The Listing of Coast Redwood as Endangered Under the IUCN Red List: Lessons for Conservation[1]

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Abstract

In 2013, redwood (*Sequoia sempervirens* (D.Don) Endl.) was listed as endangered under the International Union of Conservation of Nature (IUCN) Red List. While this listing has no political or legal consequences for the management of redwood, it could have economic consequences as land and mill owners of the redwood region have sought to link redwood to sustainable practices in the marketplace. This paper argues that the listing of redwood, however, is fundamentally flawed by the metrics of the Red List, and that the listing misses the chief conservation challenges related to redwood, which center on ecosystem functionality, not continued existence of individuals in the wild. The IUCN, which maintains the most globally comprehensive list of threatened species, and which seeks to influence conservation actions, could address this flawed listing by creating multiple lists, including a "threatened ecosystem" list.

Keywords*:* conservation, endangered species, *Sequoia sempervirens*

Introduction

Concern about species extinction has increased in light of the profound consequences of human activities that have contributed to increasing extinction rates (Barnosky et al. 2011). Proposals to conserve species and biodiversity have ranged from local to global, with accompanying policy and logistical mechanisms at each level. At the global level, one of the most far-reaching efforts has been conducted by the International Union for Conservation of Nature (IUCN), an organization that has been compiling the Red List of Threatened Species (Red List) since 1964. The Red List informs conservation policies and planning by functioning as "a clarion call to action" and has become regarded as a tool that provides consistency in labeling species in need of conservation investment (Vie et al. 2008).

In 2013, coast redwood (*Sequoia sempervirens* (D.Don) Endl.), a commonly-utilized commercial timber species of the west coast of the United States, was determined to be endangered under the IUCN categorization system, meaning it is deemed to be facing "a very high risk of extinction in the wild." This paper is intended as a discussion piece, asserting that the listing of redwood as endangered is flawed and misstates the real threats to redwood ecosystems – which revolve not around the continued existence of the species, but to ecosystem functionality. The listing of redwood as an endangered species under the IUCN Red List criteria deserves the attention and critique of experts within the redwood region. Within this context, this paper aims to fulfill two objectives: 1) to inform researchers and managers of the redwood region of the listing, and 2) to raise questions about the listing of redwood, its legitimacy and potential consequences. I begin with an overview of the IUCN Red List and brief history of redwood conservation, detail the rationale for listing redwood as endangered, and consider the implications of listing redwood as endangered—for the IUCN Red List, and for redwood managers. I end with suggested modifications for the IUCN Red List, which is tasked with maintaining a scientifically credible list of globally threatened species that can be used by scientists and policy makers.

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IUCN: Creating a Global List of Endangered Species

The committees of scientists who created and update the IUCN Red List have assessed a small percentage of the world's total species (~2.5 percent), but it is nonetheless the most comprehensive list of threatened species in the world (Vie et al. 2008). The Red List is updated yearly and available online. The list began in the 1960s as Red Data Books, and over time its categorization system has shifted in an effort to be scientifically defensible, objective, and useful for conservation purposes; and to create categories that are comparable across species and regions (De Grammont and Cuaron 2006, Mace et al. 2008). The Red List has been extensively cited by academics—there are over 1000 citations of the 2004 Red List alone, and many prominent studies have utilized Red List data to analyze global trends of biodiversity and conservation (for example, Brooks et al. 2006). However, controversy and contention have surrounded some listings. Some have questioned the transparency of supporting documentation, going so far as to claim that analyses have "degenerated into assertion based on secret science" (Mrosovsky 1997, p. 436). Others have critiqued more narrowly the validity of certain listings, which potentially "detract attention from those populations that are truly threatened with extinction (Broderick et al. 2006, p. 25) and "create a scenario where limited resources may not be efficiently focused on those specific regions or populations that are declining and in need of rapid conservation action" (Godfrey and Godley 2008, p. 156; Seminoff and Shanker 2008).

