ELEMENT OCCURRENCE DATA STANDARD

February 6, 2002

NatureServe

in cooperation with the

Network of Natural Heritage Programs
and Conservation Data Centers

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TYPOGRAPHIC CONVENTIONS

BOLD SMALLCAPS - key methodological terms
UPPERCASE - field names
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2 EO DEFINITION

An **Element Occurrence** (EO) is an area of land and/or water in which a species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For species[1] Elements, the EO often corresponds with the local population, but when appropriate may be a portion of a population (*e.g.*, long distance dispersers) or a group of nearby populations (*e.g.*, metapopulation). For community Elements, the EO may represent a stand or patch of a natural community, or a cluster of stands or patches of a natural community. Because they are defined on the basis of biological information, EOs may cross jurisdictional boundaries.

An Element Occurrence record[2] is a data management tool that has both spatial and tabular components including a mappable feature and its supporting database. EOs are typically represented by bounded, mapped areas of land and/or water. EO records are most commonly created for current or historically known occurrences of natural communities or native species of conservation interest. They may also be created, in some cases, for extirpated occurrences.

There are two kinds of EOs: principal **EOS** and **SUB-EOS**. EOs may also be categorized according to descriptive classes and labels.

2.1 Principal EOs

The characteristics of principal EOs are globally defined for each individual Element (see Section 4, EO Specifications). A principal EO may be a single contiguous area or may be comprised of discrete patches or subpopulations.

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[1] In this Standard, the term "species" includes all entities at the taxonomic level of species (including interspecific hybrids), as well as all subspecies and plant varieties. Subspecies and varieties are collectively termed "infraspecific taxa". Other subsets of species (*e.g.*, geographically distinct population segments not recognized as infraspecific taxa) are sometimes designated as species Elements, and recurrent, transient, mixed-species animal assemblages (*e.g.*, shorebird concentration areas) may also be considered Elements.

[2] In this Standard, the term "Element Occurrence record" is used in a general sense to refer to a set of data associated with a particular EO. In many database implementations, this information will be contained in multiple tables.

For species, a principal EO conceptually represents the full **occupied habitat** (or previously occupied habitat) that contributes, or potentially contributes, to the persistence of the species at that location. Generally, a principal EO corresponds to a population or metapopulation.[3] Principal EOs are typically separated from each other by barriers to movement or dispersal, or by specific distances defined for each Element across either unsuitable habitat, or suitable but apparently unoccupied habitat.

For community types[4], principal EOs represent a defined area that contains (or contained) a characteristic species composition and structure. Principal EOs are separated from each other by barriers to species interactions, or by specific distances defined for each Element across adjacent areas occupied by other natural or semi-natural community types, or by **cultural vegetation**.

Rarely, principal EOs of the same Element can overlap or contain another principal EO; however, in such cases, the features must have significantly different levels of associated information (see Section 7.16.2, Overlapping Principal EOs). An example of a situation in which this might occur would be when an EO based on general historical information is created, and then a second, much smaller, EO is developed from new field survey data that locates it within the boundaries of the first. Both principal EOs should be retained until additional survey work establishes that the second EO is actually the same as first and should therefore replace it.

Although a principal EO conceptually represents the full occupied habitat (for species) or area (for communities), evidence for a particular occurrence may not necessarily provide complete knowledge of its full extent. Whether the full extent of occupied habitat or area is actually known for an EO may depend on different factors, including the intensity and extent of survey, the types of survey techniques employed, characteristics of the Element (*e.g.*, plants that seed bank, animals with secretive behaviors), and the level of expertise of the person(s) collecting data. In cases where knowledge of the full extent or area of an occurrence is not known, only the portion of the occupied habitat or area that is known should be recorded from the evidence available. The EO record should indicate whether the full extent of occupied habitat or area of an occurrence is known by distinguishing between situations where there is (a) confidence that the full extent of the EO is known; (b) confidence that the full extent of the EO is *not* known; and (c) uncertainty whether the full extent of the EO is known.

In some cases, a population or community may be so extensive that it is impracticably large for information management or site-level conservation action (*e.g.*, many migratory birds, whales, some riparian plants, some matrix communities). For example, all of the individuals of a migratory bird species breeding over an area hundreds of kilometers across may function as a single population, making it impractical to treat this population as a single principal EO. In these situations, principal EOs should be defined on the basis of separation distances, or natural or cultural geographic

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[3] For animals, metapopulation structure may arise when habitat patches are separated by distances that the species is physically capable of traversing, but that exceed the distances most individuals move in their lifetime (that is, the patches support separate subpopulations). If habitats are so close together that most individuals visit many patches in their lifetime, the system will tend to behave as a single continuous population (Gutierrez and Harrison 1996, McCullough 1996). For plants, demographically significant exchange among subpopulations can occur through dispersal of seeds, spores, pollen, and other propagules. Persistent dormant propagules may result in metapopulation dynamics over time as well as space.

[4] In this Standard, the term "community type" will be used to distinguish a community Element from a community EO (*i.e.,* ecological community) when the distinction is not apparent from the term "community" alone.

features (but not jurisdictional or cadastral[5] boundaries) that subdivide the population or community (see Section 4.3, Separating EOs). In such cases, the population (or metapopulation) structure or full community extent should still be considered in protection and management planning.

2.2 Sub-EOs

Although the principal EO conceptually represents the entire occupied area, there may be smaller geographically distinct areas *within* the principal EO for which information could be useful for conservation planning, biological monitoring, or biological management at local levels. These geographically nested components are referred to as sub-EOs. Sub-EOs must be contained within a principal EO of the same Element. Note that sub-EOs should not be created simply to represent different parts of a principal EO comprised of noncontiguous patches.

Sub-EOs may be defined as

a) areas utilized by species for specific behaviors or life history functions (*e.g.*, feeding areas, dens, nest sites);

b) areas of differing composition, or higher density, quality, or conservation concern (*e.g.*, demes or subpopulations, different age stands or successional phases, old growth patches, concentrated breeding areas);

c) discrete areas (within a principal EO characterized by noncontiguous patches) for which it is desirable to maintain information for each area in separate records (*e.g.*, to facilitate recordation of monitoring data); or

d) other areas marked by non-biological divisions assigned for convenience in mapping, monitoring, or management (*e.g.*, geographic, political, and land survey map units). The creation of sub-EOs defined by these divisions should generally be avoided because they are not biologically significant.[6]

Sub-EOs could be used to facilitate information management in cases where a principal EO is particularly large, complex, or crosses jurisdictional boundaries. Such principal EOs may present challenges, including incomplete knowledge of the full extent of the EO, loss of detail about specific sub-populations or community patches, and difficulty in supporting information needs related to inventory, monitoring, management, conservation planning, and environmental review. However, sub-EOs should not replace the use of a principal EO to represent the full extent of the occurrence.

A single observation based on ephemeral circumstantial evidence (*e.g.*, tracks or scat for wide-ranging carnivores) should not be recorded as a sub-EO, but may be recorded in a manual Element file or in a separate observations database.

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[5] In this Standard, the term "cadastral" refers to ownership lines and public land survey lines (*e.g.*, townships, ranges, and sections in US public land surveys).

[6] Some geographic units, such as watersheds, may sometimes reflect biological divisions, particularly for many freshwater Elements.

2.3 Feature Labels

An EO can be assigned an *optional* descriptive **FEATURE LABEL** indicating *what that EO is* (*e.g.*, deme, nest, den, watershed). In practice, feature labels are most useful for sub-EOs. They may also be useful for those principal EOs that are based only on evidence for some component (*e.g.*, nest, den) of the full occupied area[7], but are generally not recommended for those principal EOs that may be conceptually characterized simply as "occupied habitat". One notable exception for species with unusual life histories involves the use of feature labels to distinguish significantly different kinds of principal EOs representing the full occupied habitat (*e.g.*, a clone-forming perennial plant occurring at a given site as a single gender or life history stage could be described using feature labels such as "male clone", "gametophyte", *etc.*).

The use of feature labels describing EOs is optional in a global context because the unit of conservation is the principal EO, and there is no need envisioned for multi-jurisdictional aggregation of information on sub-EOs (for which feature labels are most useful). In addition, feature labels (and sub-EOs) will be defined in more ways in different programs than can be predicted.

2.4 Location Use Classes

For migratory species that utilize geographically and seasonally disjunct (*i.e.*, not contiguous) locations, all EOs (both principal and sub-EOs) *should* be assigned a descriptive "class" name that *groups EOs by their season of occurrence*. Because a species may vary in vulnerability during different seasons (*e.g.*, due to more or less aggregation), an EO for a species at a particular season may have greater or lesser conservation value than EOs for the same species at another season. These potential differences in seasonal conservation value between disjunct locations are indicated through the use of **LOCATION USE CLASSES** (*e.g.*, "breeding", "nonbreeding", and "migratory stopover"[8]), thus helping to guide conservation planning. Assigning EOs to location use classes allows identification and conservation of EOs from each vulnerable class, which is vital to the conservation of such species.

Location use classes pertain only to Elements that occupy geographically disjunct locations at different seasons. Classes are not applicable to nonmigratory Elements, and are generally not applicable to terrestrial or freshwater migratory Elements that move between contiguous areas. See Appendix A: Migratory Status and Location Use Class for further clarification on the utilization of Location Use Classes and Feature Labels.

2.5 Persistence and Practical Conservation Value

A primary purpose for delineating EOs is to guide conservation (*e.g.*, site protection, environmental review, inventory, recovery efforts, research) for the Elements represented by those

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[7] Use of a feature label for a principal occurrence representing a component of the full occupied habitat for the Element indicates that further field survey work is needed.

