MISSING THE LINK: THE IMPORTANCE OF KEEPING ECOSYSTEMS INTACT AND WHAT THE ENDANGERED SPECIES ACT SUGGESTS WE DO ABOUT IT

BY

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The Endangered Species Act was created in response to a rapid decline in species biodiversity. Although Congress chose direct protection of individual species as its tool, protecting ecosystems (a necessary component of biodiversity) was clearly one of the goals for which that tool was to be used. A species can be abundant in some areas and declining in others, such that protecting the entire species does not make sense. Congress dealt with this issue by amending the Endangered Species Act in 1978 to allow for protection of "distinct population segments," thereby allowing the population in decline to be protected in spite of the abundance of the species elsewhere. This, of course, raises the question as to why we should bother to do so. Why, if a species is thriving elsewhere, should we save its struggling members in a given population?

The Fish and Wildlife Service and National Marine Fisheries Service answered this question by requiring—in their policy statement for listing distinct population segments—that the population be significant. While this is a very reasonable limitation, the definition of significant is far too narrow, focusing entirely on the population's significance to its own taxon. The scientific literature on biodiversity, discussed at length in this Article, suggests that species populations vary in importance to their own ecosystems. Indeed, certain species populations in certain ecosystems can be extremely valuable to the protection of biodiversity, even if not valuable to the survival of that species. In light of clear Congressional intent to preserve biodiversity, including expressly listing the conservation of ecosystems as a purpose of the Act, it is important that we also consider the value of a distinct population segment to the ecosystem in which it lives.

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I. INTRODUCTION

The very first goal Congress expressed in the "Purposes" subsection of the Endangered Species Act[1] was "to provide a means whereby the ecosystems upon which threatened and endangered species depend may be conserved."[2] This clear statement, much like the recognition of species' "ecological" value,[3] demonstrates an understanding of the interdependence of species and their ecosystems, as well as a corresponding intent to protect both. Indeed, one cannot be saved without the other.

In spite of how clearly Congress expressed its intent to conserve ecosystems in the text of the Act, the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS), the agencies charged with administering the Act, claim that they have no authority to do so.[4] Granted, most of the Act is focused on direct species protection via the process of listing certain species for special protections.[5] However, in 1978, Congress amended the Act in a manner that had the potential to fill the void

[1] Endangered Species Act of 1973, 16 U.S.C. §§ 1531–1544 (2000).
[2] *Id.* § 1531(b).
[3] *Id.* § 1531(a)(3).
[4] *See infra* notes 101–108 and accompanying text.
[5] 16 U.S.C. § 1533(c) (2000).

in ecosystem protection by allowing one population of a given species to be separately listed while leaving the rest of that species (perhaps healthy in other regions) unprotected.[6] Species can be of varying value to their ecosystems, which should be treated as an important consideration in protecting individual populations.

The goal of this Article is to combine consideration of the purposes of the Endangered Species Act (ESA) with an understanding of the science of ecosystem functioning in order to promote better policy. Part II of this Article will provide some of the background information needed for a basic understanding of the regulatory framework at issue throughout the Article. Then, in Part III, I will provide a relatively in-depth discussion of the complexities of ecosystem science, in a manner accessible to non-scientists (like myself), in the hope that better understanding will lead to a greater willingness to change policy. Part IV will apply this science to determine how we might best work toward the goals of the ESA, making a case for better protection of ecosystems and suggesting how to go about it. The Article will then conclude with a plea for policy change in light of the previous discussions.

II. BACKGROUND

A. Listing Species Under the ESA

The ESA was enacted in 1973 as the first comprehensive U.S. effort to preserve biodiversity.[7] While there are other components to the statute, the one most relevant to this discussion is the process created for listing threatened or endangered species to recieve substantial protections via the various other provisions in the Act.[8] The power to list these species belongs to the Secretary of the Interior and the Secretary of Commerce, who have delegated that power to FWS and NMFS, respectively (collectively "the Services").[9] Getting on this list is an extremely important achievement because once a species is listed its preservation becomes more important than competing economic interests.[10]

A species is endangered if it "is in danger of extinction throughout all or a significant portion of its range,"[11] and it is threatened if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."[12] In determining whether a species

6 *Id.* § 1532(16).

7 *See* Tenn. Valley Auth. v. Hill, 437 U.S. 153, 180 (1978) (finding that the ESA was "the most comprehensive legislation for the preservation of endangered species ever enacted by any nation").

8 16 U.S.C. § 1533(c).

9 *Id.* § 1533(c)(1); 50 C.F.R. § 402.01(b) (2006).

10 *See* Tenn. Valley Auth. v. Hill, 437 U.S. at 174 (stating that it is "beyond doubt that Congress intended endangered species to be afforded the highest of priorities").

11 16 U.S.C. § 1532(6).

12 *Id.* § 1532(20).

fits into one of these two categories, the Services must consider five factors:

> (A) the present or threatened destruction, modification, or curtailment of its habitat or range;
> (B) overutilization for commercial, recreational, scientific, or educational purposes;
> (C) disease or predation;
> (D) the inadequacy of existing regulatory mechanisms; or
> (E) other natural or manmade factors affecting its continued existence.[13]

This, of course, leaves the very important threshold question of what constitutes a "species," which is no simple matter, even among scientists.[14]

B. Defining "Species" to Include "Distinct Population Segments"

The Act's original definition for the species it set out to protect included "any subspecies of fish or wildlife or plants and any other group of fish or wildlife of the same species or smaller taxa in common spatial arrangement that interbreed when mature."[15] Thus, it did not provide for individual populations to be listed separately from the remainder of their species. There are two obvious flaws with such an arrangement. First, once a species is listed it would generally be protected across the board, regardless of its varying population densities.[16] This would have the inefficient consequence of protecting members of the species that lived in areas well-populated by that species, in the event that it was in trouble in a significant portion of its range. The second flaw was that the focus on each species as a whole ignored the protection of ecosystems upon which many species (including humans) rely.

Fortunately, or so it might have seemed, it was not long before Congress amended the ESA in a manner which had the potential to resolve both of these problems.[17] The definition of species has since included "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature."[18] By allowing different populations of the same species to be treated differently for

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[13] *Id.* § 1533(a)(1).

[14] Anna L. George & Richard L. Mayden, *Species Concepts and the Endangered Species Act: How a Valid Biological Definition of Species Enhances the Legal Protection of Biodiversity*, 45 NAT. RESOURCES J. 369, 370 (2005) (noting that "there is no universally accepted definition for a biological species").

[15] *See* Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act, 61 Fed. Reg. 4,722, 4,722 (Feb. 7, 1996) [hereinafter DPS Policy].

