
NATURAL RESOURCES JOURNAL

Volume 45
Issue 2 *Spring 2005*

Spring 2005

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ABSTRACT

There is no single accepted definition of a "species" in the natural sciences, nor does the Endangered Species Act (ESA) offer one. Instead, prolonged debate over species concepts has allowed various stakeholders to embrace and defend particular definitions based upon personal agendas that may be at odds with the objectives of the ESA. The best approach to arriving at a biologically accurate definition of a "species" is to use a hierarchy of species concepts to compare diversity across all taxonomic groups and not to limit recognition of species to groupings identifiable by humans using one particular technique. Adopting this hierarchy of concepts will provide theoretically sound and empirically testable data enabling the most accurate identification of species-level biodiversity.

INTRODUCTION

[K]nowledge and understanding often do not lie in definitions.[1]

The growing threat of extinction of biodiversity worldwide has prompted an interdisciplinary response emphasizing the need for greater and more effective conservation efforts. Because conservation of biological diversity requires logical collaboration, cooperation, and communication among policy makers, lawyers, educators, management officials, and biologists, differences between the jargon and the ultimate goals of the different disciplines represented by these occupations can serve as one of the biggest obstacles to achieving effective conservation

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1. JODY HEY, GENES, CATEGORIES, AND SPECIES: THE EVOLUTIONARY AND COGNITIVE CAUSES OF THE SPECIES PROBLEMS 32 (2001).

policies. Given these differences among disciplines, it is not surprising that there is confusion, frustration, and disappointment when issues central to these various fields overlap.

Laws may be written with complex, yet necessary, procedural requirements that have no obvious purpose or meaning to biologists. Many environmental cases brought to trial result in decisions based upon legal, not biological, interpretations of the statutes in question. Historically, the result has been limited effective progress in both understanding the need for conservation and the enforcement of conservation of biodiversity—particularly in the absence of a conscious effort by members of the various stakeholder disciplines to further their understanding of key concepts, needs, and issues central to other disciplines. Hence, while it is clear that an interdisciplinary response to the worldwide conservation and biodiversity crisis is needed, education and training must be implemented across disciplines for such an agenda to be successful.

Clearly, one of the major barriers to interdisciplinary conservation efforts is the unique and often complex terminology necessary for any disciplinary practice. Although such terminology may be commonly used within a profession, it may also be poorly understood or defined by those within or outside a particular field of study. In some instances, words that are known to be contentious within a discipline create so much controversy that many practitioners give up hope of understanding the meaning, avoid the dialogue, or end up employing a definition that is wrong or incomplete because of personal frustration or purely the attitude that research must progress in a discipline despite controversy over terminology. This phenomenon has happened to many of the most essential concepts in the physical and natural sciences, including definitions for various terms, such as planet, ecosystem, community, or wetlands.[2] As with these essential concepts, there is no universally accepted definition for a biological species. However, because the species is such a fundamental unit in most scientific research, those concerned with conservation within and outside of the biological sciences have mistakenly felt secure that the word was well understood, universally accepted, and not an area for debate.

Almost 30 years after the Endangered Species Act (ESA)[3] was written, agencies administering the Act are still unclear as to how to

2. *See* Richard L. Mayden, *On Biological Species, Species Concepts and Individuation in the Natural World*, 3 FISH & FISHERIES 171, 192 (2002).

3. Endangered Species Act of 1973, 16 U.S.C. §§ 1531-1544 (2000).

recognize the "species" they should be protecting.[4] Moreover, biologists have been unable to reach clear agreement on how to define the word "species." Although it is commonly held that species are the quintessential building blocks of natural history and the fundamental measurable unit of biodiversity, the means by which we can confidently quantify their existence and members are not agreed upon.[5] Discussions involving various conceptualizations of species[6] proliferate in systematic biology; however, there is little consensus regarding what is an appropriate way to universally delineate and quantify species diversity.[7]

Because new species are continually being discovered, even in the United States, it is important that their legal definition reflect the biological reality of these entities as they exist in nature and that the parties interested in an interdisciplinary movement to protect and conserve biodiversity are made fully aware of the critical issues involved. With continued disagreement, confusion, and apathy about species concepts or definition in the biological sciences, it is difficult to articulate a clear policy, grounded in biology, that can be used in the ESA to protect real biodiversity.[8]

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4. *See* 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, 618 (1994).

5. *See* Richard L. Madyen, *Consilience and a Hierarchy of Species Concepts: Advances Toward Closure on the Species Puzzle*, 31 J. NEMATOLOGY 95, 95 (1999).

6. The phrase "species concept" is used to avoid the limitations that are inherent within a set definition. As defined in Merriam-Webster's Collegiate Dictionary (1998), a concept is "1 : something conceived in the mind : THOUGHT, NOTION 2 : an abstract or generic idea generalized from particular instances." When a new species is discovered, the published document that formally recognizes and names this new species is referred to as a "species description." Species can only be described, not defined, as a definition would set limits on something that is constantly changing. Species are identified in nature by various methods employed by scientists that are closely tied to the concept used. In this article, the term "species concepts" will be used during the discussions of biological conceptualizations of species, while "species definition" will be used during discussions of the legal definition of species.

7. *See, e.g.*, SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE (Quentin D. Wheeler & Rudolf Meier eds., 2000) (prominent scientists were invited to present a series of papers documenting their position on favored species concepts); *see also* Edward O. Wiley, *The Evolutionary Species Concept Reconsidered*, 27 SYSTEMATIC ZOOLOGY 17, 18 (1978); Richard L. Mayden & Robert M. Wood, *Systematics, Species Concepts, and the Evolutionary Significant Unit in Biodiversity and Conservation Biology*, 17 AM. FISHERIES SOC'Y SYMP. 58, 84 (1995). These examples are only a small selection of the wide-ranging literature available on these concepts.

8. *See* Ray Vaughan, *State of Extinction: The Case of the Alabama Sturgeon and Ways Opponents of the Endangered Species Act Thwart Protection for Rare Species*, 46 ALA. L. REV. 569, 586 (1995).

The purpose of this article is to demonstrate how adopting a theoretically sound and empirically testable definition of a species will enhance the effectiveness of the ESA and facilitate the international, interdisciplinary conservation effort. Section I provides an overview of the ESA, with a brief summary of major related court decisions. Section II discusses how a faulty application of species concepts or definitions will lead to bad decisions, both biologically and legally. Section III explains how an appropriate species concept hierarchy can be used to identify and protect units of biodiversity, allowing for a closer union of science and law for conservation purposes.

I. OVERVIEW OF THE ACT

The Endangered Species Act, often hailed as our landmark environmental law, was written to protect biodiversity with little regard for its impact upon humans. It is one of the first environmental laws without a cost-benefit analysis, thus requiring the government to place a high status on protection of biodiversity. The purpose of the ESA is to identify imperiled species, delineate methods of providing them protection,[9] prevent future harm to the species,[10] and penalize harm that occurs.[11] Section 2 is the substantive part of the statute, declaring the purpose and policy of the ESA. Specifically, it requires that species be protected because of their "esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people."[12] Definitions for terms used within the ESA are contained in Section 3,[13] which will be discussed later.

Section 4 creates the means by which imperiled taxa are listed as threatened or endangered. No species is given any protection under the ESA until officially listed by the government, no matter how near extinction it may be.[14] Thus, Section 4 describes what dangers may cause a species to become endangered, as well as the procedure for federal listing of a species. Listing decisions are made "solely on the basis of the best scientific and commercial data available" to the Secretary of the Interior.[15] The goal behind the listing is not merely to prevent extinction; federal agencies must provide sufficient resources so the species is able to recover and ultimately be removed from the list.

9. 16 U.S.C. § 1533.
10. *Id.* § 1536.
11. *Id.* §§ 1538, 1540.
12. *Id.* § 1531(a)(3).
13. *Id.* § 1532.
14. *Id.* § 1533(a)(3).
15. *Id.* § 1533(b)(1)(A).

Once the species is federally listed, different resources are to be made available to aid the goal of conservation. The Secretary of the Interior must publish a list of all endangered and threatened species and must review this list at least every five years.[16] Furthermore, the Secretary must also oversee the designation of "critical habitat"[17] and implement "recovery plans"[18] to aid in the survival of the species. Thus, the requirements of Section 4 are assigned to the Secretary of the Interior, as aided by the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS), and include identifying, listing, monitoring, and protecting imperiled species through the use of regulations and recovery plans.

One of the major impacts of the ESA comes from the requirements placed upon federal agencies to compel their cooperation in environmental matters. All federal agencies are directed to ensure that their actions do not jeopardize the listed species or their critical habitat.[19] Thus, if a federal action occurs in an area likely to contain endangered species, biological assessments must be made before these actions are carried out.[20] Although the law is targeted at federal actions, a private party or other governmental body may also be subject to this law if operating under a federal lease or other federal involvement.[21] Section 7 also creates the Endangered Species Committee, which is able to grant an exemption for the other requirements of Section 7 should the Committee deem it necessary.[22]

The final operative part of the ESA is contained in Section 9, which lists prohibited activities involving endangered species, all of which are considered "takings." Under the ESA, it is illegal to import, export, possess, move, sell or hold listed species.[23] Section 9 applies not

16. *Id.* § 1533(c).

17. Defined in § 1532(5)(A) to include the specific areas both within and outside the geographic range of the species, so long as it is "essential to the conservation of the species." The purchase of this land is covered by funds designated in § 1534(a); this critical habitat purchase has been the basis for the creation of many of the lands in the National Wildlife Refuge system.

18. *Id.* § 1533(f). Recovery plans contain descriptions of management actions, measurable criteria to determine when species may be removed from the list, and estimates of the time required and costs involved in reaching these goals.

19. *Id.* § 1536(a)(2).

20. *Id.* § 1536(c).

21. *See* Conservation Law Found. of New England, Inc. v. Andrus, 623 F.2d 712, 715 (Mass. App. Ct. 1979) (holding that ESA applies to applicants for leases for offshore drilling as well as the government).

22. 16 U.S.C. § 1538(e) (colloquially known as the "God Squad" due to the Committee's power to determine the fate of a species).

23. *Id.* § 1538(a)(1).

only to the federal government, but to all persons, agencies, and organizations, whether or not they are aware the species is listed. Despite these explicit and strong protective measures for species, exceptions are allowed. For example, Section 10 allows for "incidental take" permits to be issued following delineated procedures.[24]

The definitions outlined in Section 3 probably have created the most controversy with respect to the ESA, largely resulting from different interpretations of both the definitions found within the legislation and specific words used within those definitions.[25] For instance, "take" is defined with the string of verbs, "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[26] Most of these verbs offer a very clear picture of an intentional act of damage to an individual member of a species, but the words "harass" and "harm" are not as clear in identifying whether the target is to a single organism, a population, or the species as a whole. Thus, the FWS has provided further clarification as to what constitutes harming and harassing species. "Harass" is defined as "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."[27] The Code of Federal Regulations goes on to define "harm" as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering."[28] Both of these definitions emphasize that the "taking" of an endangered species can occur across populations, not merely to an individual organism. Precedent cases involving these definitions and their ramifications are discussed briefly below.

