PENNSYLVANIA BIOLOGICAL SURVEY HANDBOOK

CHAPTER 2. THE PENNSYLVANIA BIOLOGICAL SURVEY (PABS) STATUS DETERMINATION PROCESS

(revised 7 January 2016, 1 September 2021)

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CHAPTER 2. THE PENNSYLVANIA BIOLOGICAL SURVEY (PABS) STATUS DETERMINATION PROCESS (revised January 2016)

INTRODUCTION

PABS status determination is the process of classifying the entire range of risk of decline and possible extirpation from the state—from Endangered and Threatened to Least Concern—of species, subspecies, and varieties of organisms and of ecological communities (throughout this document called elements of biodiversity, or simply elements). It is an adaptation of internationally agreed-upon methods developed by NatureServe (Appendices 2-A, 2-B, and 2-C), the International Union for Conservation of Nature (Appendices 2-D, 2-E, and 2-F), and the Committee on the Status of Endangered Wildlife in Canada (Appendix 2-G). PABS status determination is science-based and objective and is intended to be an easily and widely understood system. The process focuses attention on the prevention of further declines and on the need for action to recover long-term viability for those elements at risk of state extirpation. The Pennsylvania Game Commission (PGC), Pennsylvania Fish and Boat Commission (PFBC), and Pennsylvania Department of Conservation and Natural Resources (DCNR) weigh additional considerations, for instance, regulatory, sociopolitical, and economic ramifications, prior to the regulatory listing of an element. The differences between status determination and regulatory listing are clear-cut:

STATUS DETERMINATION

Status determination is the process by which PABS—in an independent advisory capacity to the PGC, PFBC, and DCNR—evaluates an element's risk of loss from the state and recommends or petitions that an element at risk be considered for regulatory listing as provided by law (Wild Resource Conservation Act: 34 Pa.C.S.A. § 2167; 34 Pa.C.S.A. § 2924; 34 Pa.C.S.A. § 925; 32 P.S. §§ 5301–14). Determinations are made using an established procedure based on objective science, expert opinion, criteria specified in official regulations and non-regulatory guidelines, and criteria from authorities such as NatureServe (NatureServe 2008; Faber-Langendoen et al. 2012; Master et al. 2012), IUCN (IUCN 2012a, 2012b, 2014), and COSEWIC (COSEWIC 2014). The element status list maintained by PABS is advisory, not regulatory. It is desirable to maintain consistency between PABS non-regulatory and agency regulatory lists; under current law the authority to do so rests with the agencies.

REGULATORY LISTING

Regulatory listing is the process by which the PGC, PFBC, and DCNR—building on the independent and scientifically objective status determination process—use an established procedure (specifying petition, documentation, and public participation requirements, among other items) and consider policy, cost/benefit comparisons, current protection profiles, and other factors to classify and list elements as Endangered, Threatened, or Near Threatened, and in the case of DCNR, Rare or Vulnerable instead of Near Threatened.

NATURESERVE STATUS ASSESSMENTS—PHASE 1
IN THE PABS STATUS DETERMINATION PROCESS

The first step in the PABS element status determination process is to apply the NatureServe status assessment method. NatureServe is a nonprofit organization based in the U.S. that links together a public-private network of independent organizations operating across the Western Hemisphere, including state natural heritage programs. It provides conservation-related data, tools, and services to partner organizations, private and government clients, and the public. One of NatureServe's software tools analyzes data collected by natural heritage programs to rate the conservation status of elements (species, subspecies, and varieties of organisms, and ecological communities) using standardized criteria designed to be as consistent and objective as possible (Faber-Langendoen et al. 2012; Master et al. 2012). Data on each element are run through the assessment tool, a Microsoft Excel-based spreadsheet known as the Rank Calculator. It weighs various factors within the context of the particular biology of an element to estimate its risk of state extirpation or global extinction. The Rank Calculator is designed to be used at multiple scales within an element's range—at the global, national, or subnational (state) level—making its use an appropriate first step in conducting element status determinations for Pennsylvania.

The Rank Calculator works by evaluating 10 factors in 3 categories—rarity, threats, and trends. At minimum, a rank can be calculated using one rarity factor and either one threat or one trend factor. The minimal approach allows status assessments to be conducted rapidly. It can be applied in cases where little information is known about an element's biology or if a more in-depth literature review is possible but time-prohibitive. In the best case, all data available to address multiple Rank Calculator input factors are incorporated into an element's status assessment. Data availability for each rarity, threat, and trend factor varies greatly across the spectrum of Pennsylvania's biodiversity; the Rank Calculator status assessment method enables a uniformity of treatment across varying levels of data availability. The task of regularly assessing the conservation status for all of Pennsylvania's qualifying elements is enormous, but it is made feasible by using the Rank Calculator as a first step in the status determination procedure.

The Rank Calculator is an effective coarse-filter tool for conducting status assessments and documenting the factors considered for each assessment but it is not meant to be used as the sole basis for listing or delisting elements (NatureServe 2008). The PABS criteria based on IUCN/COSEWIC methodology constitute a more appropriate toolkit to look in greater detail and at a finer scale at extirpation risks. The Rank Calculator results are helpful for prioritizing which elements need to be more closely evaluated using the PABS criteria.

The Rank Calculator is periodically updated as more information on extinction risks for taxonomic groups becomes available in the peer-reviewed published scientific literature, (as of January 2016, the current version is Rank Calculator v3.186).

