NatureServe Conservation Status Assessments: Methodology for Assigning Ranks

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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 (ERWG), which was formed in 2004. ERWG members responsible for the 2009 version of this document (Faber-Langendoen et al. 2009a) including (in alphabetic order) Roxanne Bittman, Don Faber-Langendoen, Geoff Hammerson, Bonnie Heidel, Larry Master, Jennifer Nichols, Leah Ramsay, Kristin Snow, Adele Tomaino, Bruce Young. In particular 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. The original members of the 2009 working group accepted the task of reviewing the new issues found in this 2012 upgrade, and we were pleased to add Andy Teucher of the British Columbia Conservation Data Centre to help us with this upgrade. More recently, Margaret Ormes of NatureServe and Marilyn Anions of NatureServe Canada have joined to help move us into the next phase of our work. Donna Reynolds, from NatureServe, has been a key advisor and programmer for integration of our ranking methods into Biotics.

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Contents

Executive Summary

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

Rank Factors

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

Methods (described in this document)

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

Tools

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

NatureServe and its member programs and collaborators use a suite of factors to assess the extinction and extirpation (regional extinction) risk of plants and animals, and the elimination and extirpation risk of ecosystems. By researching and recording information on a set of conservation status factors, biologists can assign a conservation status rank to these species and ecosystems (or "elements" of biodiversity) 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 characteristics of the factor: **rarity** (six factors), **threats** (two factors), and **trends** (two factors). Once assigned, scores for the individual factors within **rarity** and **threats** are used to create an initial status score. That score is then adjusted by addition

or subtraction of the **trends** score to yield a revised status score, which is translated into a calculated rank. This calculated rank is reviewed, in rare cases adjusted (with reasons documented) by the assessor, and recorded as the final assigned conservation status rank—for global element status using the G1-G5 scale, or using an equivalent scale for national and 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/elimination or extirpation 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 gives greatest weight to **rarity** factors. 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 or eliminated.

The set of factors used to assess conservation status are, by category, **rarity**: Population Size, Range Extent, Area of Occupancy, Number of Occurrences, Number of Occurrences or Percent of Area Occupied with Good Viability/Ecological Integrity, and Environmental Specificity (used only when the Number of Occurrences and Area of Occupancy ratings = 'Unknown'); **threats**: Assigned Overall Threat Impact (generated by considering the scope and severity of major threats), and Intrinsic Vulnerability (used only if the Overall Threat Impact rating = 'Unknown'); **trends**: Long-term and Short-term Trends in population size or area.

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 **threats** or **trends** category. For each factor, a rating is selected from a scale of values. For conservations status factors used both by NatureServe and the World Conservation Union (IUCN) to evaluate species risk (e.g., Area of Occupancy), break points for rating scales used by NatureServe coincide with those in the IUCN Red List criteria for species (IUCN Standards and Petitions Subcommittee 2011). Depending on the precision of the information supplied and the number of factors for which information exists, a specific conservation status rank (G1, G2, G3, G4, or G5) or a range rank (G1G2, G2G4, etc.) 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 GU status rank (for 'Unrankable') is assigned.

NatureServe developed a rank calculator to facilitate the process of assigning conservation status ranks through automation. The calculator works in combination with NatureServe's

data management system (Biotics) which contains the element database, including the status factor information and assigned conservation status ranks for all elements.

The updated ranking system and new calculator introduced in 2009 represented a major upgrade of NatureServe ranking methods (Faber-Langendoen et al. 2009a, NatureServe 2009). This new 2012 version (NatureServe Conservation Status Assessment Method 2012, or "Status Method 2012"), and the associated rank calculator (NatureServe 2012) is a modest upgrade to the 2009 version (See summary in Master et al 2012).

As with that version, our goal is to foster 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 and subnational ranks. The revised factor definitions and values used in NatureServe's updated conservation status assessment protocol (Master et al. 2012) are also designed to enhance compatibility with international efforts that assess element risk, including IUCN ranks.

Status Assessment Method

For many years, NatureServe and its network of natural heritage programs and conservation data centers have been assessing the relative extinction/elimination or extirpation 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. 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 re assessed as new information becomes available.

ERWG's work resulted in revisions to the factors and values used to assess conservation status, and a more defined process for combining factor ratings in a manner consistent with their relative impact on risk. In addition,

the group developed a rank calculator that facilitates the process of assigning status ranks through automation – a major upgrade of the existing protocol. It is important to remember, however, that regardless of improvements to the assessment method and use of the rank calculator, resulting calculated ranks are only as good as the quality of information used to assign ratings to the underlying individual status factors.

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, which is based on a "weight-of-evidence" approach (Linkov et al. 2009), is distinctive as compared to many rule-based approaches that are available, such as that of the World Conservation Union (IUCN) Red List for species (IUCN 2001) or others for ecosystems (Rodriguez et al. 2011, Raunio et al. 2008, Nicholson et al. 2009). An overview and comparison of these systems for species is provided in Master et al. (2000), and for ecosystems in Nicholson et al. (2009). The history of NatureServe's conservation status ranking methodology is summarized in Master et al. (2012).

This document describes in detail the newly standardized methods to be used to assign a NatureServe conservation status rank, based on information collected on element rarity, threats, and trends. The basic conservation status factors are summarized, uncertainty and data quality in assigning a factor rating are examined, their roles in assessing extinction/elimination or extirpation risk are identified, and an overall conservation status rank is derived. This document also describes how to implement this status assessment method using the rank calculator, which automatically calculating status ranks by applying the requisite rules, weights, and points.

Factors Used for Assessments

Conservation Status Factors

Ten factors are used to assess conservation status, grouped into three categories—**rarity**, **threats**, and **trends**—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. Factors in the **rarity** category consist of Population Size, Range Extent, Area of Occupancy, Number of Occurrences, Number of Occurrences or Percent of Area Occupied with Good Viability/Ecological Integrity, and Environmental Specificity. The **trends** category contains the factors Long- and Short-term Trends in population size or area. In the **threats** category, factors consist of Overall Threat Impact, which is determined by considering the scope and severity (i.e., magnitude or impact) of major threats, and Intrinsic Vulnerability (used only if the Overall Threat Impact rating = 'Unknown'). Table 1 illustrates the organization of these status factors, and provides brief definitions. Note that all of the conservation status factors, except for Population Size, apply to both taxa (species, subspecies, populations, and plant varieties) and 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. (2012) for the introduction to and detailed descriptions of the status factors.

Table 1. Summary of NatureServe Conservation Status Rank Factors.

Factor Category	Subcategory	Factor	Definition
Rarity	**Range/ Distribution**	Range Extent	Minimum area that can be delimited to encompass all present occurrences of a species or ecosystem, typically excluding extreme disjuncts and vagrancies.
		Area of Occupancy	Area within the range extent that a species or ecosystem actually occupies. For species, 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[1] and some other occurrence types. For ecosystems, areas can be measured or estimated directly based on the best available information. Area of Occupancy for ecosystems is assessed based on selecting the typical spatial pattern of the type (small patch, large patch, matrix).
	Abundance/ Condition	Population Size (species only)	The estimated total wild population of a species, 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.
		Number of Occurrences	Number of extant locations (stands) of an ecosystem, or discrete areas occupied by a species (typically subpopulations, populations, or metapopulations).[2]
		Number of Occurrences or Percent Area with Good Viability/ Ecological Integrity	1) Number of occurrences (locations, stands of an ecosystem, or number of locations, subpopulations, populations, metapopulations of a species) 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) Percent of the total area occupied by a species or ecosystem that has excellent-to-good viability or ecological integrity.
		Environ-mental Specificity	The degree to which a species or ecosystem depends on a relatively scarce set of habitats, substrates, food types, or other abiotic and/or biotic factors within the overall range. Relatively narrow requirements are thought to increase the vulnerability of a species or ecosystem.

Continued

1 Grid counts and area values should be used even if occupancy is linear; see Master et al. (2012) for more information.

2 See guidelines in the Element Occurrence Data Standard in NatureServe (2002). See Master et al. (2012) for a discussion on the limitations of using occurrences for conservation status assessments.