[16] An exception to this in practice, which is notable in that it immediately preceded the 1978 amendments discussed *infra*, was the listing of the bald eagle as endangered in 43 states, threatened in five states, and not at all in Alaska, based on its varying conservation status in these different areas. Determination of Certain Bald Eagle Populations as Endangered or Threatened, 43 Fed. Reg. 6,230 (Feb. 14, 1978).

[17] Endangered Species Act Amendments of 1978, Pub. L. No. 95–632, 92 Stat. 3751 (1978) [hereinafter 1978 Amendments].

[18] *Id.* (emphasis added); *see also* DPS Policy, *supra* note 15 at 4,722.

conservation purposes, Congress provided the Services with an effective tool for ecosystem preservation, as some ecosystems may depend far more heavily on a given species than others.[19] Unfortunately, the Services take a far more conservative approach in implementing the 1978 Amendments' addition of the distinct population segment (DPS) concept.[20]

C. The DPS Policy

Although Congress amended the ESA to include DPSs in 1978, it was not until 1996 that the Services published a clear policy as to how they would determine whether a population qualified as a DPS.[21] The Policy contains three evaluative steps, each one serving as a prerequisite to consideration of the next.

First, the Services will consider the "[d]iscreteness of the population segment in relation to the remainder of the species to which it belongs."[22] Discreteness of a population may be based on its being either "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors;" or "delimited by international governmental boundaries" where there are significantly different regulatory protections.[23]

Next, and only if the Services have determined a population to be discrete, they will evaluate "[t]he significance of the population segment to the species to which it belongs."[24] Significance, by far the more controversial factor, is determined based upon the following four criteria:

1. Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon,
2. Evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon,
3. Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range, or
4. Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.[25]

It is only then, once a DPS has been found to be both discrete and significant, that the Services move on to the third step and consider the

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19 *See infra* notes 140–144 and accompanying text.

20 *See* George & Mayden, *supra* note 14, at 395 (noting that "[a]lthough this [species] definition could be used quite flexibly in decisions over protection of populations, it is normally used in a conservative fashion").

21 DPS Policy, *supra* note 15 at 4,725. That said, NMFS did partially address the issue in 1991 with a policy for determining "evolutionarily significant unit[s]" of salmon stocks. Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon, 56 Fed. Reg. 58,612, 58,618 (Nov. 20, 1991).

22 DPS Policy, *supra* note 15, at 4,725.

23 *Id.*

24 *Id.*

25 *Id.*

population's conservation status under the ESA, in the same manner as with species in general.[26] In other words, they will next consider the five factors listed at the beginning of this Part.

Although the wisdom of this Policy will be discussed at greater length in Part IV, it is worth pointing out, before getting into the scientific discussion, that this significance test is extremely narrow, in that it only allows for consideration of the population's value to its own species. This is in spite of the clearly stated purpose of protecting ecosystems,[27] the requirement to use "the best scientific and commercial data available,"[28] and the well-established principles of ecosystem function discussed below. The Services defend this narrow view of significance by citing to a comment made by a subsequent Senate committee that the DPS authority should be used "sparingly."[29] However, as one federal court has pointed out, this statement is "subsequent legislative history" that cannot "support[] the argument that a prior Congress intended the Services to use the DPS authority 'sparingly.'"[30] Nor should sparing use require the Services to ignore the most significant needs of ecosystems. As we shall see, the DPS-listing authority could still be used sparingly if based on ecosystem science.

III. SPECIES INTERACTIVITY AND ECOSYSTEM FUNCTIONING

A. While You Were Sleeping

My son, a toddler, has a board book called While You Were Sleeping, which takes him all over the world to see what various creatures were up to while he was snug in his bed.[31] It is truly amazing, for young and old alike, to think about how much activity there is around the world at any given moment. The following are just a few of the things that are happening while you are sleeping or going about your day.

Starfish are valiantly defeating the aggressive mussels that would otherwise dominate the rocky intertidal ecosystem.[32] A variety of other sea creatures, such as anemones, limpets, and barnacles, gratefully accept the space these starfish have made available by keeping the mussels in line, resulting in about twice as many healthy species overall.[33]

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26 *Id.*

27 16 U.S.C. § 1531(b) (2000).

28 *Id.* § 1533(b)(1)(A).

29 DPS Policy, *supra* note 15, at 4,725 (citing S. REP. NO. 96–151, at 7 (1979)).

30 Ctr. for Biological Diversity v. Lohn, 296 F. Supp. 2d 1223, 1235 (W.D. Wash. 2003); *see also* United States v. Price, 361 U.S. 304, 313 (1960) (noting that "the views of a subsequent Congress form a hazardous basis for inferring the intent of an earlier one").

31 JOHN BUTLER, WHILE YOU WERE SLEEPING (Peachtree Publishers 2001) (2000).

32 Yvonne Baskin, *The Work of Nature*, 106 NAT. HIST. 48, 48 (1997); *see also* Robert T. Paine, *Food Web Complexity and Species Diversity*, 100 AM. NATURALIST 65, 65–71 (1966) [hereinafter Paine, *Food Web Complexity*].

33 *See* Paine, *Food Web Complexity*, *supra* note 32, at 65 (hypothesizing that "[l]ocal species diversity [in the rocky intertidal zone] is directly related to the efficiency with which predators prevent the monopolization of the major environmental requisites by one species"); *see also*

Microbes, including several species of bacteria and cyanobacteria, are busily paving portions of Israel's Negev desert.[34] Motivated purely by their own self-preservation from the intense desert heat, these microbes secrete sugars into the sandy surface and turn it into a black crust.[35] Meanwhile, desert porcupines and beetles are also hard at work digging pits.[36] This unintended cooperation combines with rain, which ricochets off of the hardened sand and into these pits, creating pools that stay damp much longer than the ordinary sand.[37] Plant seeds are carried to these pits by wind and use this water to grow, creating lush oases that are home to numerous other species.[38]

Sea otters are making a meal of kelp-eating sea urchins, keeping their populations down and thereby maintaining the entire kelp forest ecosystem.[39] Sea urchins can't eat all the kelp, but their impact is likewise greater than their size as they eat away at the base of the seaweed until that entire "tree" of kelp drifts away.[40] Kept to reasonable numbers by sea otters, the urchins can be far less destructive members of their community, but left unchecked, the kelp forest, along with the numerous species that call it home, would disappear.[41]

When not sacrificing themselves to provide threatened spotted owls with about half of their diet, flying squirrels perform a vital function in supporting fungi that have a key symbiotic relationship with trees.[42] Ectomycorrhizal fungi form a coating on the roots of trees and live on sugars from the trees in exchange for increasing the tree roots' ability to take in nutrients and water from the soil.[43] The flying squirrels feed on truffles, underground fungi that bear ectomycorrhizal fungi spores.[44] These spores are able to survive their passage through the squirrels' digestive system, and are thus spread to the roots of other trees.[45] In addition to all this interaction, the flying squirrels also owe a debt of gratitude to woodpeckers, whose tree holes make up some of the squirrels' homes.[46]

Robert T. Paine, *The Pisaster-Tegula Interaction: Prey Patches, Predator Food Preference, and Intertidal Community Structure*, 50 ECOLOGY 950, 950–61 (1969) [hereinafter Paine, *Pisaster-Tegula*] (examining the interaction between a keystone species, the carnivorous starfish *Pisaster ochraceus*, and its secondary preferred prey, *Tegula fenebralis*).