The NatureServe definitions are independent of the PABS status categories; however the PABS categories may be crosswalked to the NatureServe definitions when appropriate. For some elements—e.g., many arthropods and all ecological communities—NatureServe assessments are the only method of status determination done so far.

DEFINITIONS FOR THE NATURESERVE STATUS CLASSIFICATION SYSTEM

Five primary S-rank Rank Calculator outputs are used by NatureServe to describe an element's risk of extirpation from a subnational region (state or province):

S1   **Critically Imperiled** in the state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.

S2   **Imperiled** in the state/province because of rarity due to very restricted range, very few occurrences (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.

S3   **Vulnerable** in the state/province due to a restricted range, relatively few occurrences (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.

S4   **Apparently Secure**—uncommon in the state/province but not rare; some cause for long-term concern due to declines or other factors.

S5   **Secure**—common, widespread, and abundant in the state/province.

Other S-rank definitions are used where exceptions on element status are not covered by the primary outputs:

SNR   **Unranked**—state/province conservation status is not yet assessed.

SU   **Unrankable** currently due to lack of information or due to substantially conflicting information about status or trends.

SX   **Presumed Extirpated**—believed to be extirpated from the state/province; not located despite intensive searches of historical sites and other appropriate habitat, with virtually no likelihood that it will be rediscovered.

SH   **Possibly Extirpated (Historical)**—occurred historically in the state/province and the likelihood of rediscovery is considered to be high enough to justify effort to relocate occurrences. The element's presence may not have been verified in the past 20–40 years. An element could become SH without such a 20–40 year delay if the only known occurrences in a state/province were destroyed or if it had been extensively and unsuccessfully looked for.

S#S#   **Range Rank**—a numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the element. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).

SNA   **Not Applicable**—conservation status rank is not applicable because the element is not a suitable target for conservation activities, e.g., a nonnative species or an ecological community dominated by nonnatives.
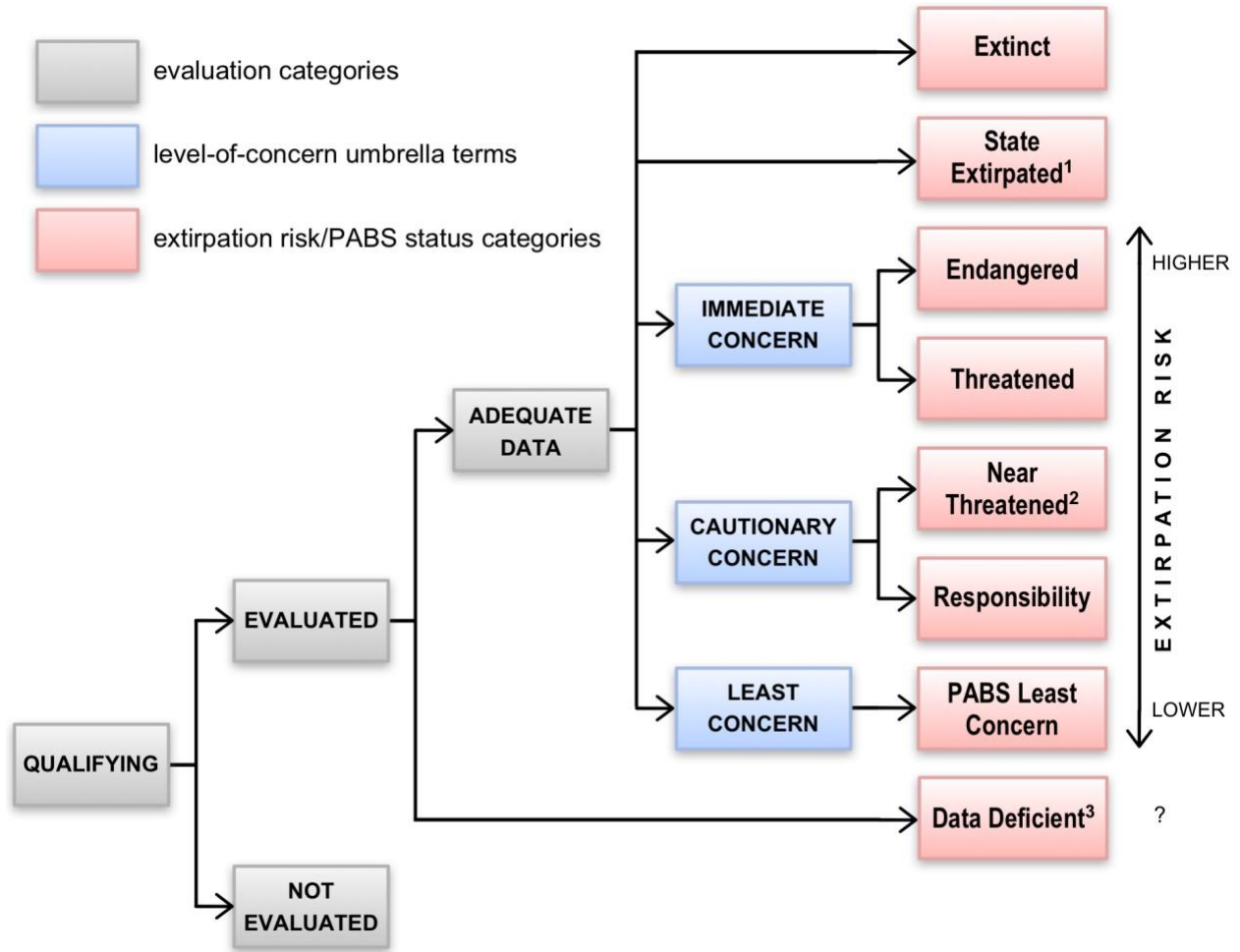
¹ Most **State Extirpated** elements do not fall under the umbrella of **Immediate Concern**; however, there are exceptions (see description on page 2-7).
² PABS's Vascular Plants Technical Committee (VPTC), Bryophytes and Lichens Technical Committee (BLTC), and DCNR's **Rare** and **Vulnerable** categories are subdivisions of, and collectively equivalent to, **Near Threatened**.
³ The VPTC, BLTC, and DCNR's **Tentatively Undetermined** category (TU) is equivalent to **Data Deficient**.