Redwood Conservation: an Overview

Redwood conservationists of the late 19th century, often patrician visitors from urban places, were romantics who "advocated scenic protection" for isolated redwood groves; old growth redwoods were described as majestic, but valued much more highly for their timber as the urban centers of the West Coast were built (Schrepfer 1983, p. 6). The Save-the-Redwoods League was established in 1918 by academics who gained financial support from businessmen and professionals to purchase small redwood groves, and later established several redwood parks (Schrepfer 1983). These piecemeal conservation efforts were replaced in the mid- to late 20th century by concerted efforts at maintaining the last remnants of old growth, including boycotts, legal action, and direct action such as tree sits (Bevington 2009).

As of 2016, more than 90 percent of remaining stands of old-growth redwoods were located in protected areas, and privately-held second- and third-growth redwood stands were managed under one of the most stringent private forest land regulatory systems in the United States. Strategies for conservation have therefore shifted from preserving pockets of old-growth reserves to maintaining contiguous redwood stands with increased structural diversity. This involves protecting redwood forest around the old-growth patches, and working to increase heterogeneity in remaining stands, which lack multiple canopy layers and the complex crown structure found in large trees and needed by many wildlife species[3] (Lorimer et al. 2009, Van Pelt et al. 2016).

The IUCN Listing of Redwood

The protocols for listing species under the IUCN Red List have been updated seven times since 1990, most recently in 2001 (version 3.1). Current categories for listing range from "least concern" to "extinct," with three categories for Threatened species: Critically Endangered, Endangered, and Vulnerable (fig. 1).

[3] Correspondence with Emily Burns, Save the Redwoods League.

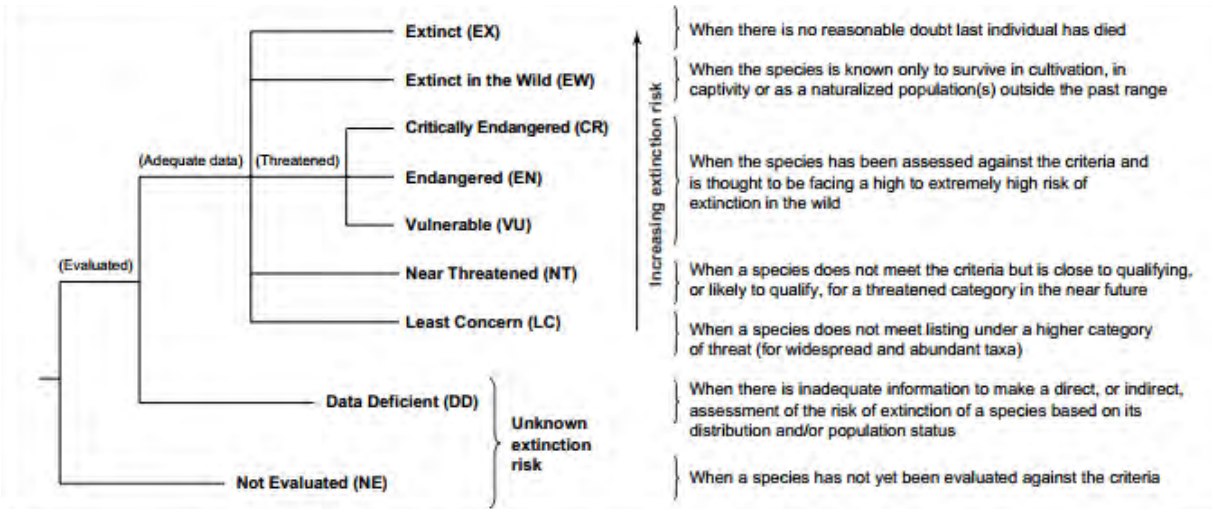

Figure 1—IUCN Red List categories, from Rodrigues et al. (2006).

Redwood was listed as endangered by the IUCN, part of an assessment of 615 conifers. Of those conifer species, 211 (34 percent) were listed as one of the three categories of threatened.[4] The overall framework of the IUCN Red List Version 3.1 is complex and beyond the scope of this paper, but the detail provided here is sufficient to understand the listing status of redwood. Redwood was listed as endangered under the categorization of *A2acd*—the significance of each of these designations is described in table 1.[5]

Table 1—Criteria or subcriteria for the listing of redwood as endangered under the IUCN Red List

Redwood listing criteria/subcriteria	Explanation
A: (criteria)	The population of mature individuals has been reduced.
2: (subcriteria)	The population of the species has declined by ≥50% over the last 10 years or three generations, whichever is longer. The reduction has not ceased, is not understood, or may not be reversible.
The subcriteria of a, c, and d refer to the basis for listing the species:	
a: (subcriteria)	The species was listed as a result of direct observation.
c: (subcriteria)	The species has had a decline in area of occupancy, extent of occurrence (the area of all of the known or potential present occurrence of the taxon), and/or quality of habitat.
d: (subcriteria)	The species was listed because of actual or potential levels of exploitation.

