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NatureServe Conservation Status Assessments:

Methodology for Assigning Ranks

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NatureServe

April 2009

Acknowledgments

This document provides comprehensive guidelines for assigning a conservation status rank to all elements of biodiversity tracked by NatureServe. The document has been developed by the Element Ranking Work Group, which was formed in 2004. Current members are Larry Master, Don Faber-Langendoen, Adele Tomaino, Jennifer Nichols, Leah Ramsay, Bonnie Heidel, Roxanne Bittman, Geoff Hammerson, Bruce Young, and Ben Wigley; Kristin Snow provided the programming skills and feedback to the working group on how best to implement the Rank Calculator. Past members include Larry Morse, Paul Hendricks, Steve Rust, and Troy Weldy. We appreciate their contributions to this project.

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Executive Summary

NatureServe and its member programs and collaborators use a suite of factors to assess the extinction or extirpation (regional extinction) risk of plants, animals, and ecosystems (or "elements" of biodiversity). By researching and recording information on a set of conservation status factors, biologists can assign a conservation status rank to these elements at both global and regional (i.e., national/subnational) scales. The protocol for assigning a conservation status rank is based on scoring an element against ten conservation status factors, which are grouped into three categories based on the characteristic of the factor: rarity (six factors), trends (two factors), and threats (two factors). Once assigned, scores for the individual factors within each of these categories are pooled and the resulting three summary scores are combined to yield an overall numeric score, which is translated into a calculated rank. This calculated rank is reviewed, adjusted if deemed appropriate by the evaluator (with reasons documented), and recorded as the final assigned conservation status rank, using a G1-G5 scale for global element status, or the equivalent scale for national or subnational assessments.

The conservation status factors that comprise each category help guide the consistent and rigorous recording of information to facilitate the assignment of a conservation status. Weights assigned to individual factors reflect their perceived influence on extinction risk for the element. The computation for the calculated status score relies on information from all assessed factors to assign a rank rather than from any single factor, and weights rarity factors the most, followed by trends factors, and then threats. This approach reflects the view of many conservationists that rarity has the most important, but not sole, influence on the probability that a species or ecosystem will become extinct.

The set of factors used to assess conservation status, by category, are:

- **Rarity:** Population Size, Range Extent, Area of Occupancy, Number of Occurrences, Number of Occurrences or Percent Area with Good Viability/Ecological Integrity, and Environmental Specificity (used only when the Number of Occurrences and Area of Occupancy are unknown);
- **Trends:** Long-term and Short-term Trend in population size or area;
- **Threats:** Threat Impact (generated by considering the scope and severity of the major threats), and Intrinsic Vulnerability (used only if Threat Impact is unknown).

Information for all ten conservation status factors is not required to assign a status. At a minimum, information for only two of eight "core" factors is needed, as long as these factors include either two rarity category factors (one of which must be either Range Extent or Area of Occupancy), or one rarity factor and one factor from the trends or threats category. Depending on the precision of the information supplied and the number of factors for which information exists, a specific conservation status rank (e.g., G1, S3) or range rank (e.g., G1G2, N2N4) can be derived. If the conservation status factor information does not meet the minimum necessary to assess conservation status, or the information for multiple factors is too imprecise, a "U" status rank is assigned (e.g., GU, NU).

When assessing each of the ten conservation status factors, ratings are selected from either a logarithmic or categorical scale of values. For conservations status factors that are used by both NatureServe and IUCN (e.g., Area of Occupancy), break points for these scales coincide with those in the IUCN Red List criteria. If available information for a species or ecological type does not permit a single value for a factor to be determined, a range of values can be selected.

NatureServe has developed this rank calculator to facilitate the process of assigning conservation status ranks through automation (NatureServe 2009). The calculator works in combination with NatureServe's data management system, Biotics 4, which

The NatureServe Network

NatureServe is a non-profit conservation organization whose mission is to provide the scientific basis for effective conservation action. NatureServe represents an international network of biological inventories—known as natural heritage programs or conservation data centers—operating in all 50 U.S. states, Canada, Latin America and the Caribbean. The NatureServe network is the leading source for information about rare and endangered species and threatened ecosystems. Together with these network member programs, we not only collect and manage detailed local information on plants, animals, and ecosystems, but also develop information products, data management tools, and conservation services to help meet local, national and global conservation needs.

contains the element database, including the rank factor information and assigned conservation status ranks for all elements.

The updated ranking system and new calculator represent a major upgrade of NatureServe ranking methods. They provide rank standardization—helping to increase the consistency, objectivity, and transparency of the conservation status assessments, facilitate maintenance of the ranks, promote NatureServe network collaboration, incorporate fields that were added previously to lend robustness to ranking, and provide utility in generating global ranks as well as national or subnational ranks. The revised factor definitions and values used in NatureServe's updated conservation status assessment protocol (Master et al. 2009) are also designed to ensure international compatibility, including the ability to calculate IUCN ranks.

Overview of the Status Assignment Method

For many years, NatureServe and its network of natural heritage programs and conservation data centers have been assessing the relative extinction risk of species and ecosystems. Conservation status ranks have been derived by relying on experts trained in making decisions about the relative imperilment of species and ecosystems based on information on status factors (see Regan et al. 2004). This process of assigning a conservation status rank has been qualitative to date, in part due to the challenges of assessing many thousands of species and ecosystems in a timely fashion with limited resources (Master 1991). Although the status ranks are subject to ongoing peer review as biologists collect new information throughout the NatureServe network, the qualitative approach to conservation 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 nevertheless influenced by personal judgments, perceptions of risk, and systemic biases.

For these reasons, in 2004 NatureServe formed the Element Ranking Work Group (ERWG) to develop a transparent ranking protocol that would address the above issues and deficiencies. Along with revisions to the assessment factors and values, the major product of this group is a rank calculator that facilitates the process of assigning status ranks through automation—a major upgrade of the existing protocol. More specifically, revisions to the conservation status assessment process were undertaken for the following reasons:

- Ranking systems should be free of bias, transparent to users, and consistently applied within and between groups, and across political boundaries.
- Despite a robust system for recording information about status factors, there is little and/or varying guidance to practitioners on how to use these factors to assign conservation status ranks.
- NatureServe ranking is a "black box" to outsiders, while at the same time NatureServe status ranks are increasingly being used in formal ways that have significant biodiversity, economic, and other impacts, including U.S. Forest Service sensitive-species designations, forest products industry certification standards, official subnational listings, The Nature Conservancy's ecoregional planning, U.S. Fish and Wildlife Service and other agency/jurisdictional priority setting, etc.
- Ranking systems are more readily maintained and improved when the status factors, including ones with gaps in information and uncertainties in interpreting information, can be individually addressed and then regularly reassessed as new information becomes available.

NatureServe's system of ranking for both species and ecosystems is similar to many others in the types of information gathered, but its method of assigning a status rank is distinctive as compared to many rule-based approaches that are available, such as that of IUCN's Red List for species (IUCN 2001) or others for ecosystems (Rodriguez et al. 2007, Raunio et al. 2008, Nicholson et al. 2009). An overview and comparison of these systems is provided for species in Master et al. (2000), and for ecosystems in Nicholson et al. (2009). The history of the NatureServe's conservation status ranking methodology is summarized in Master et al. (2009).

This document describes in detail the newly standardized methods to be used to assign a NatureServe conservation status rank, based on the information collected on rarity, trends, and threats. The basic conservation status factors are summarized, their roles in assessing extinction or extirpation risk are outlined, the roles of uncertainty and data quality in assigning a factor rating are examined, and guidelines for using the new rank calculator (NatureServe 2009) to automatically calculate status ranks for review are provided.

Note that the ranking methodology presented in this document is an upgrade, not a replacement, of NatureServe's current protocol, and helps to ensure that status ranks are more consistent, repeatable, and transparent in comparison with assessments derived by the more subjective and qualitative approach previously used. Based on prior evaluations (Faber-Langendoen et al. 2007), the majority of conservation status ranks assigned prior to this 2009 status assessment upgrade did not change by more than one rank when these methods are implemented. This is not too surprising, as the underlying conceptual thought process for assessing NatureServe conservation status (Master 1991) has not significantly changed. For information on any conversions needed for rank factor values assigned before implementation of the 2009 upgraded methodology, see Master et al. (2009).

Conservation Status Factors

Primary Status Factors

Ten primary factors are used to assess conservation status, grouped into three categories—rarity, trends, and threats—with two to six conservation status factors in each category to ensure that the information needed to assign conservation status is consistently and rigorously recorded. Table 1 illustrates the organization of these primary status factors, and provides brief definitions. Note that all of the conservation status factors, except for Population Size, apply to taxa (species, subspecies, populations, and plant varieties) and to ecological types (ecological communities, associations, and ecological systems). We often refer to taxa colloquially as "species" and to ecological types as "ecosystems." See Master et al. (2009) for additional details on status rank factors.

TABLE 1
Summary of NatureServe Conservation Status Rank Factors.

Factor Category	Factor	Definition
RARITY	**Range Extent**	Minimum area that can be delimited to encompass all present occurrences of an ecological type or taxon, typically excluding extreme disjuncts and vagrancies.
	Area of Occupancy	Area within the range extent that an ecological type or taxon actually occupies. For taxa, area can be estimated by counting the number of occupied cells in a uniform grid. In most cases a grid of size 2x2 km (a cell area of 4 km^2) should be used, but a smaller 1 km^2 grid is appropriate for linear and some other occurrence types. For ecological types, areas can be measured or estimated directly based on the best available information. Grid counts and area values should be used even if the occupancy is linear; see Master et al. (2009) for more information.
	Population Size *(species only)*	The estimated total wild population of a taxon, occurring in its natural range and based on counts or estimates of the number of individuals that are currently of a reproductive age or stage, or mature and currently non-reproducing. This category is not included in the assessment calculation for annual plants or invertebrates with population sizes that fluctuate greatly from year to year.