FIGURE 2-1. **PENNSYLVANIA BIOLOGICAL SURVEY (PABS) STATUS CLASSIFICATION SYSTEM FLOWCHART.** The revised (January 2016) PABS element* status classification system is adapted, in part, from IUCN categories (see Appendix 2-D), with added Cautionary Concern categories that emphasize preventing elements from becoming Endangered or Threatened. It is intended to be the default status classification system for all PABS technical committees, recognizing that for some taxa it may be appropriate to subdivide the Near Threatened status category into two or more subcategories, e.g., the Rare and Vulnerable categories of PABS's Vascular Plants Technical Committee (VPTC) and Bryophytes and Lichens Technical Committee (BLTC). See pages 2-5 – 2-9 for definitions of the PABS status categories.

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* Elements may be species, subspecies, or varieties of organisms or ecological communities.

APPLYING MODIFIED IUCN CRITERIA TO COMPREHENSIVE DATA—PHASE 2 IN THE PABS STATUS DETERMINATION PROCESS

Before elements are recommended to the state agencies for listing, PABS technical committees subject them to a higher level of scrutiny than is typical of the NatureServe status assessment method. The PABS status determination protocol uses all of the available data pertinent to the element's status in Pennsylvania and applies criteria developed by the International Union for Conservation of Nature (IUCN) modified for use at a regional level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and by the PABS technical committees. Before describing the PABS status determination process in detail (beginning on page 2-9) it is expedient to clarify the definitions of the categories of PABS elements of concern (Figure 2-1 and below).

DEFINITIONS FOR THE PABS STATUS CLASSIFICATION SYSTEM (revised January 2016)

PABS ELEMENTS OF CONCERN

PABS elements of concern are species, subspecies, varieties, and special-significance populations* of organisms and ecological communities that PABS believes are in need of conservation action or are likely to be confirmed as in need of conservation action with further research. Needed conservation action varies depending on population numbers and their trends, on habitat conditions and their trends, and on the degree and type of current and predicted threat. On one extreme, there may need only to be periodic monitoring of element occurrences[†] and existing and potential stressors. On the other extreme, an element may already be extirpated or need immediate measures to prevent its extirpation or extinction. The often-used terms "species of concern" and "species of conservation concern" have numerous definitions, some prescribed by regulations. Generally these other definitions are less encompassing than the definition of PABS elements of concern.

QUALIFYING

An element qualifies for evaluation if there is adequate documentation that: (1) it is native (indigenous), i.e., it has freely occurred in the wild in Pennsylvania either permanently or regularly—during some portion of its annual cycle in the case of species, subspecies, or varieties—prior to and since European settlement, or (2) it is a wild, free-ranging species, subspecies, or variety that has expanded its range into Pennsylvania subsequent to European settlement, but without direct human assistance, from a region where it naturally occurred and it has produced viable populations that have persisted for at least a threshold number of years. The relevant consecutive years of residence for major species groups is determined by PABS technical committees. For instance the Ornithological Technical Committee uses at least 10 years for birds; and

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*Special populations are wild populations of species of PABS Least Concern (defined on page 2-9) considered to be of state, regional, or national conservation significance because of their predicted importance for sustaining genetic diversity and evolutionary potential within the species.

[†]Element occurrences, or "EOs," are areas of land or water where a species, subspecies, variety, or ecological community of concern is present and has practical conservation value, i.e., is or has a chance of being viable for a significant duration.

the Mammals Technical Committee defines a resident breeder as any combination of 3 breeding events either in separate years, separate element occurrences, or a combination of either. Vagrants (characterized by a short-term occurrence outside of, but near a species', subspecies', or variety's usual range) that fail to establish persistent resident populations spanning specified time periods generally do not qualify for evaluation. An element may be considered as eligible for evaluation if it is of Immediate Concern or Cautionary Concern (defined below) in adjacent states. Most such elements are edge-of-range species, subspecies, or varieties, i.e., their total ranges barely overlap Pennsylvania's borders.

NOT EVALUATED

A Qualifying element is Not Evaluated when it has not been assessed using the NatureServe Rank Calculator or IUCN/COSEWIC criteria A through E (Table 2-1). For many invertebrate, fungus, and protist species and ecological communities that have never been evaluated, technical committees (and subcommittees) customarily use the NatureServe Rank Calculator to develop lists of representative elements with high priority for evaluation against the IUCN/COSEWIC criteria.