Factor Category	Subcategory	Factor	Definition
Threats		Overall Threat Impact	Degree to which the integrity of an ecosystem or viability of a species 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 species, or likelihood of regeneration or recolonization for ecosystems, make it susceptible or resilient to natural or anthropogenic stresses or catastrophes.
Trends		Long-term Trend	Degree of past directional change in population size (for species 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 50 years for ecosystems, or within 10 years or 3 generations, whichever is longer (up to 100 years), for species.

Table 1. (continued) Summary of NatureServe Conservation Status Rank Factors.

Other Factors of Interest

In addition to the ten conservation status factors used to assess extinction/elimination 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 population viability analysis (PVA) may supplement the factor information used to assess the species' conservation status.
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. Formerly a conservation status factor in the outdated pre-2009 assessment method. Although this information is potentially still useful, the degree of threat indirectly assessed by this attribute is better represented by the Overall 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 extirpation 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 extirpation risk of a population has been underestimated and that the rank should be changed to a higher risk category.[3]
Comparison of Global and National/ Subnational Rank Information	Useful when assigning conservation status, especially when the national/subnational information is more current or detailed than the global information or vice versa. Historically, a subnational rank that implied that a species or ecosystem was more secure at the state/province level than it was nationally or globally was not acceptable (e.g., a rank of G1S3 was invalid), and similarly, a national rank that implied that an element was more secure at the national level than it was globally was not acceptable. This rule is under review, because current methods provide a more explicit role for Threats and Trends, which may indicate low levels of risk at national/subnational scales as compared to global scales, and a one-rank difference may be permissible (e.g., G1S2).

3 See IUCN (2003) and Master et al. (2012) for further details on the use of information on rescue effect in status assessments.

Implementing the Status Assessment Method

A step-wise combined point and rule based approach is used in the Status Assessment Method to explicitly and consistently calculate and assign conservation status ranks from assessed status factors. Table 3 below summarizes the steps in the process, which are then described in detail in the section that follows. Note that application of the points and rules in the assessment method are facilitated through use of an automated rank calculator, as described in the "Applying the Status Assessment Method with the Rank Calculator" section. See also Appendix C for a worked example.

Table 3. Point-based steps and rules for assessing conservation status.

Assessment Process Step		Basis/Rule
1	Assign status factor ratings	Available data used to assign rating (value code). *Table 4 provides an example of a status factor ratings scale.*
2	Apply Core and Conditional Factor Rules to factors with assigned ratings to determine which factors will be used for the assessment	Rules: • Always Use Core Status Factors • Conditional Status Factor Use • Use of Rating for Number/Percent Viability/Integrity Factor Options *Table 5 provides a summary of these rules*
3	Apply Minimum Core Factor Requirement Rules to determine whether conservation status can be assessed, and if not, the conservation status to be automatically assigned	Rules: • Required Minimum Core Factor Combinations • Automatic U Status with Minimum Factor Requirement Failure *Table 6 provides a summary of these rules.*
4	Apply Extreme Rarity Assignment Rules to automatically assign a conservation status when ratings indicate extreme rarity of the element	Rules: • Automatic H Status Assignment Based on Extreme Rarity • Automatic X Status Assignment Based on Extreme Rarity • Automatic 'Critically Imperiled' Status Assignment Based on Extreme Rarity *Table 7 provides a summary of these rules.*
5	Assign points to factor ratings	Rating code conversion to points (e.g., rating code of A = 0.69 pts). *Figure 1 illustrates status factor scales for assigning points; Table 8 illustrates the values and points for* ***trends*** *factors.*
6	Weight individual status factors	Factor weights are based on relative factor contribution to category. *Table 9 provides status factor weightings.*
7	Calculate category sub-scores	Factor weights and scores are used to calculate category sub-scores. *Table 9 lists factors used for each category sub-score calculation.*
8	Weight **rarity** and **threats** status factor categories	Category weights are based on the relative influence of RARITY and THREATS categories on risk. *Table 9 provides category weightings*.

Continued

Table 3. (continued) Point-based steps and rules for assessing conservation status.

	Assessment Process Step	Basis/Rule
9	Calculate Initial Status Score from **rarity** and **threats** sub-scores	Weighted Average Method. *Table 9 shows scoring process.*
10	Determine calculated status score by applying **trends** sub-score	Trend Subtraction/Addition Method. *Table 9 shows scoring process.*
11	Translate calculated score to Calculated Conservation Status Rank	Point score conversion to status rank (value code), or status range rank using point spread criteria. *Table 10 provides value ranges for conservation status ranks; Figure 2 illustrates examples of calculated status resulting from application of point spread criteria.*
12	Review and assign Conservation Status Rank	Final overall Assigned Conservation Status is based on calculated results of assessment process and documented reasons

1. Assign Status Factor Ratings

For conservation status assessments, ratings (value codes) 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 categorical scale of values provided for each factor. Note that guidance provided in Master et al. (2012) should be 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 Subcommittee 2011).

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.

Table 4 provides an example of a scale of single rating codes (vs. range ratings) as an example, specifically those used for the Range Extent status factor.

Table 4. Example of a conservation status factor ratings scale.

Rating Codes for Range Extent
Z = Zero (no occurrences believed extant)
A = <100 sq km (< about 40 sq mi)
B = 100-250 sq km (about 40-100 sq mi)
C = 250-1,000 sq km (about 100-400 sq mi)
D = 1,000-5,000 sq km (about 400-2,000 sq mi)
E = 5,000-20,000 sq km (about 2,000-8,000 sq mi)
F = 20,000-200,000 sq km (about 8,000-80,000 sq mi)
G = 200,000-2,500,000 sq km (about 80,000-1,00,000 sq mi)
H = >2,500,000 sq km (> about 1,000,000 sq 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 U = 'Unknown' rating code cannot be combined with any other value as a range rank.

Two status factors deserve special mention. First, the Overall Threat Impact status factor requires a multi-step process to assign a rating—assessing a detailed list of threats according to scope, severity, and timing, calculating individual impact values for each identified threat, and then calculating an Overall Threat Impact rating from these individual impacts (see Master et al 2012); this process is greatly facilitated by use of the rank calculator, which automates all the impact calculations. Second, there are two options for using the factor Number of Occurrences or Percent of Area Occupied with Good Viability/Ecological Integrity, as shown below.

- Estimate the number of species or ecosystem occurrences[4] that have excellent-to-good estimated persistence, represented by an occurrence rank of A or B.
- Estimate the percentage of the ecosystem area or species habitat that is occupied and in excellent-to-good condition.

Note that "good estimated persistence" for an occurrence equates to good viability for species, and good ecological integrity for ecosystems. (See Hammerson et al. 2008 and Faber-Langendoen et al. 2011, Table A11, for additional explanation of occurrence viability and ecological integrity using a scorecard of A–D ratings).

4 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. (2012) for further discussion of species and ecosystem occurrences.

2. Apply Core and Conditional Factor Rules

Under the upgraded conservation status assessment method, the ten status factors have been categorized as either "core" for status assessments, or "conditional"—used primarily when information on specific core fields is lacking. In addition, a series of rules has been developed (partly based on the availability of information for some factors) which specify whether, and how, each status factor is used in the calculations underlying the assessment method. The rules also define the circumstances under which ratings for the two conditional status factors (Intrinsic Vulnerability and Environmental Specificity), and ratings for the two options for a single factor (Number of Occurrences with Good Viability/Ecological Integrity and Percent of Area Occupied with Good Viability/Ecological Integrity) can be included in an assessment.

Rule: Always Use Core Status Factors

- Core factors should always be used in the assessment if ratings have been assigned.

Rule: Conditional Status Factor Use

- Intrinsic Vulnerability is USED ONLY IF Overall Threat Impact rating = 'Unknown' or has not been assessed (null);
- Environmental Specificity is USED ONLY IF **BOTH** the Number of Occurrences **AND** Area of Occupancy ratings = 'Unknown' or have not been assessed (null).

Rule: Use of Rating for Number/ Percent Viability/Integrity Factor Options

- **IF** ratings have been assigned for both the Number of Occurrences with Good Viability/Ecological Integrity **AND** Percent of Area Occupied with Good Viability/ Ecological Integrity options for this factor, **THEN** the more restrictive of the two values (i.e., rating indicating

the greater risk of extinction/elimination or extirpation) is used in the assessment.