[8] "Breeding" and "nonbreeding" classes are applied to occurrences that represent seasonally resident populations. The "migratory stopover" class, even though also nonbreeding, is applied to occurrences that represent populations during a nonresident, migrating phase. Note that there may not be a one-to-one correspondence between location use classes and breeding and nonbreeding Element ranks for a particular species (*e.g.*, the classes "migratory stopover" and "bachelor colony" both apply to the nonbreeding Element rank).

occurrences. It is therefore critical that EOs have **PRACTICAL CONSERVATION VALUE** for the Elements they represent. Persistence at a specific location typically establishes the conservation value of that location.

Generally, in order to qualify as an EO, the potential continued presence and/or regular recurrence of an Element at a given location is necessary. In other words, an Element must potentially persist at a location in order to be designated an EO. Evidence of likely ephemeral presence of an Element at a location, lacking persistence, should not result in the designation of an EO. For most Elements (especially perennial plant species, stable communities, and nonmigratory animal species), persistence is presumed to be established by evidence of presence. More specifically, for community Elements, stability is judged as persistence under natural processes for a time period specific to that Element.

For some plant species (*e.g.*, those with long-term seed dormancy or other dormant stages), very dynamic communities, and migratory animal species, persistence is often defined by real or apparent recurrence. This recurrence may be due to return migrations, periodic disturbance, or fluctuating environmental conditions. For aerial migrants during their migration, the designation of an EO requires temporary (*e.g.*, a week or more) presence in a given season, significant aggregation, and likely recurrence in different years. (See Appendix B: Persistence and Practical Conservation Value.)

Historical occurrences (despite their possible lack of persistence) and extirpated populations may also be designated as EOs (see Sections 2.10, Historical EOs and 2.11, Extirpation). Information on the location of these EOs may be useful for directing future field surveys, conducting range and trends analyses, and environmental review. Extirpated EOs, when suitable habitat remains extant, may be appropriate sites for reintroduction.

2.6 Captivity/Cultivation

Species in captivity or cultivation (*e.g.*, zoos, botanical gardens, tree farms) are not EOs. These populations are not dependent on natural habitat and may be readily moved.

2.7 Anthropogenic Habitat

Species populations that are regularly or periodically found in specific anthropogenic habitats may be EOs, particularly if the species arrived at the site without being transported there by humans and the habitat continues to provide appropriate conditions without specialized intensive management. Examples of such EOs include pelicans inhabiting reservoirs; peregrine falcons nesting on skyscrapers; plants along roadcuts; ferns growing on old masonry; bats roosting under bridges, in abandoned structures, and in mines; and plants growing in farm ponds or cemeteries. The captive, cultivated, or intensely managed species of such cultural settings as farms, tree plantations, horticultural landscaping, or ornamental ponds seldom qualify as EOs.

2.8 Reintroduction/Restoration

For species, areas occupied by populations that have been re-established within their native range are EOs. EOs may also represent habitat occupied by an Element that has been reintroduced, but that is not yet known to be established. See Section 5.2.3, Origin Status Subranks for a discussion of labeling such occurrences; see also Section 5.4.2, EO Rank Sequence for a discussion of the relative conservation importance of reintroduced/restored EOs.

Communities that have been restored *de novo* by intensive planting or seeding (*e.g.*, restoration of a cornfield to a prairie) are generally not considered EOs, since it is thought that such communities, including their invertebrate fauna and microbial organisms, cannot readily be recreated. However, in some cases (*e.g.*, for very rare community types) it may be desirable to track restorations as EOs.

2.9 Introduction/Exotics

An area where a species is not native (*i.e.*, where it has been introduced, through direct or indirect human intervention, outside its historical range) is not an EO unless it is critical to the survival of that species. For example, sea lamprey is an exotic species in the upper Great Lakes; its presence there is a result of indirect human intervention, specifically the construction of the Welland Canal. However, a population newly established *through natural dispersal* to an appropriate natural, semi-natural, or anthropogenic habitat may be an EO, even if outside its historical range.

2.10 Historical EOs

EOs may be recorded for locations known to be previously occupied by a species or community, even if current field survey information is lacking. This is particularly useful for documenting locations where the Element might be expected to occur or re-occur at some future time, information that may be important in planning field research and in conducting environmental review. Historical EOs, in some cases, may also be useful for demonstrating the former distribution or pattern of decline of an Element. The timeline for categorizing an EO as historical is Element and location specific (*i.e.*, the time will vary by Element and location). See Section 5.2.1, Basic EO Ranks for guidance on designating an EO as historical.

2.11 Extirpation

EOs may represent locally extirpated Elements for the purpose of ranking, surveying, environmental review, and/or restoring the Element across its native range. This may include Elements for which the habitat is either extant or destroyed.

2.12 Recordation and Representation

Information related to EOs may be recorded in tabular form and displayed through the use of mapped representations. See Section 7, EO Spatial Representation for guidance on developing EO representations.

3 EO NESTING

3.1 Principal EOs and Sub-EOs
3.2 Characteristics of Sub-EOs

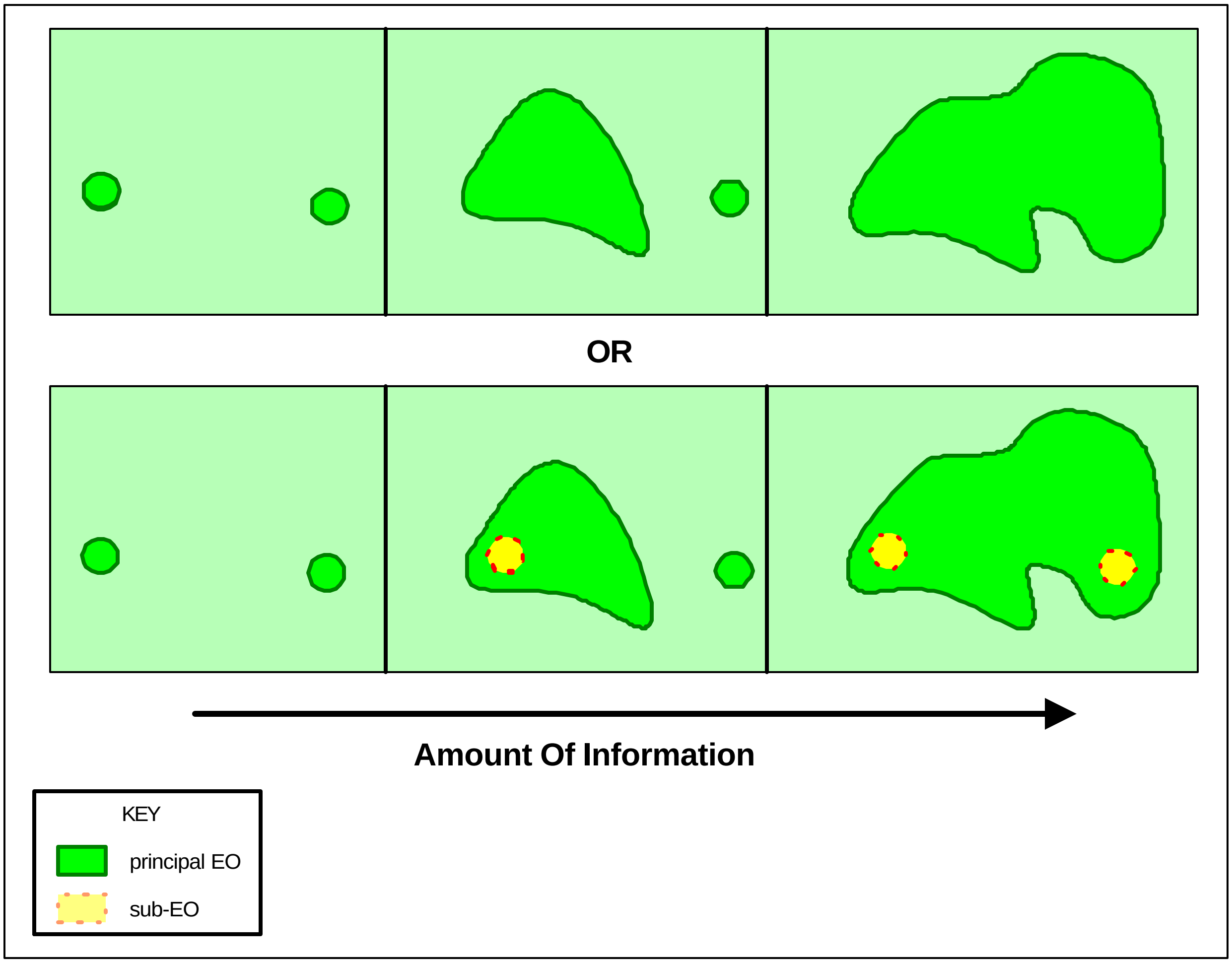
3.1 Principal EOs and Sub-EOs

All principal EOs should be tracked in an Element Occurrence file, regardless of whether they have sub-EOs nested within them. Assessing the number of principal occurrences of an Element is useful as one of several factors in Element ranking; another such factor is a measure of the estimated viability of each extant EO (*i.e.*, EO ranks). For certain Elements, it may be desirable to track sub-EOs as well. Sub-EOs may provide additional information on the Element at that location that would be useful for site-specific conservation planning, biological monitoring, or biological management purposes. EOs and sub-EOs can be identified using feature labels that describe what the EO is. (See Sections 2.1 through 2.4 for more specific information about EO definitions and descriptive feature labels and classes).

The distinction between principal and sub-EOs may be understood by considering how the amount of information can affect the delineation of EOs. Because knowledge about an EO may increase over time, what was once delineated as a principal EO may become a sub-EO (and optionally tracked) as more information about occupied area is obtained.

