FACTORS AFFECTING SPECIES' RISK OF EXTINCTION: AN EMPIRICAL ANALYSIS OF ESA AND NATURESERVE LISTINGS

DAVID N. LABAND and MICHAEL NIESWIADOMY*

The authors examine the impact of environmental and political variables on two measures of species imperilment across 49 U.S. states: the fraction of all species in a state identified by NatureServe as being "at-risk" of extinction, and the fraction of species in a state listed under the U.S. Fish & Wildlife Service's (FWS) Endangered Species Act (ESA). A highly significant determinant of both measures is the fraction of species endemic to the state. Population growth increases the at-risk measure, but not the ESA listings. There is a significant concern for plant imperilment by NatureServe, but not by the FWS.

I. INTRODUCTION

There are two principal sources of data on ecologically imperiled species in the United States: (1) listings of threatened and endangered species under the Endangered Species Act (ESA, 1973), and (2) listings of species considered by NatureServe to be at risk of extinction. The language of the ESA admits no influence on the determination of listings other than scientific necessity:

> The Secretary shall make determinations required by subsection (a)(1) of this section ***solely on the basis of the best scientific and commercial data*** available to him after conducting a review of the status of the species and after taking into account those efforts, if any, being made by a State or foreign nation, to protect such species, whether by predator control, protection of habitat and food supply, or other conservation practices, within any area under its jurisdiction; or on the high seas. (U.S. Code, Title 16, Chapter 35, Section 1533(b)(1)(A), emphasis added)

Listings of species at-risk of extinction by NatureServe (2002) are based on:

> . . . a consistent and rigorous methodology for assessing extinction risk that is based on evaluation of multiple factors. Evaluation criteria include: the number and condition of populations and individuals; the area or range occupied by the species; population trends (that is, whether numbers are increasing, stable or declining); and known threats. Biologists assess each species against these multiple risk factors based on the best available scientific information and assign the appropriate conservation status rank.

In theory, then, listings under the ESA and NatureServe should be consistent. In fact, there is substantial discrepancy between the two indices, with the NatureServe listings containing many more species considered ecologically imperiled than have obtained recognition and protection under the ESA. In part, this discrepancy may reflect financial constraints imposed on the U.S. Fish and Wildlife Service, which is charged with implementing the ESA. In addition, it has been argued that implementation of the ESA has been influenced by economic considerations, as translated through the political process. For example, Bean (1991) and Mehmood and Zhang (2001) have argued that economic factors played an important role in determining congressional votes on amendments to the ESA. Moreover, there is evidence that how fast species proposed for listing actually get listed (Bean, 1991; Ando, 1999, 2001, 2003),

*This is a revision of an article presented at the Western Economic Association International 79th annual conference, Vancouver, July 1, 2004, in a session organized by David Laband, Auburn University. This research was supported by a McIntire-Stennis grant to the first author through the School of Forestry and Wildlife Sciences at Auburn University. The authors appreciate the assistance provided by Karen Anderson and Tim Hall of the U.S. Fish and Wildlife Service and the helpful comments of Wade Martin and two reviewers. The authors are solely responsible for remaining errors.

Laband: Professor of Forest Economics & Policy, Auburn University, Auburn, AL. E-mail labandn@auburn.edu
Nieswiadomy: Professor of Economics, University of North Texas, Denton, TX. E-mail miken@unt.edu

ABBREVIATIONS

FWS: U.S. Fish and Wildlife Service
ESA: Endangered Species Act
LCV: League of Conservation Voters
OLS: Ordinary Least Squares

Contemporary Economic Policy (ISSN 1074-3529)
Vol. 24, No. 1, January 2006, 160–171
Advance Access publication November 11, 2005
doi:10.1093/cep/byj015

the types of species that get listed (Metrick and Weitzman, 1996; Weitzman and Metrick, 1998; Ando, 2003), and the geographic distribution of listings (Rawls and Laband, 2004) are subject to the influence of economic interests through the political process. Complicating matters is the fact that implementation of the ESA is also subject to judicial intervention (Associated Press, 2004).

These criticisms of how the ESA has been implemented may create doubts about whether ESA listings are based significantly on scientific criteria. In this article, the authors provide empirical evidence in support of scientific foundations for ESA listings. They do so by analyzing factors that influence species' ecological imperilment across states, using two different measures of species imperilment: the fraction of all species in a state identified by NatureServe as being "at-risk" of extinction, and the fraction of species in a state listed under the U.S. Fish & Wildlife Service's Endangered Species Act (ESA). At issue is whether the factors that influence listings compiled by NatureServe also influence ESA listings.

One of the authors' principal findings is that both measures of species' ecological imperilment are influenced strongly by the fraction of species found only in each state. These endemic species exist in relatively small, ecologically distinct niches and are characterized by small populations that are consistent with being ecologically vulnerable. Another consistent finding is that aquatic species are especially subject to being listed as ecologically imperiled. However, there are notable differences between the two explanatory models, especially with respect to the impact of human population growth and the imperilment of plant species. In the next section, the authors identify factors that influence species' ecological viability. They then introduce their empirical model and data, followed by presentation and discussion of their empirical findings.

A. Factors that Influence Species' Ecological Viability

Biodiversity and Endemic Species. For a given rate of naturally occurring extinctions at any given point in time, the number of ecologically fragile species per fixed geographic area will be greater in areas inhabited by relatively large numbers of species than in areas not supporting much biodiversity (Wilson, 1988). One way of making apt comparisons across desired units of analysis is to identify the number of fragile species in each unit, with an explicit control variable for total biodiversity in each unit. Alternatively, one can divide the number of fragile species in the focus area by the total number of species found in the focus area. This approach, which the authors adopt, permits comparison across units to be made in terms of the proportion of species that are imperiled.

In addition, due to wider ranges of moisture, temperature, and geophysical attributes, some states have greater numbers of unique ecological niches than others, which support plant and animal species found nowhere else. These endemic species are inherently more likely than species with wider ranges of habitat to be characterized by low populations and to be vulnerable to relatively sudden changes in environmental conditions. *Ceteris paribus*, the authors expect the fraction of ecologically imperiled species in a state to be positively impacted by the fraction of species endemic to that state.

Human Population Growth. The health and/or ecological viability of plant and animal species may also be impacted (for better or worse) by anthropogenic activity. It seems likely that the severity of any deleterious impacts is positively related to the significance and extent of man's activity. Human activity (e.g., residential and commercial building) directly pressures populations of target plants and animals. As a result, as human populations increase, they "crowd out" other species. If human population-induced crowding-out of other species occurs to the point of jeopardizing the viability of those other species, the number of ecologically fragile species should be greater in states characterized by higher rates of growth in the population of *Homo sapiens* than in states with lower population growth rates of *Homo sapiens, ceteris paribus*.

Species Type. The impact of mankind on non-human life forms is not uniform across species. Some species thrive in the presence of humans; others appear to be quite human-intolerant. To account for the diversity of species in each state, the authors include variables measuring the portion of a state's species that NatureServe classifies as: (1) terrestrial vertebrates,

(2) aquatic vertebrates, (3) vascular plants, or (4) invertebrates. As the fraction of all species that are terrestrial increases, the fraction of species that are ecologically imperiled might be expected to climb, since man is also a terrestrial being. Thus, the crowding-out effect referred to previously may be, in the main, especially germane to other terrestrial species. However, many terrestrial species are mobile, at least within some geographic range, and thus able to escape the immediate impact of human presence/activity. This suggests that although terrestrial species are in direct competition with *Homo sapiens* for space, the crowding-out effects implied by a steadily increasing human population may not be significantly detrimental to most terrestrial species.

On the other hand, even though humans are not overtly aquatic creatures, the effects of man's presence and activities are felt acutely by aquatic species. This is because people directly alter the natural composition of water by using it as a coolant and as a repository for waste materials, and because water filters out land and air pollution, exposing aquatic life to high concentrations of these pollutants. Further, aquatic life cannot easily escape some, if not most, of these pollutants, since they travel in suspension and move wherever water moves. Many terrestrial animals can actively avoid mankind's toxic residuals; aquatic life cannot. Thus, one might hypothesize that aquatic life may be more imperiled than terrestrial life by man's activities. This is an unresolved empirical question. Furthermore, because plants live in fixed locations and cannot migrate easily, they are, in theory, especially susceptible to exogenous disturbance of their environment. Again, this suggests that plants may be differentially adversely affected by man's presence as compared with mobile terrestrial life. Whether invertebrates are more or less imperiled than other taxonomic groups by man's activities is difficult to determine *a priori*. In the absence of prior expectation about the strength of species-class effects, the authors look to the coefficient estimates to gain information. However, for the purposes of this investigation, the issue of interest is whether ESA listings and NatureServe listings are both influenced by similar ecological considerations. Thus, the authors will be looking for evidence that the influence of species-class effects (if any) is reflected in both ESA and NatureServe listings.

Hunting, Fishing, Farming, and Forest Cover. Hunters and fishermen have asserted that they promote the ecological viability of the species they hunt because their license revenues fund research on species reproduction, health, management, habitat enhancement, and so on. But there is an associated reason to believe that hunting and fishing promote the ecological viability of game species: private landowners have an economic incentive to set aside and/or develop habitat conditions that game species desire. By proving to prospective hunters and fishermen that desirable game species are abundant on their property, private land owners can profit by selling hunting and/or fishing rights. As a side effect of enhancing the ecological well-being of the target species, private land owners' preservation and development of habitat for game species also expands habitat for certain non-game species that share ecosystems with game species. But the aggregate net effect of hunting and fishing on species imperilment is not clear. Human disturbance of critical micro-habitat, albeit unintended, still may harm the affected species. In addition, by encouraging the ecological vitality of target species, there may be numerous indirect effects (some positive, some negative) on other species.

The incidence of hunting and fishing (or agriculture) in a state also may serve as a proxy for the fraction of the population that is rural. While a specific link between percent of rural population and fraction of ecologically imperiled species has not, to the authors' knowledge, been established, one anecdotal claim is that rural dwellers have a greater appreciation for nature than do urban dwellers. If so, then states with a relatively greater proportion of agricultural activity than others may have fewer ecologically fragile species because the relatively large rural population avoids activities that degrade the environment. It is also possible that farming and ranching promote more diverse habitats for species than exist in urban areas. If so, this also would suggest an inverse relationship between measures of agricultural activity and measured species imperilment.

As the amount (percent) of forest cover in a state increases, the authors generally would expect to observe fewer ecologically threatened species. This is because for those species that are forest-dependent, more forest implies less resource stress. Having said this, it should be pointed out that not all forest cover is created equal. While not much is known yet about the ecological consequences of intensively managed forests, there are fears that monoculture forests support far less species diversity than do natural forests (Carlton, 2004). It is also possible that NatureServe or the FWS perceive threats (due perhaps to imminent forest loss) to be great for species dwelling in forests. Furthermore, some environmental groups have pressured the FWS to list animal species in order to protect old-growth forests, which would indicate a positive relation between listings and forest cover. Thus, the sign of the forest variable is difficult to predict *a priori*.

B. *Political Variables*

Because of the previously documented concern that ESA listings may be subject to political influences, the authors consider several political variables in their models. First, they include a variable to measure the environmental rating of each state's congressional delegation. The authors use the League of Conservation Voters (LCV) rating on a scale of 0 to 100, with 100 being the highest environmental score, averaged across the members of each state's delegation to the U.S. House of Representatives, over the 1973–2000 period. It is tempting to declare that states with higher LCV scores will be characterized by more ESA listings. However, the relationship may not be this simple. It may be that states with relatively large numbers of voters who are sensitive to environment issues elect representatives who support pro-environment legislation and also have adopted state-specific and local measures to protect the environment. This means that a relatively high LCV score for a state's congressional delegation could be related negatively to that state's relative incidence of ecologically fragile species.

The second political variable the authors use is the percent of the 1973–2000 period during which a state had a member on the Interior Subcommittee of the House of Representatives' Appropriations Committee. Since this subcommittee provides budgetary oversight for the U.S. Fish & Wildlife Service (which controls the listing process pursuant to the ESA), the authors expect that states with more representation on this subcommittee are better able to influence listings under the ESA. For similar reasons, a reviewer suggested that the authors include variables that reflect each state's representation on the Environment and Natural Resources Subcommittee of the House Merchant Marine and Fisheries Committee, and on the Clean Water, Fisheries, and Wildlife Subcommittee of the Senate Environment and Public Works Committee.[1] Both of these subcommittees are critical to legislative re-authorization of the ESA. This reviewer also suggested including a variable that measures each state's representation in the White House, through either the presidency or vice presidency. The fact that the president can withhold his signature from legislatively approved bills provides the president (and surely also the vice president) opportunities to make suggestions to members of the above-listed subcommittees when potential listings are of special interest to their home states.

As pointed out by Ando (1999, 2001), the net effect of political representation on these committees (or in the White House) is ambiguous. No doubt, economic development interests occasionally collide, politically, with environmental interests. But politicians represent *all* interests, so there is no *a priori* way of discerning whether representation on the aforementioned committee will be, on balance, reflected in more or fewer listed species.

C. *Dependent Variables*

There are at least two sources of information on the number of ecologically imperiled species per state: the U.S. Fish and Wildlife Service, which lists threatened and endangered species under mandate from the Endangered Species Act (1973), and NatureServe. NatureServe was formerly the statistical arm of the Nature Conservancy, and since 1999 has operated as "...the country's leading source of biological information for conservation planners, government agencies and land managers" (Stevens, 2000). In cooperation with natural heritage program members in all 50 states, NatureServe has compiled, and maintains, a detailed database of over 21,000 plant and animal species in the United States, including nearly 16,200 vascular plants, approximately

1. The exact names of these subcommittees changed occasionally over the 28-year period that the authors analyzed.

2,550 native vertebrate animal species (including mammals, birds, reptiles, amphibians, and freshwater fishes), and a wide spectrum of invertebrates (including "all 2,600 species in the following groups: freshwater mussels, freshwater snails, crayfishes, large branchiopods, butterflies and skippers, underwing moths, tiger beetles, and dragonflies and damselflies"). Since the number of ecologically imperiled species is likely to be related to the overall number of species in existence in a given state, the authors model species imperilment as the fraction of all known (according to NatureServe) species in a state that are identified by NatureServe as at risk of extinction or on the ESA list.

NatureServe's "at-risk" species are defined as the number of "a state's plants and animals that are at risk of extinction due to rarity or other factors." This measure includes species with a conservation status of extinct, imperiled, or vulnerable (corresponding to Global Heritage Conservation Ranks of GX, GH, G1–G3). If both "at-risk" and ESA listing variables constitute unbiased measures of species' ecological imperilment, then the authors would expect the effects of the explanatory variables to be similar for both models. However, if the coefficients are different, then the authors might reasonably question whether both measures of species imperilment truly are unbiased.

II. MODEL AND DATA

The specific model the authors estimate is:

$$
\begin{aligned}
(1)\quad & \text{Percent Imperiled Species}_i \\
& = a_1\text{PctEndemic}_i + a_2\text{PctTerrestrial}_i \\
& \quad + a_3\text{PctAquatic}_i + a_4\text{PctPlant}_i \\
& \quad + a_5\text{PctInvert}_i + a_6\text{PopGrowth\%}_i \\
& \quad + a_7\text{PctForestland}_i + a_8\text{PctFarmland}_i \\
& \quad + a_9\text{PctHuntFish}_i + a_{10}\text{LCV}_i \\
& \quad + a_{11}\text{Housefws\%}_i + a_{12}\text{Senatefws\%}_i \\
& \quad + a_{13}\text{Presvp\%}_i + a_{14}\text{ISHAC\%}_i + \varepsilon_i.
\end{aligned}
$$

The authors introduce two measures of Imperiled Species:

PctAt-Risk_i = the number of species in state i identified by NatureServe as ecologically "at risk" in 2000 divided by the total number of vascular plant and animal species catalogued by NatureServe that are found in state i, and

PctListed_i = the number of species in state i listed as threatened or endangered by the U.S. Fish & Wildlife Service under the auspices of the Endangered Species Act, divided by the total number of vascular plant and animal species catalogued by NatureServe that are found in state i.

Definitions of the explanatory variables are as follows:

PctEndemic_i = the number of species endemic to state i, divided by the total number of plant and animal species catalogued by NatureServe that are found in state i.

PctTerrestrial_i = the number of vertebrate terrestrial species found in state i, divided by the total number of plant and animal species catalogued by NatureServe that are found in state i.

PctAquatic_i = the number of vertebrate aquatic species found in state i, divided by the total number of plant and animal species catalogued by NatureServe that are found in state i.

PctPlant_i = the number of plant species found in state i, divided by the total number of plant and animal species catalogued by NatureServe that are found in state i.

PctInvert_i = the number of invertebrate species found in state i, divided by the total number of plant and animal species catalogued by NatureServe that are found in state i.

$\text{PopGrowth\%}_i$ = average annual population growth rate in state i from 1973–2000.

PctForestland_i = the proportion of state i's area that was characterized by forest cover, averaged over 1977, 1987, and 1997.

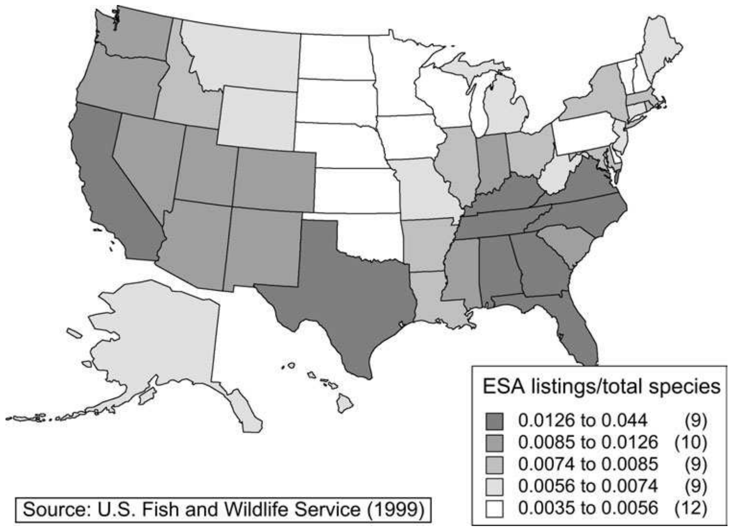
PctFarmland_i = the proportion of state i's area that was devoted to agricultural (farming and ranching) production, averaged over 1973–2000.

PctHuntFish_i = the proportion of state i's population that engaged in hunting/fishing in 1991.

LCV_i = the average rating by the League of Conservation Voters (on a scale of 0–100) of state i's delegation to the House of Representatives during 1973–2000.

Housefws_i = the proportion of time from 1973 to 2000 that state i was represented on the Environment and Natural Resources Subcommittee of the House Merchant Marine and Fisheries Committee, which is responsible

FIGURE 1
ESA Listings, 2000



for making periodic recommendations regarding re-authorization of the ESA to the full House of Representatives.

Senatefws_i = the proportion of time from 1973 to 2000 that state i was represented on the Clean Water, Fisheries, and Wildlife Subcommittee of the Senate Environment and Public Works Committee, which is responsible for making periodic recommendations regarding re-authorization of the ESA to the full Senate.

$\text{Presvp\%}_i$ = the proportion of time from 1973 to 2000 that state i was represented in the White House, either by the president or vice president.

$\text{ISHAC\%}_i$ = the proportion of time from 1973 to 2000 that state i was represented on the Interior Subcommittee of the House Appropriations Committee, which is responsible for budgetary oversight for the U.S. Fish and Wildlife Service—the agency charged with making ESA listing decisions.

ε_i = is the error term.

Equation (1) was estimated (for each measure of species imperilment) using spatial autocorrelation correction. Spatial econometric techniques have been devised to examine relationships among nearby entities. Perhaps the most fitting description of the nature of the problem is Tobler's (1979) first law of geography: "everything is related to everything else, but near things are more related than distant things." For example, if species face relatively high risks in one state, species in neighboring states are likely to be affected by spillover threats. Figures 1 and 2 show the distribution of these two measures of species imperilment.

The two types of spatial regression models that have been employed most are spatial lag models and spatial error models. The spatial lag model (also known as the mixed regressive–spatial autoregressive model) is postulated as:

$$y = \rho W y + X\beta + \varepsilon \tag{2}$$

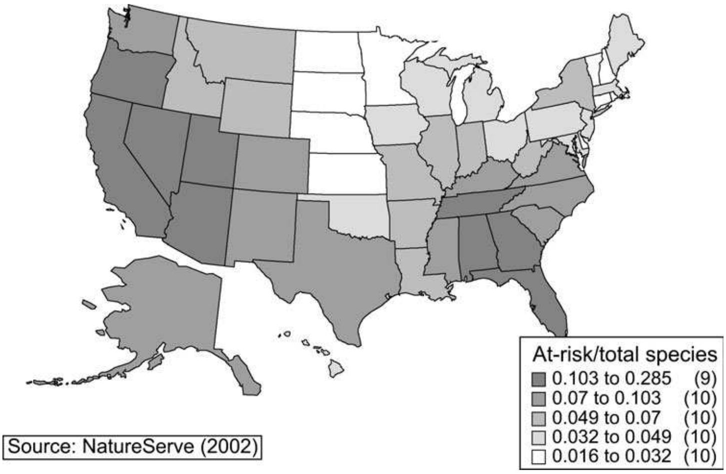
where ρ is the coefficient of the spatially lagged dependent variable, W is a spatial weights matrix (to be discussed below), X is an N by K matrix, β is a K by 1 vector of parameters associated with the exogenous variables X, and ε is a normally distributed disturbance term with a diagonal covariance matrix.

