Designatable Units for Species Status Assessment and Protection

DAVID M. GREEN

Redpath Museum, McGill University, Montreal, PQ, H3A 2K6, Canada, email david.m.green@mcgill.ca

Abstract: Species status assessment and the conservation of biological diversity require that status units for populations below the species level be defined when appropriate. Finding a definition for the 'distinct population segment' provision contained in the U.S. *Endangered Species Act* has been tackled largely in terms of Evolutionarily Significant Units, yet contrasting conceptions of the Evolutionarily Significant Unit parallel those of the learned and unsolvable debate over what constitutes a biological species. As with species concepts, Evolutionarily Significant Units are not resolvable into a single approach, to the potential detriment of biodiversity protection. A practicable means to identify entities for status assessment is the idea behind the Designatable Unit. As necessary, Designatable Units may be recognized in cases where a single status designation for a species is not sufficient to portray probabilities of extinction accurately. The Designatable Unit, unlike the Evolutionarily Significant Unit, arises in the process of determining status as a device for reporting status and not as a concept for subspecific systematics. Designatable Units may be based on established taxonomy, genetic evidence, range disjunction, and/or biogeographic distinction. They do not apply to biologically arbitrary management units and should not be recognized if all subdivisions within a species have the same risk status. The pragmatic approach of the Designatable Unit, adopted by the Committee on the Status of Endangered Wildlife in Canada for status assessment of species under the Canadian *Species at Risk Act*, avoids the most serious conceptual and methodological pitfalls of other approaches.

Key Words: status assessment, endangered species, evolutionarily significant unit, designatable unit, distinct population, extinction risk

Introduction

Management and protection of endangered or threatened species require that they be assessed, recognized, and officially listed in some manner. It is widely recognized that accurate species status assessment demands that populations below the species level be considered when appropriate, and most endangered species legislation takes this into account. Accordingly, Section 3(15) of the U.S. *Endangered Species Act* of 1973 has provision for listing "distinct population segments" of vertebrate animals by including them in the definition of "species". Likewise, Section 2(1) of the Canadian *Species at Risk Act* (SARA) of 2002 enables the consideration of distinct populations for legal listing by including them under the definition of "wildlife species".

However, attempts to define what “distinct populations” may be as units for assessment, designation, and legal protection have been laden with difficulties. For the most part, conservation geneticists and systematists working under the terms of the U.S. *Endangered Species Act* have equated “distinct population segments” with “Evolutionarily Significant Units” (ESUs), which Ryder (1986) proposed as “subsets of the more inclusive entity ‘species’, which possess genetic attributes significant for the present and future of the species in question”. Subsequently, a plethora of concepts and criteria for delimiting ESUs has emerged (Fraser and Bernatchez 2001). This has fueled a lively intellectual debate but has not lead to any universally accepted practice. When the preservation of biological diversity in all its forms is at stake, this is untenable.

Evolutionary Significant Units: The ‘Species Problem’ Extended

ESUs have largely been investigated using molecular methods, principally mitochondrial DNA phylogeography (Moritz 1994, 2002; Grady and Quattro 1999). In many cases, the results are unequivocal and neatly divergent; reciprocally monophyletic groups emerge, which may be labeled ESUs. This approach is particularly useful in species with readily definable genetic and geographic units, particularly anadromous salmonid fishes (Waples 1991); however, this is not always the case. Mitochondrial haplotypes and nuclear genomic distinctions do not necessarily align (Ferris et al. 1983; Waits et al. 2000; Rognon and Guyomard 2003). Furthermore, strict adherence to monophyly as a criterion discounts the anagenetic evolution that is part of the diversification of species (Pennock and Dimmick 1997; Crandall et. al. 2000; Pearman 2001). In the cases of both the black turtle, a Pacific Ocean form of the green turtle (*Chelonia mydas)* (Karl and Bowen 1999), and the dusky seaside sparrow (*Ammodramus maritimus nigrescens*) (Avise and Nelson 1989), phylogenetic reconstructions indicate that distinct forms have arisen from within evolutionary lineages. Recognizing this as paraphyly may be reasonable in terms of understanding the cladogenic history of populations, but in terms of depicting total genetic diversity, it is inadequate. Cladistic methods purposefully ignore the autapomorphies that make lineages distinct though do not carry phylogenetically informative information.

The lack of consensus surrounding the ESU (Waples 1998; Bowen 1999; Young 2001) stems from many of the same philosophical and interpretive dilemmas plaguing the derivation of an acceptable scientific definition of ‘species’ by systematists (Cracraft 1997; de Queiroz 1998). The long-standing ‘species problem’ has had two intertwining philosophical and scientific aspects to it. There has been the issue of definition (i.e., ontology), beset with an assortment of philosophical conjectures which cannot be empirically tested (Sober 1993). More germane is the issue of discerning species (i.e., epistemology), fraught with an accumulating cornucopia of competing species concepts (Mayden 1997), each of which emphasizes a different aspect of the biology of species. Three examples will suffice. The Biological Species Concept appeals to contemporary attributes of organisms, particularly evidence of interbreeding. The Phylogenetic

Species Concept, including de Queiroz's (1998) General Lineage Concept, emphasizes historical patterns of descent, particularly monophyly of lineages. The Phenetic Species Concept works with measurable parameters of similarity or difference. No one concept has proven universally acceptable among biologists.