The other contested definition given under Section 3 is that of a species: "The term 'species' includes 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."[29] This definition does not define a species at all; it merely provides for protection of groups below the species level. This omission could be read as a deferment to

24. *Id.* § 1539(a)(2) (one such procedure may be the adoption of an approved Habitat Conservation Plan to mitigate the harm to the species and its critical habitat).
25. *Id.* § 1532.
26. *Id.* § 1532(19).
27. Endangered and Threatened Wildlife and Plants, 50 C.F.R. § 17.3 (2002).
28. *Id.*
29. 16 U.S.C. § 1532(16).

allow for a scientific, not legal, judgment of species status. Instead, this language actually creates a loophole in which the protection offered by the ESA is vulnerable because section 3 offers no guidelines to aid in identifying species. Unfortunately, species identification is an area of biology that is still quite contentious; there is no single accepted method for recognizing species.[30] As discussed below, the definition of species is an important issue, equal in importance to the conflict generated over the aforementioned terms "take" or "harm."

The first major case to draw attention to the problem of species definition was *Palila v. Hawaii Department of Land & Natural Resources*.[31] Palila,[32] an endemic finch from Hawaii, were undergoing a decline attributed to the loss of mamane and naio trees, critical habitat necessary for the bird's feeding and breeding.[33] The decline of the mamane ecosystem occurred on state lands maintained by the Hawaiian Department of Land and Natural Resources (DLNR) for hunting feral sheep and goats.[34] However, the presence of the ungulates caused overgrazing of the shoots and sprouts of mamane, ultimately resulting in a decline in the regeneration of mamane trees. While there was no concurrent competition between the palila and the ungulates for food,[35] the ungulates were causing habitat degradation of the forest, thus harming the palila by preventing their recovery.[36]

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30. *See, e.g.*, John J. Wiens & Maria R. Servedio, *Species Delimitation in Systematics: Inferring Diagnostic Differences Between Species*, 267 PROC. ROYAL SOC'Y LONDON SERIES B 631, 632 (2000); Jack W. Sites, Jr. & Jonathon C. Marshall, *Delimiting Species: A Renaissance Issue in Systematic Biology*, 18 TRENDS ECOLOGY & EVOLUTION 462, 462 (2003).

31. 471 F. Supp. 985 (D. Haw. 1979), *aff'd*, 639 F.2d 495 (9th Cir. 1981).

32. U.S. FISH &WILDLIFE SERV., PALILA RECOVERY PLAN 6 (1986).

33. As defined in 16 U.S.C. § 1532(5)(A)(i), "critical habitat" includes those geographic areas in the species' range "on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management consideration or protection." The critical habitat may not be established throughout the entire species range except in circumstances determined by the Secretary of the Interior. Thus, critical habitat is used to designate areas vital to the species' behavioral patterns, such as breeding or feeding.

34. *Palila*, 471 F. Supp. at 990.

35. The palila primarily fed upon the seeds and pods, so there was no direct competition for food in the mamane, but, eventually, heavy grazing by goats upon the forest would inhibit regrowth of the mamane to an extent that there were no seeds and pods produced for palila consumption. U.S. FISH & WILDLIFE SERV., *supra* note 32, at 10 (listing food sources for the palila); *Palila*, 471 F. Supp. at 990 (listing mamane as a food source for goats).

36. At the time *Palila* was first brought to court, "harm," as used in the ESA's definition of "take," was defined as

> an act or omission which actually injures or kills wildlife, including acts which annoy it to such an extent as to significantly disrupt essential behavioral patterns, which include, but are not limited to, breeding,

The district court found that the palila were dependent upon the mamane forests.[37] Moreover, the presence of the feral sheep and goats were the main cause of the destruction of these forests, and the efforts of the Hawaiian DLNR were inadequate to ensure the continued health of the ecosystem.[38] Thus, the court concluded that the effects of the exotic species on the palila were harmful enough to constitute an "unlawful 'taking' of the palila" under the regulations promulgated by the Secretary of the Interior.[39]

Just over a year later, the defendants filed an appeal challenging the summary judgment of the district court and its finding of a "taking."[40] In response, the Ninth Circuit Court declared that only two material facts could result in a reversal of the lower court's summary judgment in favor of the plaintiffs: (1) whether the palila were endangered, and (2) whether the actions of the Hawaiian DLNR constituted a taking.[41] Because the defendants did not offer sufficient evidence of a factual dispute, there was no preclusion of summary judgment. Moreover, the Circuit Court also affirmed the district court's interpretation of the term "taking" as being that a species may be harmed simply through habitat modification.[42] Thus, on the first appeal, the palila were protected from habitat destruction on state land.

Five years later, circumstances in Hawaii had changed enough to resurrect the case in *Palila III*.[43] The facts and debates were virtually the same, but the FWS had changed the definition of "harm," in the meantime, to avoid a reading that would "include habitat modification or degradation alone without further proof of death or injury."[44] Now proof of habitat modification was not enough to protect a species; actual injury to the species also had to be demonstrated.[45] Moreover, the feral sheep and goats had been removed from the land in accordance with the earlier rulings, but were replaced with domestic sheep, which the DNR

> feeding, or sheltering; significant environmental modification or degradation which has such effects is included within the meaning of "harm"....

40 Fed. Reg. 44,412, 44,416 (Sept. 26, 1975).

37. *Palila*, 471 F. Supp. at 989.

38. *Id.* at 990-91.

39. *Id.* at 995.

40. *Palila*, 639 F.2d 495, 495 (9th Cir. 1981).

41. *Id.* at 497.

42. *Id.* at 497-98.

43. *Palila*, 471 F. Supp. at 989; Palila v. Haw. Dep't of Land & Natural Res., 649 F. Supp. 1070, 1073 (D. Haw. 1986), *aff'd*, 852 F.2d 1106 (9th Cir. 1988).

44. Endangered and Threatened Wildlife and Plants, Final Redefinition of "Harm," 46 Fed. Reg. 54,748 (Nov. 4, 1981).

45. *Id.*

hoped would cause fewer problems.[46] Scientific studies showed a slight increase in the numbers of the palila, but no definite upward trend in population numbers.[47] Despite the new definition, the district court still held that "a finding of 'harm' did not require death to individual members of the species; nor did it require a finding that habitat degradation was driving the species further toward extinction."[48] Judge King stated that the revised definition of harm used by the Secretary of the Interior "stresses the critical link between habitat modification and injury to the species."[49] Thus, the court's ruling was resoundingly similar to its earlier holding. A habitat modification could harm a species by a direct negative impact on that species or simply an activity that prevented the recovery of the species, even if the activity was carried out by a non-human species.[50]

The decision again was appealed to the Ninth Circuit Court, which affirmed the lower court's ruling.[51] However, this time the court showed more hesitation when considering the magnitude and duration of habitat degradation that could be considered "harm." Although the court did not contest that the presence of the sheep was harming the palila, affirming the district court's ruling, it did not address the question of the extent of habitat destruction.[52] Thus, *Palila II* left unclear how the court would deal with actions that prevent the recovery of the species but do not drive it to extinction. Despite the lack of resolution to the debate over habitat destruction, the court did set an important precedent by maintaining that habitat degradation was a causal factor for harming a species.[53]

A new controversy about the definition of "harm" to a species soon developed in a different setting. In 1992, small landowners and logging and timber companies brought litigation against the Department of the Interior for the vague definition of the word "harm."[54] Their goal of logging and development was thwarted by the presence of the endangered red-cockaded woodpecker and the threatened northern

46. *Palila*, 471 F. Supp. at 989; Palila v. Haw. Dep't of Land & Natural Res., 649 F. Supp. 1070, 1073 (D. Haw. 1986), *aff'd*, 852 F.2d 1106 (9th Cir. 1988).

47. U.S. FISH & WILDLIFE SERV., *supra* note 32, at 6.

48. *Palila*, 649 F. Supp. at 1075.

49. *Id.* at 1077.

50. *Id.*

51. *Palila*, 852 F.2d at 1111.

52. *Id.* at 1110-11.

53. *Id.* at 1108.

54. Sweet Home Chapter of Cmtys. for a Great Or. v. Lujan, 806 F. Supp. 279, 282 (D.D.C. 1992), *aff'd sub nom.* Sweet Home Chapter of Cmtys. for a Great Or. v. Babbitt, 1 F.3d 1 (D.C. Cir. 1993), *rev'd*, 17 F.3d 1463 (D.C. Cir. 1994), *rev'd sub nom.* Babbitt v. Sweet Home Chapter of Cmtys. for a Great Or., 515 U.S. 687 (1995).

spotted owl.[55] The plaintiffs tried a novel method of attacking the FWS interpretation of "harm" by claiming it was too broad, and, thus, it must be considered void for its vagueness.[56] Moreover, the plaintiffs argued that no critical habitat protection was necessary for the northern spotted owl because it was only threatened, not fully endangered.[57]

The district court was able to resolve the issue by examining the reauthorization of the ESA in 1982.[58] The court noted that Congress was aware of the *Palila I* and *Palila II* decisions and did not try to reverse the decision through legislation.[59] Therefore, Congress had, by its inaction, effectively affirmed the court's earlier decision, thus upholding the Ninth Circuit's interpretation of "harm."[60] Further, nothing in the definition was too vague for appropriate enforcement. The district court also ruled that the FWS afforded the same protection to threatened species because, under Section 4(d), "the Secretary may by regulation prohibit with respect to any threatened species any act prohibited under section 1538(a)(1)."[61]

Following this ruling, there was an immediate appeal to the D.C. Circuit Court.[62] The D.C. Circuit affirmed the ruling of the district court, holding that nothing in the language of the ESA was too broad for interpretation.[63] Judge Mikva added, "It is hard to imagine what 'incidental takings' might be other than habitat modification. Indeed, the legislative history of the 1982 amendments reveals that habitat modification was precisely what Congress had in mind."[64]

The plaintiffs then submitted a second appeal to the D.C. Circuit Court, contesting the definition of "harm" as promulgated by the FWS.[65] Upon rehearing, one judge changed his mind, shifting the balance of the court.[66] The D.C. Circuit's opinion was therefore modified, holding the earlier definition of "harm" to be invalid.[67] In reaching its decision, the court cited the U.S. Supreme Court opinion in *Lucas v. South Carolina Coastal Council*,[68] written by Justice Scalia, in which the Court considered

55. *Id.*
56. *Id.*
57. *Id.*
58. *Id.* at 284.
59. *Id.*
60. *Id.*
61. *Id.* at 286.
62. *Sweet Home*, 1 F.3d at 1.
63. *Id.* at 5.
64. *Id.* at 11.
65. *Sweet Home Chapter of Comtys. for a Great Or.*, 17 F.3d at 1464.
66. *Id.*
67. *Id.* at 1472.
68. *Id.* at 1464 (citing to *Lucas*, 505 U.S. 1003 (1992)).

the issue of how best to discern the line between regulations preventing harm and regulations withdrawing a benefit.[69]

In *Sweet Home III*, the D.C. Circuit Court held that a farmer harvesting crops or trees upon which a species depends was withdrawing a benefit—a "harm" it identified as comparable to the United States refraining from providing humanitarian aid to the people of Somalia.[70] The court concluded that simply refraining from providing a benefit to an endangered species was not "harm." Rather, "harm" had to involve direct application of force.[71]

The government petitioned immediately for a rehearing, but this petition was denied on August 12, 1994.[72] Meanwhile, the Ninth Circuit Court heard *National Wildlife Federation v. Burlington Northern Railroad.*[73] In its *Burlington* holding, although the court did not find that the actions of Burlington Railroad created a significant impairment of the ability of grizzly bears to recover, it essentially restated its *Palila* decision, omitting mention of *Sweet Home.*[74] During this period, a district court within the Ninth Circuit declined to use the *Sweet Home* precedent to overrule the Ninth Circuit Court decision. The district court declared it would follow the laws of the Ninth Circuit until the Supreme Court or the Ninth Circuit itself reversed that decision.[75]

In early 1995, the Supreme Court agreed to hear *Babbitt v. Sweet Home Chapter of Communities for a Great Oregon (Sweet Home V)* because the split between the circuit courts had to be resolved. Beyond the discrepancy of opinion within the Ninth and D.C. Circuits, several other districts were also drawing different interpretations of "harm" and "taking."[76] In a 6-to-3 majority, the Supreme Court held that the Secretary was using a reasonable interpretation of "harm" by allowing habitat modification to be within the definition of "take."[77] Justice Stevens, who wrote the opinion, used an ordinary usage definition of harm, found in Webster's dictionary, to affirm that the agency's definition of "harm" used in the regulation was reasonable.[78] Justice

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69. *Id.*

70. *Id.* at 1464–65.