Factor Category	Factor	Definition
RARITY *(cont.)*	**Number of Occurrences**	Number of extant locations (stands) of an ecological type, or discrete areas occupied by a taxon (typically subpopulations, populations, or metapopulations). See guidelines in the Element Occurrence Data Standard in NatureServe (2002). See Master et al. (2009) for a discussion on the limitations of using occurrences for conservation status assessments.
	Number of Occurrences or Percent Area with Good Viability/ Ecological Integrity	1) Number of occurrences (locations/stands of an ecological type or locations/subpopulations/populations/ metapopulations of a taxon) that have excellent-to-good viability or ecological integrity (A or B occurrence ranks), such that there is the likelihood of persistence if current conditions prevail; ***or*** 2) the percent of the total area occupied by a taxon or ecological type that has excellent-to-good viability or ecological integrity.
	Environmental Specificity	The degree to which a taxon or ecological type 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 taxon or ecological type. (Used only if the Number of Occurrences and Area of Occupancy are Unknown or Null.)
TRENDS	**Long-term Trend**	Degree of past directional change in population size (for taxa only), extent of occurrence, area of occupancy, number of occurrences, and/or viability or ecological integrity of occurrences over the long term (ca. 200 years).
	Short-term Trend	Degree of past directional change in population size (for species), extent of occurrence, area of occupancy, number of occurrences, and/or viability or ecological integrity of occurrences in the short term, considered to be typically within 30 years for ecological types, or within ten years or three generations, whichever is longer (up to 100 years), for taxa.
THREATS	**Threat Impact**	Degree to which the integrity of an ecological type or viability of a taxon is affected by extrinsic factors (stressors) that degrade integrity or viability, and which are characterized in terms of scope and severity. Threats are typically anthropogenic, having either direct (e.g., habitat destruction) or indirect (e.g., introduction of invasive species) impact.
	Intrinsic Vulnerability	Degree to which intrinsic or inherent characteristics, such as life history or behavior patterns for taxa, or likelihood of regeneration or recolonization for ecological types, make it susceptible or resilient to natural or anthropogenic stresses or catastrophes. (Used only if the Threat Impact is Unknown or Null.)

There are two options for using the factor Number of Occurrences or Percent Area with Good Viability/Ecological Integrity. The first option is to estimate the number of species or ecosystem occurrences[1] that have excellent-to-good estimated persistence, represented by an occurrence rank of A or B (ranks for occurrences are defined in Hammerson et al. 2008). The alternative option is to estimate the percentage of the species habitat or the ecosystem area that is in excellent-to-good condition. Good estimated persistence for an occurrence equates to good viability for species or good ecological integrity for ecosystems. If both number of occurrences and percent area options for this factor have assigned ratings, then the value indicating the greatest risk of extinction/extirpation is used in the conservation status assessment.

Other Factors of Interest

In addition to the ten conservation status factors identified above that are used to assess extinction or extirpation risk, there may be other information that should be considered in assigning NatureServe status ranks, shown in Table 2.

TABLE 2
Other Information Useful for Assessing Conservation Status.

Information of Interest	Description
Other Considerations	Information recorded in an optional field that might be relevant to assessing conservation status. For example, the recorded results of a PVA analysis, which may either supplement the factor information used to assess the species conservation status, or indicate a rank that differs from that which would result from a status assessment based on rank factors alone.
Number of Protected and Managed Occurrences	Number of occurrences that are appropriately protected and managed for the long-term persistence of the species or ecosystem. **No longer used as a conservation status factor with implementation of the upgraded conservation status assessment methodology.** Although this information is potentially still useful, the degree of threat indirectly assessed by this attribute is better represented by the Threat Impact status factor.
Rescue Effect	Used only at regional (national and subnational [state/provincial]) levels, Rescue Effect is the process by which immigrating propagules result in a lower extinction risk for the population being assessed. Information on Rescue Effect may indicate that a species status rank should be adjusted to a lower risk category, or that the extinction risk of a population has been underestimated and that the rank should be changed to a higher risk category. See IUCN (2003)and Master et al. (2009) for further details on the use of information on Rescue Effect in status assessments.
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. A subnational rank cannot 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 cannot exceed the global rank. Subnational ranks are assigned and maintained by state or provincial NatureServe network programs.

1 For species, the occurrence is defined by a discrete area occupied by the element and often corresponds with a local population, although it may represent a subpopulation or metapopulation for some taxa. The occurrence for an ecosystem represents an extant location of a type, typically a cluster of stands or patches. See Master et al. (2009) for further discussion of species and ecosystem occurrences.

Core and Conditional Factor Use Rules

Under the upgraded conservation status ranking protocol, the ten primary status factors identified above have been categorized as either core or conditional, depending on whether they are always to be used for status assessments when data are available, or used primarily when information on specific core fields is lacking. In addition, a series of rules (or conditions) have been developed, partly on the basis of the availability of information for some of the factors, and incorporated into the rank calculator. These rules specify whether, and how, each status factor is used in the conservation status calculation, and also define the circumstances under which the two status factors identified as conditional (Environmental Specificity and Intrinsic Vulnerability), can be included in the calculation, specifically:

- Environmental Specificity is used only if both Number of Occurrences ***and*** Area of Occupancy are unknown or not assessed;
- Intrinsic Vulnerability is used only if Threat Impact is unknown or not assessed.

The remaining eight status rank factors are the core factors. Note that even with information on these core status factors, assessing the two conditional factors may help to more fully understand the extinction or extirpation risk of a taxon or ecosystem. Table 3 summarizes the rules for using core and conditional status factors in assessing conservation status. Definitions of the factors are shown in Table 1; detailed descriptions of the factors and ratings are provided in Master et al. (2009).

TABLE 3
Summary of the Rules for Use of Core and Conditional Factors.

Factor Category	Factor	Factor Type	Rule (Condition)	Rating Example (for an A value)
RARITY	**Range Extent**	Core	Always use, if available.	Area: <100 km^2
	Area of Occupancy	Core	Always use, if available. For this factor, species assessments use either number of 4 km^2 or number of 1 km^2 grid cells; ecosystem assessments use a measurement of area.	*Species* – Count: 1 4 km^2 grid cell ***or*** Count: 1–4 1 km^2 grid cells *Ecosystems* – Area: <1 km^2
	Population Size	Core	Always use, if available (species only).	Count: 1–50 individuals
	Number of Occurrences	Core	Always use, if available.	Count: 1–5
	Number of Occurrences or Percent Area with Good Viability/ Ecological Integrity	Core	Always use, if available (but Percent Area with… can only be used if Area of Occupancy is also recorded).	*Number of Occurrences with…* – Count: 0 ***and/or*** *Percent Area with…* – Area: 0

TABLE 3 (cont.)

Factor Category	Factor	Factor Type	Rule (Condition)	Rating Example (for an A value)
RARITY *(cont.)*	**Environmental Specificity**	Conditional	Only use if both Number of Occurrences ***and*** Area of Occupancy are Unknown or Null.	Qualitative Rating: Very narrow; specialist with key requirements scarce
TRENDS	**Long-term Trend**	Core	Always use, if available.	Percent: Decline of >90%
	Short-term Trend	Core	Always use, if available.	Percent: Decline of >90%
THREATS	**Threat Impact**	Core	Always use, if available.	Impact: Very High Index: Scope – Pervasive Severity – Extreme
	Intrinsic Vulnerability	Conditional	Only use if Threat Impact is Unknown or Null.	Qualitative Rating: Highly vulnerable

Minimum Core Factor Requirements

Recognizing that information for all status factors will seldom be available for a species or ecosystem, it is not a requirement that all core factors be assessed in order to assign conservation status. **At a minimum**, information for only two factors is needed from the set of eight core factors in order to assign a status rank indicating risk of extinction/extirpation, as long as the two factors assessed are **either two rarity category factors** (either Range Extent or Area of Occupancy + one of the remaining rarity factors), ***or* one rarity factor + one factor from the trends or threats** categories (Table 4).

More specifically, to apply the minimum factor requirements, core factors are first grouped according to status factor categories and the rarity category then divided into two groups, as follows:

Rarity1 = Range Extent, Area of Occupancy

Rarity2 = Population Size, Number of Occurrences, Number of Occurrences or Percent Area with Good Viability/Ecological Integrity

Trends/Threats = Long-term Trend, Short-term Trend, Threat Impact

In order to assign a status rank, at a minimum values must be provided for one of the following two combination requirements:

A. One factor from each of the Rarity1 ***and*** Rarity2 groups; ***or***

B. One factor from either the Rarity1 ***or*** Rarity2 group ***and*** one factor from the Trends/Threats group.

Factor Groups	Core Factors	Minimum Factor Requirements		
		Combination A		*Combination B*
Rarity1	Range Extent Area of Occupancy	1 Factor		1 Factor
Rarity2	Population Size Number of Occurrences Number of Occurrences or Percent Area with Good Viability/ Ecological Integrity	1 Factor	***or***	
Trends/Threats	Long-term Trend Short-term Trend Threat Impact			1 Factor

TABLE 4
Minimum Required Core Factors for Conservation Status Assessments.

For many elements, especially those taxa and ecosystems that are either critically imperiled or abundant and secure (i.e., the top and bottom of the ranking scale), a conservation status rank assigned on the basis of only two factors may be valid with high confidence. In such cases, this is because the influence of these two factors on extinction/extirpation risk to the element is important enough to serve as the basis for accurate calculation of conservation status. However, for other taxa and ecosystems, values for such a limited number of factors may provide too little information for an acceptable representation of the risk of extinction or extirpation. Thus there is no direct relationship between the number of conservation status factors assessed and the accuracy of a calculated status rank. Because the rank calculator cannot determine accuracy or confidence, a rank will be automatically generated if the minimum factor requirements are met, and it is the responsibility of the assessor to identify any issues with the number of factors used to calculate a conservation status rank.

If neither of the two required minimum factor combinations for assessing conservation status are met, the rank calculator will automatically assign a calculated status of Unrankable (GU[2] , NU, or SU for global, national, or subnational assessments, respectively[3]). The assessor may review the Unrankable status and determine whether to complete one or more additional rank factors, or to over-ride the calculated rank.