34 Joseph Alper, *Ecosystem 'Engineers' Shape Habitats for Other Species*, 280 SCIENCE 1195, 1195 (1998).

35 *Id.*

36 *Id.*

37 *Id.*

38 *Id.*

39 *See* Britt Norlander, *Ocean Keepers: California's Sea Otters are Mysteriously Dying in Record Numbers. How Could Their Decline Affect Other Ocean Life?*, 61 SCIENCE WORLD 8, 10–11 (2005).

40 *Id.* at 11.

41 *Id.* at 10–11.

42 Pete Taylor, *Major Player—Long Overlooked by Forest Managers, the Flying Squirrel is Now Emerging as an Animal that is Critical to the Health of Certain Woodlands*, 38 NATIONAL WILDLIFE 46, 48–50 (2000).

43 *Id.*

44 *Id.*

45 *Id.*

46 *Id.*; *see also* Fred Bosselman, *A Dozen Biodiversity Puzzles*, 12 N.Y.U. ENVTL. L.J. 364,

Meanwhile, elephants are performing similar tasks, not only replenishing soil, digging water holes, and clearing paths through brush, but also, like the flying squirrels, spreading seeds via their own digestive systems.[47] What makes the elephants' job even more amazing is that scientists have discovered that entire plant species have evolved whose seeds must pass through an elephant in order to germinate at all.[48]

Prairie dogs are burrowing through soil, altering its chemistry, porosity, and organic content, thereby improving the habitat for other species.[49] They also create better conditions for grazers by increasing the density of grasses and forbs while reducing woody shrubs.[50] Their "activities also increase plant productivity, soil nitrogen, nutrient cycling, and digestibility of grasses and forbs."[51] And as if all that weren't enough of a contribution, prairie dogs are also an important part of many predators' diets.[52]

The list could go on forever. There is the gray wolf, whose restoration to Yellowstone amazingly breathed life back into all of the mammals that had been present before European colonization.[53] Then there is the grizzly bear contouring the ground with its claws and releasing scarce nitrogen from the soil while also spreading up to 70,000 seeds from berries a day.[54] And so on, but what should we learn from these relationships?

B. Waking Up: Scientists Are Analyzing These Data and Providing Good Food for Policy

Imagine a large office environment, where there are hundreds of employees doing jobs ranging from cleaning the bathrooms to running the company. In between there is a broad spectrum of staff serving the office environment in different ways. Now imagine that, due to budget cuts for staffing, it is necessary to lay off a certain number of employees. How do you choose? Clearly, all of them perform some function or they would not be there, but I expect that you would have some ideas as to how to differentiate between those who are indispensable and those who would be missed but whose functions would be absorbed quickly.

406–07 (2004) ("[T]he Red-cockaded woodpecker is the only species that excavates nest cavities in living trees in pine forests in the southern United States, and many other species of birds, mammals, reptiles, amphibians, and insects rely on these nest cavities.").

47 Jack McClintock, *Twenty Species We May Lose in the Next Twenty Years*, 21 DISCOVER 62, 66 (2000).

48 *Id.*

49 Michael E. Soule et al., *Strongly Interacting Species: Conservation Policy, Management, and Ethics*, 55 BIOSCIENCE 168 (2005).

50 *Id.*

51 *Id.* at 174.

52 *See id.*

53 *See* David S. Pennock & Walter W. Dimmick, *Critique of the Evolutionarily Significant Unit as a Definition for "Distinct Population Segments" under the U.S. Endangered Species Act*, 11 CONSERVATION BIOLOGY 611, 616 (1997).

54 Douglas H. Chadwick, *Grizzlies*, 200 NAT'L GEOGRAPHIC 2, 14 (2001) (detailing the crucial role grizzlies play in their ecosystem, calling them "the epitome of a keystone species").

Nature is like this as well, with each different ecosystem creating a different working environment for its staff and each member of that staff contributing in its own way. Like the office environment, some are more valuable than others. Scientists are getting better at understanding the complexities of ecosystem functioning and even predicting whom we cannot afford to lay off. If you were the CEO of this company, as FWS and NMFS are in the United States, wouldn't you want to use this information?

1. Keystone Species

It was barely three decades ago that examination of the roles species play in their ecosystems began to draw serious attention among scientists. Robert Paine studied the starfish that were having such an impact on mussel populations, and was fascinated by the effect their absence had on the overall biodiversity level of the intertidal ecosystem.[55] Since then there have been numerous studies in this area, resulting in rapidly growing knowledge. In the early years the focus was on what Paine had dubbed "keystone species," in reference to the wedge-shaped stone at the pinnacle of an arch that holds the two sides of it together.[56]

A keystone species is one that is indispensable to its ecosystem, serving a function not served by others, and without which the entire ecosystem machine could be drastically altered to the detriment of all other species that rely on it.[57] More than just a theory, keystone species have been found to exist in every major ecosystem.[58] The absence of a keystone species can result in cascading losses of other species as each one leads to the next down the line.[59] The substantial changes in ecosystem function are frequently unavoidable as the remaining species are often unable to play compensatory roles.[60] Indeed, some species can be so important that they "may be the only biotic entity available to perform a function."[61] While the concept of keystone species began with predators that help keep other

55 *See supra* notes 32–33 and accompanying text.

56 *See* Baskin, *supra* note 32, at 48 (explaining that "[l]ike the keystone in an arch—the wedge-shaped stone at the pinnacle that stabilizes the span—these organisms hold a community together").

57 *See id.* (stating that the power of keystone species is "disproportionate, and their removal creates ripple effects that can not only change the terms of life for all others in a community but also alter the nature and vitality of ecological processes"); *see also* Valery E. Forbes & Peter Calow, *Extrapolation in Ecological Risk Assessment: Balancing Pragmatism and Precaution in Chemical Controls Legislation*, 52 BIOSCIENCE 249, 255 (2002) ("Many nonkeystone species could be lost without any observable changes in important processes, but if a single keystone species were to be removed, dramatic changes in both the structure and functioning of the system could result.").