71. *Id.* at 1465.

72. Sweet Home Chapter of Cmtys. for a Great Or. v. Babbitt, 30 F.3d 190, 191 (D.C. Cir. 1994).

73. Nat'l Wildlife Fed'n v. Burlington N. R.R., 23 F.3d 1508, 1513 (9th Cir. 1994).

74. *Id.* at 1512–13.

75. Seattle Audubon Soc'y v. Lyons, 871 F. Supp. 1291, 1313 (W.D. Wash. 1994).

76. *See* Sierra Club v. Lyng, 694 F. Supp. 1260 (E.D. Tex. 1988); Swan View Coalition, Inc. v. Turner, 824 F. Supp. 923 (D. Mont. 1992).

77. Babbitt v. Sweet Home Chapter of Cmtys. for a Great Or., 515 U.S. 687 (1995).

78. *Id.* at 697.

Scalia, Chief Justice Rehnquist, and Justice Thomas dissented, arguing that the Act was not designed to protect populations, only individual animals of the endangered species.[79] Moreover, Justice Scalia felt that this reading imperiled an individual's use of property free from government intervention.[80] Despite this note of dissension, the definition of "harm" promulgated by the Secretary of the Interior was finally upheld by the Supreme Court, again strengthening the ESA's regulatory reach.[81]

Because the definition of "harm" has been upheld so strongly, opponents of the ESA have attempted to circumvent the act by attacking the definition of the word "species" through questioning the scientific method by which new species are discovered and described, and, thus, questioning the legitimacy of species identified for listing.[82] In one example, the taxonomic status of the Alabama sturgeon became a controversial subject during a listing process that lasted for seven years.[83] Biologists had long been aware that this sturgeon was a distinct species, and the American Fisheries Society had even considered it endangered in 1989, before its official recognition as a distinct species.[84] The fish was described [85] as a new species by Williams and Clemmer in 1991.[86] Two years later, the FWS published notice in the Federal Register of the proposed listing.[87]

In 1993, with the notice of the government's intention to list, members of industry opposed to the listing began hiring their own scientific panel to counter the findings of the FWS. The Alabama-Tombigbee Rivers Coalition, a group of industries and state-agencies making use of the rivers inhabited by the sturgeon, opposed the listing of

79. *Id.* at 717-18 (Scalia, J., dissenting).

80. *See id.* at 721 (Scalia, J. dissenting).

81. *Id.* at 687.

82. Vaughan, *supra* note 8, at 605-06.

83. Endangered and Threatened Wildlife and Plants; Final Rule to List the Alabama Sturgeon as Endangered, 65 Fed. Reg. 26,438, 26,443 (May 5, 2000) (list of endangered and threatened wildlife codified at 50 C.F.R. § 17.11 (2004)).

84. Jack E. Williams et al., *Fishes of North America Endangered, Threatened, or of Special Concern: 1989*, FISHERIES, Nov.-Dec. 1989, at 2, 3.

85. "Described" is the scientific term for a formal recognition and naming of a new species in order to "present a general picture of the described taxon." ERNST MAYR, PRINCIPLES OF SYSTEMATIC ZOOLOGY 265 (1969).

86. James E. Williams & Glenn H. Clemmer, Scaphirhynchus Suttkusi, *a New Sturgeon (*Pisces: Acipenseridae*) from the Mobile Basin of Alabama and Mississippi*, ALA. MUSEUM NAT. HIST. BULL., June 1, 1991, at 17, 20.

87. Proposed Endangered Status and Designation of Critical Habitat for the Alabama Sturgeon, 58 Fed. Reg. 33,148 (June 15, 1993).

the Alabama sturgeon.[88] Fearing that the listing of the sturgeon would lead to the protection of riverine habitat and the cessation of dredging to permit barge traffic, the Coalition prognosticated economic ruin for the state if the sturgeon was listed.[89] Looking for ways to prevent the listing, the Coalition began to question the validity of scientific findings related to the sturgeon.[90] Dr. Mike Howell, an ichthyologist from Samford University in Birmingham, Alabama, argued on behalf of the Coalition that the FWS proposal was based upon faulty science.[91] Furthermore, he argued, the listing process was futile because the sturgeon had not been seen since 1985 and therefore must be extinct.[92]

In 1993, the FWS convened a panel of expert ichthyologists to verify the validity of recognizing the sturgeon as a distinct species.[93] None of the nine members of this panel was chosen from a pool suggested by the Alabama congressional delegation, and the orders to the panel changed immediately prior to its convening. Panel members were asked to write a single report rather than submit individual reports.[94] Although the panel concluded that the scientific evidence for species status was legitimate, as announced through an FWS press release,[95] the Coalition filed suit under the Federal Advisory Committee

88. Alabama-Tombigbee Rivers Coalition v. Dep't of Interior, 26 F.3d 1103, 1105 (11th Cir. 1994). See also Joe Nabbefeld, *Controversial Report Backs Argument for Sturgeon*, BIRMINGHAM NEWS, Nov. 23, 1993.

89. Vaughan, *supra* note 8, at 608-09. Although the listing process itself does not require any economic consideration, the designation of critical habitat is made "on the basis of the best scientific data available and after taking into consideration the economic impact...of specifying any particular area as critical habitat." 16 U.S.C. § 1533(b)(2) (2000). Although this allows for some economic considerations, the Secretary must list areas that have economic importance if "the failure to designate such area as critical habitat will result in the extinction of the species concerned." *Id.*

90. David Pace, *Scientists Conclude Sturgeon Not Genetically Unique*, TUSCALOOSA NEWS, Apr. 13, 1994, at 7B (implying that because this study was released only in a draft report through the FWS, it was not subjected to the unbiased peer review process required for publication in scientific journals).

91. Vaughan, *supra* note 8, at 606.

92. *Id.* For any animal, a lack of sighting for some years is not a clear sign of extinction. For a list of fish species that were presumed extinct and were then later rediscovered after periods longer than eight years, see Richard L. Mayden & Bernard R. Kuhajda, *Systematics, Taxonomy, and Conservation Status of the Endangered Alabama Sturgeon,* Scaphirhynchus Suttkusi *Williams and Clemmer* (Actinopterygii, Acipenseridae), 1996 COPEIA 241, 267.

93. Reopening of Comment Period, Public Hearing, and Availability of Panel Report on Proposed Endangered Status and Designation of Critical Habitat for the Alabama Sturgeon, 58 Fed. Reg. 55,036 (Oct. 25, 1993).

94. Alabama-Tombigbee Rivers Coalition v. Dep't of Interior, 26 F.3d 1103, 1105 (11th Cir. 1994).

95. *Id.* at 1105.

Act (FACA),[96] enacted to prevent secret bodies from giving advice to the government.[97] The basis for the Coalition's lawsuit was the formation and lack of notice of the convening of the panel.[98]

In December 1993, while the FACA lawsuit was in court, the first Alabama sturgeon since 1985 was caught, proving that the sturgeon was not extinct.[99] Nevertheless, the suit was decided in favor of the Coalition, and the finding of the panel was blocked.[100] This was the first time a FACA suit was successful in an attempt to stop the listing process for an endangered species.[101] Subsequently, Secretary Babbitt allowed for a six-month extension of the listing process, providing more time to study the taxonomic status of the sturgeon, even though subspecies and distinct population segments could be listed with their protected critical habitat.[102] In the meantime, the FWS forensic biologists, untrained in systematics or taxonomy, conducted cursory genetic tests upon the fish and released their finding that, because there were no genetic differences between the Alabama sturgeon, shovelnose sturgeon, and pallid sturgeon, they must not be valid species.[103] This article was not peer-reviewed and was not published in the normal scientific means allowing for any scientific review or rebuttal.[104] At the end of the six-month extension, the FWS announced that it would not place the sturgeon on the list, largely because the species was too rare to list and possibly extinct, even though an individual had been captured six months prior.[105]

After this discouraging turn of events for environmentalists, the listing process halted, although the state of Alabama enacted a five-year

96. Federal Advisory Committee Act §§ 1-15, 5 U.S.C. app. 2 (2000).

97. *See id.* § 2.

98. *Alabama-Tombigbee Rivers Coalition*, 26 F.3d at 1105.

99. Joe Nabbefeld, *Net Turns Up Elusive Sturgeon, but DNA Test Urged on Pedigree*, BIRMINGHAM NEWS, Dec. 4, 1993, at 1A. *See also* Vaughan, *supra* note 8, at 624.

100. *See Alabama-Tombigbee Rivers Coalition*, 26 F.3d at 1107.

101. Vaughan, *supra* note 8, at 627.

102. Endangered and Threatened Wildlife and Plants, Extension of the Final Decision to List the Mobile River System Population of the Alabama Sturgeon as an Endangered Species, 59 Fed. Reg. 31,970, 31,973-74 (proposed June 21, 1994) (to be codified at 50 C.F.R. pt. 17).

103. Endangered and Threatened Wildlife and Plants; Withdrawal of Proposed Rule for Endangered Status and Critical Habitat for the Alabama Sturgeon, 59 Fed. Reg. 64,794 (proposed Dec. 15, 1994) (to be codified at 50 C.F.R. pt. 17).

104. *Id.*; *see also* Pace, *supra* note 90.

105. Endangered and Threatened Wildlife and Plants; Withdrawal of Proposed Rule for Endangered Status and Critical Habitat for the Alabama Sturgeon, 59 Fed. Reg. 64,794 (proposed Dec. 15, 1994) (to be codified at 50 C.F.R. pt. 17).

conservation plan to protect the sturgeon.[106] During the next three years, four more sturgeons were found, proving the species was not extinct.[107] Mayden and Kuhajda published a peer-reviewed paper in a scientific journal on the taxonomy of the sturgeon using meristic and mensural data, adding further scientific evidence of its distinctness.[108] In 1997, the Alabama Department of Conservation and Natural Resources, Mobile District Corps, Alabama-Tombigbee Rivers Coalition, and Fish and Wildlife Service worked together to draft a voluntary conservation plan and continue surveying for the sturgeon.[109]

Finally, in March 1999, the FWS again proposed the sturgeon for endangered status.[110] Once more, this provoked opposition from politicians and citizens in the state. The Coalition again challenged the validity of designating the fish as a species, despite the additional scientific evidence and lack of published research to the contrary.[111] During the second listing process, concerns were voiced about the effect of federal protection on the implementation of the 1997 Conservation Plan for the sturgeon.[112] However, this final attempt to stop a mandatory conservation plan was not successful and a few months later the sturgeon was listed as an endangered species by the FWS.[113] The state conservation agreement continued during the development of an FWS recovery plan.[114]

Given the success industry groups had in delaying the listing for a period of nine years, it is likely that the tactic of contesting the validity of the taxonomic studies will continue to occur with future proposed listings. As discussed previously, it is largely seen as the duty of the agencies in charge of endangered species to determine appropriate species in need of protection. These agencies, in turn, commonly rely

106. Richard Shelby, *Sturgeon Used in Political Game*, TUSCALOOSA NEWS, June 6, 1999, at 6D.

107. ALA. DEP'T OF CONSERVATION OF NAT. RESOURCES ET AL., CONSERVATION AGREEMENT & STRATEGY FOR THE ALABAMA STURGEON 4 (2000).