The spatial error model (also known as the linear regression model with a spatial autoregressive disturbance) is postulated as:

$$\begin{aligned} y &= X\beta + \varepsilon \\ \varepsilon &= \lambda W\varepsilon + \mu \end{aligned} \tag{3}$$

where λ is the autoregressive coefficient, W is a spatial weights matrix, and μ is a well-behaved (i.e., homoskedastic and uncorrelated) disturbance term (Anselin, 1988, pp. 34–35).

FIGURE 2
At-Risk Species, 2000



The consequences of ignoring spatial correlations are serious. Ignoring spatial lag dependence will yield biased and inconsistent ordinary least squares (OLS) estimators. Ignoring spatial error dependence will yield unbiased but inefficient OLS estimators, and the OLS standard errors will be biased. Likelihood ratio and Lagrange multiplier test statistics have been developed to determine which model best fits the data (Anselin, 1988, pp. 58–59).

Several potential spatial weights matrices have been employed by researchers. The authors employ a binary contiguity matrix of Moran (1948) and Geary (1954). If two states share a common border, they are treated as neighbors and a 1 is assigned to the weights matrix; if they do not share a common border, a value of 0 is assigned. A contiguity matrix is N by N. For the authors' example of 49 U.S. states, the contiguity matrix has 2,401 cells of zeros or ones. (Note that Alaska has no neighboring states. Also note that Hawaii is not included, because of its unique island characteristics.) Sample statistics for the data are reported in Table 1.

III. FINDINGS

The question of interest is whether factors that significantly influence NatureServe listings also significantly influence ESA listings. If so, this would suggest that, indeed, ESA listings do have a legitimate scientific foundation. If the U.S. Fish and Wildlife Service is a little more cautious than NatureServe, the implicit intercept term (percent terrestrial, percent aquatic, percent plant, and percent invertebrate sum to 1) in the ESA listings equation might be smaller, but the coefficients on the remaining explanatory variables in the two models should show a general pattern of consistency. In certain respects, this is exactly what the authors find. However, they do find notable differences between the two estimated models.

The estimated models, shown in Tables 2 and 3, have extremely high fit for cross-section analyses—the independent variables explain approximately 85–95% of the variation in the number of "at-risk" (ESA-listed) species per state. The spatial correlation tests, shown at the bottom of the tables, indicate that the spatial lag models are appropriate. Only spatial lag results are shown. The significance of the endemic variable is the reason for this strong fit. In the "at-risk" model, the coefficient on the endemic species variable consistently is somewhat greater than 1.0, meaning that the percent of "at-risk" species increases by more than 1% for every additional 1% increase in endemic species. Because of their unique characteristics and

TABLE 1
Sample Statistics

VARIABLE	MEAN	ST.DEV.	MIN	MAX
Pctlisted[a]	0.010	0.007	0.004	0.044
PctAt-risk[b]	0.07	0.05	0.02	0.29
PctEndemic[b]	0.01	0.03	0.00	0.19
PctTerrestrial[b]	0.14	0.02	0.10	0.22
PctAquatic[b]	0.05	0.02	0.01	0.09
PctPlant[b]	0.69	0.05	0.60	0.81
PctInvert[b]	0.12	0.03	0.04	0.18
Popgrow%[c]	1.13	0.94	0.00	4.80
PctForestland[d]	41.75	24.34	1.53	89.66
PctFarmland[e]	42.65	25.56	0.31	95.28
PctHuntfish[f]	0.25	0.074	0.130	0.41
Senatefws%[g]	18.62	19.89	0.00	83.33
Housefws%[g]	32.73	36.30	0.00	100.00
Presvp[h]	4.16	9.98	0.00	42.86
ISHAC%[i]	0.16	0.25	0.00	0.86
LCV[j]	46.57	17.95	13.40	84.60

Sources:

[a]Listings as a proportion of total species. U.S. Fish & Wildlife Service: http://ecos.fws.gov/servlet/TESSWeb pageUsaLists?state=all.

[b]Proportion of total species. NatureServe (2002).

[c]Percent per annum over 1973–2000 period. Data: http://www.census.gov/popest/archives/index.html.

[d]Percent of land area covered by forests (public and private) averaged over 1977, 1987, 1997 period. Data from USDA (2001).

[e]Percent of land covered by farms, 1973–2000. Data: http://www.nass.usda.gov:81/ipedb/.

[f]Proportion of age 16 and older in hunting and fishing. *1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.* http://www.census.gov/prod/1/gen/interior/, Table 58.

[g]Percent of time that a state was represented on the House (or Senate) subcommittee with oversight of U.S. Fish and Wildlife Service over the 1973–2000 period. Membership found in Brownson (annual 1973–2000), *Congressional Staff Directory*.

[h]Percent of time that a state had a president or vice president in office, 1973–2000. *Source:* see note g above.

[i]Proportion of years during 1973–2000 when state i was represented on the Interior Subcommittee of the House Appropriations Committee. *Source:* see note g above.

[j]Average League of Conservation Voters 1973–2000 rating (from 0 to 100) of state i's House of Representatives' delegates. http://www.lcv.org/scorecard.

often small populations, endemic species are more likely to be considered "at-risk." Additional species that rely on these endemic species may be "at-risk" as well. In the ESA listings model, the endemic coefficient is only about one-fifth as large. This is evidence that the U.S. Fish and Wildlife Service is more conservative (more constrained may be more accurate) in listing species than is NatureServe.

The authors find no evidence of a statistically significant relationship between the percentage of terrestrial species and either measure of species imperilment. On the other hand, they find strong, consistent evidence of a positive relationship between the percentage of aquatic species in a state and species imperilment, for both measures. The authors note that the estimated impact of PctAquatic is three times greater for at-risk listings than for ESA listings. They also find a positive and significant relationship between the percentage of plants and the percent of species listed as being at risk, but this variable is not significant in the ESA listing model. These latter two results provide some evidence in support of the claim by Metrick and Weitzman (1996) that there may be a bias in the ESA listing process that favors large, "warm fuzzy" animals—species that are more likely to be adversely impacted by man's hunting/fishing activity—over ugly, cold-blooded, immobile animals and plants, even though the latter may be more critically imperiled than the former. Although the authors' results are not directly comparable with Metrick and Weitzman (1996) (because they did not consider plants, and because the authors group species into terrestrial and aquatic types), there is evidence that plants do not receive as much attention from the FWS as from NatureServe. Nonetheless, the endemic and species categories explain a sizable portion of the variation across states in both dependent variables and provide evidence that ESA listing outcomes have, in some measure, a legitimate scientific basis.

The authors find a significant, positive impact of population growth on at-risk species, but no evidence that population growth influences ESA listings. This provides additional indication that ESA listings may be determined, in part, by factors other than scientific necessity, notwithstanding the language of the Act.

The authors find consistent evidence that both the percentage of "at-risk" species and the percentage of ESA listings are inversely related to the percentage of the state population that engages in hunting/fishing activity (PctHuntfish). In turn, the percentage of the state population that engages in hunting/fishing activity is highly correlated with the

TABLE 2
At-Risk Species Regression Estimation Results—49 States

Explanatory Variable	Estimated Coefficients (standard errors) Model 1	Model 2	Model 3	Model 4
W_Atrisk	0.2980*** (0.752)	0.2825*** (0.0719)	0.3282*** (0.0740)	0.3404*** (0.0713)
PctEndemic	1.0414*** (0.0733)	1.0693*** (0.0754)	1.1173*** (0.0826)	1.0709*** (0.0692)
PctTerrestrial	−0.0956 (0.0862)	−0.0831 (0.0834)	−0.0909 (0.0889)	−0.0285 (0.0879)
PctAquatic	0.2993*** (0.1179)	0.3142*** (0.1064)	0.4044*** (0.1068)	0.3734*** (0.1099)
PctPlant	0.0622** (0.0280)	0.0646*** (0.0273)	0.0499* (0.0234)	0.0387* (0.0237)
PctInvert	−0.0001 (0.0714)	−0.0193 (0.0713)	0.0235 (0.0691)	0.0362 (0.0690)
Popgrow%	0.0102*** (0.0028)	0.0105*** (0.0028)	0.0092** (0.0029)	0.0090*** (0.0029)
Senatefws%	−3.2E-6 (0.0001)			
Housefws%		−6.7E-5 (5.5E-5)		
Presvp%			−0.0002 (0.0002)	
ISHAC%				0.0104 (0.0070)
LCV	−0.0004*** (0.0001)	−0.0004*** (0.0001)	−0.0003** (0.0001)	−0.0003*** (0.0001)
PctHuntfish	−0.0414 (0.0294)	−0.0472* (0.0277)		
PctForestland	0.0002** (8.76E-5)	0.0002** (9.07E-5)		
PctFarmland			−0.0002** (0.0001)	−0.0003*** (0.0001)
R^2	0.9465	0.9481	0.9485	0.9495
N	49	49	49	49
Likelihood statistic	150.374	151.086	151.463	152.006
Spatial lag LR test stat.	13.17***	12.19***	14.64***	17.52***

***Statistically significant at 0.01 level; **Statistically significant at 0.05 level; *Statistically significant at 0.10 level.

percentage of land in agriculture (PctFarmland), so the authors do not include both variables in any of their estimated models. A reviewer suggested that both variables may reflect the proportion of the state population that is non-urban or, perhaps more accurately, has direct contact with and appreciation for wildlife. It is also possible that agricultural land may provide some habitat for species. The negative and significant estimated coefficient on PctFarmland is consistent with both of these interpretations. As for many of the other variables, the authors note that the coefficients are larger for PctHuntfish and PctFarmland in the at-risk model.

Both measures of species imperilment are related in a positive and significant manner to the percent of forest cover in a state. (Since PctForestland is highly [negatively] correlated with PctFarmland, the authors do not include both variables in any models.) As mentioned earlier, the impact of forests is difficult to predict *apriori*. If only the ESA listing variable were positively (and significantly) related to forest cover, perhaps the finding could be attributed to the desire of environmental groups to use the ESA to protect old-growth forests. However, since the data from both NatureServe and the FWS suggest a positive relationship between species imperilment and extent of forest cover, additional investigation is warranted.

Turning to their measures of political influence, the authors generally find little evidence that political considerations influence either "at-risk" listings (an expected result) or ESA listings (an unexpected result). Across numerous model estimations in addition to the ones reported in Tables 2 and 3, the authors fail to observe a significant relationship between ESA listings and the extent of state representation on the Interior Subcommittee of the House Appropriations Committee; the Environment and Natural Resource Subcommittee of the House Merchant Marine and Fisheries Committee; the Clean Water, Fisheries, and Wildlife Subcommittee of the Senate Environment and Public Works Committee; or the presidency or vice presidency.[2]

2. It should also be noted that ESA listings surely are influenced by court cases. This might be responsible for the divergence in numbers of ESA listings versus NatureServe listings. However, it is not at all clear that federal court cases significantly affect the state-by-state distribution of ESA listings.

TABLE 3
ESA Listings Regression Estimation Results—49 States

	Estimated Coefficients (standard errors)			
Explanatory Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
W_Percli	0.3516*** (0.1123)	0.3385*** (0.116)	0.4444*** (0.1108)	0.4108*** (0.1119)
PctEndemic	0.2037*** (0.0159)	0.2039*** (0.0171)	0.2036*** (0.0195)	0.2080*** (0.0167)
PctTerrestrial	0.0221 (0.0185)	0.0181 (0.019)	0.0139 (0.0206)	0.0183 (0.0211)
PctAquatic	0.1105*** (0.0263)	0.0932*** (0.0255)	0.0959*** (0.0268)	0.1029*** (0.0254)
PctPlant	0.0008 (0.0060)	0.0011 (0.0062)	−0.0011 (0.0054)	−0.0027 (0.0056)
PctInvert	−0.0083 (0.0155)	−0.0050 (0.0165)	−0.0015 (0.0167)	0.0006 (0.0056)
Popgrow%	−0.0004 (0.0006)	−0.0004 (0.0006)	−0.0007 (0.0007)	−0.0005 (0.0007)
Senatefws%	3.98E-5 (2.16E-5)			
Housefws%		−2.89E-8 (1.27E-5)		
Presvp%			2.19E-5 (5.03E-5)	
ISHAC%				0.0017 (0.0017)
LCV	−5.24E-5* (3.12E-5)	−3.83E-5 (3.19E-5)	−7.53E-6 (2.8E-5)	−8.91E-6 (2.78E-5)
PctHuntfish	−0.0159** (0.0067)	−0.0121* (0.0066)		
PctForestland	4.98E-5** (1.96E-5)	5.0E-5** (2.11E-5)		
PctFarmland			−3.91E-5* (2.03E-5)	−4.22E-5** (2.03E-5)
R^2	0.8738	0.8655	0.8491	0.8531
N	49	49	49	49
Likelihood statistic	224.000	222.370	220.197	220.621
Spatial lag statistic	8.265***	7.175***	11.053***	10.621***

***Statistically significant at 0.01 level; **Statistically significant at 0.05 level; *Statistically significant at 0.10 level.

Finally, the authors find that a state's League of Conservation Voters rating, as averaged across its congressional delegation, consistently demonstrates a significant inverse relationship with the percentage of species in a state that are at risk, but only one model shows a statistically significant relationship with the percentage of species listed as threatened or endangered under the ESA. The LCV rating serves as an indirect measure of how environmentally "concerned" the voters in a state are, at least relative to voters in other states. Such concern might reasonably be expected to translate into more care for the environment, broadly speaking. Thus, the authors might expect to observe an inverse relationship between LCV scores and the measures of species imperilment. However, one should not be too quick to jump to this conclusion. It is also plausible that some representatives are shrewd enough to receive high LCV ratings for the policies that impact the nation at large, but are adept at shielding their own constituents from the economic development harm of an ESA listing. In other words, these politicians' "concern" for the environment manifests itself, in terms of environmental regulations and policies, more at the national level than in their own state (Hussein and Laband, 2005). This would indeed yield the authors' finding of an inverse relationship between LCV scores and "at-risk" listings, but less robust relationship between LCV scores and ESA listings by state. But this is the only evidence that the authors are able to present (and it is inferential evidence at best) that pressure may be brought to bear by politicians in ways that influence the distribution of listings under the ESA. It is also possible that liberal states (which generally have high LCV scores) tend to be in the north and east, where there are fewer endangered species.[3]

3. The authors thank a reviewer for this comment. Also, this reviewer suggested that the empirical results for ESA listings might be influenced by a few states with large numbers of listed species. To check this, the authors re-estimated all of their models without California, Florida, and Texas (states with large numbers of endemic species and large numbers of ESA-listed species) to see whether their empirical results were different from the ones reported in Tables 2 and 3. However, the results reported in Tables 2 and 3 are robust to both samples of states.

IV. DISCUSSION

Although listings under the Endangered Species Act are supposed to be determined strictly on the basis of scientific evidence pertaining to species' ecological circumstances, previous investigators have argued that both the timing of listings and the types of species listed are influenced by non-scientific considerations. This raises a question about how much scientific underpinning there is to ESA listings. The authors investigated this question empirically by directly comparing models that estimate the impact of ecological and political factors on ESA listings and NatureServe listings of species at risk of extinction. In several areas, the authors find that scientific factors play a significant role in ESA listings. First, their findings reveal that both indices of species' ecological imperilment are influenced strongly (positively) and consistently by at least three ecological considerations: (1) the fraction of species in a state that are endemic, (2) the percentage of aquatic species in a state, and (3) the percentage of forest cover in a state. Second, the authors find consistent evidence that two anthropogenic factors, the percentage of the over-age-16 population that engages in hunting and fishing and the percentage of farmland in a state, negatively influence both listings of imperiled species. Both of these variables arguably affect the ecological viability of certain plant and animal populations.

But the authors do find areas where scientific factors are not significant for ESA listings but are for NatureServe's "at-risk" listings. First, differences in the size of the estimated coefficients on the variables in the NatureServe listings model (larger) as compared with the ESA listings model (smaller) are consistent with the observation that NatureServe lists many more species as imperiled than the ESA does. Second, NatureServe listings show a statistically significant impact of plants, whereas ESA listings do not. The authors also find that human population growth has a positive impact on NatureServe listings, but not on ESA listings. Perhaps the FWS may be pressured by citizens in rapidly growing areas to not list species under the ESA. In conclusion, why these differences between ESA and NatureServe listings exist remains a legitimate topic of inquiry.

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NatureServe Conservation Status Assessments: Factors for Evaluating Species and Ecosystem Risk

NatureServe Report
Revised Edition
April 2012

NatureServe
A Network Connecting Science With Conservation

NatureServe is a 501(c)3 nonprofit organization dedicated to providing the scientific basis for effective conservation action. NatureServe and its hemisphere-wide network of natural heritage programs are the leading source for information about rare and endangered species and threatened ecosystems.

Citation: Master, L. L., D. Faber-Langendoen, R. Bittman, G. A. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, and A. Tomaino. 2012. NatureServe Conservation Status Assessments: Factors for Evaluating Species and Ecosystem Risk. NatureServe, Arlington, VA.

Cover photo: Polar bear (*Ursus maritimus*) © Larry Master (www.MasterImages.org)

NatureServe
4600 N. Fairfax Dr., 7th Floor
Arlington, VA 22203
703-908-1800

www.natureserve.org

NatureServe Conservation Status Assessments: Factors for Evaluating Species and Ecosystem Risk

Lawrence L. Master, Don Faber-Langendoen, Roxanne Bittman,
Geoffrey A. Hammerson, Bonnie Heidel, Leah Ramsay,
Kristin Snow, Andy Teucher, and Adele Tomaino

Revised Edition

April 2012

NatureServe

Acknowledgments

This 2012 revision to NatureServe conservation status builds on the 2009 version developed by Element Ranking Work Group. Members active during the bulk of the 2009–2012 work include the authors of this report: Lawrence L. Master, Don Faber-Langendoen, Roxanne Bittman, Geoffrey A. Hammerson, Bonnie Heidel, Leah Ramsay, Andy Teucher, and Adele Tomaino. Kristin Snow provides key data programming skills for the Rank Calculator and its interface with Biotics. We thanks other members currently serving on the ERWG for their support, including Bruce Young, Margaret Ormes, and, most recently, Marilyn Anions. Past members include Steve Rust, Paul Hendricks, Bryce Maxell, and Ben Wigley. Previous revisions were done in consultation with Syd Cannings, Gwen Davis, Kathy Goodin, Paul Hendricks, Kat Maybury, Larry Morse, Bryce Maxwell, Leah Oliver, Donna Reynolds, Dale Schweitzer, Steve Taswell, Alan Weakley, Troy Weldy, and Ben Wigley; participants at the National Center for Ecological Analysis and Synthesis (NCEAS) workshops (2000–2004) on methods for assessing extinction risk; and NatureServe ecologists at a workshop in November 2000. The ideas presented also draw upon discussion with and input from staff of the member programs of the NatureServe network. We especially thank Bill Nichols for helping improve our global, national and subnational rank definitions. In addition, external data users and agency staff have provided much useful input.

The revision draws heavily from the Standards and Petitions Subcommittee of the IUCN Species Survival Commission and from the IUCN–CMP alliance to develop standard taxonomies of threats and actions. Some of the concepts incorporated here draw from draft invasiveness assessment factors (Randall et al. 2001).

Funding for 2009 revisions was generously provided by the National Council for Air and Stream Improvement (NCASI), Office Depot, U.S. Fish & Wildlife Service, USDA Forest Service, and the Sarah K. de Coizart Article TENTH Perpetual Charitable Trust. We thank the generous support of an anonymous donor for providing funds to revisit some key issues for this 2012 revision.

Preface

The *NatureServe Conservation Status Assessments: Factors for Assessing Extinction Risk* was released in 2009 (Master et al. 2009), along with the Ranking Methodology document (Faber-Langendoen et al. 2009). These methods have greatly improved our approach to assessing the conservation status of species and ecosystems. In the years since its release, several issues arose that required additional review. The Element Ranking Working Group (ERWG) (see Acknowledgments) was asked to review these issues and propose solutions. Below, we summarize the main issues and provide details on our proposed solutions that guided our revisions.

There were five main issues that we felt needed review: Population size/scales, Trends, Area of Occupancy for ecosystems, Threats, and the Biotics Upgrade to incorporate the revised rank methods.

Population Size

Issue: We considered whether to incorporate a systematic evaluation of life-histories (r-selected, k-selected species), because, for example, some species can have very high, but dynamic, population numbers (e.g., annual plants, some insects), and others can have lower, less dynamic, population numbers (e.g., whales). Scoring both types with one set of population size scales and weightings may not accurately assess extinction risk.

Response: It would be very challenging to assign all species to specific life-history strategies, since many species are intermediate between the two strategies. Furthermore, it was most straightforward to suggest that population size should sometimes not be used in calculating a conservation status for those species or species groups in which either the life-history strategy led to very dynamic population numbers from year to year, or for which it was very difficult to estimate population size. The calculator draws upon other "rarity" characteristics when population size is not used. We have reworded the text for the Population Size rank factor accordingly.

Trends (Short-Term, Long-Term)

Issue: The 2009 rank calculator method for scoring trends is not ideal in that it does not adequately distinguish decreasing trend from increasing trend, and the calculator method did not seem to be sensitive to changes in trends unless they are extreme.

Response: We found that the rank calculator method for scoring trends is not ideal for two reasons: the method for scoring trend and the insensitivity of the **trends** factors to changes in trend.

Scoring of Trend

Our typical approach to scoring rank factors sets the maximum score of 5.5, which if all factors are scored at that level, leads to a status of G5 (secure). But the trends scale is different from the rest in that the scale goes from varying levels of decline (A–F), to stable (G), to increasing rate (H–I). Thus, in principle, a population or ecosystem with an increasing trend could actually have its rank lowered (e.g., from G3 to G4). To make that happen, the maximum weighting of 5.5 should occur at G in the rating scale, and then should either be kept constant for H and I, or continue to increase above 5.5.