An example using *Haliaeetus leucocephalus* (bald eagle) is illustrated in Figure 3.1, with principal EOs represented by solid lines and sub-EOs represented by dashed lines. The first column shows two principal EOs delineated on the basis of limited knowledge about occupied area (*i.e.*, nests occupied by two pairs and minimally separated by a distance defined for the Element). The middle column shows a larger boundary delineating the known extent of a principal EO based on additional information about the occupied area (*i.e.*, breeding territory) for one of the two initial occurrences; the original information concerning the nest within the breeding territory may be optionally retained as a sub-EO. In the last column, additional information has been obtained on the breeding territory surrounding the other nest, and because the two territories are within the separation distance defined for the Element, they are merged into one large principal EO representing the area known to be occupied (by two adjacent pairs in this example). Again, nests may be optionally tracked as sub-EOs within the single principal EO. Breeding territory sub-EOs may also be optionally tracked, although this may not be particularly useful.

Figure 3.1 - Distinguishing Principal and Sub-EOs Based on the Amount of Information on the Occupied Area



Knowledge about community EOs may also increase over time. In relatively intact landscapes (*i.e.*, where no substantial barriers occur between stands), information might initially be managed for smaller areas within what could be an extremely large principal EO. The full extent of a principal EO may be difficult to determine without extensive field surveys that are often beyond the scope of a project. For example, a selective survey of unlogged old-growth portions of a northern hardwoods type in the Adirondacks may identify stands that occur within a very extensive area that is primarily second growth. In the short term these old-growth stands may be treated as principal EOs; over time, however, the full extent of the community may be identified as the principal EO, and the old-growth stands may become sub-EOs.

For information management purposes, records for principal EOs and sub-EOs have a parent-child relationship. A record for a principal EO may be linked to one or more records for sub-EOs. However, a record for a sub-EO cannot stand alone; it must be linked to its parent EO record.

3.2 Characteristics of Sub-EOs

Nested relationships typically occur for an Element when, in addition to the principal EOs, sub-EOs are delineated for conservation planning, biological monitoring, and/or biological management purposes. For such an Element, EOs that are located within larger EOs having a different feature label are represented as nested sub-EOs.

Examples:

- *Ursus arctos*, grizzly bear
  a den sub-EO located within an occupied-habitat EO
- *Marshallia grandiflora*, large-flowered Barbara's-buttons
  an individually monitored deme or subpopulation sub-EO located on a gravel bar within a metapopulation EO extending 40 kilometers along a river
- *Pinus ponderosa / Arctostaphylos uva-ursi* Woodland,
  ponderosa pine/bearberry woodland
  an old growth area sub-EO located within a larger second growth woodland EO of lower quality; note that while old growth and second growth woodlands are the same community type, they have different feature labels

For some Elements there may be multiple levels of EO nesting. In such cases, all sub-EOs, regardless of the level of nesting, are linked to the principal EO at the top of the nested set as the parent; a sub-EO is never a child of another sub-EO. Although multiple levels of nesting are possible for occurrences of some Elements, tracking more than two levels is not encouraged.

Examples:

- *Haliaeetus leucocephalus*, bald eagle
  a nest sub-EO located within a breeding territory sub-EO, which is located within a seasonal occupied-habitat EO for multiple pairs of eagles
- *Quercus alba - Quercus rubra - Carya ovata* Forest,
  white oak - red oak - shagbark hickory forest
  a high-quality old growth sub-EO located within an old growth sub-EO, which is located within early successional stage growth of the same community type

Nesting cannot occur between EOs having the same feature label for a given population of an Element.

Example:

- *Rangifer tarandus*, caribou
  a calving area cannot be located within another calving area of the same population of *R. tarandus*

3.2.1 Nesting Sub-EOs for Migratory Elements Having No Location Use Classes

Migratory Elements that utilize a single occupied habitat throughout the year have no location use classes (see Section 2.4, Location Use Classes). However, these EOs can contain nested sub-EOs.

Examples:

- *Acipenser fulvescens,* lake sturgeon
  a spawning area sub-EO located within an occupied-habitat EO (no location use class)
- *Rangifer tarandus,* caribou
  a wintering area sub-EO located within an occupied-habitat EO (no location use class)

3.2.2 Nesting Sub-EOs for Migratory Elements Having Location Use Classes

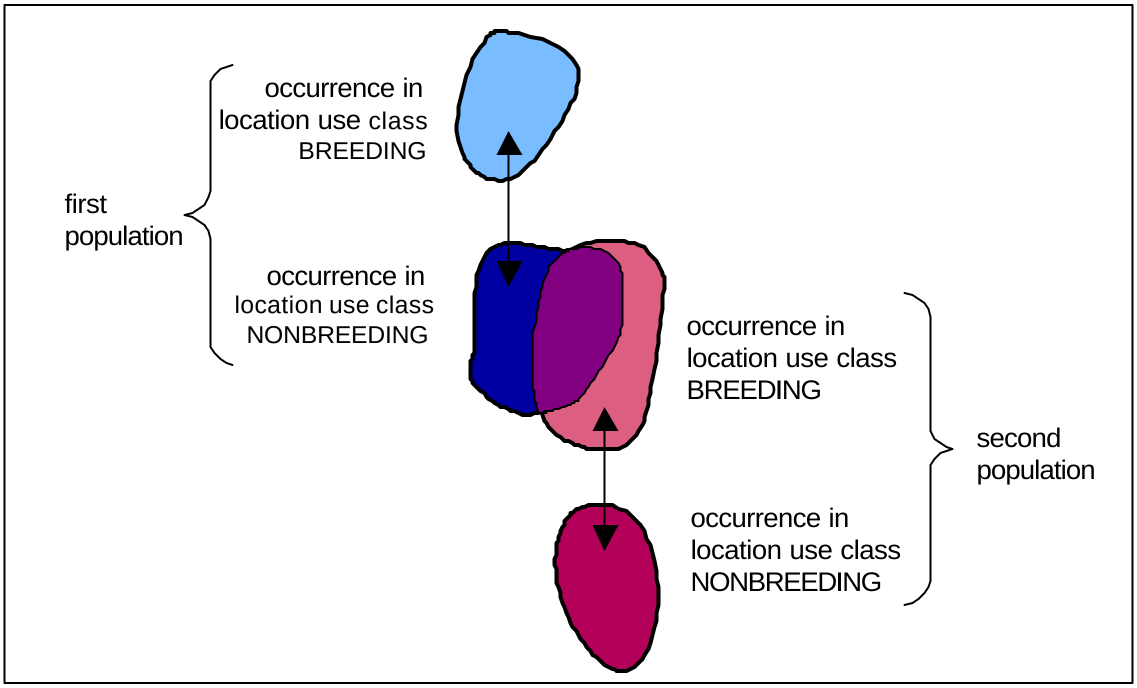
Migratory Elements that utilize multiple disjunct occupied habitats at different seasons have two or more location use classes. For these Elements, nesting can only occur within EOs of the same class.

Examples:

- *Calidris canutus,* red knot
  for location use class MIGRATORY STOPOVER: a roosting area sub-EO located within an occupied-habitat EO
- *Oncorhynchus tshawytscha,* Chinook salmon
  for location use class BREEDING: a spawning area sub-EO located within an occupied-habitat EO

Although EOs in different classes are typically geographically disjunct, it is possible for some species to have EOs in different classes that do overlap, although in different seasons (see Figure 3.2). This almost always involves different individuals. For a particular Element, occurrences that belong to different classes should not be nested because they represent different populations in different seasonal contexts.

Figure 3.2 - Example for a Particular Element Showing Overlapping Occurrences Belonging to Different Populations and Location Use Classes



3.2.3 Nesting Non-Biologically Defined Sub-EOs

In some cases, it may be useful to create nested relationships by the convenient division of an EO on the basis of extrinsic factors. Creating records for non-biologically defined sub-EOs makes it possible to track information that is unique to those sub-EOs. However, the creation of sub-EOs defined in this manner should generally be avoided because they are not biologically significant.

Extrinsic factors that occur naturally at a particular location (*e.g.*, geographic features, topographic features, landform features) may influence the division of an EO into sub-EOs, although this should be done with caution and the rationale for doing so documented in the record for each of the resulting sub-EOs.

Examples:

- *Haliaeetus leucocephalus*, bald eagle
  a watershed sub-EO that is a division of an occupied-habitat EO
- *Cardamine clematitis,* mountain bittercress
  watershed sub-EOs separated for convenience of monitoring
- *Schizachyrium scoparium – Bouteloua (curtipendula, gracilis) / Carex filifolia* Herbaceous Vegetation, northern great plains little bluestem prairie
  separate sub-EOs created for patches that occur on different landform features within an EO: a sub-EO for patches that occur within forested areas of ridges, and another sub-EO for patches of the same community type that occur on adjacent plains (since these two sub-EOs differ somewhat in composition and function, there is benefit in maintaining separate records)

Alternatively, extrinsic factors imposed by humans (*e.g.*, political and/or jurisdictional boundaries) may also determine the division of EOs into sub-EOs.