108. Mayden & Kuhajda, *supra* note 92, at 241–73.

109. Endangered and Threatened Wildlife and Plants; Final Rule to List the Alabama Sturgeon as Endangered. 65 Fed. Reg. 26,440 (May 5, 2000) (list of endangered and threatened wildlife codified at 50 C.F.R. § 17.11).

110. Endangered and Threatened Wildlife and Plants; Proposed Rule to List the Alabama Sturgeon as Endangered, 64 Fed. Reg. 14,676 (proposed Mar. 26, 1999) (to be codified at 50 C.F.R. pt. 17).

111. Michael Sznajderman, *Big Fuss Over an Alabama Fish*, BIRMINGHAM NEWS, Aug. 11, 1999, at 1A, 6A; *see also* Shelby, *supra* note 106.

112. Endangered and Threatened Wildlife and Plants; Final Rule to List the Alabama Sturgeon as Endangered. 65 Fed. Reg. 26,448 (May 5, 2000) (list of endangered and threatened wildlife codified at 50 C.F.R. § 17.11).

113. *Id.* at 26,438.

114. *Id.* at 26,448.

upon biologists to determine which species are endangered. Although the decisions over endangered or threatened status must be made with the "best scientific and commercial data available,"[115] there are no requirements or guidelines for determining if a group of organisms represents a distinct species. Therefore, the definition and identification of a species ultimately becomes the responsibility of the biologists studying these organisms. Endangered species will continue to be vulnerable to non-scientific attacks as long as biologists cannot accept a biologically sound species concept to guide the search for biodiversity.

II. HOW THE WORD "SPECIES" HAS BEEN MISUSED

If asked to name an "endangered species," typical responses from members of the general public would likely include cheetahs, pandas, bald eagles, or other charismatic mammals and birds. However, the power of the ESA to protect *all* biodiversity was not realized until a small fish halted construction of a $100 million dam.[116] The ESA makes no value judgments in prioritizing which species should be listed, but, unfortunately, our own limited knowledge about the earth's biodiversity results in biased listings. Only vertebrate groups and some plants are likely to be studied and well understood.[117] This bias exists even in our fundamental knowledge of what a species is, and is also reflected in the ambiguity of the definition in the ESA.[118] The definition, while singling out vertebrates for protection below the species level, does not provide any guidelines as to what species are or how they can be identified.[119] The definition of a species needs further clarification than what is provided in the ESA; it is far from intuitive and is still hotly debated within biology.[120] Without a widely accepted consensus among scientists, and with no concrete legal standards, there is room for a large margin of error in—and unscientific attacks against—the listing process.

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115. 16 U.S.C. § 1533 (b)(1)(A) (2000).

116. *See* Tenn. Valley Auth. v. Hill, 437 U.S. 153 (1978).

117. Public support for more charismatic organisms helps create a bias in conservation projects even more severe than that seen in taxonomic work. *See* J. Alan Clark & Robert M. May, *Taxonomic Bias in Conservation Research*, 297 SCIENCE 191, 191 (2002).

118. Kevin D. Hill, *The Endangered Species Act: What Do We Mean by Species?*, 20 B.C. ENVTL. AFF. L. REV. 239, 263 (1993) ("If the Act is meant to do more than just protect charismatic megafauna who are valued for their sentimental appeal, the definition of species must reflect the need to protect biodiversity.").

119. 16 U.S.C. § 1532(16) (2000).

120. *See generally* Joel Cracraft, *Species Concepts in Theoretical and Applied Biology: A Systematic Debate with Consequences*, *in* SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE, *supra* note 7, at 3; SPECIES: NEW INTERDISCIPLINARY ESSAYS (Robert A. Wilson ed., 1999).

This problem partially stems from the double meaning of the word "species." The word currently has two different connotations in science. One is a taxonomic unit used in classification, and the other is a conceptual unit that is fundamental to the "building blocks" of natural history.[121] The first meaning refers to the taxonomic category that was created in the Linnaean hierarchy, while the second refers to a real entity in nature that is the product of evolution.[122]

Taxonomy, or the naming and describing of species, has its roots as far back as the ancient Greeks, with Aristotle first subdividing the natural world into groups with lesser categories within these.[123] Into each group he categorized species, based on the "essence" of each, assuming that there was an ideal template for each species upon which the other members were based.[124] In the eighteenth century, Carl Linnaeus devised the biological classification system that is still in use today.[125] His hierarchy starts at the level of a *kingdom*, proceeding in less inclusive groups to the *genus* and then to the *species*. The combination of the Latinate *genus* and *species* name was used as the formal scientific name, so that the species in question might be recognized across languages.[126] At the time of Linneaus, it was still assumed that particular species were placed on the earth by a divine creator, with sharp discontinuities between taxa.[127] The concept of essentialism was also widely accepted.[128]

Today, the continued use of the Linnean hierarchy for classification purposes forces taxonomists to accept—at least during a species description—an essentialist, or typological, concept of species as unchanging entities that can be precisely delimited.[129] The species as taxon is still tied to this typological concept, although current knowledge

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121. Mayden, *supra* note 5, at 103.

122. *See id.*; R.L. Mayden, *A Hierarchy of Species Concepts: The Denouement in the Saga of the Species Problem*, *in* SPECIES: THE UNITS OF BIODIVERSITY 381, 388 (M.F. Claridge et al. eds., 1997).

123. MAYR, *supra* note 85, at 56.

124. *Id.* at 66–67.

125. *Id.* at 57–58.

126. For example, the *Scaphirhynchus suttkusi* is the Alabama sturgeon.

127. MAYR, *supra* note 85, at 58.

128. "Essentialism" refers to a classification where kinds are grouped together based upon possession of a defined attribute or property. Such a property is both necessary and sufficient for being a member of the kind. *See, e.g.*, David L. Hull, *Are Species Really Individuals?*, 25 SYSTEMATIC ZOOLOGY 174, 176 (1976); Robert A. Wilson, *Realism, Essence, and Kind: Resuscitating Species Essentialism?*, *in* SPECIES: NEW INTERDISCIPLINARY ESSAYS, *supra* note 120, at 187, 188.

129. *See* Marc Ereshefsky, *Species and the Linnean Hierarchy*, *in* SPECIES: NEW INTERDISCIPLINARY ESSAYS 285, 287 (Robert A. Wilson ed., 1999).

of biological patterns and processes has revealed that the typological concept is inconsistent with the natural world.[130]

The development of evolutionary theory has altered our perception of species as fixed entities with distinguishing traits that can be classified, the basis for taxonomic descriptions.[131] Adoption of evolutionary theory meant that there were not necessarily clear delineations between species; populations diverged over time into separate lineages, a process called cladogenesis,[132] and change occurred within the lineages over time, a process called anagenesis.[133] As a result of this new theory, scientists could no longer argue that species must have an unchanging essence wherein they could be defined as immutable biological entities. The theory of anagenesis and cladogenesis necessarily replaced categorization by typological differences between species.

Systematics, a branch of biology investigating the diversity of and relationships between species, has arisen as a companion discipline to taxonomy and has provided insights into the pattern and process of speciation.[134] These advances have supported Darwin's theory that species are products of evolution and are undergoing constant change, despite scientists' attempts through taxonomic process to categorize this diversity at a particular point in time.[135] Some modern philosophers argue that the current species problem exists because scientists have been unable to fully assimilate the Darwinian revolution.[136] Whatever the cause of the species problem, it is clear that the lack of a universally accepted definition poses a challenge to biodiversity studies, conservation science, and law. Until the debate over the species concept is resolved, there will continue to be misleading and incorrect species descriptions, as well as inadequate and inappropriate assessments of biodiversity and conservation needs.

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130. Mayden & Wood, *supra* note 7, at 84.

131. Hull, *supra* note 128, at 180.

132. E.O. WILEY, PHYLOGENETICS: THE THEORY AND PRACTICE OF PHYLOGENETIC SYSTEMATICS 8 (1981).

133. *Id.*

134. *Id.* at 7.

135. *See* Mayden, *supra* note 2, at 181.

136. *See* John Dupré, *On the Impossibility of a Monistic Account of Species*, *in* SPECIES: NEW INTERDISCIPLINARY ESSAYS, *supra* note 120, at 3. The pre-Darwinian understanding of species was of an essentialist concept (*i.e.*, species are immutable over time). However, adoption of evolutionary theory meant that there were no sharp demarcations between species (*i.e.*, they could change during time, and at different rates). Thus, some argue, our current concepts are unable to account for species because they have not fully incorporated the change associated with evolution.

The species concept debate is not a new problem in the fields of taxonomy and systematics; neither has it been ignored in the literature.[137] Entire books devoted to examining and defending various species concepts abound.[138] Although the Biological Species Concept—the original concept identifying species as reproductive units—may still be the most commonly applied, a wider variety of concepts exist within systematics. Indeed, Mayden identified at least 22 different species concepts in a recent review of the subject.[139]

The first problem preventing a common understanding of the meaning of a "species" is the double meaning of the word itself. As mentioned above, a species is a taxonomic unit of classification used by researchers in an effort to understand the pattern of life.[140] Species are also known to be the fundamental unit in natural history, the actual entities undergoing evolution and other natural processes.[141] Because these real entities are constantly changing over time, under this usage species can only be described, they cannot be statically defined. They exist independent of our attempts to classify them. True species in nature have a distinct beginning (speciation) and end (extinction) and participate in cohesive processes such as reproduction or replication, which maintain the lineage over time.[142] However, species as described and named through the taxonomic process are human-imposed groupings, used as our best guess to identify and classify these real entities. Such groupings are merely a hypothesis—our attempt to utilize the best available data to deduce these natural patterns and use them for further scientific studies. The inherent problem in defining a species surfaces when we attempt to reconcile these real entities with our limited ability to group, classify, and list all of the world's biodiversity.

Debates over species concepts tend to focus on the evidence used to identify species as a taxonomic unit rather than on the fundamental nature of a species itself.[143] Understanding a species as an entity

137. *See* Mayden, *supra* note 2, at 176.

138. *See, e.g.*, SPECIES: THE UNITS OF BIODIVERSITY, *supra* note 122; ENDLESS FORMS: SPECIES AND SPECIATION (Daniel J. Howard & Stewart H. Berlocher eds., 1998); SPECIATION AND THE RECOGNITION CONCEPT: THEORY AND APPLICATION (David M. Lambert & Hamish G. Spencer eds., 1995); Hey, *supra* note 1; SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE, *supra* note 7.

139. Mayden, *supra* note 122, at 389.

140. *Id.* at 387.

141. *Id.* at 388.

142. Hull, *supra* note 128, at 177. *See also* Mayden, *supra* note 2, at 179.

143. This occurs both in biology and law; the majority of debates surrounding how a species is defined focus on the empirical methods used for a research study, rather than question the conceptualization of species. *See, e.g.*, Kevin W. Grierson, *The Concept of Species and the Endangered Species Act*, 11 VA. ENVTL. L.J. 463, 486 (1992); Alan R. Templeton, *The*

constituting a key component of natural history is largely a theoretical problem. Actually finding, quantifying, and describing these units leads to an operational question concerning which characters[144] of a species may be validly used to recognize and diagnose the species. But before scientists can work to discover and describe new species via an operational method, it is imperative that they properly conceptualize what a species is in the theoretical sense, in order to maintain an approach to taxonomy consistent with our current knowledge of the origin of species through evolution.[145] Thus, there are two different types of species concepts: theoretical concepts and operational concepts.