EVALUATED

At minimum, a Qualifying element is Evaluated when its status in Pennsylvania has been assessed using the NatureServe Rank Calculator. The objective is to further evaluate all elements with calculated S-ranks of S1, S2, and S3 through the IUCN/COSEWIC criteria A through E, so many elements that qualify as Evaluated have gone only partway through the evaluation process.

DATA DEFICIENT

An Evaluated element is Data Deficient when there are insufficient data available to provide an adequate basis for its assignment to another category. These elements do not have sufficient Rank Calculator input factors to generate an S-rank other than SU (unknown). It is possible for an element in this category to be well studied or its biology well known but appropriate data on status or distribution are lacking. Data Deficient is therefore a category of PABS concern. The listing of an element as Data Deficient indicates that more information is needed and acknowledges the possibility that future research will show that it is at risk and qualifies for a PABS element of concern category.

ADEQUATE DATA

This evaluation category includes all elements with sufficient information to conduct a status assessment using PABS methodology.

EXTINCT

Extinction is the global disappearance of an element, usually a species, subspecies, or variety. The passenger pigeon (*Ectopistes migratorius*) is an example. An element is Extinct when there is no reasonable doubt that the last individual has died, i.e., when exhaustive surveys in known and expected habitat throughout its historic range, at appropriate times (diurnal, seasonal, annual), and over a timeframe appropriate to the species' life cycle and life form have failed to record an individual.

STATE EXTIRPATED

Extirpation, sometimes referred to as local or regional extinction, is the disappearance of an element—usually a species, subspecies, or variety—from a given area, in this case the state of Pennsylvania. Extirpation increases the probability of an organism's eventual extinction by reducing its population, genetic diversity, and geographic range. Elements that have disappeared from Pennsylvania since European settlement but still exist elsewhere are categorized as State Extirpated. The category includes NatureServe ranks SX and SH (see page 2-3). Elements ranked SH are provisionally considered to be State Extirpated but the likelihood that they may be rediscovered is considered to be high enough to justify effort to relocate occurrences; thus a fraction of State Extirpated elements are treated as being of Immediate Concern, pending more intensive searching.

An element is State Extirpated when: (1) there is a high level of certainty that the last individual of a species, subspecies, or variety potentially capable of reproduction has died or disappeared; or (2) a species, subspecies, or variety no longer regularly occurs in the state during any portion of its annual cycle; or (3) in the case of an ecological community, credible and detailed records verify its presence in the state historically but no occurrences are known today. It is not possible to set any general rules for a time period since the last observation before an element is classified as State Extirpated; it depends on how much effort has been devoted to searching. Some PABS technical committees have adopted specific timeframes for State Extirpated status. Rediscovered State Extirpated elements and State Extirpated elements that are restored as a result of a recovery effort may be reclassified by the PABS technical committees to a different PABS status category, usually Endangered.

IMMEDIATE CONCERN (umbrella term)

Immediate Concern, an umbrella term for the PABS status categories of Endangered and Threatened, emphasizes the need for timely management to stabilize or recover extant populations or occurrences to the point where the element's status can be downgraded. These elements have adequate data available to make a status determination.

ENDANGERED (includes Critically Endangered and Endangered of IUCN)

An element is Endangered when the best available data or other evidence indicate that it meets any of the IUCN/COSEWIC criteria A through E for Endangered (Table 2-1) and

therefore faces an *extremely* or *very high* risk of extirpation throughout all or a significant portion of its range within the state.

THREATENED (equivalent to Vulnerable of IUCN)

An element is Threatened when the best available data or other evidence indicate that it meets any of the IUCN/COSEWIC criteria A through E for Threatened and therefore faces a *high* risk of extirpation throughout all or a significant portion of its range within the state.

CAUTIONARY CONCERN (umbrella term)

Cautionary Concern is an umbrella term for a set of PABS status categories designed to focus proactive conservation attention on elements to prevent their declining to the point of qualifying for Endangered or Threatened status and to acknowledge Pennsylvania's special responsibility to care for elements with at least 10% of their North American population or 25% of their North American range in the Commonwealth.

NEAR THREATENED (equivalent to Near Threatened of IUCN and to Rare or Vulnerable of some PABS technical committees and DCNR)

An element is classified as Near Threatened by most PABS technical committees and either Rare or Vulnerable by the Vascular Plants Technical Committee (VPTC) and the Bryophytes and Lichens Technical Committee (BLTC) if it does not qualify as Endangered or Threatened but is susceptible to decline based on the nature of its distribution or history of exploitation. Examples include: (1) an element whose calculated NatureServe S-rank is S3 or a range rank containing S3; (2) an element that has been evaluated against IUCN/COSEWIC criteria A through E (Table 2-1) and does not qualify for Endangered or Threatened status but nearly qualifies and is likely to qualify in the near future; (3) an element for which the lack of sufficient or timely data precludes using IUCN/COSEWIC criteria, yet based on the species' history of decline, range contraction, or rarity, experts conclude it is potentially of Immediate Concern; (4) an element with an annual life cycle resulting in a significant portion of its population being concentrated in a limited number of small areas such as colonies, maternity roosts, hibernation sites, clusters of vernal ponds, or spawning beds; (5) an uncommon element that is significantly separated (disjunct) from its main area of distribution or confined (endemic) to a specialized habitat; (6) a qualifying peripheral (limit-of-range) element, often found in specialized habitats or in habitats infrequent in Pennsylvania; (7) a commercially valuable or attractive element with a high potential for exploitation such as ginseng (*Panax quinquefolius*), goldenseal (*Hydrastis canadensis*), and small yellow lady's-slipper (*Cypripedium parviflorum*). At present, the category labeled Vulnerable by the VPTC (and DCNR) refers to those three species; all of the other examples are classified by the VPTC and BLTC (and DCNR) as Rare.