Examples:

- *Canis lupus*, gray wolf
  a sub-EO delineated by subnational boundaries that is a portion of a
  multi-jurisdictional occupied-habitat EO
- *Pinus ponderosa/Schizachyrium scoparium* Woodland,
  ponderosa pine/little bluestem woodland
  two sub-EOs created for different parts of an EO: one for that portion occurring within a Research Natural Area, and another for the portion occurring within an adjacent wilderness area, each of which has very different management objectives
- *Canis lupus*, gray wolf
  two sub-EOs (one being an area designated as a recovery zone, and the other an area designated as a non-essential experimental population) that are located within an occupied-habitat EO

4 EO SPECIFICATIONS

4.1 Purpose of EO Specifications

Element Occurrence information represents one of the principal tools of heritage inventory, and serves as the basis for conservation planning. Building a quality EO database depends on clear and consistent EO specifications. Occurrences identified according to the specifications for a given Element are mapped, recorded in an Element Occurrence file, and assigned conservation ranks (*i.e.*, EO ranks) that reflect estimated viability. EOs and their ranks can be used to determine priorities for conservation site selection. Having consistently applied EO specifications across the range of an Element is especially beneficial for multi-jurisdictional and rangewide planning.

EO specifications are used to delineate and differentiate EOs. In other words, EO specifications define precisely what evidence constitutes a valid EO (*i.e.*, the minimum size, quality, or persistence required), and what distances or factors separate one principal EO from another. This will affect the number of EOs tracked. Low thresholds for minimum size or quality in the EO specifications (*i.e.*, lax criteria) may result in a proliferation of EOs having little practical conservation value, and high development and maintenance costs for biologists and data managers. Conversely, high thresholds (*i.e.*, stringent criteria) may result in a failure to designate EOs for significant occurrences of an Element.

Although the number of principal EOs is often used as one of many factors in determining Element conservation priorities (*i.e.*, Element ranks), this number should be used judiciously. For some Elements, the number of EOs may be, in part, a result of fragmentation of historically more extensive occurrences. Whether a given Element in such a fragmented landscape is represented as a single large principal EO having multiple sub-EOs or multiple small principal EOs is of little importance in ranking the Element; both means of recordation should reflect the reduced viability of the Element at that location. In such situations, consistent delineation of the EOs is important, and should be based on separation distances that are useful for delineating viable units that are practical for conservation action.

EO specifications should be based on the best available information on the biological and ecological factors that determine the estimated viability of an Element. In some cases, especially for invertebrates and other cryptic species, the best available information will consist of indirect and/or circumstantial evidence (*e.g.*, for many nocturnal moths, evidence of presence coupled with habitat patch size and quality).

For communities, EO specifications information may be organized according to the spatial patterns and ecological dynamics typical of groups of Elements. These groups can be described as matrix, large patch, small patch, and linear (see Appendix C: Spatial Patterns of Different Community Types). Ecological factors and ranking considerations may be similar for Elements within a group that share the same spatial patterns and dynamics; thus, EO specifications for Elements within a particular group may also be similar.

EO specifications should be developed for principal EOs in a *global* context. Conservation planning is often conducted rangewide or across an ecoregion, and the information available from multiple jurisdictions for this planning should be consistent, requiring that global specifications be applied in the delineation of principal EOs throughout the range of an Element. Because sub-EOs are generally defined locally and not aggregated across jurisdictions, global specifications for sub-EOs are typically not needed. Individual jurisdictions may develop local specifications for sub-EOs as they find useful and appropriate. However, in cases where sub-EOs for an Element are widely tracked, it may be useful to develop global specifications for sub-EOs; these should be incorporated with the text for the principal EO specifications.

4.2 Minimum Criteria for EOs

For species, EO specifications should outline the minimum criteria for defining precisely what constitutes an occurrence of that Element. The minimum essential criteria for determining an EO should be derived from the known biology, ecology, phenology, and/or reproductive behaviors of the Element, as appropriate. Accordingly, the minimum EO criteria for many species typically requires a single persisting, recurring, or potentially persisting or recurring individual. For some species, the specifications might include a minimum required size (population and/or area) and essential characteristics of the environment that sustain or contribute to that Element's survival and/or recurrence (*e.g.*, for migratory species). (See Sections 2.5 through 2.11 for further discussion about what constitutes an EO.)

For communities, minimum criteria for EOs are implicit in the classification of the Element. A brief description of the Element (*e.g.*, composition, structure) that includes information on characteristics that distinguish it from similar communities should be provided in a global Element summary field. Any area that is large enough to be classified as a particular community Element has, in essence, met the minimum criteria for an occurrence of that community type. Practically, however, minimum sizes may be helpful and should be provided in the EO specifications. Recommended minimum sizes for the different community pattern types are: 2 hectares for matrix; 0.4 hectare for large patch; 0.05 hectare for small patch; and 30 meters in length for linear. Stands/areas below the recommended minimum size become difficult to judge in terms of community type characteristics, and, if isolated, become heavily influenced by edge effects. For conservation purposes, generally only larger sized occurrences of each community type are tracked and the threshold for minimum size is seldom approached.

4.3 Separating EOs

Principal EOs are typically separated from other principal EOs, either by barriers or breaks, or by specified distances across intervening areas. For species, separation distances will be measured across unsuitable habitat or suitable but apparently unoccupied habitat. For communities, separation distances will be measured across intervening areas of different natural or semi-natural communities, or cultural vegetation.

4.3.1 Barriers

In addition to minimum criteria for identifying an EO, known barriers for Elements, either naturally occurring or manmade, should also be described in the EO specifications.

For species, barriers are those that almost completely prevent movement or dispersal of the Element, thereby obstructing or severely limiting gene flow. These barriers are usually abrupt, and may be relatively narrow. Typical instances of barriers for a given species should be specified in the EO specifications for that Element (*e.g.*, four-lane divided highways may limit bog turtle movement; dams exceeding 3½ meters [approximately 20 feet] in height may restrict movement of salmon; large rivers may limit small mammal movement; deserts may curtail movement of montane insects; tidal inlets greater than a certain width may be a barrier for beach plants).

For community EOs, barriers may be obstacles that limit the expansion or alter the function of communities. In effect, these barriers separate populations of most of the component species within the community, thus obstructing or severely limiting gene flow. Barriers may be common for many aquatic and wetland communities, but are typically less common for many upland terrestrial communities.

4.3.2 Separation Distances

In addition to barriers that totally, or almost completely, prevent movement and/or dispersal, distances of intervening area that restrict movement may also separate EOs. These distances are used to delineate the population units between which gene flow is significantly reduced. For comparison, IUCN (1996) characterizes reduced gene flow between units as "typically one successful migrant individual or gamete per year or less".[9] For most species, data from gene flow studies does not exist; thus, decisions on separation distances should be made on the basis of best information available. Also, consideration of gene flow is not applicable to Elements that disperse widely (*e.g.,* birds, wind-dispersed plants or insects), Elements having very long generation times (*e.g.,* giant tortoises, plants characterized by long-term seed banking or dormancy, persisting clones), or Elements that are dependent on rare but recurrent phenomena for dispersal (*e.g.,* floods, major storms).

The intent of assigning values for separation distances is to achieve consistency in the manner in which EOs are defined and mapped. The degree of restriction to movement and/or to dispersal of the Element resulting from the intervening area determines the distance(s) required to separate one EO from another. Thus, areas that are highly restrictive to the Element's movement or dispersal require smaller distances for separating EOs than areas less prohibitive to movement or dispersal.

Several factors may be used to set separation distance(s) for EOs (see Section 4.3.2.5, Factors Determining Separation Distances). The factors used to determine separation distances for EOs should be cited as justification in the EO specifications.

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[9] This IUCN guideline is used to define *subpopulations.* Because IUCN defines the *population* "as the total number of individuals of the taxon", the IUCN concept of subpopulation most closely approximates the EO concept in this Standard.

4.3.2.1 Species: Separation by Unsuitable and Suitable Habitats

When applicable, two separation distances should be specified for species Elements: one across unsuitable habitat, and another across apparently suitable habitat that is not known to be occupied (regardless of whether surveyed).[10] The use of these distances in defining EOs is designed to reflect hypothesized differences in gene flow across suitable *vs.* unsuitable habitats. However, for some species Elements, there will likely be no significant differences in gene flow across the different habitats. In these cases, only one separation distance need be specified. To promote consistency in the application of separation distances, they should be measured along the shortest route of expected travel of the Element between the edges of the known or minimally estimated occupied habitat, although this may not be a straight line (see Section 7, EO Spatial Representation).

For all species Elements, the distance of unsuitable habitat needed to separate EOs is always less than or equal to the distance of apparently suitable but unoccupied habitat needed to separate EOs. Because the unsuitable habitat cannot support the Element, a specified distance of this habitat can be more prohibitive to dispersal and residence by the Element than the same distance of apparently suitable habitat. Thus, separation by unsuitable habitat is presumed to be more definitive. Further survey work is unlikely to result in the discovery that the separation was inaccurate. It is also unlikely that unsuitable habitat will become occupied over time, and therefore, the separation between two EOs will presumably remain.

4.3.2.2 Communities: Separation by Different Community Types

For community Elements, habitat suitability or unsuitability is not applicable. Instead, community EOs may be separated by expanses of different natural or semi-natural community types, or cultural vegetation. Intervening natural and semi-natural areas will likely inhibit the expansion or function of community EOs to a lesser degree than intervening cultural vegetation. In a like manner, intervening natural and semi-natural areas with similar kinds of habitat characteristics will inhibit expansion or function of a community less than those with very different kinds of characteristics. For example, bogs separated by intervening areas of upland jack pine on bedrock are more definitively identified as distinct EOs than bogs separated by areas of black spruce swamp.

4.3.2.3 Separation Across Mixed Areas

Frequently, the area located between populations or patches may consist of a mixture of apparently suitable and unsuitable habitat, or a mixture of other natural or semi-natural community types and/or cultural vegetation. When applying EO specifications, if no mixed habitat guidance is provided, the separation distances to be applied should be conceptually based on the relative amounts of apparently suitable and unsuitable habitat.[11]

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[10] If the suitability of a particular habitat is unknown, then treat it as if it were suitable.