58 *See* Mary E. Power et al., *Challenges in the Quest for Keystones: Identifying Keystone Species is Difficult—But Essential to Understanding How Loss of Species Will Affect Ecosystems*, 46 BIOSCIENCE 609, 611 (1996).

59 *See* William Bond, *Keystone Species—Hunting the Snark?*, 292 SCIENCE 63, 63 (2001).

60 *See* S. K. Morgan Ernest & James H. Brown, *Delayed Compensation for Missing Keystone Species by Colonization*, 292 SCIENCE 101, 103 (2001).

61 R.V. O'NEILL ET AL., A HIERARCHICAL CONCEPT OF ECOSYSTEMS 206 (1986).

populations in control, scientists have since discovered numerous ways in which a species can be especially important to its ecosystem. Just a few of these are discussed below: top predators, ecosystem engineers, competitors, and facilitators.

a. Top Predators

The predators at the top of a food web can be extremely important to keeping everything balanced beneath them. Their contribution to an ecosystem is sometimes referred to as "top-down regulation" of the species community.[62] A typical result of the loss of large carnivores is the devastation of vegetation due to the overabundance of herbivores upon which these predators would normally dine.[63] In some human-populated areas where large carnivores have been extirpated, this problem is made less obvious by hunting and the shift from native herbivores to livestock.[64] There are many suburban and rural areas, however, where this is not the case and animals like skunks, racoons, opossums, and feral cats have gotten out of hand.[65] In addition to being a nuisance to humans, the overabundance of these mid-sized predators due to the absence of top predators is "a phenomenon known as mesopredator release," which "has been blamed for declines in or losses of gamebirds, songbirds, and other small vertebrates across a wide range of North American ecosystems, including grasslands, arid scrub, and eastern deciduous forest."[66] While the most commonly thought-of top predators are wolves, bears, tigers, lions, and the like, the sea otters and starfish discussed in two of the examples above are among the more popular examples in the scientific literature. While studies are still in progress as to the effect of losing top predators, this type of keystone species was the first recognized and is the most well-established.[67]

b. Ecosystem Engineers

Nearly two decades after top predators led to the concept of keystone species, knowledge of another very exciting brand of keystone species emerged: ecosystem engineers. These are species that, as their title suggests, mold the physical make-up of their ecosystem. There are two general categories of ecosystem engineers.[68] One is autogenic engineers, whose own physical make-up is itself an environment capable of sheltering other

[62] *See* Michael E. Soulé & John Terborgh, *Conserving Nature at Regional and Continental Scales—A Scientific Program for North America*, 49 BIOSCIENCE 809, 810 (1999).
[63] *Id.*
[64] *Id.*
[65] *Id.* at 811.
[66] *Id.* (citations omitted).
[67] *See, e.g.*, Paine, *Pisaster-Tegula*, *supra* note 33.
[68] *See* Alper, *supra* note 34, at 1195.

species.[69] Some excellent examples are coral, which is habitat to many sea creatures, and trees, which are habitat to birds, mammals, and insects alike.[70] The other type is allogenic engineers, which alter the environment without actually becoming a part of it.[71] The Negev microbes, elephants, and prairie dogs discussed above are just a few of the many examples of these. Ecosystem engineers are truly nature's workforce, laboring away to make things appear as we then take for granted.

Ecosystem engineers have impacts as far-reaching as the alteration of microclimates, and thus have great potential to contribute to the creation of refuges for other species under the threat of climate change.[72] Ecosystem engineers are often invaluable to key ecosystem processes, such as "hydrology, nutrient cycling and retention, erosion and sediment retention . . . while at the same time creating habitat for other species that also influence biogeochemical processes via nutrient uptake, conversion, and release."[73] Loss of a strong ecosystem engineer could be truly devastating.

Perhaps one of the best things about ecosystem engineers, from a policy-making standpoint, is that their value can be easier to predict than that of other types of keystone species.[74] By studying how these species modify their surroundings, "we are quite likely able to predict effects of ecosystem engineering on biogeochemical processes and species distributions."[75] And most relevant to the central thesis of this Article, regarding the use of this science in DPS listing decisions, by studying how these effects "vary in different environmental contexts, we can begin to predict how the effects of ecosystem engineering are likely to vary across environmental gradients."[76] In fact, beginning nearly a decade ago, scientists and mathematicians have been "trying to devise robust computer models that forecast how an engineer's activities could affect other species," commenting at the start that their work on this would take about a decade to complete.[77] Perhaps we will soon have more sophisticated methods of evaluating these species.

c. Competitors and Facilitators

While top predators and ecosystem engineers are currently the most popular of keystone species, there are many other ways for species to play important roles in their environment. Two of these that merit mention are

[69] *See id.*
[70] *See id.*
[71] *See id.*
[72] *See* Justin P. Wright & Clive G. Jones, *The Concept of Organisms as Ecosystem Engineers Ten Years On: Progress, Limitations, and Challenges*, 56 BIOSCIENCE 203, 208 (2006).
[73] *Id.*
[74] *Id.* at 205.
[75] *Id.* at 207 (citations omitted).
[76] *Id.*
[77] Alper, *supra* note 34, at 1196.

competition and facilitation. These characteristics are most often examined among species at the same trophic level, and the harshness or mildness of their environment can play an important role in determining which of these roles species play.[78] It also depends on your perspective, as demonstrated by reference to the mussels kept in check by starfish. Mussels are competitors with respect to the anemones and barnacles that vie for the same space on the rocks, but they are facilitators from the viewpoint of the hundreds of invertebrates that thrive in mussel beds but do poorly in areas populated by the mussels' competitors.[79] Facilitators are also sometimes known as "keystone mutualists,"[80] with some examples being the trees and fungi in the flying squirrel example above, as well as mobile pollinators.

2. Species Interactivity on a Continuum

Although the concept of keystone species is appealing, as well as entirely based in the reality of ecosystem function, it is also dangerously simple and all too often treated as an excessively tidy dichotomy.[81] While this simple view was initially the common approach to thinking about keystone species, by the mid-90s scientists began to view these functions and interactions in a far more complex manner, a trend which has only gained strength in the early twenty-first century. Studies culminating in the last decade have demonstrated the complexity of species' roles in ecosystem functioning.[82] The oversimplified "keystone" language is gradually being replaced by more spectrum-evoking terms, such as "strongly interacting species,"[83] or species of "community importance."[84]

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78 *See* Ben Shouse, *Conflict Over Cooperation: A Controversial Push to Focus on Positive Ecological Interactions Rather Than Competition and Predation Has Ignited a Debate Among Ecologists*, 299 SCIENCE 644, 644–45 (2003) (describing the debate among ecologists over whether to focus on negative competitive forces or positive facilitative forces as shaping natural communities).