The Language of Listing

Though the categories for IUCN Red List Version 3.1 are clear, the reasons for listing redwood are much less clear. Claims of the IUCN conifer group are listed with direct quotations from the listing and a brief explanation of problems with the listing, based on available literature.[6]

The Decline of Individuals

According to the Red List criteria, the number of mature individuals has declined by more than 50 percent over three generations (table 1). Maturity is defined as "capable of reproduction." A

[4] http://threatenedconifers.rbge.org.uk/.
[5] From http://www.iucnredlist.org/static/categories_criteria_3_1.
[6] http://www.iucnredlist.org/details/34051/0.

generation is the "average age of parents of the current cohort." [7] In redwoods, three generations could be anywhere from hundreds to thousands of years. If the estimate of generation length is based on industrial rotations of about 60 years, then three generations could be 180 years. If second-growth redwood is considered, the "parents" would be old-growth redwood, which can live for thousands of years.

With either timeline, the decline is measured in terms of number of individuals. However, it is not clear that the number of mature individuals in fact has been reduced. The extent of redwoods is essentially unchanged though may be shifting slightly at its margins, with contraction at the southern end and enlargement at the northern end of the range (Sawyer et al. 2000a). In terms of number of mature individuals, second-growth redwood trees, which are smaller and occupy less space, may actually result in more individuals per acre than old growth. Young redwood stands (second or third growth) are "a mosaic of dense, stem-exclusion stands dominated by sprouting redwoods" (Thornburgh et al. 2000, p. 240). Thus the number of mature (in IUCN terms) redwood trees may not be diminished, though the structure of the forest is much changed.

The Purposeful Replacement of Redwoods With Other Species

IUCN Red List statement: *The proportion of redwood in commercially exploited forests containing this species is still declining, due to deliberate or accidental replacement by more competitive species in the early phases of succession after clear-felling, especially Pseudotsuga menziesii [Douglas-fir]"*

IUCN Red List statement: *Its late successional to climax dominance coupled with shade tolerance means it is easily replaced by more light demanding conifers such as Pseudotsuga menziesii* [*Douglas-fir]. This can be made 'permanent' if forests are chosen to be so managed, as indeed they tend to be in commercial forestry operations.*

These two statements appear to be the crux of the argument surrounding the IUCN claim that individuals of the species are declining. Redwood stands reach exceedingly old ages and can then maintain multiple ages within shaded stands (Busing and Fujimori 2002). But redwood is unusual among conifer species for its ability to reproduce via sprouting after disturbance, whether natural or manmade. Some authors have suggested that redwood requires disturbance (such as fires or floods) to regenerate (Barbour et al. 1980, Lorimer et al. 2009). In some second-growth stands, redwood has been proportionately diminished relative to other sprouting species such as tanoak (*Notholithocarpus densiflorus* (Hook. & Arn.) P.S. Manos, C.H. Cannon, & S.H. Oh), but its widespread replacement by Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) has not been documented, nor is it documented by the IUCN Red List. In fact, harvesting in the redwood region tends to lead toward continued redwood dominance, either through seeding or sprouting, though Douglas-fir will seed in stands that previously had the species (Boe 1975).

The IUCN Red List did not provide citations to support the claim that commercial operators in the redwood region are managing to favor non-redwood conifer species.[8] The prices for redwood exceed all other conifer species in the region, according to the California Board of Equalization, which places redwood values well above Douglas-fir (table 2) and other conifers. Other authors have noted the value of coast redwood, a species "highly valued for wood quality, rot resistance, and fast growth" (Jameson and Robards 2007, p. 171).