[11] Conceptually, if $(s \div S) + (u \div U) \geq 1$, then there is more than one EO, where S = recommended minimum distance of apparently suitable habitat, U = recommended minimum distance of unsuitable habitat, s = actual distance of apparently suitable habitat, and u = actual distance of unsuitable habitat.

4.3.2.4 Recommended Minimum Separation Distances

Minimum values for separation distances have been recommended to ensure that EOs are not separated by unreasonably small distances, which would lead to the identification of unnecessarily fragmented populations as potential targets for conservation planning or action. For species Elements, minimum separation distances are generally 1 km[12] or greater for both unsuitable habitat, and for apparently suitable habitat that is not known to be occupied. For communities, the minimum separation distance delineated for intervening areas of different natural or semi-natural communities is 1 km or greater, and a distance of at least 0.5 km for interjacent areas of cultural vegetation. Table 4.1 summarizes the recommended minimum separation distances for species and community EOs.

Table 4.1 - Recommended Minimum Separation Distances

Type of Separation	Species EOs	Community EOs
barrier	qualitatively defined	qualitatively defined
unsuitable habitat	≥ 1 km	N/A
apparently suitable habitat not known to be occupied	≥ 1 km	N/A
cultural vegetation	N/A	≥ 0.5 km
different natural or semi-natural communities	N/A	≥ 1 km

Although some Elements may occur as truly separate populations at scales of separation less than 1 km, the practical value (for conservation planning and action) of delineating finer-scale EOs is often questionable. Nevertheless, a few Elements may require separation distances that are less than the established minimum; in such cases, these distances should be justified in the EO specifications.

4.3.2.5 Factors Determining Separation Distances

Several factors that may be considered when determining separation distances to be written in the EO specifications for a given Element:

a) Dispersal Distance

For species Elements, dispersal distance is the distance that individuals or propagules (*e.g.*, pollen, seeds, spores, larvae) travel from an existing location to a new location. Success of dispersal

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[12] The new recommended minimum of 1 km is more than twice the old distance of ¼ mile suggested in the Natural Heritage Program Model Operations Manual (The Nature Conservancy 1988). The recommended minimum separation distances are derived from a poll of representative programs throughout the Heritage Network, and have been tested through a pilot implementation in the Eastern Region.

depends on whether suitable habitat for establishment is reached within that distance. Typical dispersal distance for an Element is rarely known and may be extremely variable. However, since dispersal allows genetic connectivity between otherwise apparently distinct populations, separation distances between EOs should be greater than the distance of routine dispersal events.

For many Elements, a small percentage of individuals or propagules may disperse great distances. While potentially significant for establishing new populations and for reducing genetic differentiation of populations, these rare, long-distance dispersal events should not be factored into separation distances. For migratory species, dispersal distance is not a useful concept for determining separation between populations since these Elements may typically disperse over enormous distances. Considering dispersal distances in determining separation distances for such Elements may lead to impracticably large EOs.

b) Home Range

In the absence of information about dispersal distance for animals, home range size may be a useful surrogate for that knowledge based on a presumed relationship between the two. For some animals, home range is the average area occupied, utilized, and/or defended by an individual, either during its lifetime or for a given breeding season. The true extent of home range is often not well known, and may vary from year to year, and between different habitats. Generally, separation distances should be at least three times the average home range for the Element (*i.e.*, based on the length of the largest axis). In cases where the area of a home range is not known but information is available on movement (excluding dispersal and migration), use three times the distance of that movement. This distance would ensure that EOs that are, in fact, distinct remain separate despite fluctuating home range boundaries through defining adequate space between them to allow for such fluctuations.

c) Spatial Patterns of Occurrence

The relative degree of spatial patchiness of an EO is an important factor when determining separation distances for EO specifications. Spatial patterns can be measured by the size of the EO, separation between EOs, and/or the surrounding context of the EO (*e.g.*, the degree of unsuitability of the surrounding landscape).

For matrix communities, it may be difficult to develop separation distance guidelines due to their extensive and complex spatial patterns. Large readily recognizable stands that qualify as distinct EOs according to the separation distance guidelines may, nonetheless, be connected by smaller less apparent stands located within the prescribed separation distance. When such cases are found in natural or semi-natural landscapes, the smaller and larger stands may be grouped into one principal EO, with sub-EOs used to define the individual stands. However, in more altered landscapes, the intervening small stands are less likely to create a meaningful connection between the large stands; thus, large stands would be maintained as separate principal EOs.

d) Temporal Patterns of Occurrence

Changes in spatial patterns over time, including many successional phenomena, may also be considered when writing EO specifications. In general, separation distance guidelines will depend on the rate of change.

If spatial changes occur relatively frequently (*e.g.*, within a practical time frame of 25 years), then separation distance guidelines should be adjusted to incorporate the relatively dynamic temporal/spatial nature of an occurrence. In other words, because a principal EO with dynamic characteristics represents all potential varying locations of that population or community over a given time period, it encompasses an area larger than what is actually occupied at the time of survey. Thus, greater separation distances should be specified to ensure that a shifting population or patch is not recorded as multiple separate occurrences over time.

On the other hand, if spatial changes occur relatively infrequently (*e.g.*, the population or community remains at a particular location for longer than 25 years), then for all practical purposes, separation distance guidelines should reflect the relatively stable nature of the occurrence. In other words, temporal factors should be considered largely irrelevant, and separation distance guidelines should be based on current factors only.

Temporal patterns of occurrence may be an important consideration for many species (*e.g.*, birds that are dependent on grassland communities; plants characterized by seed banking that may only be apparent for discontinuous periods of time). Temporal patterns of occurrence may also be an important consideration for very dynamic communities (*e.g.*, meadow and marsh communities that move up and down streams in relation to beaver dams). In each of these cases, occurrences may not appear to persist locally if considered at one time only, but do persist in the larger landscape over a longer time frame.

e) Comparability with Similar Functional Groups

Similarity in components of species biology or community processes (*e.g.*, a - d above) between Elements may be an important consideration in developing EO specifications. This functional similarity is often found in groups that are related through taxonomy, shared ecological factors, or some combination of the two (*e.g.*, “alliance” for communities, “genus” for species, ecological groups within an alliance). However, groups may be functionally related without having any taxonomic relation (*e.g.*, conifer and mixed matrix communities occurring in the same pattern in a boreal ecoregion, riffle-dwelling mussel species occurring in similar patterns of abundance). Functionally similar Elements should have comparable separation distances; it would normally not make sense to specify separation distances for functionally similar Elements that differ by an order of magnitude.

These factors to be considered in determining separation distances may be dependent on other components (*e.g.*, landscape may affect dispersal distance, population density may influence home range size, and sex may determine average movement distance). Although multiple factors may influence the decision on separation distances specified, the most significant factor(s) should be provided as justification in the EO specifications.

4.3.3 Feature Labels and Location Use Classes

To help ensure consistency in describing EOs, specific labels used for an Element should be described in the EO specifications, as appropriate.

4.3.3.1 Feature Labels

The use of feature labels for describing EOs is optional (see Section 2.3, Feature Labels). A feature label will not affect the status of an EO as either a principal EO or sub-EO. Since not all programs will track feature labels for a given Element, meaningful analyses of aggregated sub-EO data are not possible. If widely used, feature labels for particular Elements may be provided in the EO specifications to foster consistency in labeling EOs among different programs.

4.3.3.2 Location Use Class

Location use classes should always (and only) be specified in the EO specifications for migratory Elements with multiple occupied-habitat EOs (including aerial, anadromous, and marine Elements), since for conservation planning purposes, migratory Elements with disjunct areal requirements may have different conservation priorities during different seasons (see Section 2.4, Location Use Classes). Protection of these distinct habitats is essential for the survival of the Element.

For migratory Elements having seasonally disjunct occupied habitats, there will be at least two location use classes, typically a “breeding” class and a “nonbreeding” class. Many species will also have a “migratory stopover” class. In cases where these migratory Elements have some nonmigratory populations, there may be a need for an additional “nonmigratory” class. (See Appendix A: Migratory Status and Location Use Class.)

4.4 Inferred Extent for Some Animal Species

[Although this section is included here, it is not part of the Draft EO Data Standard developed through a formal design and acceptance process by the EO Working Group. It is based on information obtained during an EO workshop convened in September, 1999, to collect requirements for a Heritage Data Management System (HDMS) currently under development. Approximately half of the participants at this workshop were members of the EO Working Group. Subsequent information on this topic has been provided by zoologists Larry Master and Geoff Hammerson.]

Most EOs are located in an area of suitable habitat that exceeds the spatial requirements for the Element. However, principal EOs are developed on the basis of what was actually observed in the field, without inclusion of any unsurveyed but available suitable habitat at that location (see Section 7.17.2 for the single exception to this model). While EOs accurately reflect what is known from underlying survey information, an EO with a confidence extent = “N” (or perhaps “?”) may not effectively illustrate the likely extent of the Element at that location. (See Section 2.1 for further discussion on confidence extent.) In such cases, after the principal EO has been mapped, a separate inferred extent (IE) feature could be created for some animals to better illustrate the potentially/probably occupied habitat, and could be utilized in analyses for which estimates of occupied area would be useful (*e.g.*, conservation planning, environmental review).

An IE feature is developed by adding a specific IE distance to the underlying spatial data for the Element at that location. For animals that are known to utilize a home range, an IE distance should be provided in the EO specifications for the Element. The IE distance is an approximate spatial requirement for a particular species, typically based on the average home range (specifically, a distance equal to the diameter of the median home range). However, for some animals (*e.g.*, pond-breeding amphibians, rattlesnakes moving from a den) the IE distance represents the distance from an initial location (in any direction) that would encompass the ultimate destination of 75-90% of the dispersing adult individuals. See Section 7.17.1 Inferred Extent for a more detailed description of the use of IE distance.