79 *Id.* at 644.

80 L. Scott Mills et al., *The Keystone-Species Concept in Ecology and Conservation*, 43 BIOSCIENCE 219, 220 (1993).

81 *See, e.g.*, Derek O. Teaney, Comment, *The Insignificant Killer Whale: A Case Study of Inherent Flaws in the Wildlife Services' Distinct Population Segment Policy and a Proposed Solution*, 34 ENVTL. L. 647, 694–95 (2004) (arguing for a black-and-white distinction as to whether a species is a keystone species or not and that keystone species should be considered per se significant, thus, merit protection as a DPS). It is worth noting that the article's focus is on other matters.

82 *See generally* James H. Brown et al., *Complex Species Interactions and the Dynamics of Ecological Systems: Long-Term Experiments*, 293 SCIENCE 643 (2001) (in particular see discussion of cascading interactions and compensatory species dynamics at pp. 647–48).

83 *See generally* Soulé et al., *supra* note 49 (explaining that the concept behind keystone species is how strongly they interact with associated species in a variety of mechanisms).

84 *See generally* Power et al., *supra* note 58, at 609–10 (stating that "[t]o better reflect [the] current use, we define a keystone species as one whose impact on its community or ecosystem is large, and disproportionately large relative to its abundance" and explaining that the definition must look to the "strength of the effect of a species on a community or ecosystem trait").

Scientists have realized that "interactivity of species is a multidimensional continuum, not a simple dichotomy."[85]

Some scientists are dividing species into "functional groups" to determine how many fill a given function and to weigh functionality against pure biodiversity.[86] Scientists believe that diversity of functional groups is more important to a stable ecosystem than diversity of species,[87] and one study even showed that increased diversity of functional groups actually increased the productivity of the ecosystem.[88] Because focusing excessively on species themselves and neglecting their interactions poses a danger to ecosystem functional integrity, "some biologists suggest that any definition of biodiversity should emphasize protection of the many ecological processes that involve a multiplicity of species."[89]

Further evidence of the complexity of placing values on various species is the phenomenon of species coextinction, which involves species that are connected to one another without necessarily being keystones of the ecosystem as a whole, a concept which "is a manifestation of the interconnectedness of organisms in complex ecosystems."[90] In such complex ecosystems, "many species obligately depend on one another" in various and intricate ways.[91]

"Emphasizing strengths of interactions instead of a keystone/nonkeystone dualism is more than a semantic improvement; it recognizes the complexity, as well as the temporal and spatial variability, of interactions."[92] These concepts are on the cutting edge of conservation biology, with numerous additional studies underway to increase our understanding even further. This makes it the "best available science."[93] Therefore, it must be taken into account in regulating biodiversity under the ESA.

IV. THE DPS POLICY MUST BE CHANGED TO CONSIDER A POPULATION'S SIGNIFICANCE TO ITS ECOSYSTEM

As discussed in Part II, FWS and NMFS have a joint policy for determining whether to list a DPS for ESA protections, and one element of that determination is the evaluation of the significance of the population

85 Soulé et al., *supra* note 49, at 171.

86 *See* Bosselman, *supra* note 46, at 433–36.

87 *See* Brian H. Walker, *Biodiversity and Ecological Redundancy*, 6 CONSERVATION BIOLOGY 18, 22 (1992) (concluding that focusing on functional groups rather than species is more effective in ensuring long-term persistence of biota).

88 *See* David Tilman et al., *The Influence of Functional Diversity and Composition on Ecosystem Processes*, 277 SCIENCE 1300, 1301 (1997); ecosystem productivity is discussed further *infra*, Part IV.A.

89 Bosselman, *supra* note 46, at 435.

90 Lian Pin Koh et al., *Species Coextinctions and the Biodiversity Crisis*, 305 SCIENCE 1632, 1634 (2004).

91 *Id.* at 1632.

92 Mills et al., *supra* note 80, at 223.

93 *See* Soulé et al., *supra* note 49, at 175.

segment at issue.[94] All three district courts to address the validity of the significance prong have upheld it, but only as to whether to consider significance at all, and only based on deference to the agencies.[95] The Ninth Circuit has recently done the same.[96] In addition, it previously had occasion to strike down a DPS listing for not adhering to the narrow limitations in the significance prong,[97] but noted that it had not been asked to weigh in on the validity of the policy itself.[98] The fatal flaw in the policy is not the fact that a population must be significant in order to be listed, which is a reasonable way to avoid the problem of excessive reach, best illustrated by the absurd example of federally protecting a population of squirrels in a city park.[99]

The problem is that the significance test is not actually a test of significance. To the contrary, it merely asks the question of whether the loss of the given population would be harmful to that species overall.[100] This is one way in which a population might be significant, but there are many other ways as well, as made clear in Part III of this Article. It is actually a sort of syllogistic fallacy. To say that all populations that are important constituents of their species are significant (which, of course, they are) does not lead logically to the conclusion that all significant populations matter to the rest of their species. Some populations may be critically significant to their ecosystems, as well as to numerous other species. Granted, this is more of a policy choice than a logical calculation, but if the Services are going to defend this choice on the basis of using the DPS authority "sparingly," as opposed to citing to some statutory mandate to only concern themselves with the protection of the individual species they list (there is none), then the factor must truly be one of significance. Considering true significance will still allow for "sparing" use of the DPS-listing authority.

In responding to comments that they should consider the importance of a DPS to its environment, the Services made the following statement: "Despite its orientation toward conservation of ecosystems, the Services do not believe the Act provides authority to recognize a potential DPS as significant on the basis of the importance of its role in the ecosystem in which it occurs."[101] No supporting authority was provided for this position, nor does it make any sense. In making up the entire DPS policy from

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94 DPS Policy, *supra* note 15, at 4,725.

95 Nw. Ecosystem Alliance v. U.S. Fish & Wildlife Serv., No. CV 03-1505-PA, 2004 WL 1774559, at *3 (D. Or. Aug. 2, 2004), *aff'd*, 475 F.3d 1136 (9th Cir. 2007); Ctr. for Biological Diversity v. Lohn, 296 F. Supp. 2d 1223, 1235–36 (W.D. Wash. 2003); Maine v. Norton, 257 F. Supp. 2d 357, 388 (D. Me. 2003).