The inconsistency in terminology among organizations and agencies for this category can lead to confusion. For some years several PABS technical committees devoted to animal species used three permutations of "candidate" for this category: Candidate

Proposed, Candidate at Risk, and Candidate Rare. PABS dropped the term candidate as a status category to avoid confusion with its usage with a different meaning by the agencies. During the time between when PABS determines an element is Threatened or Endangered and when it is legally listed as such, the element is a candidate for listing. Use of the term candidate is an agency prerogative.

RESPONSIBILITY

Responsibility elements have at least 10% of their North American total population or 25% of their North American range in Pennsylvania. In the long run, managing source (or core) populations is a more balanced conservation strategy than solely reacting to declines. Some, but not all, Responsibility elements are also categorized as Endangered, Threatened, or Near Threatened.

PABS LEAST CONCERN

Elements are of Least Concern only within the context of the PABS status classification system. Least Concern elements include some of the most important organisms and ecological communities from the standpoint of their numbers, distribution, and ecological functions. Many Least Concern elements, especially large, conspicuous ones (e.g., game and timber species or common forest communities), are managed and monitored by Pennsylvania's resource management agencies. Acknowledging the limited, mainly volunteer resources available for the monumental task of biodiversity monitoring and conservation, the primary focus of PABS is on other PABS elements of concern categories. Although most PABS attention is focused on status categories other than Least Concern, it is recognized that the boundary between Least Concern and other categories is potentially volatile. The recent example of Pennsylvania's most common bat species, the little brown bat (*Myotis lucifugus*), changing from a Least Concern element to an Immediate Concern element in just four years (2008 to 2012) exemplifies this.

PABS STATUS DETERMINATION STEPS

The status of most vascular plant, vertebrate, mollusk, moth, butterfly, and ecological community elements has already been assessed at least once and at least through the second step in the status determination process (outlined below). Others, including most non-vascular plant, other invertebrate, fungus, lichen, and protist elements, have not yet been assessed for the first time.

Elements that have already been assessed need to be reassessed when there have been changes in their status or when new, more accurate, detailed, or comprehensive data have become available. Reassessment introduces two potentially confusing terms: "upgrade" and "downgrade," or alternatively "uplist" and "downlist." "Up" and "down" in this case refer to levels of extirpation risk and thus concern. A species facing increasing risk can be upgraded (uplisted). For example, the Allegheny woodrat (*Neotoma magister*) is classified as Threatened in Pennsylvania, but it has continued to decline for three decades since its last status determination. Evaluating this species using more up-to-date data sources may

lead to an upgrade to Endangered status. A species facing decreasing risk can be downgraded (downlisted). The bald eagle (*Haliaeetus leucocephalus*) is an example of a species that is doing well and has recently been downgraded by the PGC and USFWS.

Four steps are followed when elements are initially assessed (starting at step 1), when they are reassessed (starting at step 2), or when there is a petition for a status change (starting at step 2).

1. A list of Qualifying elements is prioritized for assessment from checklists of native species, subspecies, and varieties of organisms and of ecological communities. For the best-studied element groups, e.g., vertebrates and vascular plants, all elements have been or eventually can be assessed. For others, lists of Qualifying elements may be in the form of a selected sample. The conservation status of the selected elements is assessed using the web-available latest version of NatureServe's Rank Calculator (described on pages 2-2 – 2-3).

2. Rank Calculator results are used to prioritize elements to be evaluated using the modified IUCN/COSEWIC criteria. At this point the more common elements—those with calculated S-ranks of SX, S4, S5, S4S5, SU, or SNA—are considered to be Evaluated and are assigned to a PABS category, in most cases to State Extirpated, Least Concern, or Data Deficient.

3. Elements with calculated S-ranks of SH, S1, S2, S3, or a range rank containing S3 are further assessed through the IUCN/COSEWIC criteria A through E (Table 2-1) in order to be assigned a PABS elements of concern category.

4. For status determinations of Endangered and Threatened, assessment results and documentation of all findings are communicated to the appropriate agency (see Chapter 4).

The IUCN categories and criteria used in step 3 have been adapted to accommodate Pennsylvania's regulatory language and 46,055 square mile (119,280 km^2) area. The COSEWIC modified version of the IUCN system is used because IUCN criteria were designed to be applied at a global, not regional, scale. PABS elements of concern categories differ somewhat from those used by the IUCN: PABS's Endangered category includes both Critically Endangered and Endangered of IUCN; PABS's Threatened category is equivalent to the IUCN's Vulnerable category; and in IUCN parlance Threatened is an umbrella term that includes both Immediate Concern and Cautionary Concern of PABS.

Despite differences in terminology PABS has not changed the definitions and explanations of IUCN/COSEWIC criteria A through E (Table 2-1). PABS technical committees follow IUCN and COSEWIC's published guidelines (Appendices 2-E and 2-G) when applying the criteria to species, subspecies, varieties, and ecological communities. However, some PABS technical committees have made minor modifications to the IUCN/COSEWIC criteria in recognition of the distinctive biology of the groups of organisms within their purview. Those modifications are the subject of the next section.