- **IF** a rating has not been assigned for the Area of Occupancy status factor, **THEN** then the Percent of Area Occupied with Good Viability/Ecological Integrity option for this factor *cannot* be used in the assessment.

Note that even when ratings have been assigned for the core status factors, rating the two conditional factors may help to more fully understand the extinction/elimination or extirpation risk of a species or ecosystem. Table 5 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. (2012).

Table 5. Summary of the rules for use of core and conditional status factors.

Factor Category	Sub-category	Status Factor	Factor Type	Rule For Status Factor Use
Rarity	Range/ Distribution	Range Extent	Core	**Rule:** Always Use
		Area of Occupancy	Core	**Rule:** Always Use
	Abundance/ Condition	Population Size (species only)	Core	**Rule:** Always Use
		Number of Occurrences	Core	**Rule:** Always Use
		Number of Occurrences or Percent of Area Occupied with Good Viability/ Ecological Integrity	Core	**Rule:** Always Use at least one of the two options, Number of Occurrences … or Percent of Area Occupied … **Apply rule:** Use of Rating for Number/ Percent Viability/Integrity Factor Options • If both options have ratings, use value indicating greater risk • If rating is not assigned for Area of Occupancy, cannot use Percent of Area Occupied … rating
		Environ-mental Specificity	Condi-tional	**Apply rule:** Conditional Status Factor Use • Use only if both Number of Occurrences and Area of Occupancy ratings = 'Unknown' or null
Threats		Overall Threat Impact	Core	**Rule:** Always Use
		Intrinsic Vul-nerability	Condi-tional	Apply rule: Conditional Status Factor Use • Use only if Overall Threat Impact rating = 'Unknown' or null
Trends		Long-term Trend	Core	**Rule:** Always Use
		Short-term Trend	Core	**Rule:** Always Use

3. Apply Minimum Core Factor Requirement Rules

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, ratings for only two factors are needed from the set of eight core factors to assign a status rank indicating risk of extinction/elimination or extirpation, provided they meet the minimum core factor requirements. To apply the rules, core factors are first grouped by factor category (**rarity**, **threats**, **trends**), and the **rarity** category is then divided into two subcategories, as shown in Table 6.

Rule: Required Minimum Core Factor Combinations

Values must be provided for one of the following two core factor combinations:

A. One factor from each **rarity** subcategory, specifically: one factor from the Range/Distribution subcategory **AND** one factor from the Abundance/Condition subcategory;

OR

B. One factor from the **rarity** category **AND** one factor from either the **threats OR trends** category.

Rule: Automatic U Status with Minimum Factor Requirement Failure

IF neither of the two required minimum factor combination requirements are met, **THEN** a U = Unrankable (GU, NU, SU)[5] conservation status is automatically assigned for the element.

5 See Master et al. (2012), specifically *Appendix A: NatureServe Conservation Status Ranks*, for more detailed information on status ranks.

Factor Category	Subcategory	Core Factor	Combination Options for Meeting the Minimum Core Factors Requirement	
			Combination A	Combination B
Rarity	Range/ Distribution	• Range Extent • Area of Occupancy	1 Range/ Distribution Subcategory Factor	1 **Rarity** Factor
	Abundance/ Condition	• Population Size (species only) • Number of Occurrences • Number of Occurrences or Percent of Area Occupied with Good Viability/ Ecological Integrity	1 Abundance/ Condition Subcategory Factor	
Threats		• Overall Threat Impact		1 **Threats** OR **Trends** Factor
Trends		• Short-term Trend • Long-term Trend		

If neither of the required combinations A or B is attainable, a U = Unrankable status is automatically assigned (GU, NU, SU)

Table 6. Required minimum core factor combinations for status assessments.

For many elements, especially those species 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 that meet the minimum core factor requirements may be valid with high confidence. In such cases, this is because the influence of these two factors on risk to the element is significant enough to serve as the basis for accurate calculation of conservation status. However, for other elements, values for such a limited number of factors may provide too little information for an acceptable representation of the risk of extinction/elimination or extirpation, even though the minimum core factor requirements were met. Thus, there is no direct relationship between the number of conservation status factors used in an assessment and the accuracy of a calculated status rank. It is the responsibility of the assessor to document any issues with the number of factors used to calculate a conservation status rank and/or assign a range rank to indicate uncertainty in the calculated status.

4. Apply Extreme Rarity Assignment Rules

Although the ranking process relies primarily on a point-based approach to weighting and combining status factors to derive a calculated status rank, there are several conditions under which a specific conservation status should be automatically assigned, regardless of any calculated status rank. As described above, an automatic assignment of U = Unrankable occurs when the minimum core factor combination requirement is not met. The remaining cases when status is automatically assigned are based on special cases of extreme rarity for specific core factors. Extreme rarity is indicated by status factor ratings of Z (zero), or range ratings that include Z (e.g., ZA or ZB).

Rule: Automatic H Status Assignment Based on Extreme Rarity
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) (e.g., ZA or ZB), **THEN** an H = Historical (GH, NH, SH) conservation status is automatically assigned for the element.

Rule: Automatic X Status Assignment Based on Extreme Rarity
IF at least one of the **rarity** status factors Range Extent, Area of Occupancy, Population Size, or Number of Occurrences has an assigned status rating of Z **AND** the assigned status ratings for the remaining **rarity** status factors are Z AND/OR range ratings that include Z, **THEN** an X = Extinct/ Eliminated or Extirpated (GX, NX, SX) conservation status is automatically assigned for the element.

Rule: Automatic Critically Imperiled Status Assignment Based on Extreme Rarity
IF either or both of the **rarity** status factors Area of Occupancy or Population Size has an assigned status rating of A or B, or an assigned range rating that includes A or B, **THEN** a 'Critically imperiled' (G1, N1, S1) conservation status is automatically assigned for the element.

Factor Category	Subcategory	Status Factor	Conditions for Automatically Assigning Conservation Status	Automatically Assigned Status
Rarity	Range/ Distribution	Range Extent	For any of these factors, range rating includes Z	H = Historical (GH, NH, SH)
		Area of Occupancy	For at least one of these factors, rating is Z **AND** For other rarity factors, ratings are Z AND/OR range ratings include Z	X = Extinct/ Eliminated at global level X = Extirpated at national/subnational levels (GX, NX, SX)
	Abundance/ Condition	Population Size		
		Number of Occurrences		
	Range/ Distribution	Area of Occupancy	For either of these factors, factor rating is A or B **OR** factor range rating includes A or B	Critically imperiled (G1, N1, S1)
	Abundance/ Condition	Population Size		

Table 7. Summary of extreme rarity rules for automatic status assignment.

5. Assign Points to Factor Ratings

Once ratings have been selected for status factors, a point score is assigned for each rating. Points are assigned using a simple linear scaling, from 0 to 5.5. NatureServe's ranking approach has standardized each of the status factor ratings to an ordinal scale using letter code values. Although a rating of A is known to be lower in value (greater risk of extinction/elimination or extirpation) than a rating of B in the **rarity** and **threats** categories, the magnitude of the difference is not specified. Since the exact mathematical distribution of the ratings is not defined, the values require careful use when combined 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/elimination, 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/elimination or extirpation risk, regardless of the underlying numeric values. Thus, the NatureServe method does not use the breakpoints for the ratings as "thresholds" (except for a few cases of extreme rarity, as shown in Table 7); rather they are points along a continuum of risk 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). The number of points assigned for different ratings has been determined on the basis of the value scale associated with that factor. Factors in the **rarity** and **threats** categories are scaled using one approach, while **trends** factors use another.

Points for Rarity and Threats Status Factors

The rating scales for conservation status factors in the **rarity** and **threats** categories 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 is constant, from 0 to 5.5, thereby initially giving each factor an equal contribution in status assessments (but see "3. Weight Individual Status Factors" below). The maximum point value was set to 5.5 for this status assessment method because the NatureServe conservation status rank scale is essentially a 5 point scale; that is, G1 to G5 ranks (indicating critically imperiled to secure, respectively), with the additional 0.5 points accounting for historical and extinct/ eliminated or extirpated elements.

With the overall point range fixed at 0 to 5.5 for every factor in the **rarity** and **threats** categories, 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. Figure 1 provides examples of the different scales used to assign points to rating values for the Range Extent factor in the **rarity** category, and Overall Threat Impact from **threats**.