96 Nw. Ecosystem Alliance v. U.S. Fish & Wildlife Serv., 475 F.3d 1136, 1143–45 (9th Cir. 2007).

97 Nat'l Assoc. of Home Builders v. Norton, 340 F.3d 835, 852 (9th Cir. 2003).

98 *Id.* at 841.

99 *See* Teaney, *supra* note 81, at 693 (showing that without a significance test it is possible that some park squirrels could satisfy the other requirements required to be listed under the ESA despite the fact that park squirrels do not need protection and that such protection would clearly be outside the purview of the ESA).

100 *See* DPS Policy, *supra* note 15, at 4,725 (directing that the second prong requires consideration of the DPS' significance "to the species to which it belongs").

101 *Id.* at 4,723.

scratch, the Services point to the fact that "distinct population segment" is an ambiguous term, thus allowing them to interpret it in any reasonable fashion.[102] This position was recently upheld in *Northwest Ecosystem Alliance v. U.S. Fish and Wildlife Service*, in which the Ninth Circuit granted the DPS Policy *Chevron* deference,[103] noting that "Congress expressly delegated authority to the Service to develop criteria for evaluating petitions to list endangered species."[104] It is not uncommon in political circles, when faced with popular support for an action one does not wish to take, to plead lack of authority to do so. The Services simply do not have that option here, as they have argued (successfully in the Ninth Circuit) that they do in fact have this authority.

The Services acknowledge, however, that they are expected to use the best available science and follow "sound biological principles."[105] They further note that the "interpretation adopted should also be aimed at carrying out the purposes of the Act," then quote the language regarding "provid[ing] a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved . . . ."[106] This sets up inconsistent positions. After conceding that they must give effect to Congress' intent to conserve ecosystems and use the best science available in doing so,[107] the Services go on to say they have no authority to consider ecosystem survival in making decisions to list individual species populations. The fallacy of this position is even more apparent when considering the extent to which undisputedly protected species depend upon healthy ecosystems, as well as the fact that Congress expressly included "ecological" as one of the values of these species.[108] It is all very circular, but that is itself the point: species and their ecosystems are mutually dependent and thus share in each other's value.

A. Individual Ecosystem Survival: Why Should We Care?

Clear congressional intent is not the only reason to conserve ecosystems; naturally, that policy concern had its reasons. Healthy ecosystems are not only critical to supporting the numerous nonhuman

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102 *Id.* at 4,722 (noting that the term "population" can be used to mean any number of different things in different contexts and "distinct population segment" is not a term used in scientific discourse often enough to have a clear meaning).

103 Chevron v. Natural Res. Def. Council, 467 U.S. 837 (1984).

104 Nw. Ecosystem Alliance v. U.S. Fish and Wildlife Serv., 475 F.3d 1136, 1141 (9th Cir. 2007).

105 DPS Policy, *supra* note 15, at 4,722.

106 *Id.* (quoting 16 U.S.C. § 1531(b) (2000)).

107 *Cf.* Daniel J. Rohlf, *There's Something Fishy Going On Here: A Critique of the National Marine Fisheries Service's Definition of Species Under the Endangered Species Act*, 24 ENVTL. L. 617, 625 (1994) ("Given the challenges of integrating law and biology, an analysis of whether NMFS or FWS is properly discharging its duties under the ESA must evaluate whether the agency has accurately identified congressional policy, and whether the agency is carrying out that policy consistent with current biological knowledge.").

108 16 U.S.C. § 1531(a)(3) (2000).

species that occupy them, including endangered and threatened species the ESA undisputedly sets out to protect, but are also directly beneficial to human life. Indeed, many scientists consider intact ecosystems to be far more valuable than individual species.[109] We rely on the conditions generated by natural ecosystems for our very survival on this planet.[110] These benefits, generally referred to as "ecosystem services," include "purifying air and water, detoxifying and decomposing waste, renewing soil fertility, regulating climate, mitigating droughts and floods, controlling pests, and pollinating plants."[111] "Nonhuman organisms process the air we breathe, the water we drink, the ground we tread," and nearly a third "of all human food comes from plants pollinated by bees."[112] By having more plant-rich ecosystems, such as rainforests, we can reduce atmospheric carbon and thereby slow down the crisis of global warming.[113]

There is a growing consensus that poor protection of ecosystems (and consequently their services) is "the single greatest failing of modern environmental law and its greatest challenge today."[114] As with most environmental problems, ecosystem loss is a result of the tragedy of the commons, in that no one has to pay for their services and no one has to pay damages for contributing to their demise.[115] That said, there is one way in which the situation is actually even more perverse than a traditional tragedy of the commons situation. In the usual scenario, there is some limited good that people can just take for free. Those who get there first, and do not care about leaving others with nothing, take it all, resulting in the scarcity of that good for the rest of the public—say, for example, sheep in a meadow. In this scenario the problem is one of unfair distribution; some people have sheep and others have none, nor can they simply enjoy their presence in the meadow unscathed. When developers destroy ecosystems, however—while they are similarly having an unfair harmful impact on the environment—they will share equally with the rest of us the tragic loss of ecosystem services, potentially leading to the end of human life on earth. The actors in the traditional tragedy of the commons scenario are rational and selfish. Destroying our planet's life support system, even for short-term economic gain, is entirely irrational. Refusing to protect ecosystems from these irrational actors is even more so.

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109 *See* Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253, 259 (1997).

110 *See* SIMON A. LEVIN, FRAGILE DOMINION: COMPLEXITY AND THE COMMONS 6 (1999).

111 James Salzman et al., *Protecting Ecosystem Services: Science, Economics, and Law*, 20 STAN. ENVTL. L.J. 309, 310 (2001).

112 Jim Chen, *Webs of Life: Biodiversity Conservation as a Species of Information Policy*, 89 IOWA L. REV. 495, 547 (2004).

113 *Id.; see generally*, AL GORE, AN INCONVENIENT TRUTH: THE PLANETARY EMERGENCY OF GLOBAL WARMING AND WHAT WE CAN DO ABOUT IT (2006).

114 Salzman et al., *supra* note 111, at 310.

115 *See id.* at 312 (Ecosystem "services themselves have no market value for the simple reason that no markets exist in which they can be exchanged. As a result, there are no direct price mechanisms to signal the scarcity or degradation of these public goods until they fail. Partly as a result, ecosystems are degraded.").