[7] http://www.iucnredlist.org/static/categories_criteria_3_1
[8] Follow-up emails with the listing author did not result in further citations.

Table 2—Harvest values for redwood and Douglas-fir timber, estimated by the California Board of Equalization (2016)

Species	Volume per log, board feet	Log size	Timber value, dollars (variation dependent on geographic region)[9]
Redwood	>300	Large	$570-$700
	150-300	Medium	$560-$600
	<150	Small	$490-$520
Douglas-fir	>300	Large	$100-$360
	150-300	Medium	$80-$330
	<150	Small	$60-$310

In addition to the economic incentives for commercial timber production, there are regulatory requirements for retaining and enhancing redwood reproduction on a long term basis. Most of the redwood region falls within the state of California, which regulates commercial forest operations under the Z'Berg-Nejedly Forest Practice Act of 1973. The California Forest Practice rules require replanting within 5 years following harvest. Further, the major industrial forest landowners in the redwood region have long term sustained yield plans on their properties providing further stability of redwood forests.

The Need to Maintain Old Growth and Regulate Logging

Under listed threats, the IUCN Red List highlights the need to "preserve" old growth, a suggestion that is unlikely to meet with much objection today.

IUCN Red List statement: *The conservation issues involving Sequoia sempervirens pertain largely to the necessary preservation of the remaining 'old growth' Redwood forest for ecological reasons and involve much less questions about survival in the wild of the species.*

While the criteria for listing redwood as endangered were based on number of individuals, this statement points to the more relevant conservation issue of redwood, that of maintenance of old growth stands, which have dramatically diminished in extent since the arrival of Euro-American settlers and the establishment of commercial logging regimes (Sawyer et al. 2000a). Old growth redwood forests consist of trees of many ages, including large and old trees, and structural complexity and variability (van Mantgem and Stuart 2012). However, almost all remaining old-growth redwood forests are protected—either in the region's system of state and national parks, or through agreements with the U.S. Fish and Wildlife Service designating protected areas for the federally-listed marbled murrelet (*Brachyramphus marmoratus*).

IUCN Red List statement: *Logging the species should be under stricter regulation allowing regeneration to maturity of this species.*

As a proposed conservation action, the IUCN Red List notes that the species should reach maturity in order to allow for regeneration. Maturity is defined by the IUCN as 'capable of reproduction.' Rotation ages in the redwood region vary, but even at the very lowest range of harvest ages, around 50 years old, the species is capable of reproduction. Maturity, however, is a very young age in the full course of redwood development, and at this age redwoods may not serve the many habitat functions of older redwood trees.

Under the California Forest Practice Rules, harvesting is restricted in terms of extent, timing, and cumulative impacts, including cumulative impacts to late seral habitat. Each harvest on private and state lands within California is documented in a Timber Harvesting Plan, created by a professional forester, and available to the public for review and comment. Multiple agencies (e.g., the California Dept. of Fish and Wildlife, Regional Water Boards) review each plan, including an on-the-ground

[9] Estimated for June-December 2014, http://www.boe.ca.gov/proptaxes/pdf/20142H_Final.pdf. Douglas-fir values were limited to the redwood region for geographic comparability.

assessment of impacts to public trust resources. Regulations for Timber Harvesting Plans are updated annually by the California Board of Forestry, a multi-stakeholder board approved by the Governor of California. As an example, recent regulations have clarified the responsibilities of the state's forestry sector to sequester additional carbon as part of the state's innovative and progressive global warming mitigation efforts.

Changing Area of Occupancy As a Result of Urbanization

IUCN Red List statement: *second cause of decline of area of occupancy for redwoods is urbanization, at present a relatively minor factor, but predicted to increase much in the next few decades.*

In the listing, subcriteria c notes that the species has had a decline in 'Area of Occupancy,' defined as the extent of the occurrence of the species, itself defined as an area around which an imaginary boundary can be drawn to encompass all the known or projected sites of occurrence for the species. Sawyer et al. (2000b) state that redwoods are still found throughout their historical range. There is little evidence to suggest that urbanization or other anthropogenic land use changes threaten the area of occupancy for redwoods, as the IUCN has defined its terms.