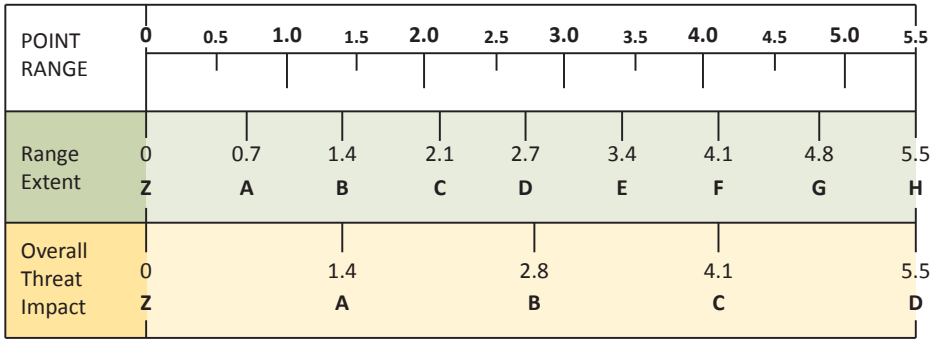

*Figure 1. Scales used for assigning points to ratings for status factors in the **rarity** and **threats** categories.*

Points for Trends Status Factors

The approach to scoring status factors in the **rarity** and **threats** categories sets a maximum score of 5.5 (see Figure 1 above); if all status factors are scored at that maximum level, a status will be G5 (secure). However, the scale used for status factors in the **trends** category differs in that the scale goes from varying levels of decline (A-F), to stable (G), to an increasing rate (H-I). To capture this aspect of trend, the Trend Subtraction/Addition Method is used for scoring. This method is based on the assumption that a negative trend should move a rank toward greater imperilment (proportional to the size of the decline), and an increasing trend should likewise push a rank toward a more secure value, as shown in Table 8.

Rating Values For Short- and Long-term Trend	Assigned Points
A = Decline of >90%	-0.50
B = Decline of 80–90%	-0.40
C = Decline of 70–80%	-0.31
D = Decline of 50–70%	-0.22
E = Decline of 30–50%	-0.14
F = Decline of 10–30%	-0.07
G = Relatively stable (=10% change)	0.00
H = Increase of 10–25%	0.07
I = Increase of >25%	0.14
U = Unknown	

*Table 8. Summary of the values and points assigned to **trends** factors, based on the Trend Subtraction/Addition Method.*

6. Weight Individual Status Factors

In this step of the status assessment process, original factor scores in all categories are multiplied by specific factor weights (see Table 9). It should be noted that some of the individual factors within each of the status factor categories—**rarity**, **threats**, and **trends**—are considered greater contributors to the influence of that category on element extinction/elimination or extirpation risk. These factors with greater influence are, therefore, weighted more heavily than others in the category when calculating a category sub-score.

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 for assessing rarity of an element, and because rarity is a strong indicator of the risk of extinction/elimination or extirpation of an element, the methodology pre-dating the 2009 conservation status assessment protocol upgrade favored using those status 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: 1) 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); 2) NatureServe's Element Occurrence (EO) concept (described in NatureServe's "Element Occurrence Data Standard" [NatureServe 2002]) only works well for rare species rather than those that are common; 3) Many of NatureServe's external partners have had difficulty understanding the concept of an EO as a potentially viable conservation unit; and 4) EO criteria (i.e., separation distance, tracking criteria) are not consistently applied across the NatureServe network, making it hard to "count" EOs.

The Status Assessment Method identifies four factors that most strongly influence element extinction/elimination or extirpation risk (Table 9). The first three of these are **rarity** factors—Population Size, Area of Occupancy, and Number of Occurrences or Percent of Area Occupied with Good Viability/Ecological Integrity—and the fourth is a **trends** factor—Short-term Trend.

Factors with Greater Influence on Risk/ Greater Assigned Weight

Rarity factors

- Population Size, for species, is an obvious first factor to weight more heavily because there is growing evidence which empirically demonstrates that the size of a population is the characteristic most correlated with risk of extinction (Mace et al. 2008).
- Area of Occupancy is weighted more heavily because it represents the next best measure of species abundance after population size, which can be difficult to estimate. For ecosystems, Area of Occupancy is the single best measure of rarity.
- Number of Occurrences or Percent of Area Occupied with Good Viability/ Ecological Integrity is weighted more heavily because, in some ways, this factor 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.

Trends factor

- Short-term Trend is weighted more heavily because, although information on both long- and short-term trends is important, it is the short-term trend that more directly captures the current status of a species or ecosystem.

7. Calculate Category Sub-scores

Sub-scores for each category are calculated from the weighted scores derived in the previous step 6. However, the process for deriving **rarity** and **threats** sub-scores differs from that for determining the **trends** sub-score as follows.

- **Rarity** and **threats** category sub-scores result from weighted factor scores which are summed and then divided by the summed weights within each category.
- **Trends** category sub-score is calculated using the Trend Subtraction/Addition Method, which sums the weighted scores for factors within the category.

Table 9. Factor and category weightings and calculation of overall conservation status score.

Factor Category	Weight	Sub-category	Factor	Factor Weight	Process
Rarity	0.7	Range/ Distribution	Range Extent	1.0	Factor weight(s) and score(s) are used to calculate **rarity** category sub-score
			Area of Occupancy	2.0	
		Abundance/ Condition	Population Size	2.0	
			Number of Occurrences	1.0	
			Number of Occurrences or Percent Area with Good Viability/Ecological Integrity	2.0	
			Conditional use: Environmental Specificity	1.0	
Threats	0.3		Threat Impact	1.0	Factor weight and score are used to calculate a **threats** category sub-score
			Conditional use: Intrinsic Vulnerability	1.0	
Weighted average of **rarity** and **threats** sub-scores is calculated as an initial status score					
Trends			Long-term Trend	1.0	Trend Subtraction/ Addition Method is used to calculate a **trends** category sub-score
			Short-term Trend	2.0	
Trends sub-score is applied to initial status score to calculate the final overall conservation status score					

8. Weight Rarity and Threats Status Factor Categories

To account for the differing amount of influence that the **rarity** and **threats** categories have on element extinction/extirpation or elimination risk, each of these two categories has an assigned weight, with **rarity** weighted more (70%) than **threats** (30%). These assigned category weightings have been established through rigorous testing against existing NatureServe status assignments and found to be the most reasonable in assessing risk (Faber-Langendoen et al. 2007). Placing the emphasis on the **rarity** category status factors 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/eliminated or be extirpated (Mace et al 2008). The **rarity** and **threats** category weightings are applied to the category sub scores from step 7 above.

9. Calculate Initial Status Score from Rarity and Threats Sub-scores

An initial status score for the element is calculated based on the weighted average of the **rarity** and **threats** sub-scores.

10. Determine Calculated Status Score by Applying Trends Sub-score

A calculated conservation status score or range is computed by applying the sub-score developed for the **trends** category based on assigned factor ratings (Step 7, Table 9) to the calculated initial status score resulting from the previous step 9.

11. Translate Calculated Score to Calculated Conservation Status Rank

The calculated scores from Step 10 are translated to the appropriate conservation status rank according to the values and rank equivalencies shown in Table 10. The range of values for each rank is equal in size (i.e., G2 = 1.6–2.5, G3 = 2.6–3.5) except for G1, which includes all scores <1.5, as illustrated in Table 10. These rank value ranges were chosen for use in assigning conservation status instead of an evenly spaced set of ranges (such as 0.0–1.1, 1.1–2.2, etc.), after evaluation of both scales.

The scale adopted (in Table 10) is a more precautionary approach to assessing conservation status, and was selected for several reasons. First, extensive testing through comparison of existing status ranks (managed in Biotics) with ranks generated by this Status Assessment Method 2012 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.[6] Second, in limited testing of particular elements, it was found that when using an evenly spaced scale, if all the status factor ratings were high in terms of conservation concern (e.g., with assigned A, B, or C ratings) except for one, and if that one remaining factor indicated some level of security (e.g., D or lower ratings), the calculator-generated scores were down-ranked more than would appear to be warranted based on review of the factor ratings.