B. What Needs To Be Changed and How

The ability to list populations of a species without listing the species as a whole creates a fantastic opportunity—and an obligation—to protect fragile ecosystems from the effects of losing struggling populations of an otherwise healthy species, particularly where ecosystems depend heavily on the presence of that species. In theory, and assuming adequate implementation,[116] the general listing of at-risk species already provided for in the ESA should be adequate to protect species from extinction. Indeed, even if a species is worse off in some geographical areas than others, if loss of the failing populations would be dire enough to place the entire species at risk it could still be listed due to the "significant portion of its range" language.[117] In other words, the significance of populations to their own species, at least to the extent that they are necessary to secure that species' future, has already been accounted for in the ESA. Indeed, determining whether the at-risk "portion of its range" is "significant" would likely take into account some of the same variables the Services are using in their DPS policy. In any event, this determination is clearly about significance to the species as a whole.[118]

This is why it is important, in order to give effect to the addition of distinct population segments, not to confine our implementation goal to protection of entire species. To do so simply makes no sense, as we are listing a population, not a species as a whole, when we list a DPS. In addition, and as discussed at length in Part III, the primary value of a population is often to its ecosystem, which in turn is valuable to other species, including humans. By judging the significance of a DPS solely in terms of its value to its own species, we render DPS protection virtually redundant. Although there have been some listings under the current DPS Policy,[119] it will be a rare situation when a DPS will be able to meet this criterion where the species itself does not otherwise qualify for listing.[120] This is not to say that we should not protect a DPS that is significant to its taxon, as there will be circumstances where this is better than listing the entire species, such as where differing management practices are warranted for different areas, but we must not ignore the often far more essential needs of its ecosystem.

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[116] If only it were so!

[117] *See* 16 U.S.C. §§ 1532(6), 1532(20) (2000).

[118] *See* Clarification of Significant Portion of the Range for the Contiguous United States Distinct Population Segment of the Canada Lynx, 72 Fed. Reg. 1186, 1186–89 (Jan. 10, 2007) (to be codified at 50 C.F.R. pt. 17) (analyzing the significance of portions of lynx range according to their value to the taxon).

[119] *See, e.g.*, Determination of Threatened Status for the Contiguous U.S. Distinct Population Segment of the Canada Lynx and Related Rule, 65 Fed. Reg. 16,052, 16,060–61 (Mar. 24, 2000) (to be codified at 50 C.F.R. pt. 17) (determining that the lynx population in the contiguous United States constitutes a DPS).

[120] *See, e.g.*, Nat'l Ass'n of Home Builders v. Norton, 340 F.3d 835, 844–52 (9th Cir. 2003) (striking down the listing of the Arizona DPS of pygmy owls because none of the many rationales supporting the listing could demonstrate the significance of the DPS to the pygmy owl taxon—as required under the DPS Policy—showing how difficult it is to support a listing in this manner).

In sum, the DPS Policy should be amended to include consideration of the significance a DPS has to its ecosystem. This should not be about black-and-white cutoffs, such as whether or not the population meets some preset (and inevitably arbitrary) definition for being a keystone species.[121] Rather, its level of importance should be weighed along with the other significance factors. For example, in an otherwise close call, any demonstrable value to the ecosystem would suffice to tip the scales. Conversely, where none of the other factors can be supported, a strongly interactive species should still be protected due to its greater value to the ecosystem. There are, of course, many different possible scenarios, but the key point here is that the process should not be ecosystem blind. While it is impossible to get around the fact that a DPS determination is inherently a policy decision,[122] that decision is supposed to be based on the best science available, and recognizing interspecies relationships and ecosystem functioning is the best science available.

As discussed in the next subsection, the science is well underway to aid in proper implementation of a meaningful DPS policy. The time has thus come to draft such a policy, realistically acknowledging the long-term impacts of the listing decisions to be made pursuant to it. The Services must take into account the significance of a population to its ecosystem, without rigid cutoffs, considering this value—like most values—on a continuum.

C. Why This is Practicable

In making excuses for the DPS Policy's complete lack of concern for ecosystem health, the Services complain that they cannot possibly consider a population's value to its ecosystem due to the fact that "it may be assumed that most, if not all, populations play roles of some significance in the environments to which they are native, so that this importance might not afford a meaningful way to differentiate among populations."[123] This statement evinces a lack of understanding of the relevant biological principles and is a departure from the more continuum-oriented approach taken with most of the other DPS factors.[124]

Indeed, nearly every factor to be balanced in making DPS determinations exists in various shades. "Persistence of the discrete population segment in an ecological setting unusual or unique for the

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121 *See* Mills et al., *supra* note 80, at 219 ("[P]olicy recommendations [that call for focusing protection on keystone species] imply that a clear operational definition exists for keystone species. In contrast, we argue that the term is broadly applied, poorly defined, and nonspecific in meaning.").

122 *See* Daniel J. Rohlf, *Section 4 of the Endangered Species Act: Top Ten Issues for the Next Thirty Years*, 34 ENVTL. L. 483, 512 (2004) (noting that "an agency cannot arrive at a decision about the significance of a population without adding to the mix policy reasons why that population might be important").

123 DPS Policy, *supra* note 15, at 4,723.

124 *See, e.g.*, *id.* at 4,725 (listing the elements that are considered in deciding the status of a possible DPS and the factors that are examined for each of the elements).

taxon"[125] would exist along a continuum of how similar or different the setting was. "Evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon"[126] would create a spectrum of the significance of the gaps. "Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics"[127] leaves room for various levels of genetic differentiation. The same nuanced differentiation can be made for the variable roles species play in their ecosystems, which is at least as important a consideration as the others listed.

Species can have large, small, or extremely limited effects.[128] Indeed, if the policy were changed as I have proposed, the risk of it being applied too liberally is slim because "most species in ecosystems—and most at-risk species—are less dominant and exert what influence they have on ecosystem functioning in relatively small numbers."[129] Rather than treating all species the same, we'd be recognizing that the "[c]onsequences of progressive biodiversity declines depend on the functional roles of individual species and the order in which species are lost."[130]

Several scientific papers, each of which is authored by multiple scientists recognized in their fields, provide practical guidance relevant to implementing a DPS policy such as I have proposed. The first endorses "defin[ing] the community importance of a given species as the percentage of other species lost from the community after its removal, [and then] plotting, for a hypothetical community, the relative community importance of each species."[131] This article goes on to criticize the fifty percent cutoff that some had been applying to define keystone species, advocating instead for the continuum view, and notes that community importance likely correlates to species interactivity.[132] Species interactivity, of course, is easier to study without removal experiments, and is thus a useful proxy for community importance.

The next practical advice comes from a truly impressive group of scientists whose names appear throughout the literature on these issues.[133]

125 *Id.*

126 *Id.*

127 *Id.*

128 *See* Wright & Jones, *supra* note 72, at 203–05.