Insensitivity of the Trend Factor to Changes in Trend

After testing the above adjustment to scoring of trend, a still more fundamental issue remained: the **trends** factors, based on linear changes in points, were not sensitive enough to changes in trends. The reason for the lack of sensitivity is that the trend categories are split finely (6 categories, some with only 10% spreads). The result of having so many categories is that even with a pretty substantial decline (30-50%, or even 50-70%), the assigned points for such a decline are quite high (2.75 and 2.06 respectively), contributing to a smaller change in rank than may be expected for such a decline. These patterns were not changed when various linear or exponential weightings were tested.

Further investigation showed that the effect of trend on the final rank was very dependent on the values of the other factors, in that it had a centralizing tendency: it was biased against the extremes, and tended to pull ranks away from G1 or G5 unless the trend value was also extreme (>90% decline or >25% increase). For example, if all of the **rarity** factors combine to give a calculated value of 1.9, this would place the species firmly in G2. Using the original trend scoring, a trend of D (50-70% decline) would actually make the final calculated rank LESS imperiled, because the trend score (2.06) is higher than the overall combined score from the other factors (1.9). A decline of 70% or more would be required to push the rank towards G1. Even more concerning, the more at risk a species is due to **rarity** factors, the greater the decline has to be in order to calculate a rank that is more imperiled. And the converse is true as well: a presumptive G5 with stable trends will get pushed towards G4.

Under further review, it also became apparent that ranks generated using the 2009 calculator, if different from the preexisting ranks in Biotics, tended to vary more strongly on the side of lowering the rank (less imperiled). We now think this is in large part due to the method for scoring the trends factors.

The Trend Subtraction Method

For all these reasons, we turned to a new method for scoring trend, developed by Andy Teucher, a method we call the Trend Subtraction Method. The method is based on the assumption that a negative trend should move a rank toward greater imperilment (proportional to the size of the decline), and an increasing trend should likewise push a rank toward a more secure value. The basic approach of this method is to calculate an initial score based on **rarity** and **threats** factors, and then either subtract from that score when there is a negative trend or add to it when there is an increasing trend, to obtain a final rank score. The procedure is as follows:

1. An initial rank score is calculated from a weighted average of **rarity** and **threats** factors, with the **rarity** score weighted 0.7, and **threats** weighted 0.3.
2. Trend scores (long- and short-term) are given values (points). These are scaled exponentially from -0.50 (>90% decline) to 0.00 (stable trend) and up to 0.14 (>25% increase).
3. Long- and short-term trend values are multiplied by their weights, and the weighted values are summed to give a total overall trend score. Long-term Trend has a weight of 1, and Short-term Trend has a weight of 2.

4. The total overall **trends** score is added to the initial rank score **rarity/ threats** to give a final calculated rank score.

An example:
A species has a **rarity** score of 3.6, and a **threats** score of 4.2. A weighted average of these results in an initial rank **rarity/ threats** score: (3.6*0.7) + (4.2*0.3) = 3.78 (equivalent to G4)

The species has a long-term decline of 80-90% (code B = -0.40) and a short-term decline of 30-50% (code E = -0.14). Multiplying these assigned code values by the appropriate trend weights (1 and 2, respectively) and summing them provides a final **trends** score: (-0.4*1) + (-0.14*2) = -0.68.

Add the initial **rarity**/**threats**-based rank score to the final **trends** score to get a final calculated rank score: 3.78 + -0.68 = 3.10 (equivalent to G3)

Testing the Trend Subtraction Method
We compared results of the Trend Subtraction Method and the earlier 2009 method to the original assigned global ranks for a sample of 1,018 amphibians, mammals, reptiles, fishes, mussels, and plants. Overall, the Trend Subtraction Method calculated ranks more accurately (closer to the original carefully but qualitatively assigned ranks) than the 2009 method (75% of the Trend Subtraction Method were within a rounded rank of the original assigned rank, compared with only 67% for the 2009 method). When the newer ranks did deviate from original assigned ranks, the Trend Subtraction Method ranks did so more conservatively more often than the earlier 2009 method (29% of the Trend Subtraction Method ranks were more imperiled than original assigned ranks, and 23% were less imperiled, compared with the 2009 method in which 26% of calculated ranks were more imperiled than the original ranks, and 33% were less imperiled).

Area of Occupancy for Ecosystems

Issue: The guidance in the 2009 description of Area of Occupancy for ecosystems suggests that ecologists consider spatial pattern (matrix, large patch, small patch) when scoring this factor, but the rank calculator provides no clear way of incorporating this information.

Response: We developed three main rating scales for estimating the Area of Occupancy (AOO) for ecosystems, based on their spatial pattern: matrix, large patch, and small patch. Types with linear spatial patterns can be assigned to either the small patch or large patch scale. Definitions for these spatial patterns were already included in the 2009 edition. The spatial pattern of ecosystem types is typically included in the description of the type, so this information is readily available. Some types have a variety of spatial patterns, depending on the ecoregion they are found in, and the user should choose a typical pattern, based on a "moderate risk" approach to assessing conservation status. These ranges in scales will provide much greater flexibility for ranking at multiple levels of the NVC and IVC hierarchy and for ranking Ecological Systems. The current AOO scale is essentially the same as the Large Patch scale, so all current ratings will be assumed to be based on Large Patch until a review of this factor can be completed.

We tested this revised AOO approach on the 130 associations, and on 50 Latin American Ecological Systems element data (Carmen Josse, pers. comm. 2010). The approach improved the ranking of these ecosystem types, especially for small patch types, which typically were ranked too high, because their area occupied was small, even when they were very common.

In future tests, we will compare the grid cell approach to estimating AOO with that of actual area occupied through spatial mapping, and assess the merits of the two approaches. The use of grid cells for assessing AOO is recommended in the IUCN Red List criteria for threatened ecosystems (Rodriguez et al. 2011).

Threats

Issue: NatureServe adopted a draft of a threats scoring method for characterizing scope, severity, and timing (immediacy) of threats, as developed by IUCN – CMP (Conservation Measures Partnership), and is very loosely derived from a scheme used by Birdlife International. We sought to clarify where IUCN is itself in its treatment of threats in our review of this method.

Response: NatureServe adopted the threats list published by the IUCN-CMP team (Salafsky et al 2008) and adopted a draft of a threats scoring method developed by that team (Butchart pers. comm. 2009). At this time IUCN itself has not yet reviewed or agreed to adopt this method. Nonetheless, NatureServe and partners have found the scoring method very helpful and are proceeding with its use. This includes modifications over the past two years to accommodate the addition of threats that may not be rolled up into the final score and some other adjustments to both simplify its use and make the final score more reflective of the level of threat.

Biotics Upgrade

Issue: For the NatureServe network to make maximum use of the revised methods, the calculator should work closely with NatureServe's Biotics Data Management System. New programming is needed to make that happen.

Response: The benefits of using the revised conservation status factors and the ranking methodology, as incorporated in the rank calculator, will be greatest when these factors and methods are incorporated into Biotics. We are moving all central element ranking data into the new format specified by the 2009 conservation status revision and this 2012 revised version. In addition, we have developed script to export data from Biotics into the rank calculator, and to import the results of the rank calculator back into Biotics. Until the new version of Biotics that incorporates this revised methodology has been implemented, we will provide a "patch" to all NatureServe network programs using Biotics that will update the system to accommodate this methodology.

Contents

Ursus maritimus (Polar Bear)	
RARITY	
Range Extent	>2,500,000 sq km
Area of Occupancy	> 20,000 sq km
Number of Occurrences	19 occurrences
Population Size	20,000–25,000 individuals
Environmental Specificity	Narrow – specialist, key requirement polar sea ice
TRENDS	
Short-term Trend	Decline of <30% to relatively stable
THREATS	
Intrinsic Vulnerability	Highly vulnerable
Primary Threat	Global warming
Threat – Scope	Pervasive – affects 71-100% total population or occurrences
Threat – Severity	Serious – likely to reduce total population by 31-70% within 3 generations
Threat - Impact	High
Overall Threat	Substantial, imminent
NatureServe Conservation Status Rank: G3 - Vulnerable	

Photo: © Larry Master. www.MasterImages.org

Executive Summary

Primary Goal: To assess the conservation status of species and ecosystems—specifically the extinction risk of species and elimination risk of ecosystems at global scales, and their extirpation risk at national and subnational (e.g., state, province, territory) scales—using standard methods. NatureServe and its network program staff across North America collect and evaluate data for species and ecosystems of concern using these methods and tools to ensure that assigned status ranks are accurate and consistent, based on current field and remote sensing information.

Rank Factors (described in this document)

- Eight core status rank factors are identified as relevant to risk assessments of extinction/elimination, or extirpation
- Descriptions of each factor include the basis for its use, and its evaluation and rating criteria

Methods

- Factors are organized into three categories (rarity, threats, trends)
- Conditional rules for use of factors are applied to ensure that adequate information is used for assessing status
- Factors are scaled and weighted according to their impact on risk
- Consistent factor scaling and weighting allows the use of points to effectively score the contribution of each factor to risk
- Scores are weighted and combined by category resulting in an overall calculated rank, which is reviewed, and a final conservation status rank assigned

Tools

- A rank calculator automates the process of assigning conservation status ranks
- NatureServe's Biotics database provides management for all conservation status information

NatureServe and its member programs and collaborators use a suite of factors to assess the conservation status (extinction or extirpation risk) of species of plants, animals, and fungi, as well as the conservation status (elimination or extirpation risk) of ecosystems (ecological communities and systems). Conservation status is summarized as a series of ranks from critically imperiled to secure, and these ranks may be derived at global, national, or subnational levels. This document details the NatureServe factors that are used to assess extinction risk.

NatureServe's methods, which have been evolving since 1978, are used by its network of natural heritage programs and conservation data centers throughout North America. The NatureServe network compiles the data and information needed to assess extinction risk both subnationally and globally. In recent years, NatureServe has worked with the World Conservation Union (IUCN) to standardize the ratings for shared information fields, such as Range Extent, Area of Occupancy, Population Size, and Threats. This standardization permits the sharing of information between organizations and countries, and allows the information to be used in both IUCN as well as NatureServe assessments. NatureServe has also developed a “rank calculator” to increase the repeatability and transparency of its ranking process. Ten status factors are grouped by **rarity**, **threats**, and **trends** categories, and information is recorded for each of the status factors, in so far as possible. The “rank calculator” then computes a numeric score, based on weightings assigned to each factor and some conditional rules, which is translated to a calculated status rank. This calculated rank is reviewed and adjusted if deemed appropriate (with documentation of the reasons for adjustment) before it is recorded as the final assigned conservation status rank.

NatureServe conservation status assessment methodology contains a number of features, most notably that it (1) considers all of the status factor data collectively in assigning a status; (2) may produce “range-ranks,” (e.g., G1G3 = globally critically imperiled to vulnerable) to transparently reveal the degree of uncertainty in a status when the available information does not permit a single status rank; (3) explicitly considers threats in the assessment; (4) assesses conservation status for both species and ecosystems (ecological communities and systems); and (5) is sufficiently complete for North American species that global, national, and subnational ranks are routinely linked to facilitate conservation priority-setting.

Introduction

The primary purpose of Conservation Status Assessments is to evaluate potential extinction (species), elimination or extirpation risk of elements of biodiversity (species, communities, and systems), including regional extinction or extirpation risk. Risk is an essential piece of information to inform biodiversity conservation. However, it must be used with other information (e.g., genetic distinctness, importance of area, immediacy of threats, inclusive benefits, feasibility) to guide conservation planning, priority setting for reserve selection, inventory, official national and subnational (i.e., listings, and recovery and management planning (see Appendix D).

NatureServe and its member programs and collaborators use a suite of factors to assess the conservation status of species of plants, animals, and fungi, as well as ecosystems (ecological communities and systems). The outcome of researching and recording information on the conservation status factors is the assignment of a conservation status (rank) with supporting documentation. A summary of the conservation status categories is provided in Appendix A. Data gathered on these status factors form the backbone of information used to assess extinction risk.

This document provides an overview of each of the status factors used in NatureServe conservation status assessments. Before the description of each factor, a brief summary of the history of its development is provided, followed by definitions of key terms. Along with the detailed status factor descriptions, some guidance is offered on how to assign values to each of the factors. Procedures for how to combine the status factor values into a conservation status rank are provided in Faber-Langendoen et al. (2012).

A Brief History of NatureServe Conservation Status Assessment

This edition of the NatureServe Conservation Status Factors document is the latest version in a series, beginning in 2003, of substantive changes to the conservation status factors since the early 1980s, when NatureServe's conservation status assessment was first developed.

- **1978:** System initially developed, combining global and local considerations into one "rank" (A1, A2, B1, B2, B3, C); used only for species
- **1982:** Current system of global, national, and subnational "ranks;" 8 factors considered and scored; used for both species and ecosystems; qualitative in its application (The Nature Conservancy 1988, Master 1991)

- **1994:** Guidance on how to apply conservation status assessments to communities; release of a list of G1 and G2 community types in the U.S.
- **2000:** Eight factors subdivided into 11 factors, each "scored" into a larger number of ranges to better coincide with IUCN Red List break points (see Appendix B), and to facilitate development of a quantitative ranking process
- **2003:** Separation of Conservation Status (risk of extinction or extirpation) from Distribution Status (origin, regularity, currency and confidence of presence) for national and subnational status assessments
- **2009:** Revisions to data structure needed for application in Red List assessments, and to better match break points, weightings, and definitions for factors that are used for both NatureServe and Red List assessments. Note that the coded rating values for a number of the factors are exponential, especially at the higher ends (i.e., Population Size, Range Extent, and Area of Occupancy). Exponential scaling at the high ends for these values helps to reasonably distinguish 1–2 categories used for species and communities at lower risk of extinction (the LC and G4–G5 ranks used by IUCN and NatureServe, respectively), while a finer subdivision helps to distinguish 3–4 categories used for species and communities that are at some risk of extinction (the CR-NT and G1-G3 ranks). The 2009 revisions are described in Master et al. (2009) and Faber-Langendoen et al. (2009).
- **2012:** Revision in 2012 are summarized in the Preface to this document. The five main issues were: Population size/scales, Trends, Area of Occupancy for ecosystems, Threats, and the Biotics Upgrade to incorporate the revised rank methods. The updated Conservation Status Factors are provided in this document; updates to the Rank Methods are provided in Faber-Langendoen et al. (2012) and updates to the Rank Calculator are provided in NatureServe (2012).

In addition to changes made to status factors in 2000 and 2007 related to compatibility with IUCN Red List methodology (IUCN 2001, IUCN Standards and Petitions Subcommittee 2011, Mace et al. 2008), NatureServe is seeking to improve element conservation status ranking by increasing the transparency, repeatability, consistency, and trainability of the assessment process. To achieve this, the current "black box" ranking method is being replaced with a set of rules and point weightings structured to utilize status factor information to assign 1 5 ranks and range rank categories for indicating conservation status. To that end, a "rank calculator" has been developed that automates and standardizes the process, computing a numeric score from factor ratings, which is automatically translated to a calculated status rank. This calculated rank is reviewed, adjusted if deemed appropriate (with reasons for adjustment documented), before it is recorded as the final assigned conservation status rank. A companion document describes the rank method, including the use of the calculator (Faber-Langendoen et al. 2012).

Revisions to fields since 1999

- Abundance is separated into Population Size (species only) and Area of Occupancy
- Area of Occupancy is measured for species using a grid system (2 x 2 km2). As a result, Linear Distance of Occupancy is no longer needed as a coded field.
- A companion field named Percent Area with Good Viability/Ecological Integrity has been provided for the Number of EOs with Good Viability field. The minimum coded value of

the two fields is used, if both are completed.

- Trends are divided into Long- and Short-term Trends.
- Overall Threat now has a comprehensive list of general and specific threats, each of which can be evaluated independently based on scope, severity, and timing. The impact of each threat is calculated based on scope and severity. Overall impact of threat is then calculated based on the impacts of the individual threats.
- Fragility is redefined somewhat and renamed as Intrinsic Vulnerability, but is only used as a factor when information on threat impact is not available.
- Environmental Specificity is added as a formal factor, but is only used when values for **rarity** factors are not available.
- Number of Protected and Managed Occurrences is no longer used as a status factor, although this information may still be of interest for status assessments.

Revisions to field values

- Adjustments to match all IUCN (2001) breakpoints to improve compatibility in both documentation of status and exchange of information, as well as to more readily permit conversion of existing NatureServe network program data. See Appendix B for the IUCN categories and a summary of the criteria, and see Appendix C for a comparison of NatureServe, IUCN, and COSEWIC (Canada only) statuses.
- Finer division of value choices to more readily permit the use of a rule/point-based status assessment algorithm.
- Zero distinguished as a separate value where pertinent (e.g., for extinct or extirpated or possibly extinct species or extirpated ecosystems [ecological communities and systems]).
- Changes in C, D, and E level values for the Number of Occurrences factor address the long-recognized need to have the C-level cutoff lower than 100 to provide a better breakpoint for species and communities that are vulnerable vs. those that are apparently secure. This change to a breakpoint at 80 then led to another breakpoint at 300 (based on roughly a four-fold increase at each level), which may be helpful in distinguishing apparently secure vs. secure species or ecosystems (ecological communities and systems).

Revisions to weightings of status factors

Traditionally, much weight was given to **rarity** status factors when assigning conservation rank status. In particular, the Number of Occurrences, and either Area of Occupancy (communities) or Population Size (species), were considered the primary factors that established the possible range of ranks. Final determination of the overall status rank was then based on consideration of the remaining status factors. Past and ongoing long- and short-term trends and projected trends (i.e., threats) were given insufficient weight relative to their importance in most other analyses of extinction risk factors and in other conservation status assessment methodologies (e.g., IUCN 2001, COSEWIC 2006, Musick 2004, Andelman et al. 2004, O'Grady et al. 2004).

Within the cluster of **rarity** factors, NatureServe ranking has traditionally given special weight to the Number of Occurrences. But an analysis of this factor indicates that it should be used cautiously and not weighted as much as other **rarity** factors in determining conservation status for several reasons, including:

- There are substantial inherent difficulties in delineating populations and stands or patches;

- For some groups of taxa (e.g., large ranging carnivores, long-distance migrants) the delineation of the occurrences is arbitrary and would not correspond to populations or subpopulations (see Occurrence definition below under General Definitions);
- Occurrences are typically not recorded for species that are not at risk;
- Only exemplary occurrences are recorded for ecosystems that are not at risk;
- Occurrences are frequently delineated inconsistently between jurisdictions and across the range of a species or community;
- The number of occurrences increases as a species' or community's range becomes more fragmented and the species or community becomes more at risk (not less at risk, as is implied by an increase in the number of occurrences!).

The first four of these considerations also apply to the Number of Occurrences or Percent Area with Good Viability/Ecological Integrity. For species at risk, the number of good occurrences typically decreases as the species becomes more imperiled. However, see footnote under this factor regarding widespread and ubiquitous (e.g., euryecious) species, which may have very few large occurrences.

Implemented through the rank calculator, the method first calculates an initial rank score based on **rarity** status factors (70%) and **threats** status factors (30%), and either subtracts from that score when there is a negative **trend**, or adds to it when there is an increasing **trend**, to obtain a final calculated rank score. Within the set of **rarity** factors, the Number of Occurrences is weighted less than the other factors, namely, 1) Population Size, 2) Number of Occurrences or Percent Area with Good Viability/Ecological Integrity, and 3) Area of Occupancy, such that the Number of Occurrences now will contribute less to the overall rank if other rank factor information is available. Within **trends**, Short-term Trend is weighted twice as much as Long-term Trend.

Some General Definitions

Definitions, for purposes of this document, are provided below for several terms that are used generally in the conservation status factors descriptions and discussions found in this document. A few additional, more specialized terms are defined in the discussions of particular factors. In general, these definitions are consistent with those used by IUCN (2001).

Extinction or Elimination Risk Risk indicates the likelihood that a species (extinction) or ecosystem (elimination) will totally vanish or die out. The time frame should fall within the scope of human planning and policy setting, including the ability to judge the success of restoration efforts. Extinction risk is assessed for species using 10 years or 3 generations, whichever is longer, up to a maximum of 100 years (IUCN 2001). For ecosystems, elimination risk is assessed using a 50-year time period (Rodriguez et al. 2007). Risk at the regional (national,subnational) level is referred to as extirpation risk)

Geographical Level (Global, National, Subnational) NatureServe conservation status assessments have been developed primarily at three geographical levels. Global status, along with the corresponding individual factors, pertains to a species or ecosystem over its entire range (i.e., globally). A particular species or community can have only a single NatureServe global conservation status. National status applies to a portion of a species or ecosystem range that occurs in a specified nation or comparable geographically distinct area (e.g., a disjunct portion of a nation that is customarily treated separately for biogeographic or conservation purposes, such as Puerto Rico). Subnational status applies to a principal subdivision of a nation, such as a state or province, but sometimes a nonpolitical region customarily treated as a subnational unit (e.g., insular Newfoundland is treated separately from mainland Labrador, but together they form the Canadian province of Newfoundland and Labrador). NatureServe conservation status may also be used for other clearly bounded geographic areas (e.g., national parks). For long distance migrants, the subnational status may apply to a breeding, non-breeding, or migratory population within the jurisdiction.

Occurrence An occurrence is an area of land and/or water in which a species or ecosystem is, or was, present. An occurrence should have practical conservation value for the species or ecosystem as evidenced by historical or potential continued presence and/or regular recurrence at a given location. For further discussion of the species or ecosystem occurrence concept, see NatureServe's "Element Occurrence Data Standard" (NatureServe 2002).