4.5 Characteristics of Good EO Specifications

To ensure accuracy, practicality, reliability, and consistency in defining EOs (within the constraints of the information available), EO specifications should

a) have global application, addressing the Element throughout its range;

b) be specific, not ambiguous; avoid the use of adjectives and/or phrases that could be interpreted differently, such as “recent”, “large”, “somewhat”;

c) provide minimum criteria for determining a species EO, or provide recommended minimum size for a community EO;

d) provide examples of typical barriers, if they exist;

e) provide separation distances for species that differentiate one EO from another across: (1) unsuitable habitat, and (2) apparently suitable habitat that is not known to be occupied;

f) provide separation distances for community types that differentiate one EO from another across: (1) different natural or semi-natural communities, and (2) intervening areas of cultural vegetation;

g) provide justification for separation distances specified above, including citation if available (unless the recommended minimum separation distances [described in Section 4.3.2.4 above] are used);

h) address all potential location use classes;

i) optionally, state any widely used feature labels that might facilitate communication;

j) provide an inferred extent distance for animals that utilize a home range;

k) be peer reviewed (along with EO rank specifications); all data centers within the range of the Element will be invited to review the EO specifications. Comments should be received from a minimum of two reviewers, including at least one from the appropriate Central/Regional Zoology, Botany, or Ecology program staff. In addition, review by other experts (either within or outside of the Heritage Network) familiar with the Element or the taxonomic group to which it belongs is encouraged;

l) include the author(s); and

m) include the date that the EO specifications were most recently substantially revised (such that previous versions are obsolete and occurrences should be re-evaluated using the revised specifications).

The above characteristics may be used as a checklist when developing or reviewing EO specifications.

4.6 Developing EO Specifications

Poorly conceived EO specifications are likely to be interpreted differently by different individuals and/or at different times, and result in inconsistently identified EOs. This can misdirect conservation activities. Ensuring that specifications are developed in accordance with the characteristics listed above can be accomplished, in part, by following standard guidelines. Separation distances and barriers should be identified in the EO specifications, as should location use classes and feature labels, where appropriate.

When developing EO specifications, an Element should be considered throughout its range. Characteristics of Elements may vary significantly in different parts of the range (*e.g.*, for species using different habitat in different ecoregions). In such cases, specific minimum criteria and separation distances could be provided in the EO specifications for the different portions of, or habitats in, the range; however, this should be done with great caution.

In the absence of global EO specifications for a particular Element, jurisdictions are encouraged to develop them in coordination with Central Zoology, Botany, or Ecology (rather than diverting resources into the development of multiple interim local guidelines). In situations where developing global EO specifications is not feasible, interim local guidelines can be developed.

Central Zoology, Botany, and Ecology will maintain separate draft EO specifications while new editions of specifications are being developed and reviewed; this will ensure that they are not confused with the current operational specifications until the review process is completed and any revisions incorporated.

Sources of information for developing EO specifications should include the scientific literature, scientific experts in and outside of the Heritage Network, those conservation data centers that track the Element, and personal field experience with the Element. Any information that would contribute to the detail and completeness of the EO specifications for a particular Element should be forwarded to Central Heritage Operations. Any questions or comments on specifications should be directed to Central Zoology, Botany, or Ecology.

Since inventory and research continually yield new biological and ecological information, the development of EO specifications is an iterative process that incorporates new data. However, due to the collective cost to data centers in implementing revisions, specifications should only be revised when there is substantial new information that would correct any existing specifications as they relate to EO viability or other conservation considerations. Central Zoology and Botany may make minor editorial changes to EO specifications to ensure stylistic consistency. It is recommended that data centers make copies of new EO specifications as they are created or received for archiving in manual files; as subsequent editions of specifications are developed for an Element, archived copies can provide information on the previous criteria utilized in identifying occurrences of that Element.

To prevent duplication of effort when developing EO specifications, it may be practical to develop a set of criteria that would be broadly applicable to an entire functional group of Elements, identified as a “specifications group”. Because Elements within a particular specifications group have similar components of species biology or community processes, EO specifications for the Elements within that group would differ only minimally, if at all. The EO specifications developed for the group could later be modified as appropriate for a particular Element in the specifications group, at which point the Element would be removed from the group; the initial set of group EO specifications would continue to be applied to the Elements remaining in the specifications group, however. Central Zoology, Botany, and Ecology should maintain documentation on EO specifications developed for specifications groups.

In cases when information on a particular Element is scant or incomplete (due to lack of thorough research or secretive behaviors of the Element), it may be useful to identify another Element that is presumed or hypothesized to be functionally similar and base the EO specifications for the lesser-known Element on those of the better-known Element. Alternatively, if a specifications group comprised of functionally similar Elements can be identified, then the lesser-known Element could be added to the group and the EO specifications developed for the group utilized.

4.7 Templates for Writing EO Specifications

Using a template when drafting EO specifications may help ensure that they are well written and include all information necessary to accurately and consistently define an EO. Figures 4.1 through 4.3 show templates that should be used when writing EO specifications. These models represent three general categories of Elements: species Elements with one type of occupied-habitat EO; migratory species Elements with multiple, disjunct types of occupied-habitat EOs (*i.e.*, Elements having location use classes); and community Elements. For examples of EO specifications developed using the templates, see Appendix D. For complete definitions of data fields in the templates, see Appendix F [to be completed during Phase 2 of the EO Design Project]. Separation distances should be determined on the basis of one or more of the factors described in Section 4.3.2, Separation Distances.

Figure 4.1 - EO Specifications Template for Species Elements Having No Location Use Classes

SPECS GROUP (name of specifications group, if applicable)

MINIMUM EO CRITERIA (minimum criteria for valid EO)

EO Separation

SEPARATION BARRIERS (example[s] of typical barriers that would separate EOs)

SEPARATION DISTANCE – UNSUITABLE HABITAT (in kilometers)

SEPARATION DISTANCE – SUITABLE HABITAT (in kilometers)

ALTERNATE SEPARATION PROCEDURE
(procedure for separating EOs if one or both separation distances cannot be specified)

SEPARATION JUSTIFICATION
(basis for separation distances, including citation if available)

Feature

FEATURE LABELS (widely used feature labels)

Inferred Extent

IE DISTANCE (distance to be used as buffer for creating IE features, in kilometers)

IE NOTES (notes relating to the specified IE distance)

Edition

SPECS AUTHOR (significant contributors to specifications)

SPECS EDITION DATE (YYYY-MM-DD)

SPECS NOTES (internal notes relating to development of specifications)

Note: Inferred extent attributes are utilized for some animal Elements only.

Figure 4.2 - EO Specifications Template for Migratory Species Elements Having Location Use Classes

SPECS GROUP (name of specifications group, if applicable)

LOCATION USE CLASSES (list of classes for Element [for example, BREEDING, NONBREEDING])

attributes below repeat for each location use class for the Element

LOCATION USE CLASS (specific class from list of classes for Element)

MINIMUM EO CRITERIA (minimum criteria for valid EO of specified class)

EO Separation

SEPARATION BARRIERS (example[s] of typical barriers that would separate EOs of specified class)

SEPARATION DISTANCE – UNSUITABLE HABITAT (in kilometers)

SEPARATION DISTANCE – SUITABLE HABITAT (in kilometers)

ALTERNATE SEPARATION PROCEDURE
(procedure for separating EOs of specified class if one or both separation distances cannot be specified)

SEPARATION JUSTIFICATION
(basis for separation distances for specified class, including citation if available)

Feature

FEATURE LABELS (widely used feature labels for specified class)

Inferred Extent

IE DISTANCE (distance to be used as buffer for creating IE features for specified class, in km)

IE NOTES (notes relating to the specified IE distance)

Edition

SPECS AUTHOR (significant contributors to specifications for specified class)

SPECS EDITION DATE (YYYY-MM-DD)

SPECS NOTES (internal notes relating to development of specifications)

Figure 4.3 - EO Specifications Template for Community Elements

SPECS GROUP (name of specifications group, if applicable)

MINIMUM SIZE (minimum size for valid EO)

EO Separation

SEPARATION BARRIER (example[s] of typical barriers that would separate EOs)

SEPARATION DISTANCE – CULTURAL VEGETATION (in kilometers)

SEPARATION DISTANCE – DIFF NAT/SEMI-NAT COMM (in kilometers)

ALTERNATE SEPARATION PROCEDURE
(procedure for separating EOs if one or both separation distances cannot be specified)

SEPARATION JUSTIFICATION
(basis for separation distances, including citation if available)

Feature

FEATURE LABELS (widely used feature labels)

Edition

SPECS AUTHOR (significant contributors to specifications)

SPECS EDITION DATE (YYYY-MM-DD)

SPECS NOTES (internal notes relating to development of specifications)

5 EO RANKS AND EO RANK SPECIFICATIONS

5.1 Purpose of EO Ranks and EO Rank Specifications

EO ranks provide a succinct assessment of **ESTIMATED VIABILITY**, or **PROBABILITY OF PERSISTENCE** (based on condition, size, and landscape context) of occurrences of a given Element. In other words, EO ranks provide an assessment of the likelihood that if current conditions prevail an occurrence will persist for a defined period of time, typically 20-100 years (see Section 5.5, Establishing the EO Rank Scale). EO ranks are considered in assigning global, national, and subnational[13] Element ranks (GRANKs, NRANKs, and SRANKs), and are a critical tool for conservation planning. EO ranks may be used effectively in conjunction with Element conservation status ranks to guide which EOs should be recorded and mapped (see Section 6, EO Tracking), and to help prioritize EOs for purposes of conservation planning or action, both locally and rangewide.[14]

EO rank specifications should establish criteria for a ranking scale, should be based on knowledge of historical evidence and current status, and should include threshold values for the best conceivable occurrences and those having only fair viability. Like EO specifications, EO rank specifications should be developed in a global context. This means that the best occurrence in a particular jurisdiction or geographic area (*e.g.*, ecoregion) may not be highly ranked or even viable. Information about local prioritization of EOs can be recorded in optional fields or existing comment fields in the Element National or Subnational Ranking file.