The same discord, for precisely parallel reasons, attends concepts of the ESU. Waples's (1991) view of an ESU is that it comprises a population or a group of populations that "(i) is substantially reproductively isolated from other conspecific population units, and (ii) represents an important component of the evolutionary legacy of the species." The first part of this clearly harkens to the Biological Species Concept. Moritz's (1994) ESU concept as populations that "(i) are reciprocal monophyletic for mtDNA alleles, and (ii) demonstrate significant divergence of allele frequencies at nuclear loci" equally clearly appeals to a Phylogenetic Species Concept. Also phylogenetically based is Fraser and Bernatchez's (2001) argument for the ESU to be best conceived of as "a lineage demonstrating highly restricted gene flow from other such lineages within the higher organizational level (lineage) of the species", which echoes de Queiroz's (1998) species concept. Finally, Vogler and DeSalle (1994) conceived of ESUs as "groups that are diagnosed by characters which cluster individuals or populations to the exclusion of other such clusters", a proposition in line with the Phenetic Species Concept.

The Pragmatic Alternative: Designatable Units

Endangered species protection and recovery is too pressing a concern to remain embroiled in issues of systematics or philosophy. A different approach is needed. Recognition of populations below the species level for assessment must be guided by the general objective of preventing elements of biodiversity from becoming extinct or extirpated. The appropriate approach to assigning status should be to first examine the species as a whole, and then as necessary, to examine the status of Designatable Units (DUs) below the species level in cases where a single status designation for a species is not sufficient to accurately portray probabilities of extinction within the species.

Designatable Units may be recognized on the basis of established taxonomy, genetic evidence, range disjunction, or biogeographic distinction. The most obvious form a DU may take is a recognized subspecific taxon as listed in an appropriate standardized faunal or floral checklist such as the American Ornithological Union's checklist of birds, or the Society for the Study of Amphibians and Reptiles' list of names of North American amphibians and reptiles (Crother et al. 2000). For example, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists separate status designations for subspecies of loggerhead shrike (*Lanius ludovicianus migrans vs. L. l. excubitorides*) and northern water snake (*Nerodia sipedon sipedon vs. N. s. insularum*)**.** For taxononic groups for which no standardized lists are available, subspecific taxa recognized by relevant scientific authorities are available.

Designatable Units may also be identified based on evidence of genetic distinctiveness, which may consist of heritable morphological, life history, and/or behavior traits, and/or evidence from genetic markers such as allozymes, DNA microsatellites, DNA restriction fragment length polymorphisms, or DNA sequences. These methods return ESUs in the strict sense of Waples (1991) or Moritz (1994). For example, COSEWIC (2004) listed the Interior Fraser River run of coho salmon (*Oncorhynchus kisutch*) as opposed to other populations of the same species (COSEWIC 2004).

Disjunctions between substantial portions of a species' global geographic range indicate that dispersal of individuals between those regions is severely limited or impossible. As such, range disjunctions are indicators of probable genetic differentiation, and, therefore, may be used as the basis for recognizing DUs. The Nova Scotia population of Blanding's turtle (*Emys blandingii*) is an example of this as it is completely isolated from other populations of the same species and has a different probability of long-term survival.

Finally, occupation of differing biogeographic regions by a species reflects the probable existence of historical or genetic distinctions and adaptations in each of those regions. Biogeographic regions are typically depicted on an ecozone or biogeographic zone map. In northern latitudes, following glaciation, terrestrial species with good dispersal abilities, such as large mammals, birds, or plants with small, wind-blown seeds, have formed readily recognizable biogeographic zones (Commission for Environmental Cooperation 1997), whereas many smaller, less vagile terrestrial animals, including terrestrial molluscs, amphibians and reptiles, entered their present northern ranges by following a limited number of dispersal corridors. Freshwater species may be distributed following entirely different rules in accordance with watersheds. COSEWIC (2004) has listed both the woodland caribou (*Rangifer tarandus caribou)* and tiger salamander (*Ambystoma tigrinum*) populations based on occupation of biogeographic zones.

Conclusions

A species, under law, is what is legislated, not what is discovered. The recognition of conservation status for species at risk of extinction is an action taken in the process of translating science into policy. Separate status designations should not be recognized for management units that are not based on biological criteria, nor should they be individually assigned to units below the species level if all such units have the same status. The concept of a Designatable Unit, concentrating on status assessment made with the best available information, aids the development of better policy and conservation action. The Designatable Unit enables focus to be placed first on status, not taxonomic units or phylogroups, by directing examination of the status of a species as a whole, and then, if necessary, on investigation of the appropriateness of assigning status to units below the species level. Recognition of DUs, unlike ESUs, therefore arises for cases where a single designation is not sufficient to accurately portray probabilities of extinction within the species. This pragmatic approach, adopted by COSEWIC for status assessment of species under SARA, avoids the most serious conceptual and methodological pitfalls of other approaches.

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