For species, the occurrence often corresponds with the local population, but when appropriate may be a portion of a population (e.g., long distance dispersers) or a group of nearby populations (e.g., metapopulation). For many taxa, occurrences are similar to "subpopulations" (but considered to be 'populations' in this document and in much of the conservation biology literature) as defined by IUCN (2001): "Subpopulations are defined as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange (typically one successful migrant individual or gamete per year or less)."[1]

For ecosystems, the occurrence may represent a stand or patch of a type, or more typically, a cluster of stands or patches, that can range in size from a few to many thousands of hectares.[2] Note that this definition applies primarily to terrestrial ecosystems, but in principle can also be used for freshwater-aquatic and marine occurrences (NatureServe 2006).

Population A population is a geographically or otherwise distinct group of individuals of a particular species between which there is little demographic or genetic exchange (equivalent to the IUCN definition above for a "subpopulation"). For animals, metapopulation structure may arise when habitat patches are separated by distances that the species is physically capable of traversing, but that exceed the distances most individuals move in their lifetime (that is, the patches support separate subpopulations or "demes"). If habitats are sufficiently close together that most individuals visit many patches in their lifetime, the individuals within and among the patches will tend to behave as a single continuous population.

Viability and Ecological Integrity Estimated viability indicates the likelihood that a species will persist for a number of generations or over a designated period of time. However, viability is a term that is generally used to describe species, not ecosystems. A somewhat analogous term that can

1 Note that IUCN (2001) also uses the somewhat different concept of "location" referring to "… a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations."

2 Note that counting the number of plots sampled for an ecosystem rarely equates directly to the number of occurrences, as multiple plots can fall within a single large occurrence.

be applied to ecosystems is ecological integrity, which is "an assessment of the degree to which, under current conditions, an occurrence of an ecosystem matches reference conditions for structure, composition, and function, operating within the bounds of natural or historic disturbance regimes, and is of exemplary size" (Faber-Langendoen et al. 2011; see also Parrish et al. 2003).

Relative viability and ecological integrity are dependent on the size, condition (both biotic and abiotic), and landscape context of the species or ecosystem occurrence. For species, population size has been demonstrated to be of paramount importance in assessing viability (e.g., O'Grady et al. 2004, Reed 2005), while for ecosystems, all three factors are of comparable importance for maintaining integrity. Ecosystems with the greatest integrity, i.e., with native species structure and composition unchanged, and natural ecosystem processes intact, have the highest likelihood of retaining integrity over time.

Entities Eligible for Assessment

Ecological Communities and Systems
Ecological communities and ecological systems are collectively referred to as "ecosystems" in a generic sense. **Ecological communities** are assemblages of species and growth forms that co-occur in defined habitats at certain times and that have the potential to interact with each other (McPeek and Miller 1996). They are typically classified using ecologically-based vegetation classifications, at multiple scales, from formations (biomes) to alliances and associations, based on the International Vegetation Classification (FGDC 2008, Faber-Langendoen et al. 2009b, Jennings et al. 2009).

Ecological systems are defined by integrating multiple ecological criteria at meso-scales, including vegetation composition and structure, driving processes, and local environmental setting. They are classified using the International Terrestrial Ecological Systems Classification (Comer et al. 2003, Josse et al. 2003). Currently, conservation status assessments use the association as the unit of assessment (which is similar in scale to the "natural community" scale of various NatureServe network program community classifications), but future applications will include types at multiple scales (see also Nicholson et al. 2009). Note that while ecosystem types include terrestrial, freshwater, and marine types, the above-referenced standard classifications are primarily terrestrial. Conservation status assessments will be applied to freshwater and marine types as standard classifications become available.

Species Plants, animals, fungi, and other organisms are species (in contrast to ecological communities or systems). In this document, the term "species" includes all entities at the taxonomic level of species (including interspecific hybrids), as well as all subspecies and plant varieties. (Subspecies and varieties are sometimes collectively termed "infraspecific taxa.") Other subsets of species (e.g., geographically distinct and evolutionarily significant population segments) may also be assessed, as well as recurrent, transient, mixed species animal assemblages (e.g., shorebird concentration areas). Species in this document includes both single species as well as these multiple species assemblages.

Assessing species populations While native, naturally-occurring populations are the primary targets for conservation, in some cases other populations comprised of individuals not native and/or naturally-occurring at a location should also be considered. Such ‘other’ populations can be described using definitions from the IUCN Guidelines for Re-Introductions (IUCN 1998):

- **Benign introduction** – an attempt to establish a species, for the purpose of conservation, outside its recorded distribution but within an appropriate habitat and eco-geographical area.
- **Re-introduction** – an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct.
- **Translocation** – deliberate and mediated movement of wild individuals or populations from one part of their range to another.

Following IUCN Standards and Petitions Subcommittee (2011), conservation status assessments should only be applied to wild populations inside their natural range, to populations resulting from benign introductions (outside the taxon’s native range), and to self-sustaining translocated and re-introduced (within the taxon’s native range) populations.

In cases where individuals have been used to supplement wild populations, these individuals and their naturally-produced offspring should be included as part of the population being assessed, provided these individuals are predicted to have a positive impact on that population. However, individuals re-introduced or translocated for short-term sporting or commercial purposes without intention of establishing a viable population should be excluded from the population being assessed.

In many cases, species have successfully expanded their natural ranges outside their historical ranges. Indeed, it will be critical for many species to move beyond their historical ranges to cope with climate change. In these instances, the expansion areas should be considered part of the species’ natural range as they were not intentionally introduced.

If the only remaining individuals of a species exist in a naturalized population (i.e., resulting from human introduction outside the natural range), or in a benignly introduced population, or in a re-introduced population not yet established, then the species should be considered Presumed/Possibly Extinct in the Wild but extant in these populations (global conservation status = GXC or GHC). If a species’ assessed status is GXC or GHC but a naturalized population of the species exists within a region (nation or state/province), this regional population should be considered to have resulted from a benign introduction and, thus, should be assigned a national or subnational conservation status based on assessment of the factors described in this document. The rationale for this exception is that when a species is extinct over its entire natural range, its presence within a region must be considered important to highlight and preserve, despite its location outside the species’ natural range.

Populations undergoing natural **hybridization** are eligible for inclusion in species assessments, but hybridization also can be a direct or indirect consequence of human activities. As described in COSEWIC (2010b):

> “Where human-mediated hybridization occurs, F1 hybrids and their introgressed progeny should generally be considered a loss to the species and a threat to its persistence; hybrids do not represent either original taxonomic group, and they do not contribute to the evolutionary lineage of either group. If introgression is known or suspected, one should consider whether it is likely to negatively affect the conservation of the species. A negative impact is one predicted to result in a reduction in the average fitness of individuals of the species being assessed (reflected, for

example, by a reduced probability of survival, reduced population growth rate, and/or reduced ability to adapt to environmental change). Under these circumstances, F1 hybrids, if identifiable, and their progeny would not be included in the assessment. Where introgression in a population is considered extensive, it may be prudent to exclude the entire population from the species being assessed. Exceptions may exist where the gene pool of a species is so small that inbreeding depression is evident, and genetic variability cannot be increased using individuals from the same genetic pool. In such situations, it may be prudent to interbreed the species with another closely related population of the same species to increase genetic variability and benefit from hybrid vigour, particularly where the species in question is otherwise expected to go extinct. This will at least preserve some of the genetic composition of the species and may restore its ecological role. However, the resultant recombinant population may be assessed as a separate population, with the original one considered extinct. Furthermore, this recombinant population would only be eligible for assessment if it is not dependent on continued introductions to persist and it does not pose a threat to the donor species contributing to the interbreeding efforts."

See COSEWIC (2010b) for more details on hybridization issues.

Assessing Ecosystems While native, naturally-occurring ecosystems are the primary targets for conservation, in some cases, "semi-natural" and restored occurrences of ecosystems could also be considered. For restoration occurrences, caution should be used in considering these as examples of native ecosystems until they are well-established. In regions where long-established land use practices now dominate the native ecosystems, "semi-natural" ecosystems may also be conservation targets.

Deriving Conservation Status From the Status Factors

Conservation status factors guide the consistent and rigorous recording of information to facilitate the assignment of a conservation status. This process of assigning a conservation status has been qualitative to date due to the challenges of assessing many thousands of species and ecosystems in a timely fashion. This qualitative approach to status assessment has led to issues with consistency, repeatability, and transparency of the status assessments. Extensive training and review have been used to minimize these problems, but subjective assessments are nonetheless influenced by personal judgments, perceptions of risk, and systemic biases. The effort to minimize these biases and inconsistencies has led to clearer guidance on the definitions of the status factors (this report) and to a more transparent, repeatable, and objective approach—a "rank calculator" that utilizes rules and point weightings to calculate conservation status based on information recorded for status factors.

As NatureServe transitions to using the newly-refined status factors and rank calculator, there are several considerations to be kept in mind:

- The current conservation status ranks (available at ***www.natureserve.org/explorer***) will not be in synchrony with the revised conservation status factors until those factors are evaluated for each species and ecosystem type (ecological community, or system), and the status rank is reassessed using the calculator. A new data field for recording the method that was used to assign conservation status will be used as a means of tracking how the status rank was determined.

- In the absence of sufficient data to use the calculator, some status ranks will remain temporarily subjective, or be GNR/NNR/SNR, although the assignment of range ranks helps to mitigate some of these unknowns.
- As has always been the case, some status assessments are based on less information than others (e.g., an assessment may be based simply on a review of published distribution, habitat, or museum collection information). Because the assessment is made on the known, available data, it may not necessarily reflect current status.
- In the absence of better information, some NatureServe global conservation status assessments have been based on review of national or subnational statuses, and some national status assessments have been based on review of subnational statuses.

Summary of the Status Factors and Their Conditional Use

Table 1 summarizes the conservation status factors used by NatureServe, its member programs, and their collaborators to assess the conservation status of species and ecosystems (ecological communities and systems).

The factors are organized into three broad categories—**rarity**, **trends**, and **threats**—and a series of conditions (rules) are specified for whether, and how, each status factor should be used.

Table 1. Summary of NatureServe Conservation Status Factors.

Factor Category	Factor	Condition (Rule)
Rarity	Range Extent	Always use, if available
	Area of Occupancy	Always use, if available
	Population	Always use, if available (species only)
	Number of Occurrences	Always use, if available
	Number of Occurrences or Percent Area with Good Viability/Ecological Integrity	Always use, if available
	Environmental Specificity	Only use if both the Number of Occurrences and Area of Occupancy are Unknown or Null
Trends	Long-term Trend	Always use, if available
	Short-term Trend	Always use, if available
Threats	Threats	Always use, if available
	Intrinsic Vulnerability	Only use if Threats is Unknown or Null

> ***Picking a Coded Value***
> *Assessors should adopt a moderate attitude, taking care to identify the most likely plausible range of values, excluding extreme or unlikely values. This is also the approach endorsed by the IUCN Standards and Petitions Working Group (2011). In many cases this will mean picking a code range (e.g., BC, BD) as the factor rating. Note that the U = Unknown code cannot be included in a range rank.*

Factor Data Types

The ten conservation status factors are each represented by at least two types of data fields, as follows:

- Coded value field(s) with associated words or short phrases; values can be expressed as either single capital letters (e.g., A, B) or as combinations to indicate an estimated range of uncertainty (e.g., AB, BD);
- Text comment field.

Additional Information of Interest

In addition to the ten NatureServe conservation status factors, several types of information may be recorded that could potentially influence the assignment of a conservation status. These information fields, described in more detail later in this document, are in Table 2 below.

Definitions and guidance for use are provided individually for each factor in the NatureServe Conservation Status Factors section below. See also the General Definitions section of the Introduction of this document for terms used in the discussion of multiple factors.

Table 2.
Other information useful for assessing conservation status.

Information of Interest	Description
Other Considerations	Optional text field for recording potentially relevant information, such as the results of a PVA analysis.
Number of Protected and Managed Occurrences	**No longer used as a status factor**, but may be used to record information potentially relevant to threats.
Rescue Effect	Used only at national and subnational (e.g., state/provincial) levels to potentially up-rank or down-rank a species.
Comparison of Global and National/Subnational Rank Information	Useful when assigning conservation status, especially when the national/subnational information is more current or detailed than the global information or vice versa. Historically, a subnational rank should not imply that a species or ecosystem is more secure at the subnational level than it is nationally or globally (e.g., a rank of G1S3 was invalid), and similarly, a national rank should not exceed the global rank. *This rule is under review, because current methods provide a more explicit role for Threats and Trends, which may indicate low levels of risk at national/subnational scales as compared to global scales, and at least a one rank difference may be permissible (G1S2).*

Conservation Status Factors

Range Extent

A Rarity Factor

Range extent for taxa can be defined as follows (modified from the International Union for the Conservation of Nature [IUCN 2001]):

> "Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a taxon or ecosystem, excluding cases of vagrancy. While this measure may exclude discontinuities or disjunctions within the overall distribution of a taxon or type (e.g., large areas of obviously unsuitable habitat), such exclusions are discouraged except in extreme cases because these disjunctions and outlying occurrences accurately reflect the extent to which a large range size reduces the chance that the entire population of the taxon will be affected by a single threatening process. Risks are spread by the existence of outlying or disjunct occurrences irrespective of whether the range extent encompasses significant areas of unsuitable habitat." (See also 'area of occupancy'.)

The range extent criterion measures the spatial spread of areas currently occupied by a species or ecosystem, however it "is not intended to be an estimate of the amount of occupied or potential habitat, or a general measure of the taxon's range" (from IUCN 2001). The rationale behind the use of this parameter in assessing conservation status is to determine the degree to which risks from threatening factors are spread spatially across the geographic distribution of the species or ecosystem.

While range extent can be measured by a minimum convex polygon (or "convex hull"), that is, the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence, there can be inaccuracies with the resulting estimates of range extent. When there are significant discontinuities or disjunctions in a species distribution, a minimum convex polygon yields a boundary with a very coarse level of resolution on its outer surface, resulting in a substantial overestimate of the range, particularly for irregularly shaped ranges (Ostro et al. 1999). The bias associated with range estimates based on convex hulls, and their sensitivity to sampling effort, may also cause problems when assessing trends if outliers are detected at one time and not another. To avoid either significantly overestimating range extent when there are sizeable disjunctions or discontinuities in a distribution, or misrepresenting the extent to which a taxon or type may be affected by a threat by reducing range size

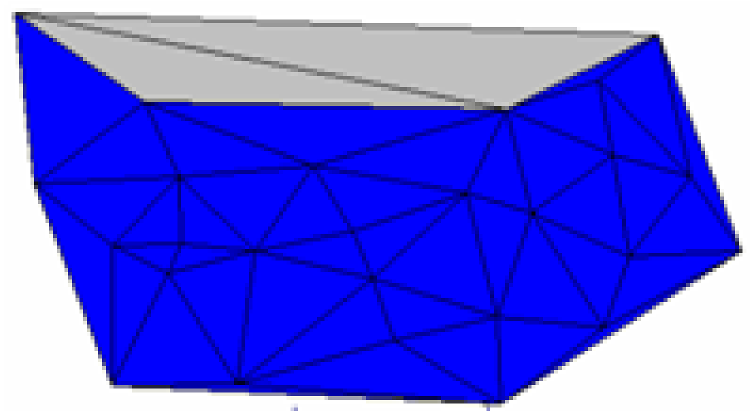


Figure 1.
Illustration of α-hull. The lines show the Delauney triangulation (the intersection points of the lines are the species' or ecological community's occurrence locations). The sum of the areas of darker triangles is range extent based on the α-hull. The two lighter colored triangles that are part of the convex hull are excluded from the α-hull. (IUCN Standards and Petitions Working Group 2008)

through exclusion of disjunctions and discontinuities, using a method such as the α-hull is recommended as it may substantially reduce the biases that can result from the spatial arrangement of occurrences.

The α-hull technique involves first drawing lines between all known or inferred points of occurrence for the species or ecosystem (i.e., drawing the convex hull). Next, any lines longer than a multiple, typically twice the average line length, are deleted from the first polygon (i.e., lines joining points that are relatively distant are deleted), such that the total range may be subdivided into more than one polygon. The final step is to calculate the range extent by summing the areas of all remaining triangles. For more details, see guidance provided by the IUCN Standards and Petitions Subcommittee (2011) and Burgman and Fox (2003). When using a GIS to measure the area of a polygon, it is important that the polygon is projected using an equal-area projection (e.g., Albers) for an accurate calculation.

Note that the use of α-hulls for determining range extent for a taxon or type with only one or two occurrences is not warranted as there are no disjunctions or discontinuities. For a single occurrence, the range extent may equal, or be slightly larger than, the area of known, inferred, or projected occupancy. Additional guidelines for the use of α-hulls will be forthcoming as additional tests are completed.

In the case of migratory species, range extent should be based on the minimum size of either the breeding or non-breeding (wintering) areas, whichever is smallest. For freshwater species and ecosystems, the extent of occurrence can be estimated by summing the areas of the 8-digit USGS hydrologic units or watersheds of equivalent scale in which extant occurrences are located. This procedure is used by the IUCN Freshwater Species Specialist Group and is acceptable when the species range is the size of a watershed or larger.

Range Extent Fields

Enter the estimated range extent (a range is acceptable): _________ sq km. Also enter the rating code that best describes the estimated current range of the species or ecosystem in the area of interest (globe, nation, or subnation). See Figure 1 for a comparison with Area of Occupancy. Use only rating values pertinent to the size of the area of interest; for example, only the A, B, C, or D values would be used in the subnational status assessment for Delaware (area = 5,004 km^2) or for Prince Edward Island (area = 5,657 km^2). Use a value range (e.g., DE) to indicate uncertainty. (See "Picking a Coded Value" on page 10.)

Select from the following values:

Z = Zero (no occurrences believed extant; species presumed extinct or ecosystem believed eliminated throughout its range)[1]

A = <100 km^2 (less than about 40 square miles)

B = 100–250 km^2 (about 40–100 square miles)

C = 250–1,000 km^2 (100–400 square miles)

D = 1,000–5,000 km^2 (400–2,000 square miles)

E = 5,000–20,000 km^2 (2,000–8,000 square miles)

F = 20,000–200,000 km^2 (8,000–80,000 square miles)

G = 200,000–2,500,000 km^2 (80,000–1,000,000 square miles)

H = >2,500,000 km^2 (greater than 1,000,000 square miles)

U = Unknown

Null = Factor not assessed

Range Extent Comments

Discuss any uncertainties in estimating the Range Extent.

1 Use a range rating that includes Z (e.g., ZA) when the species or ecosystem may be possibly extant.

Table 3. Examples of land areas approximating each Range Extent value threshold.

Rating Values	Threshold (km^2)	Threshold ($miles^2$)	Examples	Approx. Area (km^2)	Approx. Area ($miles^2$)
North America					
A/B	100	~40	Montserrat	98	38
			Nantucket, MA	121	47
B/C	250	~100	Martha's Vineyard, MA	250	96
C/D	1,000	~400	Rocky Mountain National Park, CO	1,077	416
D/E	5,000	~2,000	Delaware	5,004	1,932
			Prince Edward Island	5,657	2,184
E/F	20,000	~8,000	New Jersey	19,342	7,468
			Massachusetts	20,264	7,824
F/G	200,000	~80,000	Nebraska	198,507	76,644
			Minnesota	206,028	79,548
G/H	2,500,000	~1,000,000	Combined area of Ontario and Quebec	2,609,271	1,007,500

Continued …

Table 3. (continued) Examples of land areas approximating each Range Extent value threshold.

Rating Values	Threshold (km²)	Threshold (miles²)	Examples	Approx. Area (km²)	Approx. Area (miles²)
Latin America					
A/B	10	4	Old growth forest of La Selva Biological Station, Costa Rica	11.7	4.5
	100	~40	Monteverde Cloud Forest Preserve, CR	~105	~41
B/C	250	~100	St. Kitts and Nevis	269	104
C/D	1,000	~400	Kalakmul Biosphere Reserve, Mexico	998	385
	2,000	~800	Cotacahi-Cayapas Natural Reserve, Ecuador	2,044	789
D/E	5,000	~2,000	Trinidad and Tobago	5,130	1,981
	10,000	~4,000	Puerto Rico	9,104	3,515
			Jamaica	10,990	4,243
E/F	20,000	~8,000	Belize	22,960	8,865
	50,000	~20,000	Costa Rica	51,100	19,730
	100,000	~40,000	Guatemala	108,890	42,042
			Cuba	110,860	42,803
F/G	200,000	~80,000	Uruguay	176,220	68,038
	1,000,000	~400,000	Venezuela	912,050	352,142
G/H	2,500,000	~1,000,000	Mexico	1,972,550	761,602
			Argentina	2,766,890	1,068,296

Area of Occupancy

A Rarity Factor

Area of occupancy for taxa can be defined as follows (modified from the International Union for the Conservation of Nature [IUCN 2001]):

> "Area of occupancy is defined as the area within its 'extent of occurrence', which is occupied by a taxon or ecosystem type, excluding cases of vagrancy. The measure reflects the fact that a taxon or type will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases, (e.g., irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological or ecological aspects of the taxon or type, the nature of threats and the available data."

Distribution or habitat maps and models can be derived from interpretation of remote imagery and/or analyses of spatial environmental data, using either simple combinations of GIS data layers or by more formal statistical models. These maps can provide a basis for directly estimating area of occupancy and range extent for ecosystems, provided an accuracy assessment shows the map to be of sufficient reliability for the purpose of estimating area. Distribution and habitat maps can also provide an indirect estimate of area of occupancy (and range extent) for species. However, the following three conditions must be met. (IUCN Standards and Petitions Subcommittee 2011)

1. Maps must be justified as accurate representations of the habitat requirements of the species, and validated by a means that is independent of the data used to construct them.
2. The mapped area of suitable habitat must be interpreted (e.g., using an estimate of the proportion of habitat occupied) to produce an estimate of the area of occupied habitat.
3. The estimated area of occupied habitat derived from the map must be scaled to the grid size that is appropriate for the area of occupancy of the species (described below).