Calculating a Status Rank from a Range in Calculated Scores

In the simplest case, information for all of the status factors in a conservation status assessment is sufficient to

6 It was difficult to do rigorous comparisons of existing ranks assigned under the previous methodology with those generated by this method (2009 or 2012) because a) some of the existing ranks were 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 **threats** and **trends** factors); and b) the rating scales for status factors changed with the upgraded protocol such that factor ratings assigned under the previous methodology often had to be converted to range ratings for use with this method, which could have artificially lowered the calculated rank generated from them.

Table 10. 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

assign single value ratings (e.g., A), resulting in a single overall calculated status score that is then translated to a single calculated status rank (e.g., G1). However, if one or more of the status factors has information that is less precise than required by the rating scale (e.g., the number of EOs is known to be between 3 and 10, but the rating scale has A= 1–5, B = 6–20), the uncertainty in assessment is represented by an assigned range rating (such as AB, AC, etc.) (see step "1. Assign Status Factor Ratings" above). In such cases, the calculated status that results may actually be a range rank (e.g., G1G2).

To determine a calculated status rank from one or more factors with range ratings, the range of uncertainty is defined using values at the low and high ends of the rating, and these low and high points are then carried through all steps of the assessment method. More specifically, low and high ratings points result in calculation of low and high category sub-scores, followed by low and high initial status scores, which result in low and high overall calculated status scores. These low and high status scores are then compared with value ranges for conservation status ranks (shown in Table 10). If the overall low and high scores are spread between two or more of the value ranges, then a calculated status range rank is generated according to the point spread criteria, defined below. Figure 2 illustrates application of the criteria; examples that apply the criteria to low and high scores for a range in calculated conservation status are provided in Appendix A.

Point Spread Criteria

i. If 95% of the point spread between calculated scores is contained within the range of values for 1 status rank (see examples in Figure 2), then that rank is used as the calculated status rank.

ii. If 80–95% of the point spread between scores is contained within the range of values for 1 status rank, then that rank is used with a "?" qualifier[7] as the calculated status rank.

iii. If ≥95% of the point spread between scores is contained within the range of values for 2 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).

iv. If ≥95% of the point spread between scores is contained within the range of values for 3 consecutive status ranks, but <95% is contained within the range of 2 consecutive ranks, then those 3 ranks are used as a calculated range status rank (e.g., G2G4).

v. If <95% of the point spread between scores is contained within the range of values for 3 consecutive status ranks, then a conservation status rank of Unrankable (U) is assigned as the calculated status rank.

7 See Master et al. (2012), specifically *Appendix A: NatureServe Conservation Status Ranks*, for information on rank qualifiers.

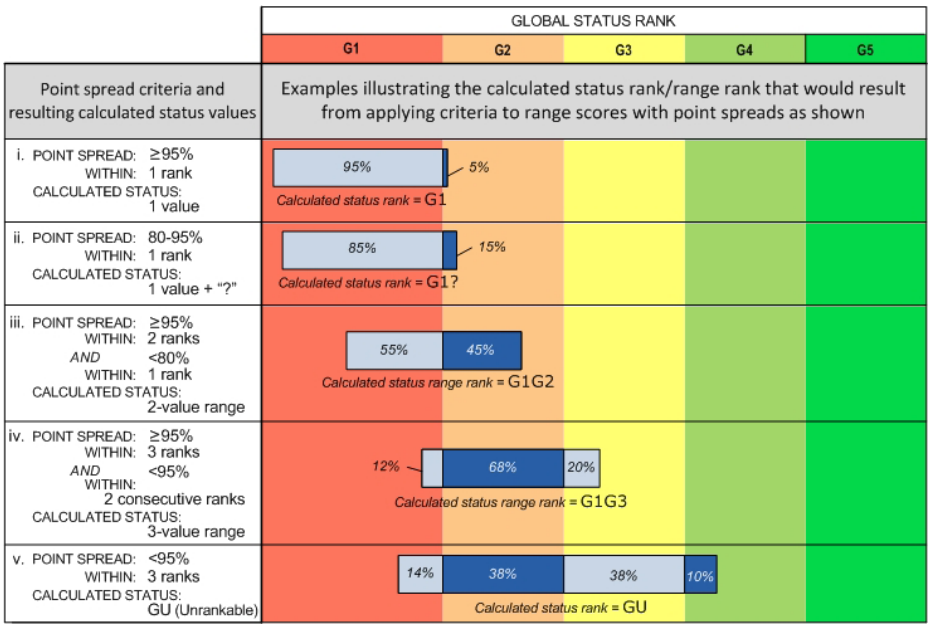

Figure 2. Examples illustrating application of point spread criteria.

12. Review and Assign Conservation Status Rank

The rule-and-point based method provides a structured process for assessing conservation status, based on what are considered to be major drivers of extinction/elimination and extirpation risk. However, the calculated rank may 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. Nonetheless, changes to the calculated rank should only be made rarely, and with well-documented reasons.

Qualifying the Calculated Rank

Upon review, there may occasionally be situations in which the rank needs to be qualified based on issues of questionable taxonomy, or whether the species or ecosystem exists only in captivity or under cultivation, or only in restored sites that are not yet established. Thus, potential reasons for qualifying a calculated status rank include:

- **Questionable taxonomy**, for global rank assessments only. If distinctiveness of this entity as a taxon 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 qualified by adding a Q after the G# (e.g., G2Q) before acceptance as the assigned global status rank.
- **Captive or Cultivated**, for global rank assessments only.[8] If the species at present is extinct in the wild across its entire native range but is extant in cultivation, in captivity, as one or more naturalized populations outside its native range, or as a reintroduced population not yet established, the calculated rank can be qualified by

8 The C rank qualifier is not used for national/subnational ranks because its meaning at a regional level is unclear. For example, a species may exist in captivity somewhere in a subnation, but it may be that the species exists in the wild in a neighboring jurisdiction, making the C qualifier uncertain. In addition, keeping information on species' captivity current from record of various zoos and sanctuaries within a jurisdiction is difficult. Thus, if an element occurs in a nation or subnation only as extant in captivity or cultivation, or as a reintroduced population/restored ecosystem that is not yet established, then the assigned status rank is NX/SX. If it is a re-introduced population/restored ecosystem that is established, then a basic N#/S# rank is used.

adding a C after the G# (e.g., G1C) before acceptance as the assigned global status rank. Similarly, if an ecosystem at present is eliminated in the wild across its entire native range, but is extant but not fully established in restorations within that native range, the calculated rank can be qualified by adding a C after the G# before acceptance as the assigned global status rank.

Adjusting the Calculated Rank

The calculator has been tested and improved over a number of years. Thus adjusting the calculated rank should only rarely be done, and then only with sufficient documentation and peer review from colleagues. But upon review of the calculated rank, there may occasionally be situations in which the assessor believes that the calculated status rank needs to be adjusted slightly up or down. Potential reasons for adjusting a calculated status rank include:

- **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 extirpation 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. (2012) 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 information 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.[9] Historically, a national/subnational rank that implied that a species or ecosystem was more imperiled at a global level than it was at a local level was not acceptable. For example, G1S3 was invalid, since in principle a species or ecosystem could not be 'vulnerable' to elimination at a global level but at the same time 'apparently secure' at a subnational level.[10] This rule is under review because current status assessment methods provide a more explicit role for Threats and Trends, which may indicate low levels of risk at national/subnational scales as compared to global scales, and a one rank difference may be permissible (e.g., G1S2).

9 See also Master et al. (2012), specifically *Appendix D: Extinction Risk and Setting Conservation Priorities*, for a discussion of the use of global and national/subnational ranks in setting priorities.

10 Note that the IUCN (2003) allows a taxon 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.

- **Other** reasons which might rarely indicate that a calculated status rank needs adjustment include ecological considerations or specific life history traits (e.g., extreme r- or k-selected[11] species), or additional information useful for assessing conservation status. Reasons for adjusting a calculated status rank should always be documented (e.g., results of a population viability analysis).

Finalizing the Assigned Conservation Status Rank

The final step in the Status Assessment Method is the assessor's review of the calculated rank and acceptance as the final assigned conservation status rank, or in rare cases, adjustment before being assigned if deemed appropriate, with reasons documented.

11 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.

Applying the Status Assessment Method with the Rank Calculator

In the previous section, the underlying process and rules for applying the conservation Status Assessment Method were described. Here, the features of the rank calculator and its automation of the assessment method are explained.