Theoretical concepts assume that species exist in nature regardless of our understanding of them or our ability to recognize them. The concepts recognize species as real entities, not merely groups constructed for human benefit. Because of these attributes, a theoretical species concept provides a framework that allows researchers to develop and test hypotheses regarding the existence of a species, an essential element of scientific studies.[146] Thus, the goal of a good operational definition is to assist scientists in identifying natural groups existing in nature that are consistent with the theoretical concept of a species.

In turn, operational concepts are meant to provide both a logical basis and methods by which scientists can delineate a species. Operational concepts and methods are based upon variously observed patterns, processes, and functions considered characteristic of species and which are identifiable, provided a user follows a standard set of methods.[147] If scientists simply use an operational definition of a species to form the basis of their understanding of these natural groups, they limit their ability to further identify biodiversity by the inherent restriction[148] or circular reasoning[149] that comes with sole reliance on an

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Meaning of Species and Speciation: A Genetic Perspective, *in* SPECIATION AND ITS CONSEQUENCES 3, 3 (Daniel Otte & John A. Endler eds., 1989) ("[A] species concept can be evaluated only in terms of a particular goal or purpose," indicating a use of species concepts only to further the study of a subdiscipline in biology, not to understand philosophically what a species is.").

144. A character is "a feature (attribute, observable part) of an organism." WILEY, *supra* note 132, at 8.

145. Mayden, *supra* note 5, at 96.

146. *See* Mayden, *supra* note 2, at 184. Species descriptions should be treated as hypotheses of lineage independence, to be empirically tested. Without operational criteria for testing, biologists may learn little from studying arbitrarily defined taxa with no uniting theoretical basis.

147. Mayden & Wood, *supra* note 7, at 94.

148. *Id.* at 95. For example, a hypothetical species concept that only accepts as valid species differences in consistent patterns of female coloration would ignore the diversity that becomes apparent seasonally when breeding males exhibit different colors within the

operational definition. The operational concept guides our efforts to identify diversity, but it is important to remember that currently described species remain merely hypotheses of independent lineages. A scientist's recognition of a group of individual organisms as a species, based upon observed differences, does not necessarily mean the organisms naturally interact as a single species. Indeed, it is very possible that what is currently recognized as a single species may actually contain multiple lineages not currently identified.[150] Thus, it is essential that those involved in species conservation understand that *both* theoretical and operational definitions are necessary to help biologists find, describe, classify, and protect biodiversity, in addition to providing the proper legal means to do so.

The principal complaint about theoretical species concepts is that they fail to guide our search for biodiversity by neglecting to set limits defining exactly how distinct two entities must be before each can be considered separate species.[151] Such proposed limits may include a set amount of genetic difference, complete reproductive isolation, or obvious morphological differences.[152] All of these characteristics have been used as the basis for at least one operational species concept.[153] However, using one single criterion as a means of recognizing separate species will only ensure that all biodiversity will fail to be recognized.[154]

Theoretical definitions for species descriptions must be able to recognize all of the species that are part of the earth's biodiversity. Taxonomists then must be flexible in the methods and tools or the

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recognized species. The operation used is strictly based upon the conception of reality of the user of that operation—a conception that may be artificial or real for that species (*e.g.*, colors perceived by *Homo sapiens* may not be comparable to colors perceived by the species we study).

149. *See* Wiley, *supra* note 7, at 18. For example, a hypothetical species concept that only accepts differences in females as valid species would ignore diversity that becomes apparent when breeding males take on different colors.

150. This is often referred to as cryptic biodiversity. *See* Robert S. Butler & Richard L. Mayden, *Cryptic Biodiversity*, 28 ENDANGERED SPECIES BULL. 24, 24 (2003).

151. Ernst Mayr, *A Critique from the Biological Species Concept Perspective: What Is a Species, and What Is Not?*, *in* SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE, *supra* note 7, at 93, 97.

152. *Id.*

153. *See* Theodosius Dobzhansky, *Mendelian Populations and Their Evolution*, 84 AM. NATURALIST 401, 405 (1950) (discussing the genetic species concept); Ernst Mayr, *Speciation Phenomena in Birds*, 74 AM. NATURALIST 249, 256 (1940) (discussing the biological species concept); C.T. Regan, *Organic Evolution*, 1926 BRITISH ASSOCIATION FOR ADVANCEMENT OF SCIENCE REPORT OF NINETY-THIRD MEETING 75 (discussing the morphological species concept).

154. Mayden, *supra* note 5, at 110.

operational concepts they use to recognize diversity.[155] Good operational concepts should enable researchers to delineate a wide variety of lineages that are consistent with theoretical concepts and should not be restricted to only those concepts that favor a single method. The current species concepts illustrate the importance of this linkage between theoretical and operational concepts.

One of the most widely accepted and easily understood concepts in use today is the Biological Species Concept (BSC).[156] The BSC simply defines species as reproductively isolated groups that cannot successfully interbreed with other groups.[157] Thus, under the BSC, the definitive criterion for what is considered a species is the ability to successfully interbreed. Although the BSC possesses both ecological and genetic components, the definition does not emphasize morphological difference. Thus, the definition is solely operational insofar as reproductive isolation is used as the principle testable method to discover new species.[158]

One legal article states that the BSC "works well most of the time" for endangered species decisions because "the vast majority of species are sexual, and occur in isolated points in space-time."[159] Other non-biological arguments in favor of the BSC highlight the fact that reproductive isolation can be quantified using genetic analysis and allows for the presence of hybrid zones.[160] However, these very qualities illustrate the biological flaws of the BSC. In particular, there is no lineage

155. *Id.* at 111; *see also* Peter C.H. Pritchard, *Status of the Black Turtle*, 13 CONSERVATION BIOLOGY 1000, 1003 (1999). Pritchard states that it is "vital that systematists avoid dependence upon a single 'favored technique' for answering questions relating to the rank of related taxa and instead utilize all the tools at their disposal." *Id.* This conclusion stems from the debate over the status of the black turtle, which is known to be distinct from the green turtle based upon consistent morphological differences, despite few genetic differences.

156. The BSC is widely used among ornithologists and mammalogists, partly due to the influence that the author of this concept has among specialists in these groups. *See* Cracraft, *supra* note 120, at 4. This is also the concept commonly introduced in introductory biological textbooks. *See, e.g.*, SYLVIA MADER, BIOLOGY 1, 332 (4th ed. 1993); CECIE STARR & RALPH TAGGART, BIOLOGY: THE UNITY AND DIVERSITY OF LIFE 2, 298 (8th ed. 1998).

157. The BSC contains both a genetic and ecological component and is defined as:

> a group of populations which replace each other geographically or ecologically and of which the neighboring ones intergrade or hybridize wherever they are in contact or which are potentially capable of doing so (with one or more of the populations) in those cases where contact is prevented by geographical or ecological barriers.

Mayr, *supra* note 151.

158. Mayden & Wood, *supra* note 7, at 96.

159. MARTY BERGOFFEN, ENDANGERED SPECIES ACT REAUTHORIZATION: A BIOCENTRIC APPROACH 11 (1995).

160. Hill, *supra* note 118, at 262.

perspective given to the evolution of species. By ignoring this fundamental aspect of species, the BSC does not offer any acknowledgement that the theoretical nature of species is as evolving entities. Moreover, although it does provide an operational method for identifying species through reproductive isolation, such a method is difficult to put into practice. It may be hard to determine exactly when interbreeding is possible and does naturally occur between two populations.[161] Exclusive use of this criterion limits the biological diversity that can be discovered under the BSC. For example, evidence has been found of gray wolves and coyotes interbreeding in disturbed habitats across Minnesota, Quebec, and Ontario.[162] If a strict application of the BSC were used, these species would no longer be recognized as distinct, but instead would be converged into one species. Application of the BSC therefore results in the loss of recognized biodiversity.[163]

One further problem of the BSC is its applicability only to sexual organisms, a limitation that greatly reduces its effectiveness in recognizing diversity. Despite the prevalence of scientific research conducted on sexual—primarily vertebrate—animals, an unknown, but large amount of the earth's diversity is composed of asexual species.[164] These cannot be identified using the BSC. Were the BSC strictly applied to all biodiversity, there would be a great decline in the number of recognized species, less scientific understanding of the nature of these species, and less effective conservation priorities.[165]

The Evolutionary Species Concept (ESC) is generally accepted as the best theoretical concept currently available to guide our quest to catalogue the Earth's biodiversity.[166] Under the ESC, Wiley first described a species as "a single lineage of ancestral descendent populations of organisms which maintains its identity from other such

161. The reproductive isolation test is particularly troubling when used on species that do not even occur in overlapping regions. Interbreeding in nature will not occur naturally without outside intervention on the part of the researcher, and it makes little sense for biologists to test for possibility of hybridization by forcing individuals from disparate areas together in a laboratory setting.

162. *See* Niles Lehman et al., *Introgression of Coyote Mitochondrial DNA into Sympatric North American Gray Wolf Populations*, 45 EVOLUTION 104, 108 (1991).

163. Mayden & Wood, *supra* note 7, at 97; Paul-Michael Agapow et al., *The Impact of Species Concept on Biodiversity Studies*, 79 Q. REV. BIOLOGY 161, 163 (2004).

164. Unfortunately, microbiology is still largely uncharted territory in biology; current estimates of diversity range from 10^5 to 10^7 species. Part of this is due to the ability for bacteria to rapidly accumulate genetic mutations that lead to new species. *See* William B. Whitman et al., *Prokaryotes: The Unseen Majority*, 95 PROC. NAT'L ACAD. SCI. 6578, 6582 (1998).

165. *See* Mayden & Wood, *supra* note 7, at 97.

166. Mayden, *supra* note 122, at 396.

lineages and which has its own evolutionary tendencies and historical fate."[167] When this concept was first proposed, Wiley felt that it would allow for hypotheses and testing of proposed species classifications because their populations might be compared to discover separate evolutionary lineages.[168] However, as scientific understanding of species changed, so has the ESC. These "ancestral descendent" populations are no longer part of the definition that, in its most recent incarnation, asserts that "[a]n evolutionary species is an entity composed of organisms that maintains its identity from other such entities through time and over space and that has its own independent evolutionary fate and historical tendencies."[169]

The ESC is accepted as a strong theoretical concept, but operationally, it is not practical to use. Species cannot be identified based upon observing evolution of an independent lineage; the process can only be inferred from data.[170] Some criticize the ESC for not providing any unique information about the significance of a species.[171] For example, Mayr argues that the "capacity for evolving is not the crucial biological criterion of a species," as every population, structure, or organ has this ability.[172] Another, similar, complaint regarding the ESC relates to its general nature; under the ESC, almost any separate population could be construed as its own lineage, and, thus, a separate species.[173] Some critics feel that applying the ESC to any group of organisms could vastly increase the number of recognized species, as any geographically isolated populations might be found to be distinct species.[174] However, proponents of the ESC argue that it is valid to recognize any population that maintains its own identity because it is no longer influenced by even minimal gene flow with its closest relatives.[175] The ESC does not limit the recognition of species by subjective, human imposed limits.

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167. Wiley, *supra* note 7, at 18.

168. *Id.* at 21.

169. Edward O. Wiley & Richard L. Mayden, *The Evolutionary Species Concept*, *in* SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE, *supra* note 7, at 70, 73.