Historically, conversion occurred in the redwood region in the 19th century for agricultural purposes, though many of these lands have reverted to redwoods because of the "vigorous sprouting ability" of redwood (Sawyer et al. 2000a, p. 32). Conversion also occurred in the middle 20th century, with timberland conversion permits totaling almost 7,689 ha (19,000 ac) throughout the region in 1970 and slowing in subsequent years (Shih 2002).

Today, the northern part of the redwood region remains remote and sparsely populated, and is mostly identified as low priority for risk from population growth and development by the California Fire and Resource Assessment Program (CDF 2010). By contrast, the southern part of the redwood region has experienced significant human development, particularly exurbanization—large-scale lots scattered throughout the forest. Exurbanization likely does not reduce the number of individual trees, but creates fragmentation of habitat.

Discussion

The concerns raised here about the veracity of the redwood listing on the Red List as endangered are not entirely new, as the "mismatch of the risk of extinction predicted from applying the IUCN criteria and that predicted from a common sense evaluation of status" has been voiced before (Godfrey and Godley 2008, p. 155). The listing itself concedes that redwood does not meet the IUCN Red List definition for endangered, as redwood conservation issues revolve around the need to maintain habitat, rather than ensure the continuation of the species in the wild.

Now that the species has been listed as endangered, it is worthwhile to examine the lessons of the listing, and its possible consequences. While the listing has had limited impacts legally and economically thus far, its intended impact (to prioritize conservation efforts) has been diluted because it ignores the conservation efforts and challenges being faced by managers and researchers in the redwood region.

Legal and Economic Consequences of Listing Redwood

There are virtually no legal or political consequences of an IUCN listing in the United States. There is no direct regulatory impact because the IUCN Red List is a guide for conservation and policy setting; it is not administered by a government or used directly as a policy tool. Some species listed on the IUCN Red List have been consequently listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES lists 5,600 species of animals and 30,000 species of plants in order to protect them from overexploitation through trade restrictions. However, conifers are exceedingly rare on the CITES list, and there are no conifers from the United

States listed on CITES.[10] Redwoods have never been proposed as candidate species for the United States Endangered Species Act (ESA) list, and would not likely qualify because the ESA targets species that are facing extinction.

Economic repercussions, however, are possible because of the reputation and status of the IUCN Red List and its utility as shorthand for assessing species' vulnerability. As an example, on the Wikipedia page for *Sequoia sempervirens*, the conservation status of the species is prominently listed as Endangered based on the IUCN listing. Should redwood become more widely perceived as endangered, it could undermine the image of responsible stewardship that has been cultivated by redwood producers. Of the five industrial companies operating in the redwood region, four are certified by the Forest Stewardship Council, widely considered the most rigorous standard, and the remaining industrial owner is certified by the Sustainable Forestry Initiative.[11] Though the timber companies of the redwood region operate in a restrictive regulatory environment, they have modified their management practices even further to maintain social license and to build reputations for sustainability in the marketplace.

Threats Facing the Redwood Forest

Focusing on whether redwoods as a species will exist in the future serves to distract from conservation issues facing redwood forest ecosystems, as elaborated by the Save the Redwoods League, which points out that it is the old-growth redwood habitat, and many of the species contained therein, which is endangered.[12] Most of the watercourses of the region have been listed as impaired under the Clean Water Act (303(d)) for sedimentation as a result of logging, and multiple species of the redwood region – particularly those associated with old-growth forests – have been listed as threatened or endangered under the ESA. Fire was historically an important disturbance agent within the redwood region, and its suppression has resulted in structural changes within the forest such as increases to litter and brush biomass (Brown and Baxter 2003).

Another concern regarding redwood forests is fragmentation and particularly parcelization. While the current rates of urbanization do not pose a threat to the *existence* of the species, the redwood ecosystem has been and will continue to be threatened by parcelization because of sales from commercial forest landowners in the face of greater economic opportunities—or "higher and better uses." These economic opportunities may be from real estate developers, or from agricultural uses (including marijuana, which is a common crop in the redwood region). Rural dispersed settlement creates threats through the introduction of non-native species, and fragmentation as a result of road building and lawns (Gobster and Rickenbach 2004). While fragmentation is not likely to reduce the *number* of redwoods, human settlement patterns may further impact wildlife and ecosystem processes within the redwood region.