Estimating Area of Occupancy for Ecosystems

For ecosystems (ecological communities and systems), measure or estimate area of occupancy based on the best available information. In linear habitats (e.g., riverine shorelines, riparian habitats, or cliffs), estimate the length of all currently occupied habitat segments. The area can be estimated by multiplying the length by the average width.

When assessing area of occupancy, consider what the typical spatial pattern of the type is across its range (i.e., its patch type), whether linear, small patch, large patch, or matrix (see Table 4). If the spatial pattern is variable across ecoregions, choose the most typical spatial pattern, adopting a moderate risk approach. The spatial pattern of the type affects the relative role of the area of occupancy rating scale in assessing extinction risk. For that reason, three separate AOO scales are provided, for matrix, large patch and small patch types (Table 5b). For the purposes of conservation status assessments, types with linear spatial patterns will be scored using the scale for either the small patch or large patch scale.

Table 4. Definitions of various patch types that characterize the spatial patterning of ecosystems (ecological community and system types).

Patch Type	Definition
Matrix	Ecosystems that form extensive and contiguous cover, occur on the most extensive landforms, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g., <5%) of the total occurrence. In undisturbed conditions, **typical occurrences range in size from 2,000 to 10,000 ha (100 km2) or more**.
Large Patch	Ecosystems that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g., >20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions, **typical occurrences range from 50 to 2,000 ha**.
Small Patch	Ecosystems that form small, discrete areas of vegetation cover, typically limited in distribution by localized environmental features. In undisturbed conditions, **typical occurrences range from 1 to 50 ha**.
Linear	Ecosystems that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions, **typical occurrences range in linear distance from 0.5 to 100 km**.

Estimating Area of Occupancy for Species

> "Classifications of risk based on the area of occupancy may be complicated by problems of spatial scale. There is a logical conflict between having fixed range thresholds and the necessity of measuring range at different scales for different taxa. The finer the scale at which the distributions or habitats are mapped, the smaller the area that they are found to occupy and the less likely it will be that range estimates ... exceed the thresholds specified in the criteria. Mapping at finer scales reveals more areas in which the taxon is unrecorded. ... The choice of scale ... may thus, itself, influence the outcome of ... assessments and could be a source of inconsistency and bias." (IUCN Standards and Petitions Subcommittee 2011, IUCN 2001)

For species, the coded value for the area of occupancy should be obtained by "counting the number of occupied cells in a uniform grid that covers the entire range of a taxon and then tallying the number of occupied cells" (IUCN Standards and Petitions Subcommittee 2011). A grid of size 2 km (a cell area of 4 km^2) appears to provide a satisfactory grid scale as the basis for an estimate or index of area occupied. Thus, in line with IUCN, a scale of 2 km (grid of 4 km^2 cells) is recommended in order to ensure consistency and comparability of results. Ideally, the grid should be "moved" around and the minimum number of grid cells used in calculating area of occupancy.

The following two documents developed by NatureServe network program staff describe processes currently being tested which provide guidance for using a GIS to both create a grid, and then utilize the grid to calculate the area of occupancy automatically for use in conservation status assessments.

- *Using a GIS to Calculate Area of Occupancy Part 1: Creating a Shapefile Grid* (R. Elliott, California Natural Diversity Database)
- *Using a GIS to Calculate Area of Occupancy Part 2: Automated Calculation of Area* (E. Prescott, British Columbia Conservation Data Centre)

In the case of migratory species, estimates of area of occupancy (as with range extent) should be based on the minimum size of either the breeding or non-breeding (e.g., wintering, migratory stopover) areas, whichever is smallest. That is, the smallest area essential at any stage to the survival of existing populations of a taxon should be used for estimating area of occupancy.

For species occurring in and confined to linear habitats (e.g., shorelines, streams) and for which one has relatively precise locations and a relatively complete inventory, the Chair of the IUCN Standards and Petitions Working Group states (pers. comm. 2008) that a 1x1 km grid can be used for estimating area of occupancy, rather than a 2x2 km grid or a measure of length x average breadth, as are used for ecosystems (ecological communities and systems). Thus, for species, the linear distance of occupancy previously used as a status factor will no longer be needed in the assessment calculation. A 1 km^2 grid may be employed as described above instead of the 4 km^2 grid or, more simply (unless the linear features are meandering or densely dendritic), the length of occupied stream miles can be estimated and multiplied by 1 km.

Area of Occupancy Fields

Enter the estimated area of occupancy (a range is acceptable): ________ km^2.

Enter the estimated linear distance of occupancy if appropriate: ________ km.

Enter the scale used for species (4 km^2 or 1 km^2 recommended): ________ km^2.

Also enter the rating code for the estimated current area of occupancy of the species or ecosystem in the area of interest (globe, nation, or subnation). Use a value range (e.g., DE) to indicate uncertainty (see “Picking a Coded Value”).

Select from the rating values for Area of Occupancy shown below, using Table 5a codes for species assessments and Table 5b codes for assessing ecosystems.

Table 5a. Species area of occupancy codes based on the number of occupied grid cells.

Species Area of Occupancy		
Code	Number of 4 km^2 grid cells	Number of 1 km^2 grid cells
Z	0	0
A	1	1–4
B	2	5–10
C	3–5	11–20
D	6–25	21–100
E	26–125	101–500
F	126–500	501–2,000
G	501–2,500	2,001–10,000
H	2,501–12,500	10,001–50,000
I	>12,500	>50,000
U	Unknown	Unknown

Table 5b. Ecosystem (ecological communities or systems) area of occupancy codes based on the spatial patterns (patch types) of ecosystem types (see Table 4).

Ecosystem Area of Occupancy (in km^2)			
Code	Matrix	Large Patch	Small Patch
Z	0	0	0
A	≤10	≤1	≤1
B	11–30	2–4	0.2–0. 4
C	31–100	5–10	0.5–1.0
D	101–300	11–20	1.1–2.0
E	301–1,000	21–100	2.1–5.0
F	1,001–5,000	101–500	5.1–20
G	5,001–25,000	501–2,500	21–100
H	25,001–200,000	2,501–20,000	101–500
I	>200,000	>20,000	>500
U	Unknown	Unknown	Unknown

Note: The Z rating code implies the species is presumed extinct or the ecosystem is believed to be extirpated throughout its range. A range rank that includes Z (e.g., ZA) should be used for species or ecosystem where the only known occurrences have not been verified as extant, but they are still possibly extant (i.e. they are considered historical).

Area of Occupancy Comments

Discuss any uncertainties in estimating the Area of Occupancy.

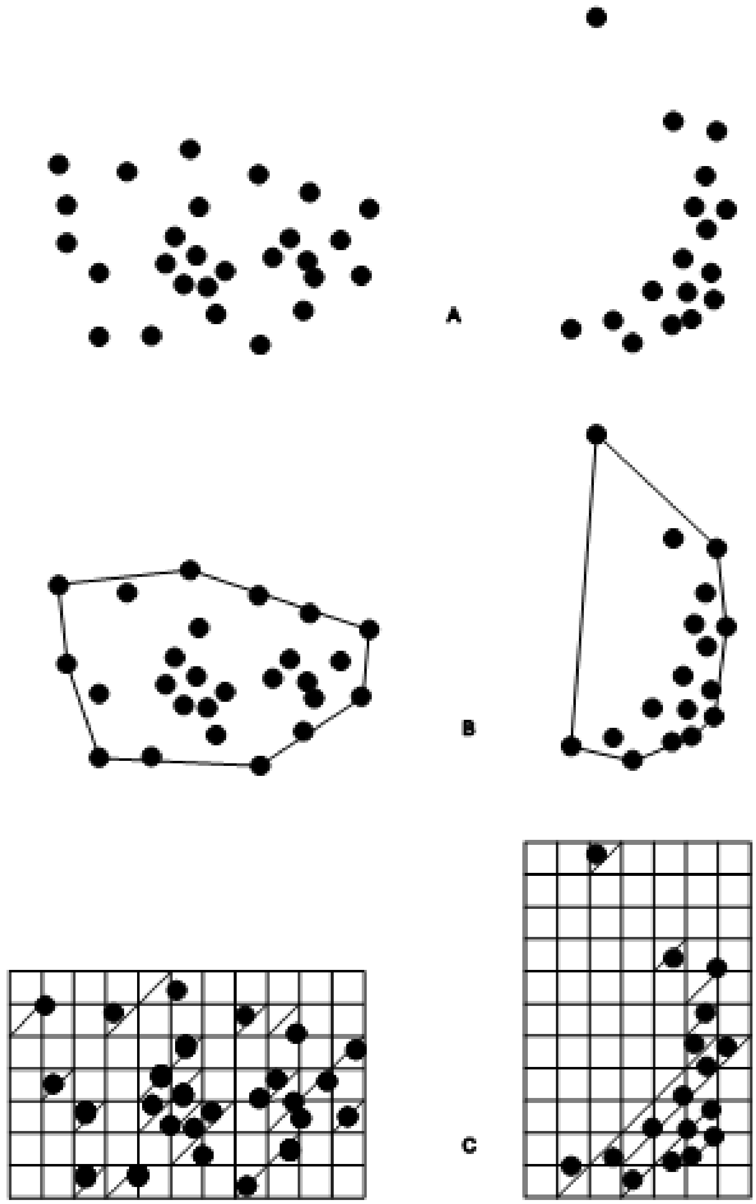


Figure 2. Illustration of the differences between Range Extent and Area of Occupancy.

(A) Is the spatial distribution of known, inferred, or projected sites of present occurrence.

(B) Shows one possible boundary to the range extent, which is the measured area within this boundary using a minimum convex hull or, preferably, an α-hull (see above) to avoid significant overestimates (e.g., right side of example B) in range.

(C) Shows one measure or index of area of occupancy, which can be achieved by the sum of the occupied grid squares.

***For species**, IUCN recommends (IUCN Standards and Petitions Working Group 2008) that area should be estimated using 2x2 km grid cells.*

***For ecological communities** and systems estimates of absolute area are preferred for area of occupancy, given the greater accuracy in mapping stands.*

Population Size

A Rarity Factor (used only for species)

Population size is the estimated current total population of the species within the area of interest (globe, nation, or subnation), based on naturally occurring and wild individuals of reproductive age or stage (at an appropriate time of the year), including mature but currently non-reproducing individuals.

As guidance, consider the following points (from IUCN 2001) when estimating population numbers (see also IUCN Standards and Petitions Subcommittee 2011):

- Juveniles, senescent individuals, and individuals in subpopulations whose densities are too low for fertilization to occur and will never produce new recruits should not be counted as mature individuals. [But see note below regarding clones.]
- In the case of populations with biased adult or breeding sex ratios, it is appropriate to use lower estimates for the number of mature individuals, which take this into account (e.g., the estimated effective population size).
- Where the population size fluctuates use a lower estimate. In most cases this will be much less than the mean.
- Reproducing units within a clone should be counted as individuals, except where such units are unable to survive alone (e.g., corals).
- In the case of taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the estimate should be made at the appropriate time, when mature individuals are available for breeding.
- Re-introduced individuals must have produced viable offspring before they are counted as mature individuals.

In addition, consideration should also be given to the following:

- For species that produce more than one generation per year, population size should be based on the smallest annual reproducing generation.
- For organisms that are only intermittently countable, consider population size to be the number of mature individuals in a typical ‘good’ year, but not a ‘poor’ year or an extraordinarily productive year. Although data rarely will be available, population size for such species conceptually should be considered as the median of the population over a ten-year or three-generation time span, whichever is longer.
- For species in which a large number of individuals typically occur in small areas, or in which individuals are short-lived (such as seed-banking annuals), population size may give a sense of security that is not warranted, and the Population Size coded value should be left as null, and the reason for this noted in the Comments field.
- If population size is very difficult to estimate for a species, then the Population Size coded value should be left as null and the reason for this noted in the Comments field.
- For clone-forming organisms that persist or spread locally but rarely, if ever, reproduce, consider the population size to be the number of distinct, self-maintaining clonal patches (approximating the number of genets), rather than the number of physiologically separate individuals (ramets).

Population Size Fields (for Species)

Enter the population size (a range is acceptable): ________.

Select also from the following rating values. Use a value range (e.g., DE) to indicate uncertainty. (See "Picking a Coded Value" in the Introduction for more information.)

Z = Zero, no individuals believed extant (i.e., species presumed extinct)[1]

A = 1–50 individuals

B = 50–250 individuals

C = 250–1,000 individuals

D = 1,000–2,500 individuals

E = 2,500–10,000 individuals

F = 10,000–100,000 individuals

G = 100,000–1,000,000 individuals

H = >1,000,000 individuals

U = Unknown

Null = Factor not assessed

Population Size Comments

Discuss any difficulties or peculiarities in the assessment of population size.

1 Use a range including Z (e.g., ZA) where there may be extant individuals even though none are currently known.

Number of Occurrences

A Rarity Factor

An occurrence is an area of land and/or water in which a species or ecosystem (ecological community or system) is, or was, present. (See Definitions section of the Introduction, above.) They represent "on-the-ground" locations where an element of biodiversity is found (i.e., the occurrence is extant or known to have recently occurred at a given location). Guidance on how to delineate an occurrence is provided in NatureServe's "Element Occurrence Data Standard" (NatureServe 2002 and updates).

The significance of the Number of Occurrences factor relates to additional risks faced by taxa or ecosystems where the species or ecosystem is either fragmented into many small occurrences (units), or where most individuals are concentrated into one occurrence (unit). Issues regarding the viability or integrity of the occurrences are assessed separately in the Number of Occurrences or Percent Area with Good Viability/Ecological Integrity factor (see this status factor below).

For many taxa, information on number of populations, rather than occurrences, will be more available and can be used in addition to or instead of occurrence information. For purposes of this factor (as well as the Number of Occurrences or Percent Area with Good Viability/Ecological Integrity factor) and as related to species, the two terms are interchangeable. For more information, see the definitions of both occurrence and population in the "General Definitions" topic in the Introduction.

Number of Occurrences Fields

Enter the estimated number of occurrences (a range is acceptable): ________.

Enter also the coded rating value for the estimated, inferred, or suspected number of occurrences believed extant for the species or ecosystem in the area of interest (globe, nation, or subnation). Use a value range (e.g., DE) to indicate uncertainty (see "Picking a Coded Value" in the Introduction). Select from the following values:

Z = 0 (zero) (i.e., species presumed extinct or ecosystem (ecological community or system) believed eliminated throughout its range)[1]

A = 1–5

B = 6–20

C = 21–80

D = 81–300

E = >300

U = Unknown

Null = Factor not assessed

1 Use a range including Z (e.g., ZA) where there may be extant occurrences even though none are currently known.

Number of Occurrences Comments

Discuss any uncertainties in estimating the number of occurrences.

Number of Occurrences or Percent Area with Good Viability/Ecological Integrity

A Rarity Factor

For species, an occurrence with (at least) good (i.e., excellent-to-good) viability exhibits favorable characteristics with respect to population size and/or quality and quantity of occupied habitat; *and*, if current conditions prevail, the occurrence is likely to persist for the foreseeable future (i.e., at least 20-30 years) in its current condition or better. See Hammerson et al. (2008) for more details. For ecosystems (ecological communities and systems), an occurrence has excellent-to-good ecological integrity when it exhibits favorable characteristics with respect to reference conditions for structure, composition, and function, operating within the bounds of natural or historic disturbance regimes, and is of exemplary size (Faber-Langendoen et al. 2011). One would expect only minor to moderate alterations to these characteristics for an occurrence to maintain good ecological integrity.

For many occurrences, viability or ecological integrity assessments or ranks have been applied by biologists and ecologists throughout the NatureServe network. For species, these Element Occurrence (“EO”) ranks estimate the probability of persistence of the occurrence. For ecosystems, the rank is a succinct assessment of the degree to which, under current conditions, an occurrence of an ecosystem matches reference conditions for that system, without any presumptions made about future status or persistence. Ranks for species and ecosystems are based on a set of “occurrence rank factors,” namely size (including population size and/or occupied area), abiotic and biotic condition, and landscape context. These factors may be further refined to specific indicators or metrics. The overall ranks range from A=Excellent viability/integrity, to D=Poor viability/integrity.

Occurrences ranked A or B indicate excellent or good, respectively, viability/ecological integrity. Future threats are *not* used to “downgrade” an occurrence rank, but ongoing events (e.g., successional changes, periodic unfavorable management) that are resulting in inexorable degradation of occurrence quality *should* be considered. See NatureServe’s “Element Occurrence Data Standard” (NatureServe 2002 and subsequent revisions), NCASI (2004), Hammerson et al. (2008), and Faber-Langendoen et al. (2011) for additional explanation of occurrence viability and ecological integrity assessments.

For many taxa, information on number of ‘populations’ with good viability, rather than occurrences, will be more available and can be used in addition to or instead of occurrence information. For purposes of this factor (as well as the Number of Occurrences factor) and as related to species, the two terms are interchangeable. For more information, see the definitions of occurrence and of population in the "General Definitions" topic in the Introduction.

As an alternative to using the estimated number of good occurrences, a companion field is provided based on "percentage of area with excellent or good viability or ecological integrity." This does not require knowledge of the number of occurrences (or populations). Instead, the total area occupied is recorded (see the Area of Occupancy status factor below), and an estimate is made of the percentage of that area which has excellent to good viability/ ecological integrity.

Number of Occurrences or Percent Area with Good Viability/Ecological Integrity Fields

Complete one or both of the following:

Enter the estimated number of occurrences with excellent-to-good viability or ecological integrity (a range is acceptable): ________.

Enter the estimated percentage of area occupied with excellent-to-good viability or ecological integrity (a range is acceptable): ________.

Select also from either or both of the following two coded rating fields. As confidence in particular occurrence ranks will degrade with the passage of time, consider using a value range (e.g., BC, BD) to indicate the range of uncertainty in the fields below (see the "Picking a Coded Value" topic in the Introduction for more information).[2]

Note that when both the Number of Occurrences with Good Viability/ Ecological Integrity and Percent Area with Good Viability/Ecological Integrity fields below have assigned rating values, the more restrictive of the two values (i.e., indicating greater rarity) will be used for calculating conservation status.

Number of Occurrences with Good Viability/Ecological Integrity

A = No occurrences with excellent or good (assessed as A or B) viability or ecological integrity

B = Very few (1–3) occurrences with excellent or good viability or ecological integrity

C = Few (4–12) occurrences with excellent or good viability or ecological integrity

D = Some (13–40) occurrences with excellent or good viability or ecological integrity

E = Many (41–125) occurrences with excellent or good viability or ecological integrity

F = Very many (>125) occurrences with excellent or good viability or ecological integrity

U = Unknown number of occurrences with excellent or good viability or ecological integrity

Null = Factor not assessed

Percent Area with Good Viability/ Ecological Integrity

A = No area with excellent or good (assessed as A or B) viability or ecological integrity

B = Very small percentage (<5%) of area with excellent or good viability or ecological integrity

C = Small percentage (5–10%) of area with excellent or good viability or ecological integrity

2 Widespread and ubiquitous (e.g., euryecious) species may have very few occurrences and, as with the Number of Occurrences, the number of occurrences with excellent or good viability may increase as the species habitats are fragmented. For these species, a coded value for the Number of Occurrences with Good Viability/Ecological Integrity should be left as null and the reason for this noted in the Comments field. This is because the number of occurrences with good viability is used in calculating a conservation status, and a small number of occurrences with good viability indicate a sense of concern that is not warranted in this situation.

D = Moderate percentage (11–20%) of area with excellent or good viability or ecological integrity

E = Good percentage (21–40%) of area with excellent or good viability or ecological integrity

F = Excellent percentage (>40%) of area with excellent or good viability or ecological integrity

U = Unknown percentage of area with excellent or good viability or ecological integrity

Null = Factor not assessed

Number of Occurrences or Percent Area with Good Viability/Ecological Integrity Comments

Discuss specific details and provide additional information, such as the number of occurrences with fair or poor viability or ecological integrity.

Environmental Specificity

A Rarity Factor

Note that this status factor is only used if information on other Rarity factors is not available. (See Table 1, Summary of NatureServe Conservation Status Factors.)

Environmental specificity is the degree to which a species or ecosystem depends on a relatively scarce set of habitats, substrates, food types, or other abiotic and/or biotic factors within the overall range. Relatively narrow requirements are thought to increase the vulnerability of a species or ecosystem. This factor is most important when the number of occurrences, and the range extent or area of occupancy, are largely unknown.

Environmental Specificity Fields:

Select from the following values:

A = Very Narrow. Specialist or ecosystem with key requirements scarce. For species, specific habitat(s), substrate(s), food type(s), hosts, breeding/non-breeding microhabitats, or other abiotic and/or biotic factor(s) are used or required by the species or ecosystem in the area of interest, with these habitat(s) and/or other requirements furthermore being scarce within the generalized range of the species or ecosystem within the area of interest, and, the population (or the number of breeding attempts) expected to decline significantly if any of these key requirements become unavailable. For ecosystems, environmental requirements are both narrow and scarce (e.g., calcareous seepage fens).

B = Narrow. Specialist or ecosystem with key requirements common. Specific habitat(s) or other abiotic and/or biotic factors (see above) are used or required by the species or ecosystem, but these key requirements are common and within the generalized range of the species or ecosystem within the area of interest. For ecosystems, environmental requirements are narrow but common (e.g., floodplain forest, alpine tundra).

C = Moderate. Generalist or community with some key requirements scarce. Broad-scale or diverse (general) habitat(s) or other abiotic and/or biotic factors are used or required by the species or ecosystem, but some key requirements are scarce in the generalized range of the species or ecosystem within the area of interest. For ecosystems, environmental requirements are broad but scarce (e.g., talus or cliff forests and woodlands, alvars, many rock outcrop communities dependent more on thin, droughty soils per se than specific substrate factors).