The Rank Calculator

The rank calculator is an automated spreadsheet that has been programmed to implement the upgraded NatureServe conservation Status Assessment Method by applying defined rules, and assigned points and weights to status factor ratings to generate a calculated rank (NatureServe 2012). The calculator consists of a number of worksheets identified by tabs, including several used for data and calculations and others containing sets of information that can be referenced when using the calculator. In order to use the full functionality of the rank calculator, the macro security setting in Excel must be Medium or Low, and macros must be enabled when the file is opened. Microsoft Excel 2003 or higher is required to use the rank calculator.

Biotics Support of Conservation Status Assessments

NatureServe manages a comprehensive database of species and ecosystem information, including factor ratings and conservation status ranks, using the Biotics data management system. Maintaining current and accurate conservation status information in NatureServe Biotics is of critical importance as the data is utilized by many agencies and organizations, both within and external to NatureServe, for informing conservation and management-related decisions. In addition to information identifying the element and some other ancillary data, the core content of a record in the Biotics Element Ranking file (shown in Appendix B) consists of:

- Assigned rating codes for each of the ten status factors, along with associated comments
- Author and date of factor ratings
- Calculated status rank
- Assigned conservation status rank (typically the same as the calculated rank; if not, see Reasons below)
- Author and date of assigned conservation status rank

- Summary of reasons for the assigned conservation status rank
- Rarely, reasons the calculated rank was adjusted before assignment as the status rank

Although independent from Biotics, the rank calculator was developed to correlate with Biotics. The database structure of Biotics facilitates export of status factor data into the rank calculator, as well as into other formats that permit analysis.

Workflow for Assessments Using the Calculator

The basic process for using the rank calculator can be summarized as: (1) moving data into the calculator, (2) generating a rank, and (3) moving data back into a database. Although there are a couple of different workflows that could be used to accomplish this process, the majority of assessments should use the workflow that begins with existing factor ratings data in Biotics (or another database with compatible data structure). The second identified workflow, described below, is to be used only when status factor ratings for an element have not yet been assigned.

Assessment Workflow Using Existing Data

Recommended workflow for conservation status assessments:

1. Export existing factor ratings data from element ranking records in Biotics into the rank calculator.

   Ideally, if these data do not yet exist, factor ratings are assigned and associated factor information recorded in Biotics (which has additional ranking fields not included in the rank calculator), then data exported to the calculator (rather than using the secondary workflow described below).

2. Use the rank calculator to:
   a. Generate a calculated rank
   b. Review the rank
   c. Record the assigned conservation status rank (equals the calculated rank except in very rare circumstances) and document reason(s) it was assigned
   d. Rarely, adjust the rank before assignment and document why it was adjusted
3. Import both the calculated and assigned status ranks, along with new documentation, into Biotics from the calculator, updating fields in the element ranking record.

Because the rank calculator does not track edits to data, it is strongly recommended that Biotics data not be edited once brought into the rank calculator for an assessment. Any edits needed should be made in Biotics prior to export. Note that if edits to imported Biotics data are made in the calculator, a process for tracking them must be established and used to record these changes in order to avoid corrupting the database when the edited data is uploaded back into Biotics. In addition, if any of the data originally exported to the calculator was then edited in Biotics during the time that conservation status was being assessed, then updating Biotics with data edited in the calculator may accidentally overwrite newer data in Biotics, leading to unintentional deletions or loss of edits made by another user.

Assessment Workflow Without Existing Data

This second workflow for conservation status assessments should be used only in cases when there are no existing conservation status factor ratings recorded in Biotics for the element:

1. Enter identifying information for the element in the rank calculator.
2. Use the rank calculator to:
   a. Enter ratings for the rank factors
   b. Generate a calculated rank
   c. Review the rank
   d. Record as the assigned conservation status rank (equals the calculated rank except in very rare circumstances) and document reason(s) it was assigned
   e. Rarely, adjust the rank before assignment and document why it was adjusted
3. Import both the calculated and assigned status ranks, along with new documentation, into Biotics from the calculator, populating fields in the element ranking record.

Using the Rank Calculator for Status Assessments

Implementation of the upgraded NatureServe conservation status assessment is greatly simplified by using the rank calculator to generate a status rank. Becoming familiar with the worksheets (i.e., tabs) before beginning to use the calculator is recommended. Note that there are several tabs that describe how to import and export data between the calculator and Biotics that will change once the data structure for the updated ranking methodology has been implemented in Biotics. The calculator worksheets are described in Table 11, followed by more detailed information on the three worksheets that are utilized in the actual ranking process. An worked example is provided in Appendix C.

Table 11. Rank calculator worksheets (tabs)

Spreadsheet	Description
Summary & Acknowledgments	Contains the Executive Summary, suggested citation, references, and recognition for members of the Element Ranking Work Group and others that have contributed to the updated methodology and development of the rank calculator.
Instructions & Rules Reference	Provides basic information on how to use the rank calculator, and summarizes the rules applied to generate a calculated status rank.
Factors Reference	Summarizes the status factors and rating value scales.
Calculator Form	In cases when no existing factor ratings data have been recorded in NatureServe's Biotics data management system for import, the form is used for entering status factor ratings for a single species or ecosystem at a time and generating a calculated rank. 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.
Calculator Table	Stores factor data, either imported from Biotics or transferred from the Calculator Form, for multiple species and ecosystems in tabular format.
Threats Instructions	Provides information on how to use the Threats worksheet.

Continued

Table 11. (continued) Rank calculator worksheets (tabs)

Spreadsheet	Description
Threats Assessment	Used to automatically calculate the rating for the Overall Threat Impact status factor based on scope and severity values entered for individual threats.
Threats Data Compiled	Stores data from the Threats Worksheet for multiple species and ecosystems.
Change log	Contains information on changes made to the rank calculator since v2.0 (2010) and whether they affect ranks generated with the earlier version of the calculator.
Worksheets below are for use until Biotics has been updated with the revised data structure	
Export from Biotics 2011	For Biotics installations that have been updated to use the new (2011) methodology use in this calculator, provides SQL queries and instructions for exporting global or subnational status factor ratings from Biotics into the rank calculator.
Export from Biotics pre-2011	For Biotics installations that have *not* been updated to use the new (2011) methodology, provides SQL queries and instructions for exporting global or subnational status factor ratings from Biotics into the rank calculator. These queries automatically convert the existing ratings that were assigned under the previous methodology to the equivalent new values during the export process.
Import into Biotics	Provides information to be considered regarding data import from the rank calculator into Biotics. Data from the rank calculator should not be imported into Biotics until the database includes the structure required to manage data for the updated methodology.

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. 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 is primarily populated with rank status data for multiple elements imported from Biotics. Once in the table, a status rank is automatically generated for each row in which the minimum factor requirements are met. However, it is the responsibility of the assessor to identify any issues with the number of factors used to calculate a conservation status rank or apply a range rank to capture the uncertainty associated with assigning values to each rank factor. The Calculator Table can also be populated with new rank status data that was entered directly in the Calculator Form, which is the workflow for elements with no existing rank status factor data.

Although possible, it is not recommended that data be entered directly in the Calculator Table, as the rating value scales for the individual status factors are not displayed on the Calculator Table worksheet, and data validation procedures are limited. Once calculated status ranks have been generated, data should not be stored in the rank calculator for the long term, but rather should be exported to, and maintained, in Biotics.

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. Although recommended only when status factor ratings for an element have not yet been assigned and imported from Biotics, status factor ratings can be entered directly into designated cells in the Calculator Form using drop-down boxes. Because the Calculator Form, with the value scales and weights provided for each status factor, is the most transparent means of examining details of the automated assessment process, single rows (i.e., elements and their rank factor ratings) from the Calculator Table worksheet can be viewed in the form one at a time.

To illustrate the processes performed by the rank calculator, steps for entering data in the Calculator Form are described at a high level.