Extreme Rarity Assignment Rules

Although the rank calculator relies primarily on a point-based approach to weight and combined status factors to derive a calculated status rank, there are several conditions under which the calculator will automatically assign a conservation status rank at the appropriate geographic level for the assessment, overriding the calculation of a numeric score. The first, as described above, is automatic assignment of an Unrankable (e.g., GU, NU, SU) status when the minimum core factor requirements are not met. The remaining "override" rules are applied by the rank calculator automatically to address special cases of extreme rarity for specific core factors, as follows:

2 Elements may be assigned an Unrankable (GU) conservation status at the global level due to lack of information or due to substantially conflicting information about status or trends (see Master et al. 2009).
3 See Appendix A for further descriptions of NatureServe conservation status ranks.

- If any of the rarity status factors Range Extent, Area of Occupancy, Population Size, or Number of Occurrences has
  - » an assigned range rating that includes Z (zero), such as ZA or ZB, then a Historical (GH, NH, SH) conservation status is automatically assigned by the calculator; ***or***
  - » an assigned rating value of Z (zero), then an Extinct/Extirpated (GX, NX, SX) conservation status is automatically assigned by the calculator.
- If either of the rarity status factors Area of Occupancy or Population Size has an assigned rating of A or B, a Critically Imperiled (G1, N1, S1) conservation status is automatically assigned by the calculator.

TABLE 5
Summary of the Rank Calculator Automatic Override Conditions.

Rule	Specific Factors	Condition	Automatic Status Rank
Minimum Core Factor Requirements	(See Table 4)	Factors assessed do not meet required combination of core factors	GU, NU, SU
Extreme Rarity Assignment Rules	• Range Extent • Area of Occupancy • Population Size • Number of Occurrences	Range rating includes Z (zero) (e.g., ZA, ZB)	GH, NH, SH
		Rating is Z (zero)	GX, NX, SX
	• Area of Occupancy • Population Size	Rating is A or B	G1, N1, S1

Calculator Process for Assessing Conservation Status

NatureServe has developed an automated spreadsheet (the "rank calculator") that has been programmed to generate standardized conservation status ranks based on recording all available information on the rank factors. The rank calculator provides a structured, replicable process for computing the risk of extinction or extirpation. It incorporates the requirements listed in Tables 3 through 5, and computes an overall numeric score, which is translated into a calculated rank to be reviewed, and possibly adjusted, before acceptance as the final assigned conservation status. (See Appendix D for an example of a completed status rank calculation.) The rank calculator can be used to assign status ranks at both global and regional (i.e., national or subnational) levels according to the geographic level of the factor information used.

The rank calculator process depends on consistent documentation of status information using the ten primary rank factors. Both points and rules are used in the process. The following steps are described in further detail in the sections that follow; the rank calculator automatically completes all but the initial and final steps of this algorithm.

1. Rank factors are assessed and a rating assigned by the user (value code)
2. Rank factors are scored (points)
3. Rank factors are weighted (points)
4. Rank factor categories are weighted (points)
5. Overall score is calculated (points, selecting factors according to rules)
6. Calculated rank is determined from the score (points, subject to some conditional rules)

7. Calculated rank is reviewed, possibly adjusted by the assessor (subject to documented reasons), and accepted as the final assigned conservation status rank.

1. Rate Status Factors

For conservation status assessments, ratings are assigned to as many status factors as possible, based on the information available for the species or ecosystem. Rating codes are selected from a logarithmic or categorical scale of values for each factor. Note that guidance provided in Master et al. (2009) should be carefully reviewed before rating status factors. In addition, when selecting the appropriate coded value for a status factor, assessors should adopt a moderate attitude towards risk, as explained by IUCN guidelines (text in part taken from IUCN Standards and Petitions Working Group 2008):

> "When interpreting and using uncertain data, attitudes towards risk and uncertainty are important. First, assessors need to consider whether they will include the full range of plausible values in assessments, or whether they will exclude extreme values from consideration (known as dispute tolerance). Uncertainty in the data is reduced when the assessor has a high dispute tolerance, and thus excludes extreme values from the assessment. We suggest assessors adopt a moderate attitude, taking care to identify the most likely plausible range of values, excluding extreme or unlikely values."

There are two status rank factors that should be specifically mentioned in this section. First, the process for determining the overall rating for the Threat Impact status factor can be facilitated through use of the rank calculator to automatically generate a rating based on information on the scope and severity of various threats to the element. Second, there is only one factor out of the ten—Number of Occurrences or Percent Area with Good Viability/Ecological Integrity—which can be rated using either or both of two separate fields (one for the number of occurrences, and the other for percentage of area). If both of these fields have an assigned rating value, the more restrictive of the two values (i.e., indicating greater rarity) is used by the rank calculator in the status assessment.

Table 6 provides a scale of single rating values (vs. range ratings) as an example, specifically those used for Range Extent.

TABLE 6
Example of a Conservation Status Factor Value Scale.

Rating Values for Range Extent
Z = Zero (no occurrences believed extant)
A = <100 square km (< about 40 square mi)
B = 100–250 square km (about 40–100 square mi)
C = 250–1,000 square km (about 100–400 square mi)
D = 1,000–5,000 square km (about 400–2,000 square mi)
E = 5,000–20,000 square km (about 2,000–8,000 square mi)
F = 20,000–200,000 square km (about 8,000–80,000 square mi)
G = 200,000–2,500,000 square km (about 80,000–1,000,000 square mi)
H = >2,500,000 square km (> 1,000,000 square mi)
U = Unknown

If the status factor data for a particular species or ecosystem is not well known or uncertain, a range of values can be selected for the factor rating rather than a single value (e.g., BC = 100–1,000 square km or CE = 250–20,000 square km). The Unknown (U) rating code cannot be combined with any other value as a range rank.

2. Assign Points to Factor Ratings

Once ratings have been selected for status factors, the rank calculator assigns a point score for each rating. The point score used has been defined in the calculator taking into account how these points would affect the original (logarithmic or categorical) scale of values for the factor. This is one of a number of issues to be considered when using a point-based approach to ranking, with or without accompanying rules (see also Sutula et al. 2006). NatureServe's ranking approach has standardized each of the status factor ratings to an ordinal scale using letter code values, regardless of whether the values are based on an underlying numeric (or interval) scale. Although a rating of A is known to be lower in value (greater risk of extinction) than a rating of B, the magnitude of the difference is not specified. Since the exact mathematical distribution of the ratings is not defined, the values cannot be readily used in calculations. Although ordinal scales provide less resolution and make it more difficult to combine factor ratings, they are more easily justifiable in terms of biological, ecological, and mathematical criteria. That is, as stated by Sutula et al. (2006), "ordinal scales require only the ability to rank [elements] based on their relative similarity to the desired assessment endpoint without knowing precisely how close the condition is to that endpoint or to the next highest rating category." The ordinal values are scaled so that the full range of ratings for each individual factor is comparable in terms of extinction or extirpation risk. In keeping with this concept, NatureServe's philosophy when creating a value scale for each status factor was to have the stepwise changes in value between ratings for an individual factor (e.g., from A to B to C) be roughly equivalent in terms of extinction or extirpation risk, regardless of the underlying numeric values. Thus, the NatureServe method does not use the break points for the ratings as "thresholds" (except for a few cases of extreme rarity, as shown in Table 5); rather they are points along a continuum of risk of extinction that can be evaluated jointly with values from other factors.

In order to enable the use of the ordinal factor ratings in calculations, each rating has a specific numeric value (i.e., points) assigned by the rank calculator. The number of points assigned for different ratings has been determined on the basis of the value scale associated with that factor. All rating scales for conservation status factors have a minimum value code of A and a maximum value of C or higher, up to I. Though the number of values in the scale varies among status factors, the point range used in the rank calculator is constant, from 0 to 5.5, thereby giving each factor an equal contribution in status assessments (but see "3. Weight Individual Rank Factors" below). The maximum point value was set to 5.5 for this protocol because the NatureServe conservation status rank scale is essentially a five-point scale; that is, G1 to G5 ranks (indicating critically imperiled to secure, respectively), plus additional categories for historical and extinct/extirpated elements.

With the overall point range fixed at 0 to 5.5 for every status factor, points were scaled in a linear fashion from A to the highest rating value for that factor. Equal intervals beginning at 0 and ending at 5.5 were then used to determine the number points to be assigned to various ratings, with the size of the interval dependent on the number of values in the rating scale. For example, the point scales for two different factors, one with values from A–D and another with values from A–H, will both have the points between 0 and 5.5 spread evenly among the rating values. Use of this relatively simple point scale for assigning numeric values to factor ratings keeps the overall approach to assessing conservation status as simple and transparent as possible. Table 7 provides examples of the points assigned to rating values for the Environmental Specificity and Range Extent factors.

Rank Factor		Rating Values and Points
Fixed Point Range *(showing 0.5 intervals)*		0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5
Environmental Specificity	Rating	A B C D
	Assigned Points	0 1.8 3.7 5.5
Range Extent	Rating	A B C D E F G H
	Assigned Points	0 0.8 1.6 2.4 3.1 3.9 4.7 5.5

TABLE 7
Example of Points Assigned to Ratings for Different Status Factors.

3. Weight Individual Status Factors

Within each of the status factor categories—rarity, trends, threats—some of the individual factors are considered greater contributors to the influence of that category on element extinction or extirpation risk, and therefore are weighted more heavily than others in the category when calculating a category score. Table 8 indicates the weights that are assigned by the rank calculator to each status factor individually to be used to calculate the sub score for each category.

Traditionally, NatureServe's methodology for assessing conservation status has emphasized factors in the rarity category. Species status assessments have historically focused on the Population Size and Number of Occurrences factors (Master 1991), while for ecological communities, Area of Occupancy and Number of Occurrences have been preferred (Grossman et al. 1994). The Number of Occurrences and Area of Occupancy are two core attributes of rarity for an element, and because rarity is a strong indicator of the risk of extinction or extirpation of an element, the methodology pre-dating the 2009 upgrade favored using those rank factors as primary starting points for assessing conservation status.