D = Broad. Generalist or community with all key requirements common. Broad-scale or diverse (general) habitat(s) or abiotic and/or biotic factors are used or required by the species or ecosystem, with all key requirements common in the generalized range of the species or ecosystem in the area of interest. For animals, if the preferred food(s) or breeding/non-breeding microhabitat(s) become unavailable, the species switches to an alternative with no resulting decline in numbers of individuals or number of breeding attempts. For ecosystems, environmental requirements are broad and common (e.g., forests or prairies on glacial till, or forests and meadows on montane slopes).

U = Unknown

Null = Factor not assessed

Environmental Specificity Comments

Describe the reasons for the value selected to indicate environmental specificity, such as how and why environmental specificity affects vulnerability of the species or ecosystem. Fields in the CHARACTERIZATION ABSTRACTS files in the NatureServe Biotics 4 data management system should be used to record detailed habitat requirements; specifically, for species use the Global Habitat Comments field on the HABITAT tab, and for ecosystems, the Key Environmental Factors field on the ENVIRONMENTAL SUMMARY tab should be used.

Long-Term Trend

A Trends Factor

Long-Term Trend Fields:

Enter the rating code that best describes the observed, estimated, inferred, or suspected degree of change in population size, extent of occurrence (range extent), area of occupancy, number of occurrences, and/or number of occurrences or percent area with good viability or ecological integrity over the long term (ca. 200 years) in the area of interest (globe, nation, or subnation). Use a value range (e.g., DE) to indicate uncertainty (see the “Picking a Coded Value” topic in the Introduction for more information).

A = Decline of >90%

B = Decline of 80–90%

C = Decline of 70–80%

D = Decline of 50–70%

E = Decline of 30–50%

F = Decline of 10–30%

G = Relatively Stable (≤10% change)

H = Increase of 10–25%

I = Increase of >25%

U = Long-term trend unknown

Null = Factor not assessed

Enter the estimated long-term trend (a range is acceptable): ________.

Long-Term Trend Comments

Specify the time period for the change noted, as well as a longer-term view (e.g., back to European or Polynesian exploration) if information is available. If there are data on more than one aspect, specify which aspect is most influential.

Short-Term Trend Fields

Enter the rating code that best describes the observed, estimated, inferred, or suspected degree of change in population size, extent of occurrence (range extent), area of occupancy, number of occurrences, and/or number of occurrences or percent area with good viability or ecological integrity over the short term, whichever most significantly affects the conservation status assessment in the area of interest (globe, nation, or subnation). Consider short-term historical trend for species within 10 years or 3 generations (for long-lived taxa), whichever is the longer (up to a maximum of 100 years); for ecosystems, consider short-term trend for 50 years.

The trend may be recent or current, and the trend may or may not be known to be continuing. Trends may be smooth, irregular, or sporadic. Fluctuations will not normally count as trends, but an observed change should not be considered as merely a fluctuation rather than a trend unless there is evidence for this.

In considering trends, do not consider newly discovered but presumably long existing occurrences, nor newly discovered individuals in previously poorly-known areas. Also, consider fragmentation of previously larger occurrences into a greater number of smaller occurrences to represent a decreasing area of occupancy as well as decreasing number of good occurrences or populations.

Select from the following rating values. Use a value range (e.g., DE) to indicate uncertainty (see the "Picking a Coded Value" topic in the Introduction for more information).

A = Decline of >90%

B = Decline of 80–90%

C = Decline of 70–80%

D = Decline of 50–70%

E = Decline of 30–50%

F = Decline of 10–30%

G = Relatively Stable (≤10% change)

H = Increase of 10–25%

I = Increase of >25%

U = Short-term trend unknown

Null = Factor not assessed

Enter the estimated short-term trend (a range is acceptable): _________.

Short-Term Trend Comments

Specify what is known about various pertinent trends, including trend information for particular factors, more precise information, regional trends, etc. Also comment, if known, on whether the causes of decline, if any, are understood, reversible, and/or have ceased. If there is knowledge that a trend is not continuing, that should also be specified.

Threats: Severity, Scope, Impact, and Timing

A calculation of overall threat impact indicates the degree to which a species or ecosystem is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest (globe, nation, or subnation). Direct threats are defined as "the proximate (human) activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes" (from Salafsky et al. 2008). For example, a direct threat may be trawling or logging. The term is synonymous with sources of stress and proximate pressures (Salafsky et al. 2008) or with "stressors" as used by the USEPA (Young and Sanzone 2002). In the categorization of threats and the calculation of overall threat, what may be called "indirect threats" are not included. Synonymous with drivers or root causes, indirect threats are "the ultimate factors, usually social, economic, political, institutional, or cultural, that enable or otherwise add to the occurrence or persistence of proximate direct threats (e.g., a factory [indirect threat] discharges heavy metals [direct threat] into a stream. There is typically a chain of contributing factors behind any direct threat" and the negative contributing factors are indirect threats (Salafsky et al. 2008).

For the most part, direct threats are related to human activities, but they may be natural. The impact of human activity may be direct (e.g., destruction of habitat) or indirect (e.g., invasive species introduction). Effects of natural phenomena (e.g., fire, hurricane, flooding) may be especially important when the species or ecosystem is concentrated in one location or has few occurrences, which may be a result of human activity. Strictly speaking, these natural phenomena may be part of natural disturbance regimes; but they need to be considered a threat if a species or habitat is damaged from other threats and has lost its resilience, and is thus vulnerable to the disturbance (Salafsky et al. 2008). In the absence of information on threats, characteristics of the species or ecosystem that make it inherently susceptible to threats should be considered under the NatureServe status factor Intrinsic Vulnerability.

For purposes of status assessment, threat impact is calculated considering only present and future threats. Past threats are recorded under "timing" but are not used in the calculation of threat impact. For conservation status assessment purposes, effects of past threats (if not continuing) are addressed indirectly under the Short-term Trend and/or Long-term Trend factors. (Note that for species or ecological communities and systems known only historically in the area of interest but with significant likelihood of rediscovery in identifiable areas, current or foreseeable threats in those areas may be addressed here where appropriate if they would affect any extant [but unrecorded] occurrences of the species or ecosystem.)

Threats may be observed, inferred, or projected to occur in the near term, and they may be characterized in terms of scope, severity, and timing. Threat "impact" is calculated from threat scope and severity (see below). The draft scheme presented here for characterizing scope, severity, and timing (immediacy) is being developed by IUCN-CMP (Conservation Measures Partnership), and is very loosely derived from a scheme used by Birdlife International.

Scope

Scope is defined herein as the proportion of the species or ecosystem that can reasonably be expected to be affected (that is, subject to one or more stresses) by the threat within 10-20 years with continuation of current circumstances and trends (Table 6). Current circumstances and trends include both existing as well as potential new threats. The ten-year time frame can be extended for some longer-term threats, such as global warming, that need to be addressed today. For species, scope is measured as the proportion of the species' population in the area of interest (globe, nation, or subnation) affected by the threat. For ecosystems, scope is measured as the proportion of the occupied area of interest (globe, nation, or subnation) affected by the threat. If a species or ecosystem is evenly distributed, then the proportion of the population or area affected is equivalent to the proportion of the range extent affected by the threat; however, if the population or area is patchily distributed, then the proportion differs from that of range extent.

Table 6. Proposed IUCN-CMP scoring of the scope of threats.

IUCN-CMP [draft] Scope of Threats Scoring	
Pervasive	Affects all or most (71–100%) of the total population or occurrences
Large	Affects much (31–70%) of the total population or occurrences
Restricted	Affects some (11–30%) of the total population or occurrences
Small	Affects a small (1–10%) proportion of the total population or occurrences

Note: Scope is typically assessed within a ten-year time frame for species and a twenty-year time frame for ecosystems.

Severity

Within the scope (as defined spatially and temporally in assessing the scope of the threat), severity is the level of damage to the species or ecosystem from the threat that can reasonably be expected with continuation of current circumstances and trends (including potential new threats) (Table 7). Note that for species, severity of threats is assessed within a ten-year or three generation time-frame, whichever is longer (up to 100 years), and for ecosystems, severity of threats is assessed within a twenty-year time-frame.

For species, severity is usually measured as the degree of reduction of the species' population. Surrogates for adult population size (e.g., area) should be used with caution, as occupied areas, for example, will have uneven habitat suitability and uneven population density. For ecosystems, severity is typically measured as the degree of degradation or decline in integrity (of one or more major or key attributes) (Faber-Langendoen et al 2011).

IUCN-CMP [draft] Severity of Threats Scoring	
Extreme	Within the scope, the Threat is likely to destroy or eliminate the occurrences of an ecological community, system or species, or reduce the species population by 71–100%
Serious	Within the scope, the Threat is likely to seriously degrade/reduce the effected occurrences or habitat or, for species, to reduce the species population by 31–70%
Moderate	Within the scope, the Threat is likely to moderately degrade/reduce the effected occurrences or habitat or, for species, to reduce the species population by 11–30%
Slight	Within the scope, the Threat is likely to only slightly degrade/reduce the effected occurrences or habitat or, for species, to reduce the species population by 1–10%
Note: For species, severity is assessed within a ten-year or three-generation time frame, whichever is longer (up to 100 years); for ecosystems, severity is assessed within a 20 year time-frame.	

Table 7. Proposed IUCN-CMP scoring of the severity of threats.

Impact

Threat impact (or magnitude) is the degree to which a species or ecosystem is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest (globe, nation, or subnation). The impact of a threat is based on the interaction between assigned scope and severity values, and includes categories of Very High, High, Medium, and Low. Details on calculating impacts from both individual threats and all threats collectively are provided in the Threats Assessment Process described below.

Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. As shown in Table 8 below, the median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%) and Low (3%).

		Scope (%)			
		Pervasive	Large	Restricted	Small
Severity (%)	Extreme	50–100	22–70	8–30	1–10
	Serious	22–70	10–49	3–21	1–7
	Moderate	8–30	3–21	1–9	0.1–3
	Slight	1–10	0–7	1–3	<1

Very High
High
Medium
Low

Table 8. The relationship of threat impact and population reduction or ecosystem decline or degradation.

For species, these impacts should correspond to ongoing and projected population reductions resulting from combinations of scope and severity.

Impacts to ecological communities and systems should represent ongoing and projected declines or degradation of area.

Timing

Although timing (immediacy) is recorded for threats to the area of interest (globe, nation, or subnation), it is not used in the calculation of threat impact.

Table 9. Birdlife International and proposed IUCN-CMP (and NatureServe) scoring of threat timing.

IUCN-CMP [draft] Timing of Threats Scoring	
High	Continuing
Moderate	Only in the future (could happen in the short term [less than ten years or three generations]), or now suspended (could come back in the short term)
Low	Only in the future (could happen in the long term), or now suspended (could come back in the long term)
Insignificant/ Negligible	Only in the past and unlikely to return, or no direct effect but limiting

Recording Threats and Calculating Threat Impacts

The scope, severity, and timing of any individual threats observed, inferred, or suspected to be directly or indirectly affecting a species or ecosystem are recorded using the IUCN-CMP Classification of Threats presented in Table 14 (see also Salafsky et al. 2008). There are 11 broad ("level 1") categories of threats, and each of these level 1 threats includes 3-6 more specific, finer ("level 2") threats. The process for recording the threats identified for a species or ecosystem and calculating the impacts of these threats is described below as a series of steps. Table 13 summarizes the values (including value ranges to express uncertainty) to be used for recording scope, severity, impact, and timing.

Threats Assessment Process

1. Record in the Classification of Threats (Table 14) an estimate of the scope, severity, and timing for applicable individual threats to the species or ecosystem that are either:
   - Level 2 threats;
   - Level 1 threat categories for which level 2 threats will not be recorded.

   Note: If only level 1 threat categories are being recorded for the species or ecosystem, skip step 3 below.

2. Apply the scope and severity values recorded in step 1 to the matrix below (Table 10) to calculate and record the impact (i.e., magnitude) for each assessed threat. If the assigned scope or severity value is a range, evaluate the highest values in the range for scope with the highest for severity and then evaluate the pair of lowest values to determine the range of threat impact.

Table 10. Calculation of threat impact.

		Scope			
		Pervasive	Large	Restricted	Small
Severity	Extreme	Very High	High	Medium	Low
	Serious	High	High	Medium	Low
	Moderate	Medium	Medium	Low	Low
	Slight	Low	Low	Low	Low

3. Record an estimate of scope, severity, and impact for each level 1 threat category that contains one or more assessed level 2 threats, based on the values of these level 2 threats as follows:
   - If there is only one level 2 threat recorded in the level 1 category, assign the scope, severity, impact, and timing values of this level 2 threat to the level 1 threat in which it is included;
   - If there are multiple level 2 threats recorded in the level 1 category, evaluate their degree of overlap;
     - » If the level 2 threats overlap, identify which of them has the highest impact and assign the scope, severity, and impact values of this level 2 threat to the level 1 category in which it is included;
     - » If the level 2 threats are substantially non-overlapping, then higher scope and severity values may be justified for the level 1 category in which they are included, and best professional judgment should be used to assign scope, severity, impact, and timing values to that level 1 threat.

   Range values may be appropriate for a level 1 threat category when one or more of the level 2 threats contained within have an assigned range value.

4. After impact has been recorded for all applicable level 1 threat categories, use these impact values to calculate an overall threat impact for the species or ecosystem according to the guidelines in Table 12. These guidelines were developed by taking the midpoint range of a particular impact rating and determining how many additional independent threats would be needed to increase the overall impact to the midpoint of the next level (see Table 11 below)

Table 11. Median impact values for each matrix cell, and the resulting midpoint of each threat impact level.

		Scope (%)				Impact Level Midpoints	
		Pervasive	Large	Restricted	Small		
Severity (%)	Extreme	75.0	46.0	19.0	5.5	75.0%	Very High
	Serious	46.0	29.5	12.0	4.0	40.5%	High
	Moderate	19.0	12.0	5.0	1.6	15.5%	Medium
	Slight	5.5	3.5	2.0	0.5	3.4%	Low

Note: Median values are based on the population reduction or ecosystem decline or degradation percentages shown in Table 8.

Using the above table, for example, four threats with Low impact ratings (thus each with midpoint of 3.4%) would be estimated to have an overall impact of 14%, which is very near the midpoint of the Medium impact level (15%). Note that if the value for one or more level 1 impacts is a range, evaluate the highest (single and range) values for every level 1 threat using Table 12 and then evaluate the lowest values to determine the range of overall threat impact. For example, three Medium–Low threat impacts indicate an overall threat impact of High–Low, and four Medium–Low impacts indicate an overall threat impact of High–Medium.

Note that Table 12 provides general guidance for determining overall impact, and values resulting from its use should be considered first approximations. For example, these guidelines may be too liberal if the level 1 threat categories mostly overlap geographically, or too conservative if the scope and severity ratings for level 1 threats are mostly greater than the median value for each range and thus mostly greater than the median values shown in Table 11 for threat impact. Best professional judgment should always be applied when assigning the final overall threat impact.

Table 12. Guidelines for assigning overall impact value.

Impact Values of Level 1 Threat Categories	Overall Threat Impact
≥1 Very High, *or* ≥2 High, *or* 1 High + ≥2 Medium	Very High
1 High, *or* ≥3 Medium, or 2 Medium + 2 Low, *or* 1 Medium + ≥3 Low	High
1 Medium, *or* ≥4 Low	Medium
1–3 Low	Low

Once calculated, record the assigned overall impact value or value range in the Overall Threat Impact field, and add notes to the Threat Comments field, particularly if the overall threat impact value was adjusted.

Note that for long-distance migratory animals, the calculation of overall threat impact should be based on the combination of highest impact level 1 threat categories at any one season (e.g., breeding, wintering, migration) rather than an aggregation of all the level 1 impacts that occur throughout the different seasons. Use the Threat Comments field to discuss the threats at different seasons.

Threats Fields

At a minimum, the Overall Threat Impact and Threat Comments fields should be recorded for a species or ecosystem, as well as the scope, severity, impact, and timing of applicable level 1 threat categories in the Classification of Threats (Table 14).

Record information on specific threats and the calculated threat impacts in the IUCN-CMP Classification of Threats provided in Table 14 (see also Salafsky et al. 2008) according to the Threats Assessment Process described above.

Values to be assigned for scope, severity, impact, and timing in the threats classification table are provided in Table 13, along with plausible ranges of values that can be used to indicate uncertainty. For definitions of the scoring values, see Table 6 for scope, Table 7 for severity, and Table 9 for timing. See Table 10 for the calculation of impact.

Note that value ranges should not be used to indicate an estimated range of variation, but rather to indicate uncertainty. In cases where there is a range of variation, an average should be used instead of a value range (e.g., if the severity of a threat varies across its scope, an average severity should be used instead of a range).

In transitioning from the pre-2009 NatureServe conservation status assessment process to that described in this document, the proposed IUCN-CMP values for scope and severity are sufficiently close to those used by NatureServe that no conversion will be necessary. However, the IUCN-CMP values for timing differ enough that it is recommended that the NatureServe data recorded for immediacy be discarded and new timing values recorded.

Proposed IUCN-CMP Individual Threats Scoring Values			
Scope	Severity	Impact	Timing
Pervasive Large Restricted Small	Extreme Serious Moderate Slight	Very High High Medium Low	High Moderate Low Insignificant/Negligible
Value ranges that can be used to express uncertainty			
Pervasive–Large Pervasive–Restricted Large–Restricted Large–Small Restricted–Small	Extreme–Serious Extreme–Moderate Serious–Moderate Serious–Slight Moderate–Slight	Very High–High Very High–Medium High–Medium High–Low Medium–Low	High–Moderate High–Low Moderate–Low Moderate–Insignificant/Negligible Low–Insignificant/Negligible

Table 13.
Values proposed by IUCN-CMP for scoring individual threats.

Threat No.	Threat Description	Scope	Severity	Impact	Timing
1	Residential & Commercial Development				
1.1	Housing & Urban Areas				
1.2	Commercial & Industrial Areas				
1.3	Tourism & Recreation Areas				
2	Agriculture & Aquaculture				
2.1	Annual & Perrenial Non-Timber Crops				
2.2	Wood & Pulp Plantations				
2.3	Livestock Farming & Ranching				
2.4	Marine & Freshwater Aquaculture				
3	Energy Production & Mining				
3.1	Oil & Gas Drilling				
3.2	Mining & Quarrying				
3.3	Renewable Energy				
4	Transportation & Service Corridors				
4.1	Roads & Railroads				
4.2	Utility & Service Lines				
4.3	Shipping Lanes				
4.4	Flight Paths				
5	Biological Resource Use				
5.1	Hunting & Collecting Terrestrial Animals				
5.2	Gathering Terrestrial Plants				
5.3	Logging & Wood Harvesting				
5.4	Fishing & Harvesting Aquatic Resources				
6	Human Intrusions & Disturbance				
6.1	Recreational Activities				
6.2	War, Civil Unrest & Military Exercises				
6.3	Work & Other Activities				

Table 14.
Classification of Threats (adopted from IUCN-CMP, Salafsky et al. 2008).

Threat No.	Threat Description	Scope	Severity	Impact	Timing
7	Natural System Modifications				
7.1	Fire & Fire Suppression				
7.2	Dams & Water Management/Use				
7.3	Other Ecosystem Modifications				
8	Invasive & Other Problematic Species & Genes				
8.1	Invasive Non-Native/Alien Species				
8.2	Problematic Native Species				
8.3	Introduced Genetic Material				
9	Pollution				
9.1	Household Sewage & Urban Waste Water				
9.2	Industrial & Military Effluents				
9.3	Agricultural & Forestry Effluents				
9.4	Garbage & Solid Waste				
9.5	Air-Borne Pollutants				
9.6	Excess Energy				
10	Geological Events				
10.1	Volcanoes				
10.2	Earthquakes/Tsunamis				
10.3	Avalanches/Landslides				
11	Climate Change & Severe Weather				
11.1	Habitat Shifting & Alteration				
11.2	Droughts				
11.3	Temperature Extremes				
11.4	Storms & Flooding				

Overall Threat Impact

Very High

High

Medium

Low

Unknown

Null = Factor not assessed

The following overall impact ranges are also permissible for expressing uncertainty:

Very High–High

Very High–Medium

High–Medium

High–Low

Medium–Low

Threat Comments

Discuss individual threats as well as overall threat impact. Whenever possible, use the standardized IUCN-CMP names for threats (shown in the Classification of Threats, Table 14).

Intrinsic Vulnerability

A Threats Factor

Note that this factor is not used if the Threats status factor has been assessed. (See Table 1, Summary of NatureServe Conservation Status Factors.)

Intrinsic vulnerability is the observed, inferred, or suspected degree to which characteristics of the species or ecosystem (such as life history or behavior characteristics of species, or likelihood of regeneration or recolonization for ecosystems) make it vulnerable or resilient to natural or anthropogenic stresses or catastrophes. For ecosystems, characteristics of the component species which make the ecosystem vulnerable are to be considered. Typically, intrinsic vulnerability is most readily assessed using the dominant species and vegetation structure that characterize the ecosystem, but it can also refer to ecological processes that make an ecosystem vulnerable or lack resiliency (e.g., shoreline fens along estuarine and marine coasts subject to rising sea levels).

Since geographically or ecologically disjunct or peripheral occurrences may show additional vulnerabilities not generally characteristic of a species or ecosystem, characteristics of intrinsic vulnerability are to be assessed for the species or ecosystem throughout the area of interest, or at least for its better occurrences. Information on population size, number of occurrences, area of occupancy, extent of occurrence, or environmental characteristics that affect resiliency should not be considered when assessing intrinsic vulnerability; these are addressed using other status factors.