1. Select the geographic level for the conservation status assessment (global, national, or subnational). Once set, every status rank generated by the rank calculator will use the designated geographic level until it is changed.
2. Enter identifying information for the element to be assessed (e.g., scientific name), indicate the Element Type (species, infraspecies,[12] animal assemblage, association, ecological system, or "other ecological type" [e.g., natural community type, alliance, group]), and if an ecosystem, indicate the spatial pattern type. Optionally, provide additional element information (e.g., Element ID, Common Name).
3. If the element has no existing status factor ratings data imported from Biotics, select rating codes from drop-down lists for as many of the ten status factors as the data permits, using range codes (e.g., BC, BD) to indicate uncertainty. If actual numeric values for a factor rating are known (e.g., 2,050 km^2 area occupied), record them in the Comments field for the associated factor.[13]

   Note that guidance provided in Master et al. (2012) should be reviewed before assigning status factor ratings. The rank calculator provides reference information: the Factors Reference tab of the rank calculator provides a summary of status factors, categories, and rating code; the Instructions & Rules Reference tab shows the points and weights assigned to each status factor, along with the weights for factor categories.
4. As data is entered in the Calculator Form, the rank calculator automatically processes the assigned factor ratings, applying the rules, algorithms, and weightings detailed in the previous "Status Assessment Method" section (see Table 3 for a summary of the process implemented in the calculator).
5. The calculated status rank is generated and automatically displayed in the Calculator Form, updated continuously as factor rating values are entered or edited in the form, until data entry/edits are completed and the calculated status rank is final.
6. Review the calculated status rank, and in almost all cases record the value in the Assigned Rank field and status comments provided in the Assigned Rank Reasons field.

12 If the element in a global assessment is an infraspecies type, the calculated status rank will begin with a T indicating an infraspecific taxon status. See Master et al. (2012), specifically *Appendix A: NatureServe Conservation Status Ranks*, for information on T status ranks.

13 Although recorded in a Comments field in the rank calculator, this is simply a temporary holding area; numerical data for conservation status factors is stored in designated fields in Biotics instead of factor Comments fields.

In rare cases where review indicates an adjustment to the calculated rank is needed, record the adjusted value as the Assigned Rank and explain reasons for the change in the Rank Adjustment Reasons field. Note that the rank generated by the calculator should be adjusted only for exceptional reasons (see "Adjusting the Calculated Rank" section above).

7. Once status factor ratings and status ranks are completed on the Calculator Form tab, save values to a new 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.

Threats Worksheet

In cases when a rating for the Overall Threat Impact status factor has not yet been assigned for the element, a value can be automatically generated using this Threats Worksheet. 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, are used to calculate overall impact. A comprehensive description of the rationale and process for determining an Overall Threat Impact rating can be reviewed in Master et al. (2012).

Note that if the Overall Threat Impact rating is believed to be "Low," then after scanning the threats table on the worksheet to ensure that nothing was overlooked, the rating can be recorded on the worksheet without further threats evaluation. In cases when the overall impact is not thought to be "Low," the steps for using the Threats Worksheet to calculate a threat impact rating are briefly described below.

1. Using the Classification of Threats table,[14] select values for the scope, severity, and timing of threats that impact the element at Level 2. If Level 2 threats within the category will not be assessed, select values at Level 1.

   The Threats Worksheet automatically generates the impact from the scope and severity values for each recorded threat.

2. Estimate and assign scope, severity, and timing values for any Level 1 threat categories that 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.

3. Impact values for each Level 1 threat category are tallied and specific guidelines, described in Master et al. (2012), are applied to generate a calculated Overall Threat Impact rating for the element.[15]

4. Review the calculated rating for Overall Threat Impact generated by the Threats Worksheet and record the value in the Assigned Overall Threat Impact field. In cases where review indicates that the rating should be adjusted, record the adjusted value as the Assigned Overall Threat Impact rating and explain reasons for the change in the associated Adjustment Reasons field.

5. Copy the impact rating to the Calculator Form by clicking the button "Copy Assigned Impact to Calculator Form." Save threats data for the species or ecosystem as a new row on the Threats Data Compiled worksheet by clicking the "Copy Data to Threats Data Compiled" button. The form can then be cleared in preparation for calculating a rating for Overall Threat Impact for the next species or ecosystem.

14 The Classification of Threats table is adopted from IUCN-CMP (Salafsky et al. 2008 and Butchart pers. comm. 2009).

15 Threats with negligible scope or severity (scope or severity threat is less than 1%) will not have an impact calculated; however, recording these threats indicates that they were identified.

Looking Ahead

Inevitably, a project such as this—evaluating and upgrading the NatureServe conservation status assessment methodology—generates additional questions or ideas. Below, we describe several issues to be explored in the years to come.

Rank Calculator Development

Status Factors

NatureServe's methodology for assessing conservation status is based on a weight-of-evidence approach, assessing the contribution of multiple status factors, organized around the three categories of rarity, trend, and threat. All factors are considered jointly when assessing element extinction/ elimination or extirpation risk, using a set of rules and points to incorporate status 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 status factor ratings change.

One issue to consider is whether there are interactions among the status 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 Status Assessment Method is sensitive enough to trends. Species or ecosystems that are common but undergoing rapid decline may not be as highly ranked (i.e., as at risk) 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? Still, we have revised our approach to handling trends in this 2012 edition, and feel it will better represent the more explicit role of trends in conjunction with other factors.

Finally, the process developed for calculating an Overall Threat Impact rating in the upgraded conservation status assessment methodology was quite new in Faber-Langendoen et al. (2009a). At that time, we wondered if the threats definition would be interpreted differently by a user, and if threats values would be lumped or split in different ways? Would the exchange ratio of severe to moderate or mild threats produce appropriate results? In particular, if there were widespread threats of unknown frequency and severity, do range ranks reflect the appropriate levels of uncertainty? To date, users have indicated its value for clarifying the role of threats in an assessment (Ramsay pers com. 2012), but we await further testing. In the meantime, we provide an upgraded version of the threats methodology and an updated worksheet in the rank calculator to facilitate its use.

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 species that are "r-selected" (populations highly-variable, high reproductive rate) versus "k-selected" (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 the Population Size factor is not used for r-selected species or for all clonal species, while the Area of Occupancy factor is required. We currently suggest that Population Size should not be used in the status calculation for some r-selected species (see Master et al. 2012). One level of specificity we do provide is the ability to use different factor rating scales for Area of Occupancy to accommodate differing patch type patterns of ecosystems, including large patch (the default value), small patch, or matrix. We hope this will increase the applicability of the calculator across the wide range of ecosystem types and at multiple scales of ecosystem types (see also below).

Ecological Community/Association Scale vs. System-Scale Calculator

Previously, NatureServe and Network ecologists have focused on the association or ecological community scale (Faber-Langendoen et al. 2009b, Jennings et al. 2009) for ranking ecosystems. The conservation status factors used in the upgraded assessment methodology have now been updated for application at multiple hierarchical scales of vegetation/ecosystem classifications (Faber-Langendoen et al. 2009b), including at the level of NatureServe's Ecological Systems (Comer et al. 2003, Comer and Schulz 2007). Many factors ratings are scale independent (i.e., Overall Threats, Short-term Trend, Long-term Trend, Percent Area with Good Viability/Ecological Integrity),and others, such as Area of Occupancy, have been modified to provide a choice in the factor rating scale used, depending on the spatial pattern of the ecosystem types. Still, others, such as Range Extent, and perhaps Number of Occurrences, may require adjustments for use with mid- or broad-scale ecosystem types.

Red List of Ecosystems

IUCN has initiated the development of risk assessment criteria to support a global Red List of ecosystems (Rodriguez et al. 2011). NatureServe is a partner organization for the Red List. The listing will complement the Red List of species and strengthen capacity to report on and monitor the status of the world's biodiversity. Most recently, five criteria have been proposed:

A. Rates of decline in ecosystem distribution;

B. Restricted distributions and continuing declines or threats;

C. Rates of environmental degradation;

D. Rates of disruption to biotic interactions; and

E. Quantitative estimates of the risk of ecosystem collapse.

These criteria will be applied using the same threshold-based approach as that of species listing, with the leading (most at-risk) criterion used to assign conservation status. The primary factors and methods used to address these criteria strongly overlap with those used in the NatureServe status assessment method, but as with species, the NatureServe method for ecosystems incorporates information on all factors when assigning a conservation status rank (weight-of-evidence approach, see Linkov et al. 2009). NatureServe staff are participating in the development of the IUCN criteria, and will compare the two methods over time.