However, past emphasis on the Number of Occurrences in assessing conservation status has been problematic, for various reasons:

- For common species, the number of occurrences loses its meaning compared with population size (i.e., the number of occurrences decreases as the species becomes increasingly widespread over the landscape, and less fragmented in its distribution);
- NatureServe's Element Occurrence (EO) concept (see NatureServe's "Element Occurrence Data Standard" [NatureServe 2002]) only works well for rare species rather than those that are common;
- Many external partners to NatureServe have had difficulty understanding the concept of an EO; and
- EO criteria (i.e., separation distance, tracking criteria) are not consistently applied across the NatureServe network, making it hard to "count" EOs.

A conceptually more robust approach to weighting status factors used in the upgraded protocol establishes Population Size, Area of Occupancy, and Number of Occurrences or Percent Area with Good Viability/Ecological Integrity as the three factors within the rarity category that most strongly indicate extinction/extirpation risk. For species, Population Size is an obvious first factor to weight more heavily because there is growing evidence that empirically demonstrates that population size is the factor most correlated with risk of extinction (Mace et al. 2008). The second rarity factor with increased weighting is Area of Occupancy because it represents the next best measure of species abundance (after Population Size, which can be difficult to estimate), and for ecosystems it is the single-best measure of rarity. The third status factor from the rarity

category to be weighted more heavily is Number of Occurrences or Percent Area with Good Viability/Ecological Integrity. This factor, in some ways, best represents the current condition of species and ecosystems through its integration of the overall impact of threats with any degradation effects resulting from past processes.

In addition to the three rarity factors that receive additional weight, one other factor is weighted more heavily in status rank calculations: Short-term Trend from the Trends category. While information on both long- and short-term trends is important, the Short-term Trend factor more directly captures the current status of a species or ecosystem.

4. Weight Status Factor Categories

To account for the differing amount of influence each of the status factor categories has on element extinction or extirpation risk, each category is assigned a weight by the rank calculator. In the upgraded conservation status assessment protocol, the rarity category factors are weighted the most (50%), followed by trends factors (30%), and then threats (20%). The category weightings are used with the category sub-scores to compute three category scores, which are then used to compute an overall calculated status score. These assigned category weightings have been established through rigorous testing against existing NatureServe status assignments and found to be the most reasonable in assessing extinction risk (Faber-Langendoen et al. 2007).

Placing the heaviest emphasis on the rarity category in rank calculations reflects the view of many conservationists that rarity represents the single-most important, but not sole, set of factors influencing the probability that a species or ecosystem will become extinct (Mace et al 2008). In addition, the assessment of rarity factors includes some consideration of the condition (viability or integrity) of a species or ecosystem and so, to a certain degree, rarity factors may also integrate some aspects of trends and threats.

TABLE 8
Weightings for Individual Factors and Factor Categories.[4]

Factor Category	Category Weight*	Factor	Factor Weight**
Rarity	0.5	Range Extent	1.0
		Area of Occupancy	2.0
		Population Size	2.0
		Number of Occurrences	1.0
		Number of Occurrences or Percent Area with Good Viability/Ecological Integrity	2.0
		Environmental Specificity (conditional use)	1.0
Trends	0.3	Long-term Trend	1.0
		Short-term Trend	2.0
Threats	0.2	Threat Impact	1.0
		Intrinsic Vulnerability (conditional use)	1.0

* *The category weights are used to calculate overall status score from category sub-scores.*
** *Factor weight(s) are used to calculate a category sub-score.*

5. Calculate Overall Status Score

The automated computation of an overall status score by the rank calculator incorporates the values resulting from previous steps in the algorithm. Integrated with these steps, the rank calculator applies several different conditions/rules (discussed in previ-

4 It should be noted that feedback from increased use of the rank calculator following implementation of this upgraded conservation status assessment protocol may indicate the need for revisions to the relative importance/weightings initially assigned to the various status factors and factor categories.

ous sections). The progression of tasks automatically performed by the rank calculator to generate a calculated rank score is:

a. Rules for the use of core and conditional factors are applied to status factors that have assigned ratings (Table 3).

b. Rules for minimum required core factors are applied (Table 4).

c. Conditions for automatic status rank assignment (override) are applied to the assigned ratings, and a conservation status rank assigned, if appropriate (Table 5).

d. A specific point value is assigned by the calculator for each factor rating value (step 2).

e. A prescribed weight is applied by the calculator to each individual factor (step 3; Table 8).

f. Three sub-scores are calculated based on the points and weightings assigned to the factors contained within each category.

g. A specific weight is assigned to each factor category (step 4; Table 8) and, with the category sub-scores, used to compute an overall calculated status score.

6. Translate Score to Calculated Status Rank

The rank calculator automatically translates calculated scores to the appropriate conservation status ranks according to the value ranges and rank equivalencies shown in Table 9, which illustrates that the ranges are equal in size (i.e., G2 = 1.6–2.5, G3 = 2.6–3.5) except for G1, which includes all scores ≤1.5. These rank value ranges were chosen, instead of an evenly spaced set of ranges (i.e., 0.0–1.1, 1.1–2.2, etc), after comparing the two scales. The scale in Table 9 was adopted as a precautionary approach to assessing conservation status for several reasons. First, extensive testing of status ranks generated by the rank calculator against existing assigned ranks (stored in Biotics) found that when an evenly spaced scale was used in the calculator, a disproportionate number of the existing G1 ranks became G1G2, G2, or occasionally G3, when generated from factor ratings by the rank calculator.[5] Second, in limited testing of particular elements, it was found that when using an evenly spaced scale, if all but one of the rank factors were rated high in terms of rarity (e.g., B) and the remaining factor was rated low, the calculator-generated values were down-ranked more than would appear to be warranted based on review of the factor ratings.

TABLE 9
Score Value Ranges for NatureServe Conservation Status Ranks.

Value Range for Calculated Score	Calculated Status Rank	Status Description
score ≤1.5	G1, N1, S1	Critically imperiled
1.5< score ≤2.5	G2, N2, S2	Imperiled
2.5< score ≤3.5	G3, N3, S3	Vulnerable
3.5< score ≤4.5	G4, N4, S4	Apparently secure
score >4.5	G5, N5, S5	Secure

5 It is difficult to do rigorous comparisons of existing ranks assigned under the previous methodology with those generated by the rank calculator because a) some of these existing ranks are not philosophically consistent with the upgraded approach to conservation status ranking (i.e., they may have been assigned with excessive emphasis on rarity through heavy weighting of the rarity factors, whereas the revised approach applied by the calculator assigns increased weight to trends and threats factors); and b) the rating value scales for status factors have been changed with the upgraded protocol such that ratings assigned under the previous methodology often had to be converted to range ratings for use in the rank calculator, which could have artificially lowered the rank generated from them.

Calculating Range Status Ranks

In the simplest case, all of the status factors used in a conservation status assessment have single value ratings assigned, and the rank calculator generates a single overall status score that is then translated to a single calculated status rank. However, if one or more of the factors have an assigned range rating indicating uncertainty (e.g., BC or BD) in the assessment (see "1. Rate Status Factors" above), then the status rank resulting from the score generated by the rank calculator may actually be a range status rank (e.g., G1G2).

To determine a status rank using one or more factors with range ratings, the rank calculator automatically defines the range of uncertainty with values at the low and high ends of the range, and performs calculations beginning with these low and high points, and carrying through all the processes of the algorithm. More specifically, the calculator automatically assigns, to the factor with the range rating, points for both the low and high values of the range, and, using these values, produces both low and high category sub-scores, followed by low and high category scores, which are then used to calculate low and high overall status scores. Whether these generated scores will be translated to a calculated range status rank or single rank depends on the extent of the point spread between the two calculated scores. To determine the calculated status rank to be assigned from a pair of range status scores, a set of range point settings is applied automatically by the rank calculator, as shown below (see examples in Table 10). Examples illustrating the underlying computations required to these apply range point settings are provided in Appendix B.

Range Point Settings

1. If 95% of the point spread between calculated scores is contained within the range of values for one status rank, then that rank is used as the calculated status rank.
2. If 80–95% of the point spread between scores is contained within the range of values for one status rank, then that rank is used with a "?" qualifier (see Appendix A) as the calculated status rank.
3. If ≥95% of the point spread between scores is contained within the range of values for two consecutive status ranks but <80% is contained within a single rank, then those two ranks are used as a calculated range status rank (e.g., G2G3).
4. If ≥95% of the point spread between scores is contained within the range of values for three consecutive status ranks, but <95% is contained within the range of two consecutive ranks, then those three ranks are used as a calculated range status rank (e.g., G2G4).
5. If <95% of the point spread between scores is contained within the range of values for three consecutive status ranks, then a conservation status rank of Unknown (U) is assigned.

7. Review, Adjust, and Assign Conservation Status Rank

The rule-and-point-based method that is used in the rank calculator provides a structured process for assessing conservation status, based on what are considered to be major drivers of extinction and extirpation risk. However, it is important that a calculated rank not be accepted as the final assigned conservation status rank for the species or ecosystem without first being reviewed by the assessor, as automated processes cannot always account for special conditions resulting from the wide diversity of species and ecosystems assessed.

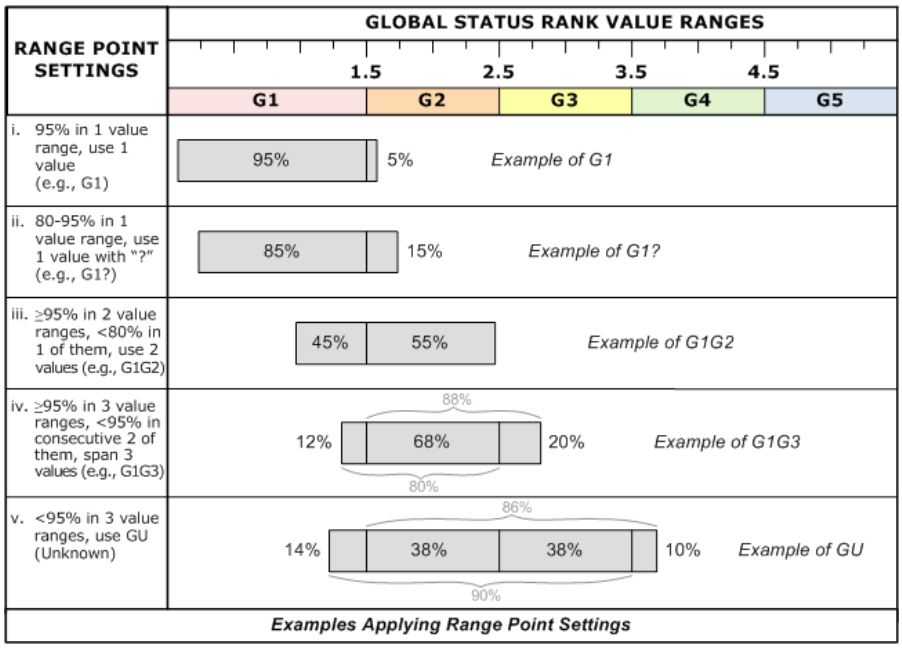

TABLE 10
Examples Illustrating Range Point Settings.