170. Jack W. Sites, Jr. & Keith A. Crandall, *Testing Species Boundaries in Biodiversity Studies*, 11 CONSERVATION BIOLOGY 1289, 1292 (1997).

171. Mayr, *supra* note 151, at 97.

172. *Id.*

173. *Id.* at 97–98.

174. *Id.* at 98.

175. Edward O. Wiley & Richard L. Mayden, *A Defense of the Evolutionary Species Concept*, *in* SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE, *supra* note 7, at 198, 200.

The Phylogenetic Species Concept (PSC) was first developed as an offshoot of phylogenetic systematics.[176] There are three different interpretations of this concept, all of which are considered operational. The first involves monophyly[177] as the single criterion.[178] The second emphasizes that species should be distinguishable via a "unique combination of character states in comparable individuals."[179] The last concept incorporates both of the previous criteria into a monophyletic, diagnosable species.[180] In each of these definitions, the species is the smallest appropriate unit of analysis.[181] Although these concepts do make important distinctions in how species are recognized operationally, they are similar enough to be discussed together for the purposes of this article.

The PSC is a very appealing operational concept because the criteria for identifying a species are very clearly outlined. The PSC favors use of any valid character to delineate a species, not the single criterion of interbreeding.[182] This is beneficial when working with any species, as all differences are considered important under the PSC. In addition, because it allows for the use of any character, the PSC is also able to accommodate both asexual and sexual species. However, there are disagreements over the concept's validity. Some scientists feel it is too arbitrary in that it allows any individual character to describe a new species.[183] Individual taxonomists are left to decide how many unique characters are needed to delineate taxa.[184] This allows for variation in how different scientists conceptually view a species. It has also been stated that species described using the PSC are artificially created through the fabrication of the human mind and are only reflections of

176. Mayden, *supra* note 122, at 405. Phylogenetic systematics is a specific approach to systematics that studies the history of speciation; the recovery of evolutionary relationships is then used to guide classification schemes. *See* WILEY, *supra* note 132, at 6.

177. "Monophyly" is a term denoting a group that shares a common ancestor; thus, when used in a species concept, all members of that species should share a most recent common ancestor, with no members excluded.

178. *See* Donn E. Rosen, *Vicariant Patterns and Historical Explanation in Biogeography*, 27 SYSTEMATIC ZOOLOGY 159, 176 (1978).

179. K.C. Nixon & Quentin D. Wheeler, *An Amplification of the Phylogenetic Species Concept*, 6 CLADISTICS 211, 218 (1990).

180. *See* Mary C. McKitrick & Robert M. Zink, *Species Concepts in Ornithology*, 90 CONDOR 1, 2 (1988).

181. Mayden & Wood, *supra* note 7, at 102.

182. Brent D. Mishler & Edward C. Theriot, *The Phylogenetic Species Concept (*sensu *Mishler and Theriot): Monophyly, Apomorphy, and Phylogenetic Species Concepts*, *in* SPECIES CONCEPTS AND PHYLOGENETIC THEORY: A DEBATE, *supra* note 7, at 44, 45.

183. Mayr, *supra* note 151, at 99.

184. *Id.*

patterns in the natural world, not processes.[185] With these points in mind, it is apparent that the PSC is useful as an operational concept, but not as a theoretical concept.

Some species concepts that have been proposed are grounded more in policy than science. The Geopolitical Species Concept (GSC) recently was developed in response to the controversy over the status of the black turtle, *Chelonia agassizii*.[186] Karl and Bowen, feeling that there were no scientific data supporting the recognition of a distinct black turtle species, proposed the black turtle was only a species based upon a GSC.[187] They defined geopolitical species as "groups of individuals confined to geographically or politically defined areas" that are "accorded species status independent of morphological, genetic, and reproductive criteria."[188] Although Karl and Bowen's recent analysis of a single nuclear gene and mitochondrial DNA did not reveal a difference between black and green turtles,[189] black turtles have long been recognized as a different species based upon morphological differences.[190] These consistent morphological differences are enough to differentiate the black turtle from the green turtle even without the use of the GSC.

As stated explicitly by Karl and Bowen, the GSC is not based upon scientific data to support hypotheses regarding species status.[191] Instead, the concept was intended for conservation purposes, as a method of identifying species that have become imbedded into local folklore and are recognized as distinct by different cultures.[192] However, there is little need, from a conservation standpoint, to change accepted taxonomy to reflect conservation needs. When writing the ESA, Congress did attend to geopolitical boundaries during the listing process, allowing for the protection of animals endangered within the United States, even if a significant amount of their range is in another country and not in jeopardy.[193] During authorizations in 1979, Congress

185. *Id.* at 100.

186. Stephen A. Karl & Brian W. Bowen, *Evolutionary Significant Units Versus Geopolitical Taxonomy: Molecular Systematics of an Endangered Sea Turtle* (Genus Chelonia), 13 CONSERVATION BIOLOGY 990, 996 (1999).

187. *Id.*

188. *Id.*

189. *Id.* at 994.

190. Black turtles have darker pigmentation patterns, a smaller size, and a different shell shape than green turtles. *See* Pritchard, *supra* note 155, at 1001–02.

191. Karl & Bowen, *supra* note 186, at 996. Karl and Bowen "propose the label *geopolitical species* (GS) for taxonomic designations that persist, but for which there are essentially no supporting data."

192. *Id.*

193. H.R. REP. NO. 93-412, at 10 (1973).

repeated that "the U.S. population of an animal should not necessarily be permitted to become extinct simply because the animal is more abundant elsewhere in the world."[194] Thus, under the ESA, species with international distributions can be legally protected, leaving no valid reason for using an insufficient species concept to recognize these "geopolitical species."

Moreover, using the GSC for species protection under the ESA will only damage conservation efforts. If there are no scientific data behind the decision to recognize a new species, it will undermine the efforts of those attempting to conserve biodiversity by wasting valuable time and resources on non-imperiled species or even opening the door for bad publicity for science as seen in the case of the Alabama sturgeon. The GSC does not provide an enhanced understanding of true species diversity nor does it protect such diversity using ethical scientific means.[195] Few species show a perfect overlap of political and biological boundaries, but trying to defend a species designation made solely from geopolitical boundaries will take away scientific credibility and waste resources of the environmental agencies. It is imperative that biologists do not refer to these domestic populations as species without sufficient scientific data to support such a designation.

Another aspect of the species concept debate stems from the ESA's inclusion of protection for "distinct population segments" (DPSs).[196] By including populations in the species definition, the statute allows for the protection of animals with declining populations in only part of their total range. For example, while managing the bald eagle, the FWS simultaneously listed the bird as endangered in 43 states and threatened in five states, and did not list it in Alaska due to differing status in these areas.[197] This listing process observes geopolitical boundaries; in other words, species may be accorded different protection levels based upon their population's status in a particular area, not necessarily across its entire range. Although this definition could be used quite flexibly in decisions over protection of populations, it is normally used in a conservative fashion.[198] During the 1979 authorizations of the ESA, Congress instructed "the FWS to use the ability to list populations sparingly and only when the biological evidence indicates that such

194. S. REP. NO. 96-151, at 7 (1979).

195. *See* Kristin Shrader-Frechette & Earl D. McCoy, *Molecular Systematics, Ethics, and Biological Decision Making Under Uncertainty*, 13 CONSERVATION BIOLOGY 1008, 1011 (1999).

196. 16 U.S.C. § 1532(16) (2000).

197. Determination of certain bald eagle populations as endangered or threatened, 43 Fed. Reg. 6230 (Feb. 14, 1978).

198. *See* Robin S. Waples, *Evolutionary Significant Units and the Conservation of Biological Diversity Under the Endangered Species Act*, 17 AM. FISHERIES SOC'Y SYMP. 8, 20 (1995).

action is warranted."[199] Perhaps because of the infrequent use of distinct population segments, government agencies have had difficultly agreeing upon how to determine when a population is distinct enough to warrant a separate listing. The FWS and NMFS promulgated a policy of recognizing the distinct population segments of vertebrates. Under the policy, vertebrate populations must meet standards of discreteness, significance, and conservation status.[200] The services have used this policy sparingly, as instructed. Only ten percent of the listed species are given status as DPSs.[201]

Beyond these standards for vertebrate populations, the NMFS has adopted the use of "evolutionary significant units" (ESUs) as a method of clearly assessing biodiversity among Pacific salmonids. The ESU, developed by Waples,[202] has attracted a great deal of attention due to the controversy surrounding all scientific and policy decisions directed at salmonids.[203] In order to be considered an ESU, a population must (1) be reproductively isolated from other populations, and (2) represent an important part of the evolutionary lineage of the species.[204] These two criteria are a compromise between the BSC and the ESC, leading to a more stringent definition of a population than many use to describe a new species.[205]

Although the NMFS primarily depends upon genetic analysis to determine reproductive isolation, such isolation may also be assessed through tagging studies to examine migration.[206] Measuring the importance of the evolutionary history of a population, or its contribution to the species as a whole, requires the use of a diverse suite of characters including determining distinct phenotypes, life history, and habitat use of the population in question.[207] The use of these prescribed methods in ESU delineation makes this concept operational rather than

199. S. REP. NO. 96-151, at 7 (1979).

200. Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act, 61 Fed. Reg. 4722 (Feb. 7, 1996).

201. *Id.* at 4722.

202. Robin S. Waples, *Pacific Salmon,* Oncorhynchus spp., *and the Definition of "Species" Under the Endangered Species Act,* 53 U.S. NAT'L MARINE FISHERIES SERV, MARINE FISHERIES REV. 11, 15 (1991).

203. *See, e.g.,* Rohlf, *supra* note 4, at 637; David S. Pennock & Walter W. Dimmick, *Critique of the Evolutionary Significant Unit as a Definition for "Distinct Population Segments" Under the U.S. Endangered Species Act,* 11 CONSERVATION BIOLOGY 611, 615 (1997).

204. Waples, *supra* note 202, at 12.

205. Mayden & Wood, *supra* note 7, at 109.

206. *See* Waples, *supra* note 202, at 13.

207. *Id.* at 14.

theoretical, which is understandable when the goal is to provide official guidelines on how to recognize distinct population segments.[208]

The ESU concept has certain merits; it emphasizes a lineage view of species, is multidimensional and non-relational, and openly states which criteria are important in diagnosis.[209] Rojas argues that this focus on species as dynamic evolutionary units is crucial for conservation, as it leads to better management decisions that allow for adaptive management for the evolutionary capacity of the organisms to respond to environmental change.[210] The ESU concept is also popular because it allows for decisions about reproductive isolation to be made in a testable fashion, through genetic analysis.[211] If genetic similarities are found between two populations, it is assumed to be evidence of gene flow, indicating the two populations are not reproductively isolated, while the presence of unique genetic characters are often used to support a hypothesis of reproductive isolation.[212] To those looking for an infallible way to identify distinct units, the ESU appears to be an ideal concept since it can be used to create a strict genetic level at which a group in question may or may not have enough diversity to be considered a species.[213] The ESU concept is, fundamentally, an attempt to legislate this genetic level through a combination of policy and biology.

Despite these positive aspects of the ESU, the concept is not adequate for identifying or conserving species. Although many biologists defend the significant role genetics plays in ESU decisions, there are valid concerns that an analysis based solely on genetics will overlook some actual species and prevent effective management practices by not accurately revealing diversity.[214] For example, the dusky seaside sparrow[215] was described as a separate subspecies because of its

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208. Robin S. Waples, *Evolutionary Significant Units, Distinct Population Segments, and the Endangered Species Act: Reply to Pennock and Dimmick*, 12 CONSERVATION BIOLOGY 718, 719 (1998).