5.2 EO Ranks

An EO rank represents the relative value of an EO with respect to others for that Element, defined according to criteria derived from specific EO rank factors (see Section 5.3, EO Rank

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[13] In this document, the term "subnation" will refer to the first order subdivision of a nation (*e.g.*, state, province, district, department).

[14] Although Element and EO ranks help to set conservation priorities, they are not the sole determining factors. The determination of priority occurrences for conservation action will include not only the conservation status of the Element and the likelihood of persistence of the occurrence, but will also include consideration of other factors such as the taxonomic distinctness of the Element; the genetic distinctness of the EO; the co-occurrence of the Element with other Elements of conservation concern at a site; the likelihood that conservation action will be successful; and economic, political, and logistical considerations.

Factors). EO ranks are assigned on the basis of data obtained from recent field surveys (except for historical, or in some cases extirpated, occurrences) by knowledgeable individuals. (See definition of “recent” under the description of “H” rank below.) The ranks should be set in accordance with specifications for “A”, “B”, “C”, and “D” ranks, or other guidelines (see Section 5.2.1, Basic EO Ranks) if these criteria cannot be applied.

Generally, EO ranks apply to principal EOs only. However, in situations where there is a need to distinguish between sub-EOs of varying size or quality (*e.g.*, to prioritize sub-EOs at a particular site), ranking of sub-EOs may be useful. Note that if sub-EOs are ranked, the principal EO should still be ranked and treated as the fundamental unit for conservation planning. In cases where sub-EOs are ranked, the rank of a sub-EO should not be higher (but may be lower) than that of the parent principal EO.

Often the global specifications developed for principal EOs could appropriately be used to rank sub-EOs as well. This is generally true in cases where quality is the primary factor differentiating principal and sub-EOs (*e.g.*, where sub-EO patches of an old-growth forest community are located within a lower quality matrix of the same forest type). This is also generally true in cases where scale is the primary factor differentiating principal and sub-EOs (*e.g.*, *Lycaeides melissa samuelis* [Karner blue butterfly] metapopulation EOs and deme sub-EOs). However, when differences between principal and sub-EOs are due to factors other than quality or scale (*e.g.*, distinct behaviors or life history functions), separate sub-EO rank specifications could be developed (*e.g.*, *Acipenser brevirostrum* [shortnose sturgeon] occupied-habitat EOs and spawning area sub-EOs). In cases where specifications for sub-EOs would be useful, such specifications can be developed locally.

5.2.1 Basic EO Ranks

Basic EO ranks used in prioritizing EOs for conservation planning purposes are shown in Table 5.1.

Table 5.1 - Basic EO Ranks

EO Rank	Description
A	excellent estimated viability
B	good estimated viability
C	fair estimated viability
D	poor estimated viability
E	verified extant (viability not assessed)
H	historical
F	failed to find
X	extirpated

The basic “A” through “D” ranks are based on currently known factors (described in Section 5.3, EO Rank Factors) that are used to estimate the viability of an EO. The more viable an EO is, the higher its EO rank and the higher its conservation value.

Whenever possible, EOs should be assigned ranks according to criteria specified for "A", "B", "C", and "D"-ranked occurrences. This includes EOs for native Elements that have been reintroduced, as well as exotic Elements (those with Element rank = "SE" or "NE", or those that are locally exotic) that are critical to the survival of the species. When evidence of presence is lacking, or when field information is not sufficient to assign an "A", "B", "C", or "D" rank, the other basic ranks, "E", "H", "F", or "X" may be used.

The "E" = EXTANT EO rank should be used for an EO that has been recently verified as still existing, but sufficient information on the factors used to estimate viability of the EO has not yet been obtained. Use of the "E" rank should be reserved for those situations where the occurrence is thought to be extant, but an "A", "B", "C", "D", or range rank cannot be assigned.

The "H" = HISTORICAL EO rank should be used when there is a lack of recent field information verifying the continued existence of an EO, such as

a) when an EO is based only on historical collections data; or

b) when an EO was ranked "A", "B", "C", "D", or "E" at one time and is later, without field survey work, considered to be possibly extirpated due to general habitat loss or degradation of the environment in the area.

This definition of the "H" rank is dependent on an interpretation of what constitutes "recent" field information. In general, if there is no known survey of an animal EO within the last 20 years, it should be assigned an "H" rank. Similarly, if there is no known survey of a plant or community EO within the last 20 to 40 years, it should be assigned an "H" rank. While these time frames represent suggested maximum limits, the actual time period for historical EOs may vary according to the biology of the Element and the specific landscape context of each occurrence (including anthropogenic alteration of the environment). Thus, an "H" rank may be assigned to an EO before the maximum time frames have lapsed. Occurrences that have not been surveyed for periods exceeding these time frames should not be ranked "A", "B", "C", or "D".

The higher maximum limit for plants and communities (*i.e.*, ranging from 20 to 40 years) is based upon the assumption that occurrences of these Elements generally have the potential to persist at a given location for longer periods of time. This greater potential is a reflection of plant biology and community dynamics. However, landscape factors must also be considered. Thus, areas with more anthropogenic impacts on the environment (*e.g.*, development) will be at the lower end of the range, and less-impacted areas will be at the higher end.

The "F" = FAILED TO FIND EO rank[15] should be assigned to an EO that has not been found despite a search by an experienced observer at a time and under conditions appropriate for the Element at a location where it was previously reported, but that still might be confirmed to exist at that location with additional field survey efforts. For EOs with vague locational information, the

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[15] The "F" rank replaces the "O" = obscure rank (an earlier standard documented in the Natural Heritage Program Model Operations Manual [The Nature Conservancy 1988]) in order to avoid any ambiguity with the word "obscure" relating in part to the location of the occurrence. According to the 1988 standard, locational obscurity is more properly indicated through use of the PRECISION field.

search must include areas of appropriate habitat within the range of locational uncertainty. An “F” rank, when applicable, supersedes an “A”, “B”, “C”, “D”, “E”, or “H” rank.

The “X” = EXTIRPATED EO rank should be assigned to an EO for which there is documented destruction of its habitat or environment, or persuasive evidence of its eradication based on adequate survey (*i.e.*, thorough or repeated survey efforts by one or more experienced observers at times and under conditions appropriate for the Element at that location).

5.2.2 Range Ranks and the “?” Qualifier

Range ranks and the “?” qualifier may be used to indicate uncertainty about particular basic ranks. Range ranks and the “?” qualifier should be used only with “A”, “B”, “C”, and “D” ranks; “E”, “H”, “F”, and “X” should not be combined with one another, with the “?” qualifier, or with “A”, “B”, “C”, or “D” ranks.

Range ranks may be assigned when there is insufficient or uncertain information such that an EO has a relatively equal probability of being either, or any, of the ranks included in the range specified. Range ranks should not be used in cases where relatively complete information on an occurrence indicates intermediacy between two ranks; in such cases, one of the two ranks should be selected. Range ranks are used provisionally, and should be replaced with an “A”, “B”, “C”, or “D” rank when knowledge permits. A four-point (“A” through “D”) scale should be sufficient for categorizing viability of EOs; a scale having finer distinctions cannot be justified given the variability of nature, incomplete knowledge, and limitations inherent in any ranking methodology.

Both one- and two-point spreads are acceptable ranges for EO ranks. The “AC” range rank may be used to indicate that an EO is simply deemed to have at least a fair probability of being viable when further information indicating the degree of viability (*i.e.*, “A”, “B”, or “C” differentiation) is lacking. EO range ranks with spreads greater than two points should not be used (*i.e.*, an “AD” rank is the same as, and should be recorded as, an “E” rank). Valid range ranks are summarized in Table 5.2.