The most commonly-used tool for maintaining species' existence in the face of decline is to impose limitations on trade. However, lowering the economic viability of redwood timber markets does not address its conservation needs, and may in fact exacerbate them. The working forests of the redwood region have maintained relatively contiguous stands over large areas, with both industrial and non-industrial owners providing the ecosystem services that accompany large, intact forests. However, their ownerships are dependent upon viable markets, which have diminished as a result of regulation, product substitution, changes to redwood products as harvests move from old growth to second-growth wood, and changing consumer preferences.

Finally, there are potential threats to redwood as a result of climate change and shifting fog patterns, as redwoods are dependent on fog as a source of moisture (Johnstone and Dawson 2010), and so could decline or decrease at their margins, in drier areas. This threat was not noted in the IUCN Red Listing.

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[10] See full list of CITES species: www.cites.org/eng/app/appendices.php.
[11] FSC: Green Diamond Resource Company, Humboldt Redwood Company, Mendocino Redwood Company, Big Creek Lumber; SFI: Sierra Pacific Industries.
[12] https://www.savetheredwoods.org/blog/wonders/celebrating-the-endangered-species-act/.

Implications for the IUCN Red List

The IUCN maintains its Red List in the hopes that it will contribute to the conservation of species in an era of unprecedented extinction levels. The IUCN Red List has great value as a global categorization system to help in the conservation of species that are threatened with extinction. However, the endangered status of *S. sempervirens* on the Red List raises concerns about the utility and objectivity of the list. Though the Red List does not mandate conservation actions, which can only be done through policy processes that weigh economic and other benefits of species, it does highlight species that are in need of conservation action. Listing species as endangered that do not meet the criteria of the listing organization raises red flags that distract from legitimate conservation concerns. In the case of redwood, the listing focuses on the continued existence of a species that does not appear imperiled, and yet does not address the ecosystem processes that are in need of conservation attention.

The redwood listing highlights a lack of local expert input. Redwood is a species that has garnered substantial conservation attention for over 100 years. It has a non-profit conservation organization dedicated entirely to its continued success (Save the Redwoods League). Yet local experts do not appear to have been consulted. One solution is to incorporate the expertise of scientists intimately familiar with species, rather than relying on broad specialist groups that tackle groups of species worldwide. The Conifer Specialist Group assessed over 600 conifer species worldwide, and its findings (at least regarding the listing of redwood) came as a surprise to many local experts.

For the purposes of informing policy, the Red List could split into multiple lists that better incorporate different ecological concerns. Mrosovsky (2003) suggests three lists: one to assess risk of extinction, a second to indicate whether the species is fulfilling its ecological role, and a third regarding economic utility (or loss of utility). Such a system may be more useful for some species that are not at risk of extinction but that may have diminished in terms of providing ecosystem services. An ecosystem risk system could use the same logic of the Red List—to make global assessments of risk possible, and to prioritize conservation efforts across regions—and could cover more ground than single-species listings. Maintaining a list of threatened ecosystems could inform a wide variety of policies that extend beyond single-species listings, such as land use policies that slow or prevent conversion. Ecosystem-level approaches provide a policy opportunity to address connectivity and function across jurisdictional, political, and ownership boundaries.

Finally, the listing of redwood highlights an important oversight of the IUCN Red List: the utility of working landscapes that connect protected areas in order to maintain ecosystem processes over large acreages. The findings of the Red List authors imply that old-growth reserves are central to redwood conservation, yet ignore the vast majority of working landscapes that could implement (and are implementing) management to create structural diversity and habitat. The Save the Redwoods League has developed the Redwoods and Climate Change Initiative, bringing together private landowners, non-profits, and governmental agencies to work on research and outreach to maintain redwood ecosystem function.[13] As part of this vision, working forests serve to connect the patches and isolated groves of protected old-growth forests and may be critical to long term sustainability of redwood ecosystem functions. Incentives to grow forests for long periods, with investments in creating more old-growth habitat and maintaining or restoring habitat connectivity, could benefit redwood ecosystems as a whole.

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