209. *See* Mayden & Wood, *supra* note 7, at 109.

210. Martha Rojas, *The Species Problem and Conservation: What Are We Protecting?*, 6 CONSERVATION BIOLOGY 170, 174 (1992). By viewing a species as a "work in progress," management decisions can be made by looking at a species' ability to change and adaptabilities of greater importance in the natural world than the ability to maintain status quo. For example, listing decisions could be based upon the variability in a population, an indication of greater capacity to adapt than size of a population alone.

211. *See* Waples, *supra* note 198, at 9.

212. *See id.* at 14.

213. *See* Grierson, *supra* note 143, at 489.

214. *See* Mayden & Wood, *supra* note 7, at 110.

215. Prior to its extinction in 1987. *See* Endangered and Threatened Wildlife and Plants; Final Rule to Delist the Dusky Seaside Sparrow and Remove Its Critical Habitat Designation, 55 Fed. Reg. 51,002, 51,113 (Dec. 12, 1990) (codified at 50 C.F.R. pt. 17).

consistently different shade and song characteristics when compared with other subspecies.[216] When morphological differences, such as pigmentation patterns, are consistently seen between populations, there is some underlying genetic basis for the expression of this difference. However, because no genetic differences were seen in one small region of its mitochondrial DNA, the dusky seaside sparrow was determined to be indistinct from the other groups, a victim of "faulty taxonomy" despite its obvious difference in pigmentation.[217] Although advances in genetic technologies are important and can help identify biodiversity, they should not be used to the exclusion of all other methods of identifying separate species.[218]

With the multitude of species concepts available, new species descriptions may be rejected purely on the basis of a reviewer's preference for a certain concept, without an examination of the scientific merit behind how the chosen concept was applied. Alternatively, some new species descriptions—and most biological studies involving species—do not identify the species concept used. It is impossible to review these studies without knowing the theoretical basis upon which research questions were posed. Moreover, as many more concepts are advanced to aid us in delineating biodiversity, this debate will become increasingly important for conservation purposes, and there will be an even more urgent demand for a single accepted concept to guide our search for biodiversity without error.

Mayden tried to untangle the species problem by creating a hierarchy of species concepts.[219] In this hierarchy, one concept—the primary concept—is the theoretical basis for species delineation, encompassing what is currently known about the origin of diversity.[220] Secondary concepts can be used as an operational surrogate for species recognition and diagnosis, as long as they are internally consistent with the theoretical basis of the primary concept.[221] Every possible method of recognizing a species is accepted through Mayden's hierarchy, which, in turn, allows for the maximum identification of biodiversity.[222]

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216. *Id.* at 51,112.

217. John C. Avise & William S. Nelson, *Molecular Genetic Relationships of the Extinct Dusky Seaside Sparrow*, 243 SCIENCE 646, 648 (1989).

218. For another example of pigmentation differences and species status, see Pritchard, *supra* note 155, at 1001, regarding the black turtle.

219. Mayden, *supra* note 122, at 418.

220. *Id.* at 419.

221. *Id.*

222. Mayden, *supra* note 5, at 114.

III. HOW THE HIERARCHY OF SPECIES CONCEPTS STRENGTHENS THE ESA

Recently, the debate regarding species' definitions has arisen from the desire to develop an easy, foolproof way of delineating the group.[223] Among conservationists, the species remains the focal point for conservation efforts, often standing in for entire ecosystems because of their ability to attract public support and sympathy for an entire region.[224] However, as highlighted in the Alabama sturgeon case, the response to an endangered species can be far from enthusiastic if the species is not considered distinct.[225] This has caused some conservationists to beg for more taxonomic stability and an end to the debate over species concepts.[226] However, a belief that one single technique will identify all species provides the basis for most of the misguided operational species concepts. Instead, the best way to allow for an interface between theoretical concepts and operational concepts is to use a hierarchical arrangement between the two.[227] While this idea is not new to the biological literature, it has only recently been resurrected. Mayr, a premier evolutionary biologist, first proposed using two different levels of concepts in the 1950s in order to account for differences between theoretical ideas and operational actions.[228]

When using a hierarchy of species concepts, a strong theoretical concept should be used as the primary species concept, giving the best conceptual recognition of the full spectrum of the diversity of life.[229] It should not be restricted by the conceptual boundaries placed upon any operational action. While using this theoretical concept to guide understanding of the existence of species in nature, secondary operational concepts should be used by scientists to describe the patterns

223. This debate is not limited to either the biological or legal professions; both sides have advocates who feel that this problem would disappear if a single genetic criterion were used to establish management units, subspecies, or species status. *See* Grierson, *supra* note 143, at 486, 487; C. Moritz, *Applications of Mitochondrial DNA Analysis in Conservation: A Critical Review*, 3 MOLECULAR ECOLOGY 401, 405 (1994).

224. T.M. Caro & Gillian O'Doherty, *On the Use of Surrogate Species in Conservation Biology*, 13 CONSERVATION BIOLOGY 805, 810 (1999).

225. *See* Shelby, *supra* note 106, at 6D; *see also* Nick J.B. Isaac et al., *Taxonomic Inflation: Its Influence on Macroecology and Conservation*, 19 TRENDS ECOLOGY & EVOLUTION 464, 466 (2004).

226. Janice S. Golding & Jonathan Timberlake, *How Taxonomists Can Bridge the Gap Between Taxonomy and Conservation Science*, 17 CONSERVATION BIOLOGY 1177, 1178 (2003).

227. Mayden, *supra* note 122, at 419.

228. Ernst Mayr, *Species Concepts and Definitions*, *in* THE SPECIES PROBLEM 1, 10 (1957).

229. Mayden, *supra* note 122, at 418.

found in nature that are inherently consistent with the primary theoretical concept.[230]

Mayden argues that the traits used by biologists are simply markers to aid in deciphering or testing for lineage independence.[231] These secondary concepts use differences in morphology, genetics, behavior, or any other character to identify evolutionary independence and distinguish the different evolutionary lineages.[232] Secondary concepts may be used interchangeably, allowing for the greatest recognition of all types of biodiversity.[233] Therefore, while the primary concept allows for the understanding of species as real entities in nature, the secondary concept allows for individuals to be placed into groups for scientific discovery and study.

The use of different operational concepts to guide our search is acceptable so long as the primary theoretical concept is an inherent part of any study. Mayden's hierarchy accepts any current species concept as a valid secondary concept if it is consistent with the theoretical underpinnings of the primary concept.[234] With this restriction, the hierarchy can be consistent among different researchers with respect to the identification of biodiversity. Thus, the most important factor guiding the species debate under this framework is the adoption of an appropriate primary species concept—one that must meet several criteria.

First, the primary species concept should represent our best understanding of available theoretical and empirical knowledge, especially concerning the evolutionary history of the proposed species. Second, species must be viewed as entities changing in space and time, not as artificial groupings. Finally, the primary concept must be able to accommodate all ranges of life forms currently recognized as species.[235] The Evolutionary Species Concept best fits these standards and is the most appropriate candidate for the hierarchy's primary species concept, particularly since the ESC incorporates all that is currently known about

230. *Id.* at 419.
231. *Id.*
232. *See id.* at 420.
233. *Id.* at 421.
234. *Id.*
235. The largest problem related to many species concepts is their inability to correctly diagnose asexual species. The Biological Species Concept is unable to identify diversity within asexual groups as it uses the criterion of interbreeding, an activity that is not found in these species. Thus, the primary species concept must allow for the existence of these species rather than ignoring their existence because they do not fit the "normal" expectations of natural groups.

species and speciation without operational restrictions.[236] Thus, the hierarchy becomes important in the correct identification and diagnosis of species because of the role secondary concepts play in helping systematists recognize distinct species. Although these secondary concepts are not acceptable by themselves, they can be used as operative surrogates for the primary concepts as long as they ultimately recover hypothesized evolutionary lineages.[237]

When used appropriately, the hierarchy is the best way to link the theoretical conceptualization of species with operational methods needed to delineate and describe a species. Individual researchers may prefer to approach the hierarchy in different ways. In some cases, one single surrogate concept may be sufficient to recognize species diversity, while other users may feel more comfortable following an ordered set of operations depending on the taxa of interest. Obviously, some secondary concepts may be inappropriate for one group of organisms and may be omitted from a particular study.[238]

In other cases, the applicable operational concepts may be grouped by their criteria for modes of reproduction, gene exchange, monophyly, and diagnosability. Secondary concepts may be placed in multiple categories depending upon their uses. Scientists can then proceed through their data sets following the assumptions of the different concepts and comparing results. As long as the theoretical and operational concepts are clearly identified so that other researchers may duplicate the tests and reach similar findings, the study has satisfied the scientific method's requirement of reproducibility and may be presumed legitimate. The use of the primary and secondary concept allows scientists to compare species delimitation under differing operational assumptions—a comparison that only recently has attracted attention in taxonomic studies.[239]

Incorporating this conceptual hierarchy into practice no doubt will meet with some resistance. In many cases, the use of different secondary concepts leads to different estimates of diversity.[240] This could have the effect of preventing consistency and increasing uncertainty in conservation strategies.[241] In this way, the hierarchy does not fulfill the

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236. Mayden, *supra* note 122, at 419.

237. *Id.*

238. As mentioned above, the Biological Species Concept does not recognize asexual species, so it should not be used in any study examining asexual organisms.

239. Sites & Marshall, *supra* note 30, at 462.

240. Mayden, *supra* note 2, at 190.

241. A. Townsend Peterson & Adolfo G. Navarro-Sigüenza, *Alternate Species Concepts as Bases for Determining Priority Conservation Areas*, 13 CONSERVATION BIOLOGY 427, 429 (1999);

perceived need in science and law for prescribing one preferred method of describing and recognizing species. A whole spectrum of surrogate concepts would be available for use in listing decisions, leaving much to the discretion of the agency and potentially preventing appropriate review. In turn, courts might focus too much attention on the different outcomes resulting from the employment of a particular surrogate concept in a species description and subsequent listing decision rather than the legality of the issue. Thus, by not advocating one clear-cut standard, the hierarchy might be seen as granting too much flexibility in determining species status and might, in turn, be more vulnerable to attack in listing determinations, as in the Alabama sturgeon case.

Yet, even using a correct biological interpretation of species will not prevent all controversy regarding status at the time of listing. Biology, as a science that must allow for the development of new hypotheses and theories, can never lead to inflexible decision making. Species described by scientists are hypotheses of those biological entities that may exist in nature. If too many uncertainties are present from inconsistent results of secondary concepts, those formulating and administering laws and policies will simply ignore potentially imperiled species because their listing might seem too controversial, both to scientists still trying to understand the groups and to the general public. Thus, the hierarchy will not always provide additional certainty that one population is, in fact, a different species, although cases where data sets conflict substantially are rare.

One further concern for many biologists is that if the hierarchy were to incorporate all secondary concepts as valid methods of identifying biodiversity, too much diversity would be recognized. This concern stems from the belief that the primary concept used, the ESC, is too broad.[242] Perhaps this fear stems from our inability to comprehend such an enormous wealth of biodiversity. Other biologists may be concerned about the cost of providing protection to such a great wealth of diversity. If more diversity is described and studied, it is likely that more endangered species will also be recognized, leading to even fewer resources for protected species.[243] Even those interested in protecting a maximum of biodiversity have reason for concern about the potential results from recognizing so much diversity. However, this hierarchy is the only way to allow the scientific community to treat the current

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see also Helen M. Regan et al., *A Taxonomy and Treatment of Uncertainty for Ecology and Conservation Biology*, 12 ECOLOGICAL APPLICATIONS 618, 619 (2002).