129 Erika S. Zavaleta & Kristin B. Hulvey, *Realistic Species Losses Disproportionately Reduce Grassland Resistance to Biological Invaders*, 306 SCIENCE 1175, 1175 (2004).

130 *Id.*

131 Mills et al., *supra* note 80, at 221.

132 *See id.* at 221, 223 (discussing the "dichotomy between food-web theory and the keystone species concept" and concluding that dropping the keystone model will lead to a system that "more explicitly accounts for the complexity of interactions in natural systems").

133 *See* Power et al., *supra* note 58 at 609 (authored by Mary Power, professor of Integrative Biology at Berkeley; David Tilman, professor of Ecology, Evolution, and Behavior at University of Minnesota; James Estes, wildlife biologist at the National Biological Service's Institute of Marine Science at U.C. Santa Cruz; Bruce Menge, professor of Zoology at Oregon State University; William Bond, professor of Botany at the University of Cape Town, South Africa; Scott Mills, professor of Wildlife Biology in the School of Forestry at University of Montana; Gretchen Daily, Interdisciplinary Research Scientist in the Biological Science department at

They adopt the "community importance" language from the previous article, and argue that in order to apply it we "must define the strength of the effect of a species on a community or ecosystem trait . . . [by calculating] the change in a community or ecosystem trait per unit change in the abundance of the species."[134] In other words, rather than waiting for species loss as in the previous method, their formula factors in alterations in ecosystem function. This may be observable at an earlier stage, and thus more useful in practice. In addition, they also found a correlation between interaction strength and community importance,[135] once again allowing for additional means of data-collection.

Finally, in a recent article, several well-known scientists discussed "strongly interacting species," and offered a list of guidelines to use in assessing interactivity levels.[136] Noting that "[w]e now understand that the biodiversity of ecosystems will degrade unless the interactions of species are maintained in as many regions as feasible," they combine the two earlier approaches and suggest an approach that looks at a species' impact both on other species and on its ecosystem.[137] They found that to maintain ecosystem function, strongly interactive species must be maintained at a level higher than the threshold for danger of extinction,[138] which could raise concern that ESA protections cannot get an at-risk population back to its optimal level. Fortunately, however, "case studies suggest that strongly interactive species, if not harassed, will often achieve ecologically effective densities without human intervention."[139]

D. Context, and Why the DPS Policy is the Best One for Applying This Science

There are at least two compelling reasons to use this approach specifically in the DPS context, more so than applying it to the ESA as a whole. First and foremost, the importance of the role a species plays in its ecosystem is extremely context-dependent, such that a given species may be indispensable in one place and less important in another. Second, it is important not to lose sight of the trees for the forest by elevating ecosystem function over biodiversity to the point of letting "redundant" species go. Because the inclusion of DPSs in the definition of "species" is the most logical part of the ESA to apply to protecting individual ecosystems, and because Congress clearly intended to conserve ecosystems, there is an implied intent that it operate in this way.

Stanford; Juan Carlos Castilla, professor and head of Marine Biology at Pontificia Universidad Catolica de Chile; Jane Lubchenco, distinguished professor of Zoology at Oregon State University; and Robert Paine, professor of Zoology at the University of Washington, Seattle, and discoverer of keystone species).

134 *Id.*

135 *See id.* at 610.

136 *See* Soulé et al., *supra* note 49 at 170–71.

137 *Id.* at 174.

138 *See id.*

139 *Id.*

Whether and to what extent a species plays a keystone role depends heavily on context, or the conditions of the ecosystem.[140] Paine's starfish, for example, "is not a keystone in areas where sand routinely washes over the rocky shoreline, burying mussels and keeping their population in check."[141] Harsher conditions can cause more species to step forward and play unexpectedly strong roles in these ecosystems, relative to their contributions elsewhere.[142] "[A] species that may be highly valuable in one place and at one time may or may not be important in another place or at another time."[143] Further, some ecosystems do not appear to have any keystone species at all, such as those that are unusually rich in biodiversity.[144] So it is not just species that exist on a continuum of community importance, but also ecosystems have their own spectrum of need. Because a species will have more value in one location than another, and thus one population of that species is more significant than another, it makes sense to apply this science in the DPS listing context.

Finally, there is legitimate concern that "if functional processes become the primary focus of conservation, . . . species richness [would] be severely threatened."[145] Once we have irreparably harmed biodiversity and finally realized our dependence on ecosystems, one could imagine a human-engineered ecosystem with just the needed species to fill the key roles and maintain adequate functioning, but with only a tiny fraction of the species diversity we have now.[146] This would be a sad state of affairs, which is why we need to maintain our concern for species in their own right. Not only are these two concerns not mutually exclusive, they are mutually dependent. This is why we must keep the existing significance factors in play as well, and it is why it is best to focus this issue on the DPS context.

V. THE LAST WORD

The Services repeatedly acknowledge their duty to use the best science available in furthering the expressed goals of the ESA, one of which is the conservation of ecosystems. Unfortunately, however, in drafting a policy

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140 *See* Power et al., *supra* note 58, at 614 ("An increasing body of evidence suggests that keystone species are context dependent. That is, keystone species are not necessarily dominant controlling agents in all parts of their range or at all times, but instead play keystone roles only under certain conditions"); *see* Wright & Jones, *supra* note 72, at 206 ("From the beginning, scientists have recognized that the effects of ecosystem engineering will be context dependent.").

141 Baskin, *supra* note 32, at 49.

142 *See* Brown et al., *supra* note 82, at 644–47; *see also* Shouse, *supra* note 78, at 644–45.

143 Bond, *supra* note 59, at 64.

144 *See* Jason E. Tanner et al., *Species Coexistence, Keystone Species, and Succession: A Sensitivity Analysis*, 75 ECOLOGY 2204, 2217 (1994) (observing that "the characteristically high diversity of coral reefs" was one reason that some "coral assemblages [did] not have a keystone species").

145 Bosselman, *supra* note 46, at 435.

146 *See id* at 435–36. (citing several scientific sources for this concern).

requiring consideration of the significance of a discrete population segment, they failed to take into account the prevailing scientific understanding that a population's significance depends largely on its role in ecosystem functioning. The importance of this role is best determined by considering the species' degree of interactivity within the particular ecosystem inhabited by the population in question. Noting Victor Hugo's famous warning that "[s]cience says the first word on everything, but the last word on nothing,"[147] I am mindful that the DPS Policy is just that: policy. That said, it is policy that is meant to be decided based on science, which Congress indicated should have "the last word," to the extent that is possible. At a minimum, science is not to be ignored.

[147] JOHN H. GIBBONS, THIS GIFTED AGE: SCIENCE AND TECHNOLOGY AT THE MILLENNIUM xiii (1997).