TABLE 2-1: COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA (COSEWIC)'S ADAPTATION OF INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN)'S CRITERIA FOR ELEMENT STATUS DETERMINATION. These are the PABS default criteria. Meeting ***any one criterion*** qualifies an element for the corresponding PABS status category. Some criteria will be inappropriate for certain elements; however, there is at least one criterion appropriate for assessing the concern categories for any element. Because it is seldom clear in advance which criteria are appropriate for a particular element, each element is evaluated against all of the criteria and each criterion met at the highest concern category is listed in the final documentation of an element's status determination.

CODES	IUCN CRITERIA DESCRIPTIONS	COSEWIC ADAPTATION OF IUCN STATUS CATEGORIES	
		ENDANGERED	**THREATENED**
A __	**REDUCTION IN POPULATION SIZE BASED ON ANY OF THE FOLLOWING:**		

A 10	An observed, estimated, inferred, or suspected reduction in total number of mature individuals over the last 10 years or 3 generations, whichever is longer, where the causes are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
	  a. direct observation
	  b. an index of abundance appropriate for the taxon
	  c. a decline in area of occupancy, extent of occurrence, and/or quality of habitat
	  d. actual or potential levels of exploitation
	  e. the effects of introduced taxa, hybridization, pathogens, pollutants, competitors, or parasites
		reduction of ≥ 70%	reduction of ≥ 50%

A 20	An observed, estimated, inferred, or suspected reduction in total number of mature individuals over the last 10 years or 3 generations, whichever is longer, where the reduction or its causes may not have ceased OR be understood OR may not be reversible, based on (and specifying) any of a. to e. under A 10.	reduction of ≥ 50%	reduction of ≥ 30%
A 30	A reduction in total number of mature individuals projected or suspected to be met within the next 10 years or 3 generations, whichever is longer (up to a maximum of 100 years), based on and specifying any of any of b. to e. under A 10	reduction of ≥ 50%	reduction of ≥ 30%
A 40	An observed, estimated, inferred, or suspected reduction in total number of mature individuals over the last 10 years or 3 generations, whichever is longer (up to a maximum of 100 years), where the time period must include both past and future and where the reduction or its causes may not have ceased OR be understood OR may not be reversible based on (and specifying) any of a. to e. under A 10.	reduction of ≥ 50%	reduction of ≥ 30%
B __	**SMALL DISTRIBUTION RANGE AND DECLINE OR FLUCTUATION IN:**		
B 10	Extent of occurrence estimated to be: and/or:	< 5,000 km^2	< 20,000 km^2
B 20	Index of area of occupancy estimated to be: and for either B 10 or B 20 estimates indicating at least two of the following (B 30, B 40, and B 50):	< 500 km^2	< 2,000 km^2
B 30	Either severely fragmented (isolated subpopulations with a reduced probability of recolonization, if once extinct) or known to exist at _____ locations.	≤ 5 locations	≤ 10 locations

B 40	Continuing decline observed, inferred, or projected in any of the following:
	  a. extent of occurrence
	  b. area of occupancy
	  c. area, extent, and/or quality of habitat
	  d. number of locations or subpopulations
	  e. number of mature individuals
	  f. successful reproduction and recruitment
		continuing decline	continuing decline

B 50	Extreme fluctuations in any of the following:
	  a. extent of occurrence
	  b. area of occupancy
	  c. number of locations or subpopulations
	  d. number of mature individuals
		extreme fluctuations	extreme fluctuations

Table 2-1 Continued

CODES	IUCN CRITERIA DESCRIPTIONS	COSEWIC ADAPTATION OF IUCN STATUS CATEGORIES	
		ENDANGERED	THREATENED
C __	SMALL AND DECLINING NUMBER OF MATURE INDIVIDUALS		
C 10	Total number of mature individuals estimated to be: and one of either of the following (C 20 or C 30):	< 2,500	< 10,000
C 20	An estimated continuing decline in total number of mature individuals of at least ___% within ___ years and ___ generations, whichever is longer, up to a maximum of 100 years in the future:	20% within 5 years or 2 generations	10% within 10 years or 3 generations
C 30	A continuing decline observed, projected, or inferred in the number of mature individuals and at least one of the following (C 40, C 50 & C 60):	continuing decline	continuing decline
C 40	No subpopulation estimated to contain:	> 250 mature individuals	> 1,000 mature Individuals
C 50	One subpopulation has:	≥ 95% of all mature individuals	100% of all mature individuals
C 60	There are extreme fluctuations in the number of mature individuals.	extreme fluctuations	extreme fluctuations
D __	VERY SMALL OR RESTRICTED TOTAL PENNSYLVANIA POPULATION		
D 10	Total number of mature individuals very small or restricted, population estimated to have: and/or:	< 250 mature individuals	< 1,000 mature individuals
D 20	For Threatened or Near Threatened only, total number of individuals very small or restricted; Pennsylvania population with a very restricted index of area of occupancy or number of locations such that it is prone to the effects of human activities or stochastic events within a very short time period (1–2 generations) in an uncertain future, and is thus capable of becoming Endangered or Extirpated in a very short time period.	does not apply	Index of area of occupancy < 20 km^2 or ≤ 5 locations
E __	QUANTITATIVE ANALYSIS		
E 10	Quantitative analysis (population projections) showing the probability of extirpation in the wild is, for Endangered species, at least 20% within 20 years or 5 generations, whichever is longer up to a maximum of 100 years, or for Threatened species, at least 10% within 100 years.	20% within 20 years or 5 generations	10 % within 100 years

PABS TECHNICAL COMMITTEE MODIFICATIONS OF IUCN/COSEWIC CRITERIA

The following modifications of the IUCN/COSEWIC criteria (Table 2-1) are used by PABS technical committees to accommodate the distinctive biology of the groups of organisms within their spheres of responsibility.