242. *See, e.g.*, Mayr, *supra* note 149, at 96.

243. Agapow et al., *supra* note 161, at 169.

taxonomy as a hypothesis while also giving conservation priority to real species.

Healthy scientific uncertainty leading to debate and progress must be balanced with the need for concrete decisions and action for conservation purposes under the ESA. Although described species are only hypotheses of historical lineages, many currently recognized species are better supported by the use of multiple secondary concepts and different data sets. The benefits of realizing and recognizing how much biodiversity truly exists far outweigh the costs of describing it. Indeed, the most beneficial result deriving from incorporating the hierarchy is that actual units of biodiversity could be recognized, leading to more productive utilization of resources during conservation. In addition, adoption of the hierarchy would alleviate two mistakes that stem from bad science and result in bad conservation: data chauvinism and value judgments.

Data chauvinism, preferring a particular data gathering method to the exclusion of all others, has become more rampant with the increase in the number of techniques for identifying species. All too often the newest technology is seen as the best and only way to gather data, instead of being seen as an alternative method to offer new insight into the group.

For example, despite the diverse array of characters available for species descriptions, morphological characters have been preferred in purely taxonomic studies.[244] In contrast, the proliferation of molecular techniques in systematic studies has led to the identification of unrecognized lineages, and represents a new approach to recognizing species.[245] Some scientists tend to favor genetic analysis as their primary method, both because it represents the latest technology and because it is perceived to offer a solution to the problems associated with morphological characters.[246] Many attempts have been made to set a level of genetic divergence for a particular gene at which two populations are assumed to be different enough to warrant separate species status.[247] If two populations do not show adequate genetic

244. Mayden, *supra* note 2, at 187.

245. *Id.*; *see, e.g.*, Alan R. Templeton, *Using Phylogeographic Analyses of Gene Trees to Test Species Status and Processes*, 10 MOLECULAR ECOLOGY 779, 780 (2001); John J. Wiens & Tonya A. Penkrot, *Delimiting Species Using DNA and Morphological Variation and Discordant Species Limits in Spiny Lizards* (Sceloporus), 51 SYSTEMATIC BIOLOGY 69, 86 (2002).

246. Morphological characters, such as color or body shape, though easiest for non-scientists to use because they do not require sophisticated techniques, tend to be disdained because they may change over an individual's lifetime or are environmentally controlled through diet or temperature.

247. Grierson, *supra* note 143, at 489.

divergence, then it is assumed that they are the same species.[248] For example, one gene frequently used by systematic biologists is found in the mitochondrial DNA,[249] which tends to evolve at a faster rate than nuclear DNA.[250] This approach no doubt would please many scientists, lawyers, and policy makers because it allows for discrete analysis, management, and regulation of endangered species.

However, a common mistake made with respect to genetic analysis is assuming that, because it is a fundamental unit of inheritance, it will forever end all disputes. No one gene is appropriate for analysis across all of biodiversity. For example, even the rates of mutation in DNA are variable.[251] Some groups of organisms, such as the sturgeon, are known to have low rates of evolution in mitochondrial DNA.[252] In a more striking example, unionid mussels, a highly endangered group of invertebrates, have evolved different mitochondrial genomes among males and females of the same species. These genomes may exhibit larger genetic differences between sexes of the same species than between different species.[253] Application of taxonomy based only on

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248. *See, e.g.*, Amy R. McCune & Nathan R. Lovejoy, *The Relative Rate of Sympatric and Allopatric Speciation in Fishes: Tests Using DNA Sequence Divergence Between Sister Species and Among Clades*, *in* ENDLESS FORMS: SPECIES AND SPECIATION, *supra* note 138, at 172, 176.

249. Mitochondrial DNA is found in the mitochondria, the cellular organelle that is responsible for producing much of the energy used for cellular activities. It is inherited through the maternal line.

250. Picking the most rapidly evolving portion of DNA is useful because differences in composition will appear quickly, ideally replicating differences in the lineages of the two species.

251. Jeannette Krieger & Paul A. Fuerst, *Evidence for a Slowed Rate of Molecular Evolution in the Order* Acipenseriformes, 19 MOLECULAR BIOLOGY & EVOLUTION 891, 896 (2002); *see also* Mayden, *supra* note 2, at 188–89.

252. *See* Krieger & Fuerst, *supra* note 251, at 891, 895–96; *see also* Andrew M. Simons et al., *Phylogenetics of* Scaphirhynchus *Based on Mitochondrial DNA Sequences*, 130 TRANSACTIONS AM. FISHERIES SOC'Y 359, 364 (2001). Sturgeons, a controversial endangered group, offer a prime example of how genetic tests should not be the sole method to evaluate species status. Alabama sturgeon, found only in the Mobile Basin, and shovelnose sturgeon, found only in the Mississippi Basin, have been found to have low genetic divergence as seen in two mitochondrial genes, despite obvious morphological differences. However, the two river basins have been isolated from each other for one to five million years, indicating that in this instance mitochondrial DNA does not necessarily evolve rapidly and, thus, should not be used as the sole benchmark for species divergence.

253. *See* Walter R. Hoeh et al., *Multiple Origins of Gender-Associated Mitochondrial DNA Lineages in Bivalves* (Mollusca: Bivalvia), 50 EVOLUTION 2276, 2278 (1996). Within the past decade, evolutionary studies of mussels have uncovered this phenomenon, known as gender-associated mitotypes. Because mitochondrial DNA is typically inherited through the maternal line, there is usually only one form of it found in any individual. However, within these mussels, an unusual type of mitochondrial DNA inheritance leads to certain individuals in a population having both forms of the DNA. These two forms may be quite genetically distinct; there may be up to 33% divergence between the two genomes. In this

DNA would create a miscalculation of recognized biodiversity. Decisions on species status that are based on set distances across a small section of total cellular DNA will provide as biased a perspective on diversity as any other single suite of characters.[254] Exclusive use of one type of data will not portray an accurate picture of biodiversity.

Closely related to the problem of data chauvinism are human value judgments in science. While some scientists may be reluctant to rely on anything but molecular data, others feel that species must be visually distinguishable. There is a hesitance among scientists to accept a species described solely on the basis of genetic difference, particularly if the human eye can discern no obvious morphological differences from another close relative. Indeed, public and political support tends to favor conservation of obviously distinct charismatic species that make ideal poster animals for environmental NGOs. Even with obvious morphological differences, there may still be little support for the recognition and preservation of a species without a general belief that this species performs a special role in its community.[255]

This type of value judgment and chauvinistic attitude regarding data will drastically limit the recognized biodiversity, as species will be identified only on a perceived notion of worth to humans. Use of a conceptual hierarchy prevents this bias by explicitly providing for all possible data to be used in species descriptions, so long as such data are compatible with the theoretical framework that holds that species have distinct evolutionary lineages and that the traits within a species are heritable.

Value judgments also play a large part in decisions of what species are studied, presented to the public, and, ultimately, saved. Though mammals comprise only 0.32% of the described species,[256] they make up 32% of the listed endangered animals in the United States.[257]

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instance, using a single criterion as a means to evaluate species status would result in an overestimate of actual biodiversity.

254. Using one gene to distinguish species can be similar to using one sentence to distinguish papers. In other words, just because two fairy tales begin with the sentence "Once upon a time..." does not mean that they will end the same way.

255. Manuel Lujan, Secretary of the Interior for the first Bush administration, stated, "Nobody's told me the difference between a red squirrel, a black one or a brown one." John Lancaster, *Lujan: Endangered Species Act "Too Tough," Needs Changes*, WASH. POST, May 12, 1990, at A1.

256. Of the 1.4 million currently recognized species, *see* EDWARD O. WILSON, THE DIVERSITY OF LIFE 13–33 (1992), 4450 of these are mammals.

257. Calculated as a percentage of the currently listed animal species out of 1078 listed animal species, 349 are mammals. Mammals still account for 19% of the listed species when combined animal and plant species (1827 listed) are used. *See* U.S. FISH & WILDLIFE SERV.,

This does not even factor in the relative abundance of mammals when compared to the total estimated species on Earth, which may place their abundance between 0.04 and 0.004%.[258] The proportion of listed mammals does not reflect a greater imperilment of this group so much as human values dictating which species should be studied and protected. In contrast, the conceptual hierarchy allows for better comparisons of diversity across all taxonomic groups.

IV. CONCLUSION

The role of scientists in helping to identify species is paramount, yet also vulnerable to attack by non-scientists and scientists alike. Both groups have questioned the identification of appropriate units of biodiversity in the listing of the Alabama sturgeon, black turtle, red wolf, gray wolf, Florida panther, and dusky seaside sparrow.[259] Nevertheless, determining species status is not a process that should occur in the courtroom. Instead, it should be an objective process, supported by scientific data and structured by a correct understanding of the various species concepts. Because conservation biology is a science, it is imperative that no decisions about species status are made with policy as the principal goal. Allowing any other discipline to intervene with taxonomic research will lead to bias and ethical dilemmas, neither of which will aid the goal of conservation.[260] Although listing decisions are unavoidably political, such pressure must not affect the science involved in species identification.

While some may describe this call for independent taxonomic research as further evidence of the "insulated ranks of university ecologists,"[261] bringing more political pressure and influence to the science involved will not produce better results. An accurate scientific understanding of species will no doubt aid legal protection, but a legally based definition of species will not help discover diversity nor will it provide an accurate assessment of the biodiversity of communities upon which *Homo sapiens* finds itself dependent.

SPECIES INFORMATION: THREATENED AND ENDANGERED ANIMALS AND PLANTS, *available at* http://endangered.fws.gov/wildlife.html#Species (last visited May 23, 2005).

258. WILSON, *supra* note 256, at 132 (Wilson estimates that between 10 and 100 million species may be present on Earth.).

259. *See, e.g.*, Karl & Bowen, *supra* note 186, at 997; Stephen J. O'Brien & Ernst Mayr, *Bureaucratic Mischief: Recognizing Endangered Species and Subspecies*, 251 SCIENCE 1187, 1187 (1991); Vaughan, *supra* note 8, at 586.

260. *See* Shrader-Frechette & McCoy, *supra* note 195, at 1009–10.

261. Robert J. Taylor, *Biological Uncertainty in the Endangered Species Act*, 8 NAT. RESOURCES & ENV'T 6, 6 (1993).

Given the current climate surrounding the ESA, it is highly unlikely that use of the hierarchy of species concepts will be mandated through legislation. However, as scientific understanding of species concepts evolves, policies reflecting that evolution must be modified, both by agencies charged with protecting species and by jurists enforcing the ESA.

Using outdated concepts to identify biodiversity is not only distasteful to conservation biologists and taxonomists, but also contrary to the ESA itself—both substantively and procedurally. The ESA was written with lofty goals in mind and is aimed at protecting not only species, but also smaller segments of species diversity that may be threatened.[262] The statute is already prepared to accommodate a wide spectrum of biodiversity and no doubt it will benefit from a more inclusive definition of species without any codified change.

Understanding the true nature of species and appropriate species concepts is important to a wide variety of disciplines working in conservation biology. Use of the hierarchy of species concepts will provide a better estimate of the number of imperiled taxa and a more accurate identification of areas of higher biodiversity, in addition to an improved understanding of processes creating and sustaining this diversity. For the ESA, use of the conceptual hierarchy will ensure that resources utilized in protecting species are, in fact, protecting real units of biodiversity and not arbitrary delineations. Given the current conservation crisis, it is vital that we not let antiquated species concepts inhibit the scope of protection possible for truly endangered species.

262. 16 U.S.C. § 1532(16) (2000).