Note that the intrinsic vulnerability characteristics exist independent of human influence, but may make the species or ecosystem more susceptible to disturbance by human activities.

The extent and effects of current or projected extrinsic influences themselves should be addressed in the comments field of the Threats status factor.

Intrinsic Vulnerability Fields

Select from the following values:

A = Highly Vulnerable. Species is slow to mature, reproduces infrequently, and/or has low fecundity such that populations are very slow (>20 years or 5 generations) to recover from decreases in abundance; or species has low dispersal capability such that extirpated populations are unlikely to become reestablished through natural recolonization (unaided by humans). Ecosystem occurrences are highly susceptible to changes in composition and structure that rarely if ever are reversed through natural processes even over substantial time periods (>100 years).

B = Moderately Vulnerable. Species exhibits moderate age of maturity, frequency of reproduction, and/or fecundity such that populations generally tend to recover from decreases in abundance over a period of several years (on the order of 5–20 years or 2–5 generations); or species has moderate dispersal capability such that extirpated populations generally become reestablished through natural recolonization (unaided by humans). Ecosystem occurrences may be susceptible to changes in composition and structure but tend to recover through natural processes given reasonable time (10–100 years).

C = Not Intrinsically Vulnerable. Species matures quickly, reproduces frequently, and/or has high fecundity such that populations recover quickly (<5 years or 2 generations) from decreases in abundance; or species has high dispersal capability such that extirpated populations soon become reestablished through natural recolonization (unaided by humans). Ecosystem occurrences are resilient or resistant to irreversible changes in composition and structure and quickly recover (within 10 years).

U = Unknown

Null = Factor not assessed

Intrinsic Vulnerability Comments

Describe the reasons for the value selected to indicate intrinsic vulnerability. Examples for species include reproductive rates and requirements, time to maturity, dormancy requirements, and dispersal patterns. For ecosystems, describe the characteristics of the community that are thought to be intrinsically vulnerable and the ecological processes on which these characteristics depend. For example, an ecosystem type may be defined by old growth features that require >150 years to recover its structure and composition after a blowdown; a pine forest type may be highly dependent on timing of masting or availability of seed sources to recover after a catastrophic fire; a wetland may be dependent on periodic drawdowns or flash flooding for regeneration of its species; a desert shrubland ecosystem with an abundant cryptogram crust (important for nutrient cycling, N-fixation, and moisture retention) may take a long time (>50 years) to recover an intact crust after disturbance due to the slow growth of the cryptogram layer.

Not a status factor, but a field for recording information not captured in the status factors.

Other Considerations

Other Considerations Field

Provide and comment on any other information that should be considered in the assignment of NatureServe conservation status. Including comments in this field is particularly important when the conservation status resulting from the overall assessment is different from the status that the values for the formal status factors, taken alone, would suggest. This field may also be used for other general notes pertinent to multiple status factors.

The following are some examples of Other Considerations:

- A population viability analysis may indicate that the species has x percent probability of surviving for y years (or an equivalent number of generations) in the same area of interest (globe, nation, or subnation).
- NatureServe global conservation status is based primarily on particular national or subnational status(es), or national status is based on particular subnational status(es).

Rescue Effect

Note that this factor and its associated data are used only for national- and subnational-level conservation status assessments for species.

Rescue effect is the process by which immigrating propagules result in a lower extinction risk for the population being assessed (see IUCN 2003). (Questions to be considered in making this judgment are shown below.)

For example, if the jurisdictional population being assessed experiences any significant immigration of propagules capable of reproducing in the jurisdiction and the immigration is not expected to decrease, changing the conservation status to a lower risk category may be appropriate. Normally, such a downgrading will involve a half-step or one-step change in status, such as changing the status from Imperiled (S2) to Vulnerable (S3), but for expanding populations whose global range barely touches the edge of the jurisdiction, a change of two or more ranks may be appropriate. Similarly, if the jurisdiction is very small and not isolated by barriers from surrounding regions, downgrading by two or more ranks may be appropriate. Conversely, if the population within the jurisdiction is a demographic sink that is unable to sustain itself without immigration from populations outside the region, AND if the extra-jurisdictional source is expected to decrease, the extinction risk of the target population may be underestimated by the criteria. In such exceptional cases, changing the status to a higher risk category may be appropriate.

For non-breeding (e.g., wintering) migratory species, changing the conservation status to a lower risk category may be appropriate if the breeding population could rescue the target population should it decline, and assuming that conditions inside and outside the jurisdiction are not deteriorating.

Questions to Be Considered

Breeding populations

- Does the national/subnational population experience any significant immigration of propagules likely to reproduce in the region? (Y/N/U)
- Is the immigration expected to decrease? (Y/N/U)
- Is the national/subnational population a sink (an area where the local reproduction of a taxon is lower than local mortality)? (Y/N/U)
- What is the distance to the next population, if not contiguous? ________ km

Visiting populations (i.e., populations that are regularly occurring but non-breeding in the jurisdiction)

- Are the conditions outside the nation/subnation deteriorating? (Y/N/U)
- Are the conditions within the nation/subnation deteriorating? (Y/N/U)
- Can the breeding population rescue the national/subnational population should it decline (plausibility of a rescue effect)? (Y/N/U)

Rescue Effect Fields

Enter the Rescue Effect (e.g., -1, -½, 0, +½, +1, +1½, +2): ________

Rescue Effect Comments

Discuss any uncertainties in estimating the Rescue Effect.

Conservation Status Rank Qualifiers

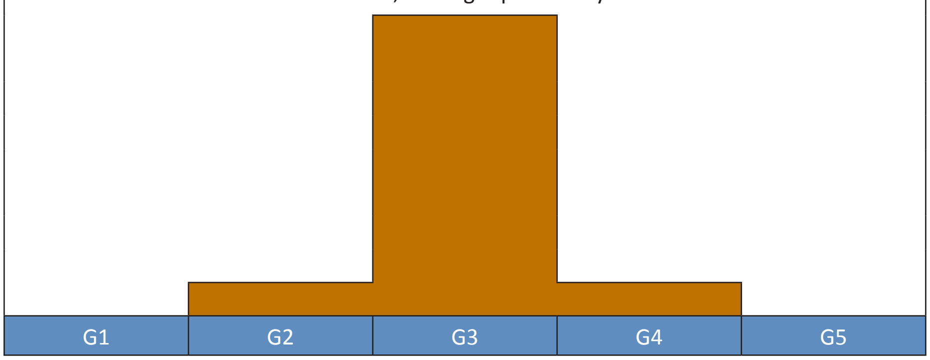
As briefly described in Appendix A, there are three qualifiers that may be appended to conservation status ranks: **?** = imprecision, **Q** = questionable taxonomy, and **C** = captive or cultivated (for species only). These qualifiers are used either to indicate the degree of uncertainty associated with an assigned status rank, or to provide additional information about the ecosystem or taxon that has been assessed.

? – Inexact Numeric Rank The addition of a ? qualifier to a 1–5 conservation status rank denotes that the assigned rank is imprecise. This qualifier is used only with the numeric status ranks, not with X, H, or U ranks, or range ranks. As described in previous sections, uncertainty about the exact status of a species or ecosystem is usually denoted by a range rank, with the range indicating the degree of uncertainty; however a #? may also be used. Figure 3 illustrates the uncertainty associated with different status ranks.

Figure 3. Comparison of uncertainty associated with examples of an exact status rank, rank with "?" qualifier, and range ranks.

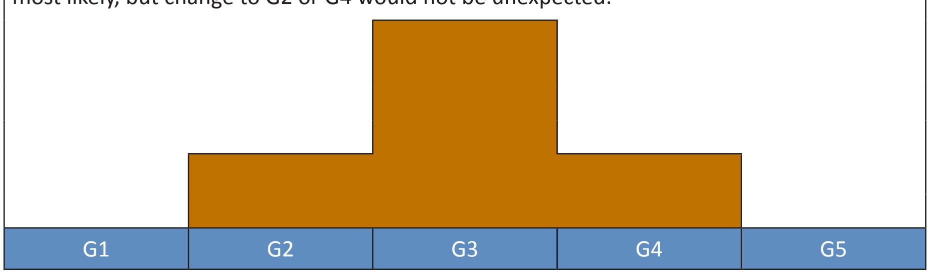
Exact Rank (G3)

Available information indicates G3 rank, but slight probability of either G2 or G4.



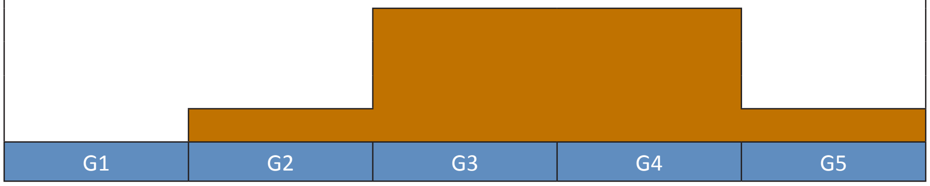
Estimated Single Rank (G3?)

Believed most likely a G3, but significant chance of either G2 or G4. Eventual change to G3 most likely, but change to G2 or G4 would not be unexpected.



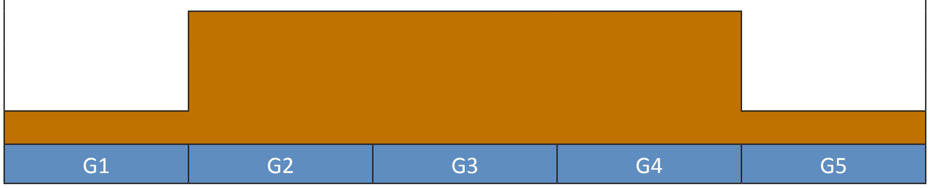
Two-Range Rank (G3G4)

Roughly equal chance of G3 or G4, but other ranks much less likely. Eventual change to either G3 or G4 most likely.



Three-Range Rank (G2G4)

Roughly equal chance of G2, G3 or G4, but other ranks much less likely. Considerable further information needed to resolve. Eventual change to either G2, G3 or G4 expected.



Q – Questionable taxonomy, which may reduce conservation priority. Use of the Q qualifier denotes that the distinctiveness of the assessed entity as a taxon or ecosystem type at the current level is questionable. More importantly, use of the Q further indicates that *resolution of this uncertainty may result in a change, either from a species to a subspecies or hybrid, or inclusion of the assessed taxon or ecosystem type in another taxon or type, such that the resulting taxon/type will have a lower-priority (numerically higher) conservation status rank than that originally assigned*.

An example of an invalid use of the Q qualifier would be a G5Q, which is not appropriate since resolution of the uncertainty associated with the assessed taxon or ecosystem type could not result in a taxon or type with a conservation status that is lower priority (higher numerically) – the assigned status (5) is already the lowest priority. Similarly, a taxon or type that may be split into several new species or types would not qualify for a Q qualifier as the conservation statuses of the resulting entities would either stay the same or have higher priority (become numerically lower); for example, a G4 taxon or type is split into three G2 and G3 ranked (higher-priority) taxa/types. Note that the Q modifier is only used with global level conservation status ranks, and not at a national or subnational level. Note also that other data fields are available at a global level to specify taxonomic uncertainties, regardless of resolution of the taxonomic uncertainty on the conservation status.

C – Captive or Cultivated Only The C qualifier is used to indicate that a taxon, at present, is extinct in the wild across its entire native range, but is extant in cultivation, in captivity, as a naturalized population (or populations) outside its historical native range, or as a reintroduced population not yet established. Note that the C modifier is only used for species status ranks at the global level, and not at a national or subnational level.

Additional Information of Interest

Number of Protected and Managed Occurrences Field

This field is no longer included in the set of core factors used for NatureServe conservation status assessments. The degree of threat to a species or ecosystem that is indirectly assessed for this field is largely addressed, and better captured, in the Threats conservation status factor. However, this field may still provide useful supplemental information for conservation status assessments.

Enter the estimated number of protected and managed occurrences (a range is acceptable): _________

Enter the code that best describes the observed, estimated, inferred, or suspected number of occurrences that are appropriately protected and managed *for the long-term persistence of the species or ecosystem* in the area of interest (globe, nation, or subnation). Note that both the protection and management criteria must be met in order to assign a rating code value. If the values are different for protected vs. managed occurrences, assign the code that represents the more restrictive of the two. For example, if several occurrences are protected but none are appropriately managed, select the A = None code.

Select from the following values:

A = None – no occurrences appropriately protected and managed

B = Few (1–3) occurrences appropriately protected and managed

C = Several (4–12) occurrences appropriately protected and managed

D = Many (13–40) occurrences appropriately protected and managed

E = Very many (>40) occurrences appropriately protected and managed

U = Unknown whether any occurrences are appropriately protected and managed

Null = Not assessed

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Appendix A

NatureServe Conservation Status Ranks

NatureServe Global Conservation Status Definitions

Listed below are definitions for interpreting NatureServe's global (range-wide) conservation status ranks. Global conservation status ranks are assigned by NatureServe scientists or by a designated lead office in the NatureServe network.

Global (G) Conservation Status Ranks

Rank	Definition
GX	**Presumed Extinct** (species) — Not located despite intensive searches and virtually no likelihood of rediscovery. **Presumed Eliminated** (ecosystems, i.e., ecological communities and systems) — Eliminated throughout its range, due to loss of key dominant and characteristic taxa and/or elimination of the sites and ecological processes on which the type depends.
GH	**Possibly Extinct** (species) or **Possibly Eliminated** (ecosystems) — Known from only historical occurrences but still some hope of rediscovery. Examples of evidence include (1) that a species has not been documented in approximately 20–40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is extinct or eliminated throughout its range.
G1	**Critically Imperiled** — At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
G2	**Imperiled** — At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3	**Vulnerable** — At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4	**Apparently Secure** — At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5	**Secure** — At very low risk or extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.

Variant Global Conservation Status Ranks

Rank	Definition
G#G#	**Range Rank** — A numeric range rank (e.g., G2G3, G1G3) is used to indicate uncertainty about the exact status of a taxon or ecosystem type. Ranges cannot skip more than two ranks (e.g., GU should be used rather than G1G4).
GU	**Unrankable** — Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Note: whenever possible (when the range of uncertainty is three consecutive ranks or less), a range rank (e.g., G2G3) should be used to delineate the limits (range) of uncertainty.
GNR	**Unranked** – Global rank not yet assessed.
GNA	**Not Applicable** — A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.[1]

Rank Qualifiers

Rank	Definition
?	**Inexact Numeric Rank** — Denotes inexact numeric rank; this should not be used with any of the Variant Global Conservation Status Ranks or GX or GH.
Q	**Questionable taxonomy** that may reduce conservation priority— Distinctiveness of this entity as a taxon or ecosystem type at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon or type in another taxon or type, with the resulting taxon having a lower-priority (numerically higher) conservation status rank. The “Q” modifier is only used at a global level and not at a national or subnational level.
C	**Captive or Cultivated Only** — Taxon or ecosystem at present is presumed or possibly extinct or eliminated in the wild across their entire native range but is extant in cultivation, in captivity, as a naturalized population (or populations) outside their native range, or as a reintroduced population or ecosystem restoration, not yet established. The “C” modifier is only used at a global level and not at a national or subnational level. Possible ranks are GXC or GHC. This is equivalent to “Extinct in the Wild (EW) in IUCN’s Red List terminology (IUCN 2001).

Infraspecific Taxon Global Conservation Status Ranks

Infraspecific taxon status ranks apply to species only; these ranks do not apply to ecological communities or systems.

Rank	Definition
T#	Infraspecific Taxon (trinomial) — The status of infraspecific taxa (subspecies or varieties) are indicated by a “T-rank” following the species’ global rank. Rules for assigning T-ranks follow the same principles outlined above. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T subrank cannot imply the subspecies or variety is more abundant than the species, for example, a G1T2 subrank should not occur. A vertebrate animal population (e.g., listed under the U.S. Endangered Species Act or assigned candidate status) may be tracked as an infraspecific taxon and given a T rank; in such cases a Q is used after the T-rank to denote the taxon’s informal taxonomic status.

1 A global conservation status rank may be not applicable for several reasons, related to its relevance as a conservation target. In such cases, typically the species is a hybrid without conservation value, of domestic origin, or the ecosystem is non-native, for example, ruderal vegetation, a plantation, agricultural field, or developed vegetation (lawns, gardens etc).

NatureServe National and Subnational Conservation Status Definitions

Listed below are definitions for interpreting NatureServe conservation status ranks at the national (N-rank) and subnational (S-rank) levels. The term "subnational" refers to state-, province- or territory-level jurisdictions (e.g., California, Ontario).

Assigning national and subnational conservation status ranks for species and ecosystems (ecological communities and systems) follows the same general principles as used in assigning global status ranks. Historically, a subnational rank, however, could not imply that a species or ecosystem is more secure at the state/province level than it is nationally or globally (e.g., a rank of G1S3 is invalid), and similarly, a national rank could not exceed the global rank. But this rule is under review, because current methods provide a more explicit role for Threats and Trends, which may indicate low levels of risk at national/subnational scales as compared to global scales. Subnational ranks are assigned and maintained by state or provincial NatureServe network programs.

National (N) and Subnational (S) Conservation Status Ranks

Rank	Definition
NX **SX**	**Presumed Extirpated**—Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation, or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered. [Equivalent to "Regionally Extinct" in IUCN Red List terminology]
NH **SH**	**Possibly Extirpated** – Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.
N1 **S1**	**Critically Imperiled**— At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
N2 **S2**	**Imperiled**— At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
N3 **S3**	**Vulnerable**— At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
N4 **S4**	**Apparently Secure**— At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
N5 **S5**	**Secure**— At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.

Variant National and Subnational Conservation Status Ranks

Rank	Definition
N#N# **S#S#**	**Range Rank** —A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).
NU **SU**	**Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
NNR **SNR**	**Unranked**—National or subnational conservation status not yet assessed
NNA **SNA**	**Not Applicable** —A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.[1]
Not Provided	Species or ecosystem is known to occur in this nation or state/province. Contact the appropriate NatureServe network program for assignment of conservation status.

1 A conservation status rank may be not applicable for some species, including long distance aerial and aquatic migrants, hybrids without conservation value, and non-native species or ecosystems, for several reasons, described below.

Long distance migrants: Assigning conservation status to long distance aerial or aquatic migrant animals (e.g., species like migrant birds, bats, butterflies, sea turtles, and cetaceans) during their migrations is typically neither practical nor helpful to their conservation. During their migrations, most long distance migrants occur in an irregular, transitory, and dispersed manner. Some long distance migrants occur regularly, while others occur only as accidental or casual visitors to a subnation or nation. Some long distance migrants may regularly occur as rare breeding or non-breeding seasonal (e.g., winter) species, but in an inconsistent, spatially irregular fashion, or as breeders that die out apparently with no return migration and no overwintering (e.g., some Lepidoptera). In all these circumstances, it is not possible to identify discrete areas for individual species that can be managed so as to significantly affect their conservation in a nation or subnation. The risk of extinction for these species is largely dependent on effective conservation of their primary breeding and non-breeding grounds, notwithstanding actions that may benefit species collectively such as protecting migratory "hotspots," curbing pollution, minimizing deaths from towers and other obstructions, etc.

An exception is those species, such as shorebirds, whose populations concentrate at particular areas during migration, and species occurring in multiple species assemblages at migration "funnels" or hotspots. Such species may be collectively treated within "Animal Assemblage" elements, for which conservation status assignment would be appropriate. Examples of such assemblages are Shorebird, Waterfowl, Landbird, and Raptor Migratory Concentration Areas. Species considered within assemblage elements differ from the more common situation during migration, whereby most long distance migrants are tied to particular places and habitats during their breeding season, as well as during the non-breeding [e.g., wintering] season when they are not in transit. For these species, conservation of both types of places is important to minimize their risk of extinction.

Hybrids without conservation value and non-natives: It is not appropriate to assign a conservation status to hybrids without conservation value, or to non-native species or ecosystems. However, in the rare case where a species is presumed or possibly extinct in the wild (GXC/GHC) but is extant as a naturalized population outside of its native range, the naturalized population should be treated as a benign introduction, and should be assessed and assigned a numeric national and/or subnational conservation status rank. The rationale for this exception for naturalized populations is that when a species is extinct over its entire natural range, the presence of that species within an area must be considered important to highlight and preserve, even if the area is not part of the species' natural range.

Rank Qualifier

Rank	Definition
N#? **S#?**	**Inexact Numeric Rank**—Denotes inexact numeric rank; this should not be used with any of the Variant National or Subnational Conservation Status Ranks, or NX, SX, NH, or SH.

Breeding Status Qualifiers[2]

Qualifier	Definition
B	**Breeding**—Conservation status refers to the breeding population of the species in the nation or state/province.
N	**Non-breeding**—Conservation status refers to the non-breeding population of the species in the nation or state/province.
M	**Migrant**—Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the nation or state/province.

2 A breeding status is only used for species that have distinct breeding and/or non-breeding populations in the nation or state/province. A breeding-status S-rank can be coupled with its complementary non-breeding-status S-rank if the species also winters in the nation or state/province. In addition, a breeding-status S-rank can also be coupled with a migrant-status S-rank if, on migration, the species occurs regularly at particular staging areas or concentration spots where it might warrant conservation attention. Multiple conservation status ranks (typically two, or rarely three) are separated by commas (e.g., S2B,S3N or SHN,S4B,S1M).

Appendix B

Summary of IUCN Red List Categories and Criteria

The following categories were developed for species red list, but the same categories are proposed to IUCN for ecosystems (Rodriguez et al. 2011). If confirmed, there is a need to update the definitions to be inclusive of both species and ecosystems.

Extinct (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Extinct in the Wild (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity, or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

Critically Endangered (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E (see below) for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

Endangered (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

Vulnerable (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

Near Threatened (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered, or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Least Concern (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable, or Near Threatened. Widespread and abundant taxa are included in this category.

