented Habitat*, 77 J. MAMMALOGY 1042, 1046 (1996).
296 *Id.*
297 *See id.;* MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-158–60.
298 *See* Forys & Humphrey, *supra* note 290, at 258–59; MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-154–55, 4-158–60.
299 *See* U.S. FISH & WILDLIFE SERV., LOWER KEYS MARSH RABBIT (*SYLVILAGUS PALUSTRIS HEFNERI*) 5-YEAR REVIEW: SUMMARY AND EVALUATION 18 (2007) [hereinafter LOWER KEYS MARSH RABBIT 5-YEAR REVIEW], http://perma.cc/H36P-FEFH.
300 MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-156.
301 *See* LOWER KEYS MARSH RABBIT 5-YEAR REVIEW, *supra* note 299, at 18.
302 Schmidt et al., *supra* note 281, at 3537.
303 *See* MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-155; Joyce Maschinski et al., *Sinking Ships: Conservation Options for Endemic Taxa Threatened by Sea Level Rise*, 107 CLIMATIC CHANGE 147, 160 (2011).
304 MULTI-SPECIES RECOVERY PLAN, *supra* note 89, at 4-1120.
305 *Id.*

troductions from wild populations.[306] However, the scope of these efforts is limited to the Florida Keys.[307] The plan also notes that "[r]ecovery actions implemented to recover the marsh rabbit will benefit other threatened or endangered species in the Lower Florida Keys, including the . . . Keys tree cactus."[308]

Both species have been reintroduced in the wild. A new population of Key tree-cactus has been reintroduced to an area of higher elevation within the cactus's historic range in an effort to protect it from sea-level rise.[309] Because the Key tree-cactus is likely to stay confined to a relatively small geographic area for the first decades after its reintroduction, it is unlikely that it will spread to other areas.

At least two attempted reintroductions of the rabbit have shown some signs of success, though the chances of survival for these translocated populations in the long term remains unclear.[310] The introduction of the Lower Keys marsh rabbit outside of its historic range could present a problem for the Service: the Lower Keys marsh rabbit population breeding with other non-listed marsh rabbit populations endemic to the southeast United States. If the offspring of this pairing was not classified as a member of the Lower Keys marsh rabbit population, it could lose its experimental population status or ESA designation. More importantly, Lower Keys marsh rabbits could inevitably breed themselves into extinction. Therefore, assisted migration of this species will require a significant investment in management planning and likely constant monitoring and management of the translocated population.

Conclusion

Assisted migration of species will be a limited but important tool that the Service must consider in saving our nation's most imperiled species. However, this tool will only be effective with greenhouse gas emission-reducing measures implemented immediately to avoid "dangerous anthropogenic interference" to species and ecosystems.[311] For species impacted by sea-level rise, the single greatest conservation tool is reducing greenhouse gas emissions.[312] Pre-

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[306] *Id.* at 4-166.
[307] *Id.*
[308] *Id.*
[309] *Key Tree Cactus Plants Reintroduced in First-Time Effort*, U.S. Fish & Wildlife Serv., South Fla. Ecological Servs. Field Office (Aug. 15, 2012), http://perma.cc/B6UK-97TB.
[310] Craig A. Faulhaber et al., *Reintroduction of Lower Keys Marsh Rabbits*, 34 Wildlife Soc'y Bull. 1198, 1201 (2006).
[311] James Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?*, 2 Open Atmospheric Sci. J. 217, 217 (2008) (quoting U.N. Framework Convention on Climate Change art. 2, *opened for signature* May 9, 1992, S. Treaty Doc. No. 102-38, 1771 U.N.T.S. 164). *See generally* Timothy M. Lenton et al., *Tipping Elements in the Earth's Climate System*, 105 Proc. Nat'l Acad. Sci. U.S. 1786 (2008); Chris Jones et al., *Committed Terrestrial Ecosystem Changes Due to Climate Change*, 2 Nature Geoscience 484 (2009); Joel B. Smith et al., *Assessing Dangerous Climate Change Through an Update of the Intergovernmental Panel on Climate Change (IPCC) "Reasons for Concern"*, 106 Proc. Nat'l Acad. Sci. U.S. 4133 (2009).
[312] Sea-level rise can be correlated with increases in temperature, which are connected to increases in greenhouse gas emissions. Warming of 1.5 to 2 degrees Celsius above preindustrial temperatures will result in an increase of seventy-five to eighty centimeters of sea-level rise. *See* Michiel