Adjusting the Calculated Rank

Upon review, there occasionally may be situations in which the assessor believes that the calculated status rank needs to be adjusted slightly up or down. In cases when the final assigned status rank differs from the calculated rank, it is especially important that the assessor document the reasons for the change in the Rank Adjustment Reasons field. Potential reasons for adjusting a calculated status rank include:

- **Questionable taxonomy**, for global rank assessments only. If distinctiveness of this entity as a species or ecosystem type at the current level is questionable, and resolution of the uncertainty may result in a lower-priority (numerically higher) conservation status, the calculated rank can be adjusted by adding a Q to the end before acceptance as the assigned global status rank.
- **Captive or Cultivated**, for global rank assessments only. If the species 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 native range, or as a reintroduced population not yet established, the calculated rank can be adjusted by adding a C to the end before acceptance as the assigned global status rank.
- **Rescue Effect**, for species national or subnational rank assessments only. If the jurisdictional population being assessed experiences significant immigration of propagules capable of reproducing in the jurisdiction, thus resulting in a lower extinction risk, the calculated rank may be raised to indicate lower priority by a half step or more (most commonly one step, e.g. from S2 to S3) before acceptance as the final assigned national/subnational status rank. In exceptional cases, lowering the calculated rank may be appropriate, if the population within the jurisdiction is a demographic sink that is unable to sustain itself without immigration, ***and*** if the immigration is expected to decrease. See IUCN (2003) and Master et al. (2009) for more information on rescue effect, and questions to be considered when the effect might be used as the basis for adjusting a rank. Jurisdictions may choose whether or not they want to take Rescue Effect into consideration.
- **A Comparison of Global and National/Subnational Rank Information** is useful when assigning conservation status, especially when the national/subnational information is more current or detailed than the global informa-

tion, or vice versa. Global and national/subnational ranks are designed to be used (displayed, provided in reports, etc.) together (e.g., G4S2) in national/subnational reports so as to provide a more complete picture of the conservation status of a species or ecosystem in the geographic area (nation, state, province) of interest.[6] The national/subnational rank should not indicate that the species or ecosystem is more imperiled at a global level than it is at a local level. For example, G3S4 is not permissible, as theoretically a species or ecosystem should not be vulnerable to extinction at a global level but apparently secure at a subnational level.[7] However, the rank calculator when applied to a species or ecosystem type at both levels may produce incongruous ranks; for example, a species is experiencing significant declines across most of its range but is stable in a particular jurisdiction. In this circumstance, either the global rank and/or the national/subnational rank should be adjusted to eliminate this discrepancy (e.g., calculated ranks of G3 and S4 for a species would be adjusted to G3 and S3 or G4 and S4).[8]

- **Other** reasons for adjusting a calculated status rank may include ecological considerations or specific life-history traits (e.g., extreme r- or k-selected[9] species), or additional information useful for conservation status assessments which may be recorded in the Other Considerations field of the NatureServe element database, such as the results of a population viability analysis.

In addition to the potential reasons for adjusting the basic rank, Appendix A should also be reviewed for possible application of rank qualifiers. These include global rank qualifiers (?, Q, and C) and, more commonly, national/subnational rank qualifiers for long-distance migratory species (B, N, and M).

Finalizing the Assigned Conservation Status Rank

Once the calculated rank has been reviewed, and adjusted if deemed appropriate by the assessor, the accepted final assigned conservation status rank must be manually recorded in the Assigned Rank field of the rank calculator. Note that the rank calculator automatically retains the initial calculated rank in a separate field.

6 See also Master et al. (2009), specifically Appendix D – Extinction Risk and Setting Conservation Priorities, for a discussion of the use of global and national/subnational ranks in setting priorities.

7 The IUCN (2003) allows a species to be more imperiled at a global level than at a regional level as their calculated imperilment statuses are not adjustable based on other considerations, as is permitted here.

8 As a specific example, if a jurisdiction has an expanding or increasing population of a species that is otherwise declining in North America (e.g., Canada warbler in British Columbia, Alberta, and Yukon) then 1) ensure that increases have been taken into account in the G-rank decline calculations; 2) if not, recalculate the G rank; 3) if the declines still swamp the increases, then the S rank should be adjusted so as to be equal to or lower than the G rank; and 4) if the increases in the jurisdictions were already included in the calculation of the overall declines for the G rank, then also adjust the S rank.

9 Population characteristics define r- and k-selection, with r species populations highly variable with reproduction by the fittest individuals occurring early and resulting in many offspring, while k species live in population conditions that are at or near equilibrium for long periods of time such that competition for limited resources is of great importance.

In the previous chapter, the underlying methodology for how the conservation status assessment ranking process is structured and automated was described. Here, the features of the rank calculator and the actual process for how it can be used by assessors to apply that methodology are explained. It is important to remember, however, that the calculator is only as good as the quality of information used to assign ratings to the individual status factors.

The rank calculator is in the form of an automated spreadsheet that has been programmed to generate calculated ranks from status factor ratings through the application of assigned points and weights according to the rules and algorithms described previously (NatureServe 2009). The calculator was developed to correlate with NatureServe's data management system (Biotics 4), which contains a comprehensive database of species and ecosystem information, including factor ratings and conservation status ranks.

Conservation Status Assessment and Biotics

In Biotics, conservation status information is maintained in Element Ranking files (see Appendix C for an example of a ranking record). In addition to some information identifying the element, the assessor and date of assessment, and a few other ancillary fields, the core content of a ranking record consists of:

- Assigned rating values and associated comments for each of the ten primary status factors;
- The calculated status rank generated by the calculator;
- The assigned status rank resulting from review, and possible adjustment, of the calculated rank;
- A summary of reasons the calculated rank was adjusted (if appropriate); and
- A summary of reasons for the assigned conservation status rank.

The database structure of Biotics is such that it can facilitate export of data for the ten status factors into other formats that permit analysis. This includes the ability to export the status factors into the rank calculator.

Process for Assessing Conservation Status

Unlike previous methodology, implementation of the upgraded NatureServe conservation status assessment protocol includes the use of a rank calculator that is independent from the Biotics data management system. Although conservation status assessments are completed using the rank calculator, data should not be stored in the rank calculator for the long term, but should be maintained in Biotics with all the other information managed on species and ecosystems. Incorporating the stand-alone rank calculator tool in the upgraded conservation status assessment methodology has required changes in the data and process flows for assessing conservation status. Two methods for performing assessments under the upgraded ranking protocol have been identified: a primary process to be used for the majority of assessments, and a secondary process to be used only when status factor ratings have not been previously recorded in Biotics.

Guidance for Use of the Rank Calculator

Primary Assessment Process

It is strongly recommended that conservation status assessments begin by assigning status factor ratings and recording associated information (e.g., comments, information on the assessment) first in Biotics or another compatible database.[1] Once recorded, these data are then exported from Biotics to the Calculator Table worksheet of the rank calculator, and a calculated status rank is automatically generated based on the imported factor ratings. The rank is reviewed, adjusted as needed, assigned, and documented by the user. The final step in the assessment process is updating Element Ranking files through import of data back into Biotics.

Revising factor data exported into the rank calculator from Biotics during an assessment is not recommended. Note that if edits to existing Biotics data are to be made in the calculator, a process for tracking them must be established and utilized to record these changes on an ongoing basis; the calculator does not track data edits. In addition to lack of automatic audit tracking, there is a risk of database corruption if edited status factor ratings are uploaded back into Biotics.

If the primary process was used for conservation status assessment and it is known with confidence that none of the status factor rating values imported into the calculator were edited during the assessment process, then the import to Biotics may consist of only new status data, specifically the following fields:

- Calculated Rank
- Assigned Rank
- Rank Adjustment Reasons
- Assigned Rank Reasons
- Rank Author
- Rank Date
- Internal Calculation Notes

If any of the status factor data exported into the calculator from Biotics were, or may have been, edited during the primary assessment process, then confirmation that no one else edited the factor data in Biotics after their export to the rank calculator should be obtained before the set of conservation status data from the calculator are used to update records in Biotics. It is recommended that a manual copy and paste process be used to transfer edited data back into Biotics,[2] since an attempt to import edited data into Biotics could overwrite existing data, which may lead to unintentional deletions or the loss of edits made by another user, and would not provide the audit tracking which automatically records changes made to status assessment data.

Secondary Assessment Process for New Status Factor Data

The secondary conservation status assessment process is recommended for use only in cases when there are no existing conservation status factor ratings recorded in Biotics or a compatible database for the species or ecosystem. In this secondary assessment process, status factor ratings values are initially entered directly into the rank calculator. Once the generated rank has been reviewed, revised if needed, assigned, and docu-

1 The Biotics data management application utilized by NatureServe for recording and maintaining data on species and ecosystems has the advantage of incorporating NatureServe standard methodologies within its structure and processes. As such, it is the recommended database for recording and maintaining conservation status information. However, a database with a compatible data structure can also be used to record and maintain this information, as well as to export data to the rank calculator.