Conclusions

A combination point and rule based approach has been developed for assigning NatureServe conservation status ranks, at both global and national/subnational levels. Implementation of this Status Assessment Method is facilitated by use of a rank calculator (currently available in spreadsheet form), which has been developed to automate the process. Basic workflow for status assessments using the rank calculator begins with the initial completion of an Element Ranking record for the species or ecosystem within NatureServe's Biotics data management system, which stores the summary data for the ten conservation status factors which have been determined to be relevant for assessing extinction/elimination or extirpation risk. The ratings values for these factors are then exported to the rank calculator. The calculator uses the methodology to apply a series of procedures (points and rules) to the factor ratings to generate a calculated status rank, which is reviewed and accepted as the assigned conservation status, or in rare cases adjusted (with reasons documented) before assignment. The status ranks and associated new data are then imported back into Biotics, updating element conservation status information. 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/elimination or extirpation of species and ecosystems. The intent of this method is not to simply assign a status rank to the most threatened elements, but to place them all on a scale that indicates their relative risk. 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, THREATS, and TRENDS. The point and rule based approach provided in the conservation status assessment method allows for a relatively simple way of integrating all of these factors.

This upgraded process of assigning conservation status is intended to enhance and replace, over as short a time period as feasible, NatureServe's existing set of status ranks developed under the pre-2009 ranking methodology. Despite the qualitative nature of 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 method and the calculator tool facilitating its use, NatureServe's ability to upgrade its status ranks will be improved based on an accurate, consistent, repeatable, and transparent method. The standardized

method will facilitate collaboration among the NatureServe network. 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 of generating global ranks based on the compilation, or roll-up, of subnational rank information.

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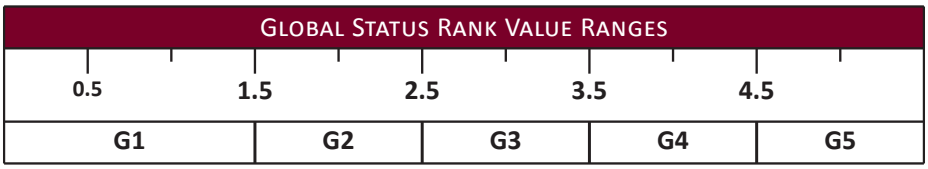
Appendix A

Incorporating Range Ratings into the Calculated Status Rank

Conservation status assessments often include one or more status factors with an assigned range rating (e.g., BC or BD) instead of a single rating value (e.g., B) due to factor information that is not precise enough to permit selection of a single value in the rating scale. In these cases, the low and high values of the range rating are carried through all steps in the assessment process, resulting in a range in calculated status rank. In such cases, the low and high scores at the ends of the range are then evaluated according to point spread criteria in order to determine the final calculated conservation status rank, which may still be a range depending on the global rank value range(s) included in the spread between status scores.

Examples below describe the process required to determine a final calculated status rank from a calculated range in status resulting from the lower precision of the information available for rating for one or more of the underlying rank factors. The graphic provides a reference for the numeric value ranges of individual G1–G5 global ranks, and the point spread criteria are included for reference as well. Note that these examples are intended simply to illustrate the processes that are implemented automatically by the rank calculator in generating a final calculated status rank or range rank from a range status rank. See the "Calculating a Status Rank from a Range in Calculated Scores" section above (especially Figure 2) for additional details on this process.



Point Spread Criteria

i. If 95% of the point spread between calculated scores is contained within the range of values for 1 status rank (see examples in Figure 2), then that rank is used as the calculated status rank.

ii. If 80–95% of the point spread between scores is contained within the range of values for 1 status rank, then that rank is used with a "?" qualifier as the calculated status rank.

iii. If ≥95% of the point spread between scores is contained within the range of values for 2 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).

iv. If ≥95% of the point spread between scores is contained within the range of values for 3 consecutive status ranks, but <95% is contained within the range of 2 consecutive ranks, then those 3 ranks are used as a calculated range status rank

Example 1:

- Low and high scores for a range in calculated conservation status: 1.4 and 2.3, respectively
- Global status of each value 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 the point spread that falls into the G2 value range, determined by using the cut-off between the G1 and G2 ranks: 2.3 – 1.5 = 0.8
- Percentage of the point spread within the G2 value range: 0.8/0.9 = 89%
- Appropriate point spread criteria to apply is (ii); 89% of the spread between scores is contained within the G2 value range, so a calculated status rank of G2? is assigned

Example 2:

- Low and high scores for a range in calculated conservation status: 1.4 and 1.6, respectively
- Global status of each value individually: 1.4 is just within the G1 value range; 1.6 is slightly within the G2 value range
- Point spread between status scores: 1.6–1.4 = 0.2
- Amount of the point spread that falls into the G2 value range, determined by using the cut-off between the G1 and G2 ranks: 1.6–1.5 = 0.1
- Percentage of the point spread within the G2 value range: 0.1/0.2 = 50%
- Appropriate point spread criteria to apply is (iii); 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 B

Example of a Global Element Ranking Record

Provided below is a global Element Ranking record (EGR) with fields containing ratings for each of the NatureServe status factors based on global (range-wide) information. Similar records are available nationally (ENR) and subnationally (ESR). These records are completed by NatureServe scientists or by a designated lead office in a NatureServe network program, and form the basis for assigned conservation status ranks.

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

GRank: G3? (Reviewed 5 April 2012, 24 Oct 2002, Changed April 5, 2012)

Calculated Rank: G3?

Override? No

GReasons:
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). The increased threat from the spread of hemlock woolly adelgid is of concern. Hemlock woolly adelgid has not been found in the upper Great Lakes region, and is absent from Michigan and Wisconsin as of February 2012.

Rarity

Range Extent

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

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

Number of Occurrences

DE: 81 to >300
There are probably a large number of EOs present, reflecting its wide range of distribution in the region.

Number of Good Occurrences or Populations

E: Many (41–125) occurrences with good integrity
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).

Threats

Scope: Medium
Severity: Medium
Threat Impact: C (Medium)
Threat 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).

Trends

Short-term Trend

F: = Decline of 10–30%

Long-term Trend

C: = Decline of >70%.
Historically, logging, the tanning industry, and development have had a very substantial negative impact on this association.

Conditional and Other Factors

Intrinsic Vulnerability

U: Unknown

Environmental Specificity

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

Other Factors of Interest:

Needs

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

Inventory Needs:

Protection Needs:

Sources

Version Date: 05 April 2012

Version Author: D. Faber-Langendoen

Version Notes: DFL updated and reviewed on November 9, 2006, Nov 5, 2007, and April 5, 2012.

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 C

Example of Completed Rank Calculation

The overall procedure for assigning a conservation status rank is summarized in Table 3. Conservation status factors are organized by **rarity**, **threats**, and **trends** categories. Each factor is assigned a rating value, which is converted to points, as documented in the Rank Calculator (NatureServe 2012). Each factor has a specified weight, with Population Size, Area of Occupancy, Number of Occurrences or Percent Area with Good Viability/Ecological Integrity, and Short-term Trend weighted more heavily because of their greater influence on risk of extinction/elimination or extirpation. A sub-score is calculated for **rarity** and **threats**, which are then weighted and summed for an initial status score. The **trends** sub-score is then subtracted from the initial status score to get the calculated score, which is then converted to the calculated rank. Data provided by Roxanne Bittman, 2012.

Continued

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	Range Extent	C	1.6	1	1.6			
	Area of Occupancy	E	2.7	2	5.4			
	Number of Occurrences	C	2.7	1	2.7			
	Population Size	F	3.9	2	7.8			
	Number of Occurrences or Percent Area with Good Viability/Ecological Integrity	C	3.3	2	6.6			
	Environmental Specificity[1]	–	–	1	–			
		Rarity subtotals:		8	24.1	3.0	0.7	2.1
Threats	Threat Impact	B	1.8	1	1.8			
	Intrinsic Vulnerability[2]	–	–	1	–			
		Threats subtotals:		1	1.8	1.8	0.3	0.6
Trends	Short-term Trend	F	-0.1	2	-0.2			
	Long-term Trend	–	–	1	–			
		Trends subtotals:			-0.2	-0.2		-0.2
						Calculated Score		2.5
						Calculated Rank[3]		G2

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.

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