serving habitat and creating habitat corridors are complimentary, necessary management strategies.[313] Some have argued the Service should issue an assisted migration regulation in light of climate change impacts to listed species.[314] However, a plain reading of the ESA reveals the Service has ample authority to help species thrive in new, climate-changed environments through active or passive assisted migration.

Some argue that "[n]ature will generally do a better job of adapting ecosystems to new baseline conditions than humans will."[315] It is true, assisted migration may be of limited utility due to the ecological risk of moving species to new areas;[316] resistance from natural resource managers, scientists, and the public;[317] and its high administrative and opportunity cost.[318] However, there is no evidence to suggest that species will have sufficient time or capacity to adapt to the new ecosystems that climate change creates. Furthermore, there are many examples of successful experimental populations, and the International Union for Conservation of Nature has stated that assisted migration may not be more risky than reintroduction and that ecological risks may be effectively mitigated through proper planning.[319] Two studies found that a majority of scholarly articles addressing assisted migration support its use and that it is the fourth most-cited climate adaptation strategy.[320] This Article follows suit and argues the Service has a responsibility under the Endangered Species Act to use passive and active assisted migration as a means by which to buy species the time and space they need to adapt.

Schaeffer et al., *Long-Term Sea-Level Rise Implied by 1.5°C and 2°C Warming Levels*, 2 NATURE CLIMATE CHANGE 867, 867 (2012). An emissions reduction of 70% by 2100 would cut in half temperature rise, preserve Arctic sea ice and permafrost, and reduce sea-level rise due to thermal expansion by nearly half. *See* Warren M. Washington et al., *How Much Climate Change Can Be Avoided By Mitigation?*, 36 GEOPHYSICAL RES. LETTERS L08703, L08703 (2009); *see also* J. Körper et al., *The Effects of Aggressive Mitigation on Steric Sea Level Rise and Sea Ice Changes*, 40 CLIMATE DYNAMICS 531, 546–48 (2013); Gerald A. Meehl et al., *Relative Outcomes of Climate Change Mitigation Related to Global Temperatures Versus Sea-Level Rise*, 2 NATURE CLIMATE CHANGE 576, 576 (2012).

[313] *See generally* Joshua J. Lawler & Julian D. Olden, *Reframing the Debate Over Assisted Colonization*, 9 FRONTIERS ECOLOGY & ENV'T 569 (2011).

[314] *See generally* Jessica Kabaz-Gomez, Note, *Rules for Playing God: The Need for Assisted Migration & New Regulation*, 19 ANIMAL L. 111 (2012).

[315] Robin Kundis Craig, *"Stationary is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 53 (2010).

[316] *See* Camacho, *supra* note 7, at 184–86 (describing the concerns of skeptics of assisted migration).

[317] *See id.* at 174; *see also* Holly Doremus, *Restoring Endangered Species: The Importance of Being Wild*, 23 HARV. ENVTL. L. REV. 1, 2 (1999).

[318] *See* Camacho, *supra* note 7, at 184; Kabaz-Gomez, *supra* note 314, at 123.

[319] Kabaz-Gomez, *supra* note 314, at 121.

[320] *Id.* at 125 (citing Nicole E. Heller & Erika S. Zavaleta, *Biodiversity Management in the Face of Climate Change: A Review of 22 Years of Recommendations*, 142 BIOLOGICAL CONSERV. 14, 18 tbl.1 (2009) and Nina Hewitt et al., *Taking Stock of the Assisted Migration Debate*, 144 BIOLOGICAL CONSERV. 2560, 2570 (2011)).