Data Deficient (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required, and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

Not Evaluated (NE)

A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

Summary of the IUCN Red List Criteria for Species

Summary of the five criteria (A–E) used to evaluate if a taxon belongs in a threatened category (Critically Endangered, Endangered, or Vulnerable).

Use any of the criteria A–E	Critically Endangered	Endangered	Vulnerable
A. Population reduction Declines measured over the longer of ten years or three generations			
A1	>90%	>70%	>50%
A2, A3, and A4	>80%	>50%	>30%
A1. Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible and understood and ceased based on (and specifying) any of the following: (a) direct observation (b) an index of abundance appropriate to the taxon (c) a decline in area of occupancy (AOO), extent of occurrence and/or habitat quality (d) actual or potential levels of exploitation (e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.			
A2. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased or may not be understood or may not be reversible, based on (and specifying) any of (a) to (e) under A1.			
A3. Population reduction projected or suspected to be met in the future (maximum 100 years) based on (and specifying) any of (b) to (e) under A1.			

Use any of the criteria A–E	Critically Endangered	Endangered	Vulnerable
A4. An observed, estimated, inferred, projected or suspected population reduction (maximum 100 years) where the time period must include both the past and the future, and where the causes of reduction may not have ceased or may not be understood or may not be reversible, based on (and specifying) any of (a) to (e) under A1.			
B. Geographic range in the form of either B1 (extent of occurrence) or B2 (area of occupancy)			
Either (B1) extent of occurrence	<100km^2	<5,000km^2	<20,000km^2
Or (B2) area of occupancy and at least two of (a) to (c):	<10km^2	<500km^2	<2,000km^2
(a) severely fragmented, or number of locations	= 1	≤5	≤10
(b) continuing decline in (i) extent of occurrence, (ii) area of occupancy, (iii) area, extent, and/or quality of habitat, (iv) number of locations or subpopulations, and (v) number of mature individuals.			
(c) extreme fluctuations in any of (i) extent of occurrence, (ii) area of occupancy, (iii) number of locations or subpopulations, and (iv) number of mature individuals.			
C. Small population size and decline			
Number of mature individuals and either C1 or C2:	<250	<2,500	<10,000
C1. An estimated continuing decline of at least (maximum 100 years)	25% in three years or one generation	20% in five years or two generations	10% in ten years or three generation
C2. A continuing decline and (a) and/or (b):			
(a.i) number of mature individuals in largest subpopulation	<50	<250	<1,000
(a.ii) or percentage of mature individuals in one subpopulation	90–100%	95–100%	100%
(b) extreme fluctuations in the number of mature individuals			
D. Very small or restricted population			
Either (D1) number of mature individuals	<50	<250	<1,000
Or (D2) restricted area of occupancy	n/a	n/a	typically: <20km^2 or # locations ≤5
E. Quantitative Analysis			
Indicating the probability of extinction in the wild to be at least	50% within 10 years or three generations (100 yrs max)	20% within 20 years or five generations (100 yrs max)	10% in 100 years

Appendix C

NatureServe, IUCN Red List, and COSEWIC Statuses Compared

The tables below provide comparisons between the different conservation status categories used by NatureServe and the IUCN Red List (each compared at multiple geographic levels), and those used by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In both tables, rough equivalencies are indicated through the display of statuses in the same row.

Comparison of NatureServe and IUCN Red List Global Statuses

NatureServe Global Status	IUCN Red List Status
Presumed Extinct (GX)	Extinct (EX)
Presumed Extinct in the Wild[1] (GXC)	Extinct in the Wild (EW)
Possibly Extinct (GH)	Critically Endangered (CR) (possibly extinct)
Possibly Extinct in the Wild[1] (GHC)	Critically Endangered (CR) (possibly extinct)
Critically Imperiled (G1)	Critically Endangered (CR)
Critically Imperiled (G1)	Endangered (EN)
Imperiled (G2)	Vulnerable (VU)
Vulnerable (G3)	Near Threatened (NT)
Apparently Secure (G4)	Least Concern (LC)
Secure (G5)	Least Concern (LC)
Unrankable (GU)	Data Deficient (DD)

1 Species ranked GXC and GHC are presumed or possibly extinct in the wild across their entire native range, but are extant in cultivation, in captivity, as a naturalized population (or populations) outside its historical native range, or as a reintroduced population not yet established. The C modifier is only used with status ranks at a global level, and not a national or subnational level. Similarly, IUCN's EW status is only used at a global level.

Comparison of NatureServe National/Subnational Statuses with IUCN Regional Red List and COSEWIC Statuses

NatureServe National/ Subnational Status	IUCN Regional Red List Status	COSEWIC Status[2]
Presumed Extirpated (NX/SX *and* GX	Extinct (EX)	Extinct (X)
Presumed Extirpated (NX/SX and *not* GX)	Regionally Extinct (RE)	Extirpated (XT)
Possibly Extirpated (NH/SH)	Critically Endangered (CR) (possibly extinct)	Endangered (EN)
Critically Imperiled (N1/S1)	Critically Endangered (CR)	Endangered (EN)
Critically Imperiled (N1/S1)	Endangered (EN)	Endangered (EN)
Imperiled (N2/S2)	Vulnerable (VU)	Threatened (T)
Vulnerable (N3/S3)	Near Threatened (NT)	Special Concern (SC)
Apparently Secure (N4/S4)	Least Concern (LC)	Not At Risk (NAR)
Secure (N5/S5)	Least Concern (LC)	Not At Risk (NAR)
Unrankable (NU/SU)	Data Deficient (DD)	Data Deficient (DD)

2 COSEWIC status (aside from Extinct) applies only within Canada, and thus, is equivalent to the national rankings of NatureServe or the regional IUCN Red List status. See ***www.natureserve.org/explorer/statusca.htm***.

Appendix D

Extinction Risk and Setting Conservation Priorities

Assessment of extinction risk and setting conservation priorities are two related, but different, processes. To set conservation priorities, extinction risk is considered along with other factors, including ecological and/or phylogenetic characteristics, historical and/or cultural preferences for some taxa over others, the probability of success of conservation actions, availability of funds or personnel to carry out such actions, and existing legal frameworks for conservation of at-risk taxa. For additional discussion of this topic, see Possingham et al. (2002), IUCN (2003), and Bunnell et al. (2009).

In the context of setting conservation priorities within a jurisdiction (e.g., state, province), it is critical to consider not only the status of a species or ecosystem (i.e., risk of local extinction or extirpation) within the jurisdiction, but also other factors such as the global status or risk of extinction, and the proportion of the global population or range that occurs within the jurisdiction. Because the extirpation risk of a species or ecosystem is not evenly distributed across jurisdictions, a particular species or ecosystem may be at significant risk in one jurisdiction but relatively secure in other jurisdictions. Thus, the use of conservation status alone to assign priority can result in the focus of conservation effort precisely where it is least likely to succeed (Possingham et al. 2002). In addition, conservation actions may begin too late to be effective if initial efforts are focused on the rarest species within a jurisdiction where the success of actions is least likely and most costly (Bunnell et al. 2009).

The following combinations of global and subnational conservation statuses are listed in a suggested priority sequence for conservation attention, all else being equal (jurisdiction responsibility, feasibility, etc.) (The Nature Conservancy 1988):

G1S1, G2S1, G2S2, G3S1, G3S2, G3S3, G4S1, G5S1, G4S2, G5S2, G4S3, G5S3

However, “all else” is never equal; the stewardship responsibilities for a species or ecosystem will vary between the different jurisdictions in which it occurs. For example, if two species with equal global and jurisdictional conservation statuses differ such that one of the species has a large percentage of its global range in a jurisdiction, that jurisdiction bears particular responsibility for securing the future of that particular species relative to the other species that has a smaller portion of its global range in the jurisdiction. Thus, it is recommended that when reporting and publishing national or subnational statuses, a jurisdiction also include not only the global statuses, but also an estimate of the proportion (%) of the global population or range for the species or ecosystems that occur within that jurisdiction.

For additional discussion of this topic, see Bunnell et al. (2009) and Keinath and Beauvais (2004). In particular, Bunnell et al. (2009) describe goals for conservation that can help jurisdictions effectively allocate their resources, and also provide two tools to facilitate the process. One of these tools sorts species into practical groups for conservation action, creating groups comprised of species that require similar actions. The other tool assigns conservation priorities by ordering “species or ecosystems based on criteria governing risk (= conservation status), modified by feasibility, stewardship responsibility (as discussed above), disjunctness, and pattern of range collapse.” (Bunnell et al. 2009) These tools thus enable priorities to be ordered within an action group, within a particular goal, or within an overall status rank. This system for conservation prioritization developed by Bunnell et al. (2009) can be applied to any North American jurisdiction.

Appendix E

Changes to Status Factors with Conversions

In moving from the 2002 NatureServe conservation status factors to using the revised 2009 factors, the value choices for several factors have been expanded for better compatibility with IUCN Red List statuses. Automated conversions for the Area of Occupancy factor and those in the **trends** and **threats** categories were developed to facilitate ranking using the updated status assessment protocol and to permit use of the rank calculator. Note in the table comparing the 2002 and 2009 factors below, these automated conversions may result in the assignment of range ranks as conservation status values in many cases. Upon review of the underlying data, it should be possible to narrow these ranges or assign single status ranks, eliminating the more imprecise range ranks altogether.

Summary of Status Factors Changes Between 2002 and 2009 With Conversions

2002 Factor	2009 Factor	Factor Change/New Rule/Conversion
Number of EOs	Number of Occurrences	
Z = 0 (zero) A = 1–5 B = 6–20 C = 21–80 D = 81–300 E = >300 U = Unknown	Z = 0 (zero; presumed extinct) A = 1–5 B = 6–20 C = 21–80 D = 81–300 E = >300 U = Unknown	Factor change? No New Rule? No

2002 Factor	2009 Factor	Factor Change/New Rule/Conversion
Number of EOs with Good Viability	Number of Occurrences with Good Viability/Ecological Integrity	
A = No (A- or B-ranked) occurrences with good viability B = Very few (1–3) occurrences with good viability C = Few (4–12) occurrences with good viability D = Some (13–40) occurrences with good viability E = Many (41–125) occurrences with good viability F = Very many (>125) occurrences with good viability U = Unknown	A = No occurrences with excellent or good (A or B) viability or ecological integrity B = Very few (1–3) occurrences with excellent or good viability or ecological integrity C = Few (4–12) occurrences with excellent or good viability or ecological integrity D = Some (13–40) occurrences with excellent or good viability or ecological integrity E = Many (41–125) occurrences with excellent or good viability or ecological integrity F = Very many (>125) occurrences with excellent or good viability or ecological integrity U = Unknown	Factor Change? Yes New Rule: Along with this field, a companion field—Percent Area with Good Viability/Ecological Integrity—has been added to replace the 2002 factor Number of EOs with Good Viability. Enter a value for the number of occurrences with good viability/ ecological integrity using this field and/or enter a value for the Percent Area with Good Viability/ Ecological Integrity field (below). If values have been recorded for both fields, the more restrictive of the two will be used in the conservation status assessment.
	Percent Area with Good Viability/Ecological Integrity	
	A = No area with excellent or good viability or integrity B = Very small percentage (<5%) of area with excellent or good viability or integrity C = Small percentage (5–10%) of area with excellent or good viability or integrity D = Moderate percentage (11–20%) of area with excellent or good viability or integrity E = Good percentage (21–40%) of area with excellent or good viability or integrity F = Excellent percentage (>40%) of area with excellent or good viability or integrity U = Unknown percentage of area with excellent or good viability or integrity	Factor change? Yes New rule: This field is an alternative replacement for the 2002 Number of EOs with Good Viability factor. Must also enter a value for Area of Occupancy.

2002 Factor	2009 Factor	Factor Change/New Rule/Conversion
Range Extent	Range Extent	
Z = Zero (no occurrences believed extant)	Z = Zero (no occurrences believed extant; presumed extinct)	Factor change? No New Rule? No
A = <100 square	A = <100 km²	
B = 100–250 km²	B = 100–250 km²	
C = 250–1,000 km²	C = 250–1,000 km²	
D = 1,000–5,000 km²	D = 1,000–5,000 km²	
E = 5,000–20,000 km²	E = 5,000–20,000 km²	
F = 20,000–200,000 km²	F = 20,000–200,000 km²	
G = 200,000–2,500,000 km²	G = 200,000–2,500,000 km²	
H = >2,500,000 km²	H = >2,500,000 km²	
U = Unknown	U = Unknown	
Population Size	Population Size	
Z = Zero, no individuals extant	Z = Zero, no individuals believed extant (presumed extinct)	Factor change? No New Rule? No
A = 1–50 individuals	A = 1–50 individuals	
B = 50–250 individuals	B = 50–250 individuals	
C = 250–1,000 individuals	C = 250–1,000 individuals	
D = 1,000–2,500 individuals	D = 1,000–2,500 individuals	
E = 2,500–10,000 individuals	E = 2,500–10,000 individuals	
F = 10,000–100,000 individuals	F = 10,000–100,000 individuals	
G = 100,000–1,000,000 individuals	G = 100,000–1,000,000 individuals	
H = >1,000,000 individuals	H = >1,000,000 individuals	
U = Unknown	U = Unknown	

2002 Factor		**2009 Factor**		**Factor Change/New Rule/Conversion**
Area/Linear Distance of Occupancy (Ecosystem)		Area of Occupancy (Ecosystem) (2009)		
Area	Linear Distance	Conversion		Factor change? Yes New rule? No See below for 2012 update to AOO based on patch types. The AOO 2009 scale is essentially equivalent to the Large Patch type of 2012 (see below), which is the default patch type.
Z = Zero	Z = Zero		Z = Zero (no occurrences believed extant)	
A = <0.4 km²	A = <4 km		A = <1 km²	
B = 0.4–4 km²	B = 4–40 km	B >> AB	B = 1–4 km²	
C = 4–20 km²	C = 40–200 km	C >> CD	C = 4–10 km²	
D = 20–100 km²	D = 200–1,000 km	D >> E	D = 10–20 km²	
E = 100–500 km²	E = 1,000–5,000 km	E >> F	E = 20–100 km²	
F = 500–2,000 km²	F = 5,000–20,000 km	F >> G	F = 100–500 km²	
G= 2,000–20,000 km²	G = 20,000–200,000 km	G >> H	G = 500–2,000 km²	
H = >20,000 km²	H = >200,000 km	H >> I	H = 2,000–20,000 km² I = >20,000 km²	
U = Unknown	U = Unknown		U = Unknown	
Area of Occupancy (Ecosystem) (2009)	Area of Occupancy (Ecosystem) (2012) in km²			
= Large Patch of 2012	Matrix	Large Patch	Small Patch	Factor change? Yes New rule? No
Z = Zero (no occurrences believed extant)	0	0	0	
A = <1 km²	<10	<1	<0.1	
B = 1–4 km²	10–30	1–5	0.1–0.5	
C = 4–10 km²	30–100	5–10	0.5–1.0	
D = 10–20 km²	100–300	10–20	1.0–2.0	
E = 20–100 km²	300–1,000	20–100	2.0–5.0	
F = 100–500 km²	1,000–5,000	100–500	5.0–20	
G = 500–2,000 km²	5,000–25,000	500–2,500	20–100	
H = 2,000–20,000 km²	25,000–200,000	2,500–20,000	100–500	
I = >20,000 km²	>200,000	>20,000	>500	
U = Unknown	Unknown	Unknown	Unknown	

2002 Factor	2009 Factor		Factor Change/New Rule/Conversion
Area of Occupancy (Species)	Area of Occupancy (Species)[1]		
	# 4 km² grid cells	# 1 km² grid cells	Factor change? Yes New rule? No Conversions:
Z = Zero	Z = 0	Z = 0	
A = <0.4 km²	A = 1	A = 1–4	A >> AC
B = 0.4–4 km²	B = 2	B = 5–10	B >> AD
C = 4–20 km²	C = 3–5	C = 11–20	C >> DE
D = 20–100 km²	D = 6–25	D = 21–100	D >> EF
E = 100–500 km²	E = 26–125	E = 101–500	E >> FG
F = 500–2,000 km²	F = 126–500	F = 501–2,000	F >> GH
G = 2,000–20,000 km²	G = 501–2,500	G = 2,001–10,000	G >> HI
H = >20,000 km	H = 2,501–12,500	H = 10,000-50,000	H >> I
	I = >12,500	I = >50,000	
U = Unknown	U = Unknown	U = Unknown	

2002 Factor	2009 Factor	Factor Change/New Rule/Information
Linear Distance of Occupancy (Species)	Area of Occupancy (Species)[1]	
	# of 1 km² grid cells	Factor change? Yes New rule? No Conversions:
Z = Zero	Z = 0	
A = < 4 km	A = 1–4	
B = 4–40 km	B = 5–10	B >> BD
C = 40–200 km	C = 11–20	C >> DE
D = 200–1,000 km	D = 21–100	D >> EF
E = 1,000–5,000 km	E = 101–500	E >> FG
F = 5,000–20,000 km	F = 501–2,000	F >> GH
G = 20,000–200,000 km	G = 2,001–10,000	G >> HI
H = >200,000 km	H = 10,000–50,000	H >> I
	I = >50,000	
U = Unknown	U = Unknown	
Environmental Specificity	Environmental Specificity	
A = Very narrow	A = Very narrow	Factor change? No New rule: Only used if Number of Occurrences and Area of Occupancy are Unknown or Null
B = Narrow	B = Narrow	
C = Moderate	C = Moderate	
D = Broad	D = Broad	
U = Unknown	U = Unknown	

1 The initial automatic conversion of Area of Occupancy for species is to 4 km^2 grid cells but in some cases (see footnote 5), it is more appropriate to convert to a 1 km^2 grid. Although this conversion and the conversion for species Linear Area of Occupancy are both fairly generous so as to conceptually attempt to capture 80%+ of actual cases, some cases (e.g., either a particularly dispersed set of small occurrences, or a very narrowly concentrated set of occurrences) will fall outside of the converted ranges, and so these conversions should be evaluated carefully when reviewing the initial calculated rank.

2002 Factor	2009 Factor	Factor Change/New Rule/Information
Long-term Trend	Long-term Trend	
A = Very large decline (>90%)	A = Decline of >90%	Conversions:
B = Large decline (75–90%)	B = Decline of 80–90%	B >> BC
C = Substantial decline (50–75%)	C = Decline of 70–80%	C >> D
D = Moderate decline (25–50%)	D = Decline of 50–70%	D >> E
E = Relatively stable (+/- 25% change)	E = Decline of 30–50%	E >> FGH
F = Increase (>25%)	F = Decline of 10–30%	F >> I
	G = Relatively Stable (≤10% change)	
	H = Increase of 10–25%	Factor change? Yes New rule? No
	I = Increase of >25%	
U = Unknown	U = Unknown	
Short-term Trend	Short-term Trend	
		Conversions:
A = Severely declining (>70% in population, range, area occupied, and/or number or condition of occurrences)	A = Decline of >90%	A >> ABC
B = Very rapidly declining (50–70%)		B >> D
C = Rapidly declining (30–50%)	B = Decline of 80–90%	C >> E
D = Declining (10–30%)	C = Decline of 70–80%	D >> F
E = Stable (unchanged or within +/- 10% fluctuation in population, range, area occupied, and/or number or condition of occurrences)	D = Decline of 50–70%	E >> G
F = Increasing (>10%)	E = Decline of 30–50%	F >> HI
U = Unknown	F = Decline of 10–30%	
	G = Relatively Stable (≤10% change)	
	H = Increase of 10–25%	
	I = Increase of >25%	Factor change? Yes New rule? No
	U = Unknown	

2002 Factor	2009 Factor	Factor Change/New Rule/Information
Overall Threat	Overall Threat Impact[2]	
		Conversions:
A = Substantial, imminent threat	A = Very High	A >> AB
B = Moderate and imminent threat	B = High	B >> B
C = Substantial, non-imminent threat	C = Medium	C >> AC
D = Moderate, non-imminent threat	D = Low	D >> BC
E = Localized substantial threat	U = Unknown	E >> C
F = Widespread, low-severity threat		F >> C
G = Slightly threatened		G >> D
H = Unthreatened		H >> D
		Factor change? Yes New rule: Threat is assigned on the basis of Scope and Severity. Timing is no longer used to determine overall Threat Impact, but it still useful to record. See text for details on threat impact calculation.
Intrinsic Vulnerability	Intrinsic Vulnerability	
A = Highly vulnerable B = Moderately vulnerable C = Not intrinsically vulnerable	A = Highly vulnerable B = Moderately vulnerable C = Not intrinsically vulnerable	Factor change? No New rule: Only used if Overall Threat Impact is Unknown or Null.
Number of Protected EOs	Number of Protected and Managed Occurrences	
A = None. No occurrences appropriately protected and managed	A = None. No occurrences appropriately protected and managed	Factor change? No New rule: Used as supplementary information only. No longer a formal rank factor.
B = Few (1–3) occurrences appropriately protected and managed	B = Few (1–3) occurrences appropriately protected and managed	
C = Several (4–12) occurrences appropriately protected and managed	C = Several (4–12) occurrences appropriately protected and managed	
D = Many (13–40) occurrences appropriately protected and managed	D = Many (13–40) occurrences appropriately protected and managed	
E = Very many (>40) occurrences appropriately protected and managed	E = Very many (>40) occurrences appropriately protected and managed	

2 For Timing, the IUCN-CMP values are sufficiently different that it is recommended that existing NatureServe data on immediacy be discarded and new timing values be recorded.

NatureServe
4600 N. Fairfax Dr., 7th Floor
Arlington, VA 22203
703-908-1800
www.natureserve.org