AMPHIBIANS AND REPTILES TECHNICAL COMMITTEE (ARTC)

Codes A 10 to A 40: in the last (or next) 20 years or 4 generations

Code B 30: ≤ 6 locations for Endangered species and ≤ 11 locations for Threatened species

BRYOPHYTES AND LICHENS TECHNICAL COMMITTEE (BLTC) AND VASCULAR PLANTS TECHNICAL COMMITTEE (VPTC)

Codes B 30 and D 20: 1 to 5 sites for Endangered species and 6 to 20 sites for Threatened species

Code C 10: < 5,000 individuals for Endangered species and < 10,000 individuals for Threatened species (The VPTC and BLTC have higher thresholds of population numbers because (1) many plants are clonal and so the number of individuals is not necessarily equivalent to the number of individual animals from a genetic diversity perspective, and (2) plant reproduction involves any individual plant having far more numerous offspring than animals but far higher offspring mortality before attaining maturity.)

ORNITHOLOGICAL TECHNICAL COMMITTEE (OTC)

Codes C 10 and D 10: pairs instead of individuals

ADDITIONAL MODIFIERS THAT HAVE THE POTENTIAL TO UPGRADE OR DOWNGRADE THE STATUS OF AN ELEMENT

The number of individuals surviving in a species, subspecies, or variety, when a credible estimate is available, exists in a context broader than just the rate of decline and habitat status, the main substance of the IUCN/COSEWIC criteria (Table 2-1). Extirpation risk also depends on a particular set of threats, genetics, life history traits (breeding biology, behavior), and other aspects of an element that impacts its survival potential. Technical committees take into account these and other factors in addition to IUCN/COSEWIC criteria in the status determination process. Considering these factors is especially useful when an element is close to the threshold between two status classifications. The use of modifiers requires experienced judgment and a dose of pragmatism. The following examples of modifiers are not an exhaustive list but will give an idea of the scope and complexity of the status determination process as carried out by PABS technical committees.

EXAMPLES OF MODIFIERS RELATED TO THE RESCUE EFFECT

The rescue effect is the natural movement of individuals through a species' range that can mitigate a regional extirpation or local population decline. If the potential for rescue is high, the risk of extirpation may be reduced and the status may be downgraded. However, barriers to natural dispersal are increasing with development and fragmentation of natural landscapes. Assisted dispersal is one method of increasing the potential for rescue. So far in Pennsylvania assisted dispersal has been limited to charismatic vertebrates, e.g., bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), peregrine falcon (*Falco peregrinus*), eastern wild turkey (*Meleagris gallopavo silvestris*), fisher (*Martes pennanti*), elk (*Cervus canadensis*), and black bear (*Ursus americanus*).

Likelihood of propagule migration: Are there any conspecific populations outside the target region within a distance from which individuals or propagules are likely to reach the region? Are there any effective barriers preventing dispersal to and from nearby populations? Is the species capable of long-distance dispersal? Is it known to do so? If there

are no conspecific populations in neighboring regions or propagules are not able to disperse to the region, a higher risk status is supported.

Evidence for the existence of local adaptations: Is there any known difference in local adaptation between regional and outside populations, i.e., is it probable that individuals from outside populations will have lower survival, reproduction, and recruitment within the region than indigenous individuals? If it is unlikely that individuals from nearby populations would have high fitness within the region, a higher risk status is supported.

Availability of suitable habitat: Are current habitat and climate conditions in the region favorable to successful establishment of immigrating individuals or propagules or has the species declined or disappeared from the region because conditions were not favorable? If there is not enough suitable habitat and current conservation measures are not leading to an improvement of the habitat within the foreseeable future, immigration from outside the region will not decrease extirpation risk and a higher risk status is supported.

Status of nearby populations: How abundant is the species in neighboring regions or states? Are the populations there stable, increasing, or decreasing? Are there significant threats to those populations? Is it probable that they produce an appreciable number of emigrants and will continue to do so for the foreseeable future? If the species is more or less common outside the region, there are no signs of population decline, the species is capable of dispersing to the region, and there is (or soon will be) available habitat, a lower risk status is supported. If the species is currently decreasing in neighboring regions, the rescue effect is less likely to occur and a higher risk status is supported.

Degree of dependence on outside source populations: Are extant regional populations self-sustaining—showing a stable or positive net reproductive rate over the years—or are they dependent on immigration for long-term survival (i.e., are most or all occurrences within the region sink populations)? If there is evidence that a substantial number of individuals or propagules regularly reach the region and the population still has poor survival, the regional population may be a sink or series of sinks. If so, and there are indications that immigration is declining, a higher risk status is supported. Both sinks and sources are important to the long-term sustainability of metapopulations. Sinks are reservoirs of genetic diversity and thus contribute to a species' evolutionary potential to adapt to changing conditions. They can serve as "insurance policies" when a source population is struck by a catastrophic decline, e.g., from disease, a severe weather event, industrial pollution, or habitat destruction.