2 NatureServe may, in the future, develop a process for importing edited data from the rank calculator into Biotics that uses NatureServe Exchanger. Such a process would provide both audit tracking and the ability for users to view all changes to existing data and accept or reject each change, that is, to compare and selectively import data back into Biotics.

mented, all the status data—the factor ratings, calculated and assigned status ranks, and associated attributes—are imported into Biotics from the rank calculator.

Other Biotics Updates

Regardless of whether the primary or secondary process is used for a status assessment, once the status data have been imported into the appropriate Element Ranking records in Biotics from the rank calculator, the following tasks need to be performed:

- Any numerical data recorded in Comments fields in the calculator must be moved into the appropriate designated fields in Biotics; and
- Because the calculator does not include reference fields and some of the other supporting fields needed to complete an Element Ranking record, this additional information must be entered in Biotics as well.

Until Biotics has been updated to include the new fields and ratings values for implementing the upgraded conservation status assessment methodology, the final import of status data into Biotics cannot occur. For details on managing status factor data and ranks according to the upgraded protocol in the interim period before Biotics has been updated, see Appendix E.

Maintaining Conservation Status Information

Maintaining current and accurate conservation status information in the NatureServe Biotics element database is of critical importance as it is relied on by many agencies and organizations, both within and external to NatureServe, for making decisions, including those related to conservation and management actions, and to government/agency listing of elements according to their risk of extinction. To facilitate the availability and use of these data, the global conservation status factor information and assigned status ranks maintained in Biotics are used to update the NatureServe Explorer website (www.natureserve.org/explorer).

Use of the rank calculator to implement the upgraded conservation status assessment method externally from Biotics creates some challenges for ensuring that the conservation status data in the Biotics element database is current and accurate. The recommended process for assessing status (specifically, entering status data in Biotics first, exporting these data to the rank calculator which generates a rank for review and assignment, and then importing the new rank data back into Biotics) is intended to address this challenge.

Using the Rank Calculator

Using the rank calculator to apply the upgraded NatureServe conservation status assessment protocol greatly simplifies the process of assigning status ranks. While implementing the upgraded protocol requires using various sets of rules and algorithms, the rank calculator automatically applies these conditions to status factor ratings and generates a rank, which then needs only review, and possibly adjustment, before being finalized. Microsoft Excel 2003 or higher is required to use the rank calculator. In order to utilize the full functionality of the rank calculator, the macro security setting in Excel must be Medium or Low, and macros must be enabled when files are opened.

The rank calculator consists of a number of worksheets identified by tabs, including several used for data and calculations and a few others containing sets of information that can be referenced when using the calculator. It is recommended that users review

each of the worksheets before beginning to use the rank calculator. The following sections describe each worksheet. Note that two tabs describing the transfer of status ranking data between the rank calculator and Biotics are labeled as "interim" as automation of this data import/export process is planned for the future.

Rank Calculator Tabs (Worksheets)

Brief descriptions of the contents of the various worksheets, listed by tab name, are:

- **Instructions & Rules Reference** provides some basic information on how to use the spreadsheet, and summarizes rules that guide the generation of a calculated status rank.
- **Factors Reference** provides a summary of all the rank factors and their rating value scales.
- **Calculator Table** stores status factor data for multiple species and ecosystems in tabular format. The data can be imported from Biotics Element Ranking files or transferred from the Calculator Form. During import, calculated ranks are automatically generated for each species or ecosystem record in the table. Although it is recommended that factor data be entered first in Biotics and then exported to the rank calculator, factor ratings can be entered or edited directly in this table, and then validated.
- **Calculator Form** is used for entering factor ratings and generating a calculated rank for a single species or ecosystem at a time. Details of the automated calculation process can be viewed most easily using this form. A row from the Calculator Table can be imported into this form for better viewing and editing.
- **Threats Worksheet** is used to automatically calculate the rating for the Overall Threat Impact status factor based on data entered on the scope and severity values for individual threats. (See the "Threats Worksheet" section below for details on this process.)
- **Threats Data Compiled** stores data from the Threats Worksheet for multiple species and/or ecosystems. It cannot, however, be used to enter threats data.

Interim Implementation Tabs:

- **Export from Biotics** provides the SQL queries and specific instructions for exporting status factor ratings data from Biotics into the Calculator Table worksheet of the rank calculator at either the global or subnational level. These queries automatically convert existing factor ratings which were assigned under the previous methodology to the equivalent new values during the export process.
- **Import into Biotics** provides some information to be considered if data is to be imported into Biotics from the rank calculator. An automated import process has not yet been developed. Because the current Biotics fields do not match the calculator fields, do not attempt to import data until Biotics has been updated with new fields and values.

Calculator Table

The Calculator Table is programmed to automatically apply the rules and algorithms to generate a calculated status rank from assigned status factor ratings. Unlike the Calculator Form, all of the ranks and factor ratings for a particular species or ecosystem are displayed in a single row rather than in different cells throughout a form. This structure provides the means to easily compare status information for multiple species and ecosystems. The calculated ranks are displayed in the left-most column of the

Calculator Table to facilitate copying, pasting, and deleting all of the editable data for a species or ecosystem as one contiguous range of cells.

The Calculator Table can be populated with data in several ways. Conservation status data from Biotics or another compatible database can be imported directly into the Calculator Table, which automatically generates a calculated status rank for each row. In addition, data entered in the Calculator Form can be saved in the Calculator Table. Although possible, it is not recommended that data be entered directly in the Calculator Table. Rating value scales for the individual status factors are not displayed on the Calculator Table worksheet. Data validation procedures are limited, and described in the rank calculator. Users should ensure that only valid rating values are entered in the table; which is facilitated by use of the Factors Reference tab of the calculator.

Calculator Form

The Calculator Form, like the Calculator Table, is programmed to automatically apply rules and algorithms to generate a calculated status rank from factor ratings. However, the form can only be used to assess the status of a single species or ecosystem at a time. Status factor ratings data can be entered directly into designated cells in the form using drop-down boxes, or they can be populated from a single row in the Calculator Table.

The Calculator Form is the most transparent means of examining details of the automated assessment process, as it provides drop-down menus with rating value scales for each status factor, and it displays the weights that are assigned to each individual factor and each factor category.

To illustrate the processes performed by the rank calculator, the steps for entering data in the Calculator Form are:

1. Select the geographic level for the conservation status assessment: G for global assessments, N for national, and S for subnational (i.e., state/provincial).

   This setting determines the letter portion of the final calculated status rank (e.g., G1 vs. N1 vs. S1); the numerical portion of the rank is not affected. Every status rank generated by the rank calculator will use the designated letter.

2. Enter identifying information for the element to be assessed (e.g., scientific name), and indicate the element Type as a species, infraspecies, animal assemblage, association, ecological system, or "other ecological type."

   Note that the factor points, weights, and calculations are the same for all species and ecosystems, so the Type setting does not affect the value of the status rank calculated;[3] however, if the "infraspecies" type is chosen for a global assessment (i.e., G was selected in step 1), the calculated status rank will begin with a T indicating an infraspecific taxon status, such as T1T2 (see Appendix A).

3. Optionally, provide additional information on the element by entering values for Element ID, Element Code (Elcode), and/or Common Name, and/or by selecting a value for Classification from the drop-down list.

4. Provide ratings for as many of the ten primary status factors as permitted by the data for the element by selecting value codes from the drop-down lists; the eight core status factors provide the best overall set of data for assessing conservation. Range values (e.g., BC, BD) should be used to indicate uncertainty in a particular rating. If actual numeric values for a factor rating

3 Suggestions that the rank calculator be customized for species vs. ecosystems, or for different guilds and trophic levels of species, were considered during its development. With use over time, it may be determined that calculator programming should be adapted, or customized instructions developed, for different categories of elements.

are known (e.g., 2,050 km^2 area occupied), they should be recorded in the comments fields associated with the assigned rating in the rank calculator.[4]

Guidance provided in Master et al. (2009) should be carefully reviewed before rating status factors. A summary of the status factors, including rating code values and factor categories, can be viewed on the Factors Reference tab. The points and weights assigned to each status factor and the factor category weights are provided on the Instructions & Rules Reference tab to help with interpreting the relative importance and contribution of each factor to the final conservation status rank.

5. As you enter data, the rank calculator automatically processes the assigned factor ratings, applying the following rules and algorithms:
    a. Use of core and conditional factors rules are applied to status factors that have assigned ratings (Table 3), including selection of the more restrictive value if ratings have been assigned to both fields (i.e., number of occurrences and percentage of area) used to represent the Number of Occurrences with Good Viability/Ecological Integrity factor.
    b. Rules for minimum required core factors are applied (Table 4).
    c. Conditions for automatic status rank assignment (override) are applied to the assigned ratings (Table 5).
    d. A specific point value is assigned for each factor rating value (Table 8).
    e. A prescribed weight is applied to each individual factor (Table 8).
    f. Three sub-scores are calculated based on the points and weightings assigned to the factors contained within each factor category.
    g. A specific weight is assigned to each factor category (Table 8) and, with the category sub-scores, used to compute an overall calculated status score.
    h. A calculated status rank is automatically generated through translation of the score into a rank based on value ranges and rank equivalencies (Tables 9 and 10).
6. The calculated status rank is automatically displayed in the Calculator Form, and is updated continuously as factor rating values are entered or edited in the form.
7. Review the calculated status rank generated by the Calculator Form to confirm that the value appears to be reasonable based on the underlying assessment data. Occasionally it may not be; in such cases, adjust the calculated rank and enter comments in the Rank Adjustment Reasons field to explain the reasons for the change. Note that the rank generated by the calculator should be adjusted only for exceptional reasons (see "Adjusting the Calculated Rank" section on page 16).
8. Enter the final assigned conservation status rank (either the calculated status rank or an adjusted rank), in the Assigned Rank field and provide comments on the status in the Assigned Rank Reasons field.
9. When status factor ratings are completed on the Calculator Form tab, values can be copied to a row on the Calculator Table worksheet by clicking the "Copy Data to Calculator Table" button. The form can then be cleared in preparation for assessing the next species or ecosystem.

4 However, when managing the conservation status rank factor data in Biotics, such numerical data are to be stored directly in the appropriate Biotics field rather than in the factor Comments field. For example, the numerical value for the Number of Grid Cells (such as "9") will be stored in a designated field in Biotics separate from the field in which the rating value (e.g., D = 6–25) for Number of Grid Cells will be recorded.

Threats Worksheet

This worksheet is used to automatically generate a value for the Threat Impact status factor in cases when a rating has not yet been assigned, and there is sufficient information on the threats to the species or ecosystem being assessed. For a comprehensive description of the rationale and process for determining values for the overall Threat Impact status factor, see Master et al. (2009).

The underlying basis for overall impact are evaluations of individual threats that impact the element, both broad ("Level 1") categories of threats and finer ("Level 2") threats contained within the Level 1 threats. The general process for using the Threats Worksheet to automatically generate a value for overall threat impact follows.

1. Select values for the scope, severity, and timing of threats that impact the element at either Level 2, or at Level 1 if Level 2 threats within that category will not be assessed, using the Classification of Threats table (adopted from IUCN-CMP, Salafsky et al. 2008) on the worksheet.
2. The Threats Worksheet automatically generates the impact for each recorded threat using the scope and severity values.
3. Estimate the scope and severity values for any Level 1 threat categories which contain at least one Level 2 threat, based on the impact(s) of the included Level 2 threat(s). The worksheet generates impacts for these Level 1 threats.
4. The Threats Worksheet automatically tallies the impact values generated for each Level 1 threat category and applies specific guidelines to generate the overall threat impact for the element (see Master et al. [2009] for descriptions of these guidelines).
5. Review the overall threat impact generated by the Threats Worksheet and adjust the value, if deemed appropriate, before it is assigned as the rating for the Overall Threat Impact factor for use in the status assessment. To copy the impact rating to the Calculator Form, click the button "Copy Assigned Impact to Calculator Form."
6. Threats data for the species or ecosystem can be saved on the Threats Data Compiled worksheet.

Looking Ahead

Inevitably, a project such as this—evaluating and upgrading the NatureServe conservation status assessment methodology—generates more questions than can be answered under the current constraints of time, funding, and energy. Below are noted several issues to be explored about rank calculator development in the years to come.

Rank Factors

NatureServe's methodology for assessing conservation status is based on assessing the contribution of multiple rank factors, organized around the three categories of rarity, trend, and threat. All factors are considered jointly when assessing extinction risk, using a set of rules and points to incorporate rank factor ratings. By having a formal status assessment method for ranking elements, we are now in a better position to evaluate how conservation status ranks change as various rank factor ratings change.

One issue to consider is whether there are interactions among the rank factors. For example, how is conservation status affected when the number of existing occurrences remains constant but some of them are degraded, and does the change match our biological and ecological expectations for conservation status?

Another issue that is of concern is whether the rank calculator is sensitive enough to trends. Species or ecosystems that are common but undergoing rapid decline may not be as highly ranked as they might under the IUCN system because other factors, such as overall abundance or range extent, would offset the effect of trends. Is this desirable?

Finally, the process developed for calculating overall threat impact in the upgraded conservation status assessment methodology is quite new. What if the threats definition is interpreted differently by a user, and threats values are lumped or split in different ways? Does the exchange ratio of severe to moderate or mild threats produce appropriate results? In particular, if there are widespread threats of unknown frequency and severity, do range ranks reflect the appropriate levels of uncertainty?

Generic vs. Specific Rank Calculator

At this time, the Element Ranking Work Group has found that a generic calculator works well across different species and ecosystems. However, the calculator may well evolve into a ranking toolbox as more is learned about plants, animals, and ecosystem factors. For example, it may be desirable to develop different calculators for "r-selected" species (populations highly variable, high reproductive rate) versus "k-selected" species (populations at or near equilibrium conditions, low reproductive rate), or for clonal vs. non-clonal species. Alternatively, it may be desirable to customize instructions such that population size is not used for r-selected species or for all clonal species, while area of occupancy is required. We currently suggest that population size should not be used in the rank calculation for some r-selected species (see Master et al. 2009).

Long-Distance Aerial or Aquatic Migrant Animals

Assigning conservation status at a national or subnational level to long-distance aerial or aquatic migrant animals (e.g., species like migrant birds, bats, butterflies, sea turtles, and cetaceans) presents special challenges. Some guidance on how to assess their conservation status is provided in this document, including use of a Breeding Status modifier (See Appendix A). More comprehensive information on assigning conservation status to migrants is currently available from NatureServe's central zoology office.

Ecological Community/Association Scale vs. System-Scale Calculator

At this time, ecologists have focused on the association or ecological community scale for ranking ecosystems. The conservation status factors used in the upgraded assessment methodology have been briefly reviewed to see if they are applicable at multiple hierarchical scales, including at the level of NatureServe's Ecological Systems. It is expected that all status factors per se are applicable at multiple ecosystem type scales. However, although many factors' ratings are independent of scale, some, such as Range Extent, Area of Occupancy, and perhaps Number of Occurrences, may require adjustments for use with mid- or broad-scale ecosystem types.

Conclusions

A combination point-and-rule-based approach has been developed for assigning NatureServe conservation status ranks, at both global and regional (i.e., national and subnational) levels. The approach begins with the initial completion of an Element Ranking file within Biotics, which stores the summary data for the ten primary status factors which have been determined to be relevant for assessing extinction or extirpation risk of species and ecosystems. The ratings values for these factors can then be exported to a rank calculator, currently available in spreadsheet form. The rank calculator contains a series of procedures (points and rules) for using the factor ratings to generate a calculated status rank, which is reviewed, adjusted if deemed appropriate (with reasons documented), and finalized. For programs without Biotics, the calculator may be used as a stand-alone application.

NatureServe's approach to conservation status assessment covers the full range of risk of extinction or extirpation. The intent of this method is not to simply assign a status rank to the most threatened elements, but to place all species and ecosystems on a scale that indicates their relative risk of extinction/extirpation. To provide the ability to evaluate risk across this range of values, a wide variety of factors are integrated together, organized in three categories—rarity, trends, and threats. The point-and-rule-based approach provided in the conservation status assessment process allows for a relatively simple way of integrating all of these factors.

This upgraded process of assigning conservation status is intended to enhance (not replace) NatureServe's existing set of status ranks and ranking methodology, and to facilitate collaboration among the NatureServe network. Despite the qualitative nature of those ranks assigned prior to implementation of the revised process, they have been used successfully for assessing many thousands of species and ecosystems in a timely fashion. With the new rank calculator tool, NatureServe's ability to upgrade its status ranks will be improved based on an accurate, consistent, repeatable, and transparent method. There will be continued emphasis on data accuracy by using the strength and expertise of the NatureServe network through ongoing peer review of new information collected by biologists throughout the network. The upgraded conservation status assessment method greatly facilitates the integration of partial and dynamic information, and enhances the possibility to generate global ranks based on the compilation, or roll-up, of subnational rank information.

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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. **Extinct** (ecological communities and systems) – Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic taxa and/or elimination of the sites and ecological processes on which the type depends.
GH	**Possibly Extinct** – Known from only historical occurrences but still some hope of rediscovery. There is evidence that the species may be extinct or the ecosystem may be eliminated throughout its range, 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 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.[1]
G1	**Critically Imperiled** – At very high risk of extinction or elimination due to extreme rarity, very steep declines, or other factors.
G2	**Imperiled** – At high risk of extinction or elimination due to very restricted range, very few populations or occurrences, steep declines, or other factors.
G3	**Vulnerable** – At moderate risk of extinction or elimination due to a restricted range, relatively few populations or occurrences, recent and widespread declines, or other factors.
G4	**Apparently Secure** – Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	**Secure** – Common; widespread and abundant.

1 Possibly Eliminated ecosystems (ecological communities and systems) may include ones presumed eliminated throughout their range, with no or virtually no likelihood of rediscovery, but with the potential for restoration, for example, American chestnut forests.

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.[2]

Rank Qualifiers

Rank	Definition
?	**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 at present is extinct 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 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.

2 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).

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 rank cannot imply the subspecies or variety is more abundant than the species, for example, a G1T2 rank 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.

NatureServe National and Subnational Conservation Status Definitions

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

Assigning national and subnational conservation status ranks for species and ecosystems follows the same general principles as used in assigning global status ranks. A subnational rank, however, cannot 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 cannot exceed the global rank. 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. (= "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 or some evidence of significant habitat loss or degradation; and 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** – Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.
N2 **S2**	**Imperiled** – Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations or occurrences, steep declines, or other factors making it very vulnerable to extirpation from the jurisdiction.
N3 **S3**	**Vulnerable** – Vulnerable in the jurisdiction due to a restricted range, relatively few populations or occurrences, recent and widespread declines, or other factors making it vulnerable to extirpation.
N4 **S4**	**Apparently Secure** – Uncommon but not rare; some cause for long-term concern due to declines or other factors.
N5 **S5**	**Secure** – Common, widespread, and abundant in the jurisdiction.

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.[3]
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.

Rank Qualifier

Rank	Definition
N#? **S#?**	**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.

3 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:

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.

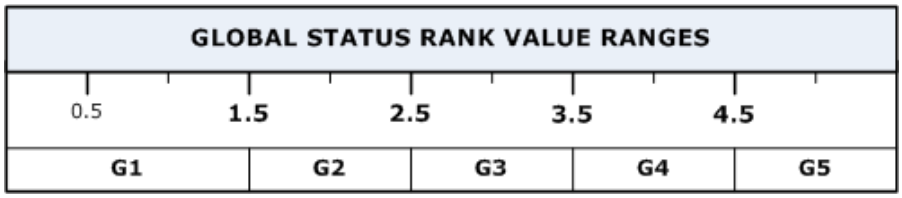
Breeding Status Qualifiers[4]

Qualifier	Definition
B	**Breeding** – Conservation status refers to the breeding population of the species in the nation or subnation.
N	**Non-breeding** – Conservation status refers to the non-breeding population of the species in the nation or subnation.
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 subnation.