EXAMPLES OF MODIFIERS RELATED TO LIFE HISTORY VARIATION

Supplementing quantitative criteria, status assessments can be based, in part, on the degree to which life history characteristics (e.g., age and size at maturity, dispersal strategy, longevity) affect extinction or extirpation probability and the likelihood that the species is vulnerable to the Allee effect of density-dependent per capita population growth rate. All else being equal:

Indeterminate growth: For indeterminately growing organisms (species that continue to grow after attaining maturity), larger species tend to be at greater risk of extinction or extirpation than smaller species.

Dispersal: Species with low dispersal rates tend to be at greater risk of extinction or extirpation than species with high dispersal rates.

Generation overlap: Species with non-overlapping generations tend to be at greater risk of extinction or extirpation than species with overlapping generations.

Specialist: Species that depend on a restricted type of habitat or food source and cannot adjust to alterations, whether natural or human-caused, are extinction- and extirpation-prone.

Reproduction and mortality: Long-lived species with low reproductive rates and low natural mortality (e.g., bats) have a higher probability of extinction or extirpation.

Species concentrations: Species breeding in colonies or requiring large numbers of their own kind for protection, to locate food sources, or for other means of survival are vulnerable to extinction or extirpation.

EXAMPLES OF MODIFIERS RELATED TO PROTECTIONS AND THREATS

Protections and threats are two sides of the same coin. For instance, the lack of regulatory mechanisms to protect an element of Immediate Concern is a threat. What protections exist, are needed, or are potentially available to stabilize or recover state Endangered and Threatened elements? These protections might include but are not limited to: (1) a state Endangered species act including a mandate to prepare recovery plans; (2) adequate and reliable funds to implement recovery efforts; (3) the amount of critical habitat already extant and protected on public lands; and (4) the degree to which critical threats have been identified and are potentially controllable or reversible.

During the element evaluation process, a higher risk status is supported if the tools and potential to protect the element being evaluated are severely limited.

The bald eagle provides a useful example of how protection has worked. First, adequate regulatory mechanisms existed and among other dictates included the requirement for a recovery plan. Second, there were federal funds available to help states implement the plan. Third, there was adequate habitat available on public lands. Lastly, chlorinated hydrocarbons were identified as the critical threat and legislation led to the removal of this threat, setting the stage for the eagle's recovery. By contrast, the extent and nature of the protections available for state Threatened and Endangered species fall far short of those available to protect federally listed species.

Threats are accounted for in the IUCN/COSEWIC criteria (Table 2-1) but only to the extent that they are: "… clearly reversible and understood and ceased; … or may not have ceased or be understood or may not be reversible." Additional information about threats can be used to upgrade or downgrade a species being evaluated. When threat trends—e.g., rate of increase or decrease in extent and severity of a threat, the number of different threats, and

anticipated new threats—are incorporated into element status considerations, the urgency for needed protections may change. Accounting for the nature and extent of this urgency is part of the status determination process.

The IUCN and the Conservation Measures Partnership (CMP), another global organization, have classified threats to elements of biodiversity. Their classification scheme (IUCN and CMP 2011) together with considerations of threat severity, extent, and trends, comprise a threats assessment toolkit for the status determination process. The classification consists of two levels of subcategories within 11 general categories: residential and commercial development; agriculture and aquaculture; energy production and mining; transportation and service corridors; biological resource use; human intrusions and disturbance; natural system modifications (e.g., fire exclusion, dams); invasive and other problematic species, genes and diseases; pollution; geological events; climate change and severe weather.

Climate change is a threat characterized by much uncertainty about how it will affect particular species, subspecies, and varieties of organisms. Due to the likelihood of complex nonlinear and synergistic effects, its impacts on ecological communities are even less certain. NatureServe has begun to compile predictions of the vulnerability of species to climate change with its Climate Change Vulnerability Index (Young et al. 2015) and extending the method to ecological communities is in the works (Comer 2015). Climate change vulnerability analyses have been done for 85 plant and animal elements of concern in Pennsylvania to date (PNHP 2015) and additional analyses are underway. For elements predicted to be highly vulnerable to ongoing and expected future weather trends—e.g., higher maximum temperatures, wider seasonal temperature variation, longer and more frequent droughts, greater severity and frequency of storms—a higher risk status may be supported. For elements predicted to be resilient to these trends, a lower risk status may be supported.

THE PRECAUTIONARY PRINCIPLE—THE ULTIMATE MODIFIER

When uncertainty prevails, the precautionary principle comes into play. Status determinations sometimes are complicated by high levels of uncertainty. It is often hard to predict with confidence how and at what rate habitats will be changed or how wild populations will react to a synergistic combination of such changes. The precautionary principle admonishes that if there is a strong suspicion among qualified experts that threats precipitated by such changes will result in an element's decline in numbers or area of occupancy, timely protections are warranted to lower the risk of irreversible future consequences. Based on such concerns, rather than waiting for incontrovertible evidence supporting a particular status, a technical committee may assign Threatened or Endangered status to an element despite the need for more data. The status can later be downgraded if further scientific findings emerge that provide sound evidence that no harm will result.

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