4 A breeding status is only used for species that have distinct breeding and/or non-breeding populations in the nation or subnation. 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 subnation. 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. Examples of Range Point Calculations

Examples providing the computations required to apply range point settings for determining calculated ranks at the global level are shown below, along with a reference graphic illustrating the numeric value ranges for global ranks. Note, however, that the rank calculator applies range point settings automatically, so these examples are only intended as an illustration of the processing that occurs behind the scenes as the calculated status rank is generated from the overall calculated score. See the section "Calculating Range Status Ranks" (especially Table 10) for details on range point calculations.



Example 1:

- Calculated status scores resulting from applying the algorithm to an underlying range rating for one of the status factors: 1.4 (low) and 2.3 (high)
- Status ranks for these two values individually: 1.4 is just within the G1 value range, 2.3 is solidly in the G2 value range
- Point spread between status scores: 2.3–1.4 = 0.9
- Amount of that point spread that falls into the G2 category, determined by using the cut-off between the G1 and G2 ranks: 2.3–1.5 = 0.8
- Percentage of score point spread that falls into the G2 category: 0.8/0.9 = 89%
- Applying Range Point Setting (2), 89% of the spread between scores is contained within the G2 value range, so a calculated status rank of G2? is assigned.

Example 2:

- Calculated status scores resulting from applying the algorithm to an underlying range rating for one of the status factors: 1.4 (low) and 1.6 (high)
- Status ranks for these two values individually: 1.4 is just within the G1 value range, 1.6 is slightly with the G2 value range
- Point spread between status scores: 1.6–1.4 = 0.2
- Amount of that point spread that falls into the G2 category, determined by using the cut-off between the two (G1 and G2) ranks: 1.6–1.5 = 0.1
- Percentage of score point spread that falls into the G2 category: 0.1/0.2 = 50%
- Applying Range Point Setting (3), 50% of the spread between scores is contained within the G2 value range leaving 50% in the G1 value range, so a calculated range status rank of G1G2 is assigned.

Appendix C. Example of Global Element Ranking Record

Information used for NatureServe conservation status assessments is stored in Element Ranking records in the Biotics 4 data management system. Ranking records can be developed for assessments at different geographic levels depending on the area within which the element is being evaluated, specifically range-wide, or at the global level (using the EGR, that is, the Element Global Ranking file), or at national or subnational (i.e., state/provincial) levels (ENR and ESR, respectively). Element Ranking records are completed in Biotics by NatureServe scientists or by a designated lead office in a NatureServe network program, and form the basis for assigned conservation status ranks.

Provided below is an example of an EGR from the NatureServe Biotics data management system, with fields containing ratings for each of the conservation status factors based on element information throughout its range. Note that the names of data fields in this example have been changed to those used in the upgraded NatureServe conservation status assessment method.

Tsuga canadensis – (Betula alleghaniensis) Forest (CEGL002598)

Eastern Hemlock – (Yellow Birch) Forest
Hemlock Mesic Forest

Classification Responsibility: Midwest

Status: Standard
Confidence: 1 – Strong
Stakeholders: Canada, East, Midwest

This mesic hemlock evergreen forest is found in the Great Lakes region of the United States and Canada.

Global Rank & Reasons

Assigned Rank: G3G4 (Reviewed 24 Oct 2002, changed 22 Jun 1998)

Calculated Rank: G4

Rank Adjustment Reasons:
Although the calculated rank was G4, the possibility of increased threat from the spread of hemlock woolly adelgid is of great concern. The calculator produced a G3 rank if Severity was assigned a Serious (i.e., Threat Impact is High), and a G4 if the Severity was assigned a Moderate (i.e., Threat Impact is Moderate). Based on the roll-up of individual Threats (which include at least two Medium Impact threats), overall Impact would be High, not Moderate.

Assigned Rank Reasons:
This mesic hemlock evergreen forest has a moderately wide range, being found fairly commonly in the Great Lakes region of the United States and Canada. It does not require particularly specific environmental factors, and there may be a large number of Element Occurrences. Under natural conditions many stands would be expected to be in a variety of old-growth conditions, but, at this time, the area occupied by such stands is a relatively small percentage of their former area (Frelich 1995).

Rarity

Number of Occurrences

Rating: DE = 81 to >300

Comments: There are probably a large number of occurrences present, reflecting its wide range of distribution.

Number of Occurrences with Good Viability/Ecological Integrity

Rating: E = Many (41-125) occurrences with good integrity

Comments: The hemlock type is part of a large matrix of northern hardwoods in the region, subject to relatively small-patch canopy disturbance dynamics, with occasional larger blow downs, and relatively rare catastrophic windstorms. Thus, under natural conditions, many stands would be expected to be in a variety of old-growth conditions (Frelich and Lorimer 1991a). At this time, the area occupied by such stands is a relatively small percentage of their former area (Frelich 1995).

Percent Area with Good Viability/Ecological Integrity

Rating: U = Unknown

Comments:

Range Extent

Rating: G = 200,000–2,500,000 square km (about 80,000–1,000,000 square miles)

Comments: This mesic hemlock evergreen forest is found in the Great Lakes region of the United States and Canada, ranging from Wisconsin and Michigan to Ontario. Range extent is about 300,000 square km.

Area of Occupancy

Rating: F = 100–500 square km (about 25,000–125,000 acres) (area)

Comments: At this time (2002) it is difficult to estimate the area, partly because inventories do not always distinguish between pure evergreen hemlock and hemlock-hardwood stands. Total area occupied may be between 200 and 400 square km.

Trends

Long-term Trend

Rating: C = Decline of >70%.

Comments: Historically, logging, the tanning industry, and development have had a very substantial negative impact on this association.

Short-term Trend

Rating: F = Decline of 10–30%.

Comments:

Threats

Threat Impact

Rating: B = High

Comments: Threats include continued logging pressures (Medium: pervasive scope, moderate severity), pathogens – woolly adelgid (Medium: small scope, extreme severity), grazing – deer browse (Medium: pervasive scope, moderate severity). If at least two individual threats have a medium impact, the guidelines suggest overall Threat Impact should be High.

Conditional and Other Factors

Intrinsic Vulnerability

Rating: U = Unknown

Comments:

Environmental Specificity

Rating: C = Moderate. Generalist or community with some key requirements scarce.

Comments:

Other Factors of Interest:

Needs

Research Needs: Better information on total acreage and short-term trends.

Inventory Needs:

Protection Needs:

Sources

Version Date: 24 Oct 2002

Version Author: D. Faber-Langendoen

Version Notes: DFL updated and reviewed on November 9, 2006, and again Nov 5, 2007.

Rank References: Frelich 1995, Frelich and Lorimer 1991a

All References: Chambers et al. 1997, Chapman 1986, Coffman and Willis 1977, Comer pers. comm., Eyre 1980, Frelich 1995, Frelich and Lorimer 1991a, Martin 1959a, Midwestern Ecology Working Group n.d., Rawinski 1984, Rogers 1980, Thompson 1996, Thompson and Sorenson 2000, Tyrrell and Crow 1994, WNHIP unpubl. data.

Appendix D. Example of a Completed Rank Calculation

Conservation status factors are organized by rarity, trends, and threats categories. Each factor is assigned a rating value, which is converted to points (see Table 7 for an example of point assignment). Each factor has a specified weight, but Population Size, Area of Occupancy, Number of Occurrences or Percent Area with Good Viability/Ecological Integrity, and Short-term Trend are weighted more heavily within their categories due to their greater influence on risk of extinction/extirpation to the element . A sub-score is calculated for each factor category based on the assigned ratings and weights of the individual factors. The resulting sub-scores are used with specified category weights to calculate three category scores. These category scores are used to compute an overall calculated score, which is then converted to a calculated status rank (see also Table 3).

Allium tribracteatum
Three-bract Onion

Assigned Conservation Status Rank: G2

Photo: © 2004 Dean Wm. Taylor

Factor Category	Factor	Factor Rating	Assigned Points	Factor Weight	Weighted Point Value	Category Sub-Score	Category Weight	Category Score
Rarity	Population Size	F	3.0	2	6.0			
	Range Extent	D	1.3	1	1.3			
	Area of Occupancy	B	0.3	2	0.6			
	Number of Occurrences	C	1.7	1	1.7			
	Number of Occurrences or Percent Area with Good Viability/Ecological Integrity	C	1.2	2	2.4			
	Environmental Specificity[1]	A	0.0	–	–			
		Rarity subtotals:		**8**	**12.0**	**1.5**	**0.50**	**0.75**
Trends	Long-term Trend	D	3.6	1	3.6			
	Short-term Trend	D	3.6	2	7.2			
		Trends subtotals:		**3**	**10.8**	**3.6**	**0.30**	**1.08**
Threats	Threat Impact	C	2.0	1	2.0			
	Intrinsic Vulnerability[2]	A	0.0	–	–			
		Threats subtotals:		**1**	**2.0**	**2.0**	**0.20**	**0.40**
						Calculated Score		**2.23**
						Calculated Rank[3]		**G2**

Notes
1 Only used if Number of Occurrences and Area of Occupancy are Unknown or Null.
2 Only used if Threat Impact is Unknown or Null.
3 G1 score ≤1.5 ; G2 1.5< score ≤2.5; G3 2.5< score ≤3.5; G4 3.5< score ≤4.5; G5 score >4.5.

Appendix E. Interim Process for Assessing NatureServe Conservation Status

Although status assessments under the upgraded methodology are completed using the rank calculator, the calculator is not intended to be used for storing conservation status information; rather, these data are to be maintained in Biotics along with all the other species and ecosystem information in the database. However, during the transitional implementation period (i.e., the time following implementation of the upgraded protocol using the rank calculator, but before NatureServe Biotics is updated to the new data structure), the final step in the status assessment process in which data are moved into Biotics from the rank calculator cannot be completed because Biotics does not yet contain the new fields and values required for the upgraded protocol.

Thus, during the transitional period of implementation, the rank calculator should be used to retain the conservation status data instead of managing these data in Biotics. Note that the same need to track edits made to status factor data exported from Biotics into the calculator must be addressed during the interim implementation period. Once Biotics has been updated with new fields and factor ratings values, status data can be moved from the calculator into Biotics as part of the assessment process, and the rank calculator should no longer be used to store these data for the long-term.

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