Table 5.2 - Range Ranks

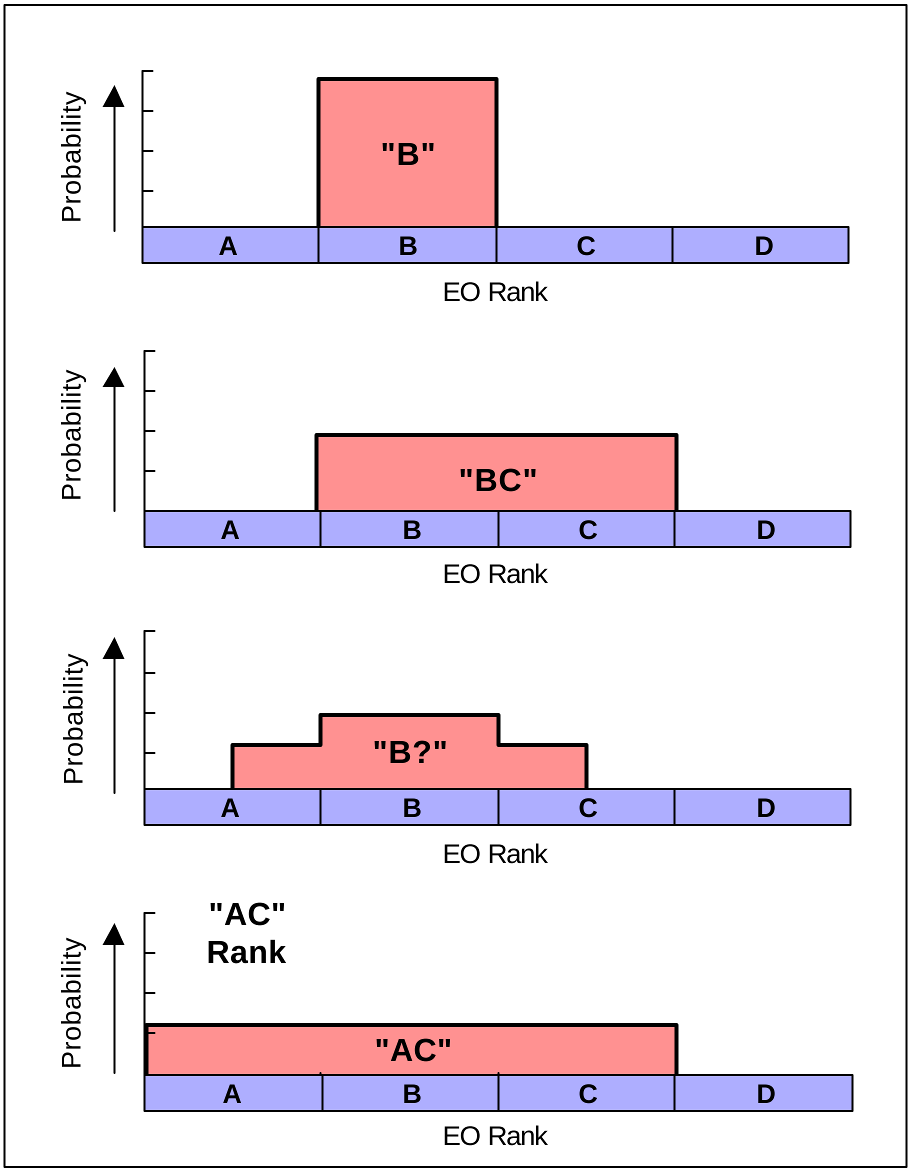
Spread	Range Rank	Estimated Viability
1 - point	AB	excellent or good (A or B)
	BC	good or fair (B or C)
	CD	fair or poor (C or D)
2 - point	AC	excellent to fair (A, B, or C)
	BD	not excellent (B, C, or D)

In many situations (*e.g.*, due to insufficient field information), the uncertainty about an EO rank may be distributed around an “A”, “B”, “C”, or “D” rank. In these cases, a “?” qualifier may be used in conjunction with one of these basic ranks to indicate uncertainty about that rank.

Figure 5.1 provides an example that conceptually illustrates the different probabilities with which assigned basic ranks, “?”-qualified ranks, and range ranks actually represent the true “A”, “B”, "C", or "D" rank of an EO. Note that in reality, there will likely be some margin of error associated with such probabilities since there cannot be absolute certainty that the true rank of an EO is accurately represented by the assigned rank. Thus, while the illustration represents probabilities with precise, clear-cut edges for the sake of simplicity, in actuality the edges of the probability distributions taper off indicating some degree of uncertainty.

Note also that Figure 5.1 illustrates the probability for various EO ranks when the distribution of "A" through "D" ranks is uniform. In reality, this may not be the case, depending on the Element-specific criteria that determine the thresholds between "A", "B", "C", and "D" ranks. As a result, probability distributions for EO ranks may actually be bell-shaped or skewed.

Figure 5.1 - Example Comparing an EO Basic Rank with Range Ranks and an A-D "?"-Qualified Rank



5.2.3 Origin Status Subranks

The majority of EOs represent naturally occurring native species populations or communities. However, Elements may be found at locations where they are not native and/or not naturally occurring[16] (see Section 2.8, Reintroduction/ Restoration and Section 2.9, Introduction/Exotics). In such cases, it may be desirable to track these occurrences if the Element is very rare, or if the occurrence is critical to the survival of the species.

Knowledge of the origin status of an EO may be useful in prioritizing occurrences for conservation purposes, since natural occurrences have inherently higher conservation value relative to both non-native occurrences and those which are not natural in origin. If an EO is not native or not natural in origin, its origin status can be indicated through the use of an origin status subrank (shown in Table 5.3) following the assigned basic EO rank or range rank (see Section 5.2.1, Basic EO Ranks, and Section 5.2.2, Range Ranks and the "?" Qualifier).

Table 5.3 – Origin Status Subranks

Origin Status Subrank	Description
r	reintroduced / restored
i	introduced

The "r" = REINTRODUCED/RESTORED subrank indicates, for species, that all or a majority of the individuals in an EO have been anthropogenically translocated to that location, which must be within a presently or historically occupied portion of the native range of the Element. A reintroduction could include a transplant from elsewhere; it could also include a transplant of some or all of the individuals in an EO to a location within the separation distance surrounding the original occurrence. In such situations, the "r" subrank should be used for the occurrence when greater than 50% of the population has been reintroduced. Removing individuals and returning them and/or their progeny to the original location does not constitute a restoration.

The "r" subrank for a reintroduced EO is retained over time unless there is evidence of significant gene flow from naturally dispersing individuals into that occurrence. Similarly, a new EO thought to be established directly or indirectly through dispersal of individuals from a reintroduced occurrence should also be treated as a reintroduced occurrence unless there is evidence of significant gene flow from other individuals dispersing from natural populations into that EO.

The "r" subrank may be used for rare community EOs that have been re-established in areas where they are believed to have previously existed (*i.e., de novo* restorations).[17] Thus, while EOs

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[16] Categorization of an occurrence as "natural" at a particular location is independent of whether the habitat at that location is natural or anthropogenic. For example, bats in a mine can be a natural occurrence (*i.e.,* not introduced or reintroduced), even though the mine is an anthropogenic habitat.

[17] The "r" origin status subrank should not be applied to degraded community EOs in which only selected components (*i.e.,* species, structures, or processes) have been reintroduced.

that are assigned an “r” origin status subrank are native, they are not natural in origin, having been established by anthropogenic means.

The “i” = INTRODUCED subrank may be used to indicate that occurrences of Elements have been introduced to areas outside of presently or historically occupied portions of their native range. EOs that are assigned an origin status subrank of “i” are neither native nor natural in origin.

In some situations there may be some degree of uncertainty about whether an EO is, in fact, introduced or reintroduced/restored. In these cases, a “?” may be used as a qualifier to the “r” or “i” origin status subrank to indicate uncertainty about the origin of the EO.

5.2.4 Valid EO Ranks

Table 5.4 defines the various legitimate combinations of characters that can be used as EO ranks.

Table 5.4 – Determining Valid EO Ranks

Initial Rank	A-D Qualifier (optional)	Origin Status Subrank	Origin Status Qualifier (optional)
A B C D	?	r i	?
E AB AC BC BD CD H F X			

To construct an EO rank appropriate for a particular occurrence, characters should be combined according to the following formula:

EO Rank = Initial Rank + “?” Qualifier (for “A”-”D” ranks only; optional) + Origin Status Subrank (if appropriate) + Origin Status Qualifier (optional)

5.3 EO Rank Factors

Because EO ranks are used to represent the relative conservation value of an EO as it currently exists, EO ranks are based solely on factors that reflect the present status, or quality, of that EO. There are three EO rank factors, each reflecting what is currently known (in an ideal situation) about an EO: size, condition, and landscape context. These factors are used as the basis for estimating the viability of an EO, *i.e.*, its EO rank. Thus:

$$\text{Size} + \text{Condition} + \text{Landscape Context} \Rightarrow \text{Estimated Viability} \approx \text{EO Rank}$$

For community Elements, the term “viability” is used loosely, since communities are comprised of many separate species, each with their own viability. Thus, the viability of a community is considered to be the sum of the viability or persistence of the component species and their ecological processes. More directly, EO ranks reflect the degree of negative anthropogenic impact to a community (*i.e.*, the degree to which people have directly or indirectly adversely impacted community composition, structure, and/or function, including alteration of natural disturbance processes). Occurrences with relatively less impacts would generally be ranked “A”, “B”, or “C” (at least “fair” viability), and those with significant degradation would be ranked “D” (“poor” viability).

It is not necessary to have knowledge of each of the three rank factors to develop EO rank specifications (especially for species). For some Elements, information on one factor may be sufficient to rank an occurrence (*e.g.*, a large population size may require, and thus imply, adequate condition and landscape context). For other Elements, information may be scant or incomplete. In such cases, EO ranks will be based on only one or a combination of the rank factors.[18] The three EO rank factors are summarized in Table 5.5 below.

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[18] For the majority of nocturnal insects, for example, little data will be obtainable on population size. In such situations, samples indicating the size of the apparently occupied habitat, coupled with information on habitat condition and landscape context, become more important than population size in defining and assessing EO rank.

Table 5.5 - EO Rank Factors and Components

FACTOR	COMPONENT	species	comm.
Size	area of occupancy	√	√
	population abundance	√	
	population density	√	
	population fluctuation (average population and minimum population in worst foreseeable year)	√	
Condition	reproduction and health (evidence of regular, successful reproduction; age distribution for long-lived species; persistence of clones; vigor, evidence of disease affecting reproduction/survival)	√	
	development/maturity (stability, old-growth)		√
	species composition and biological structure (richness, evenness of species distribution, presence of exotics)	√	√
	ecological processes (degree of disturbance by logging, grazing; changes in hydrology or natural fire regime)	√	√
	abiotic physical/chemical factors (stability of substrate, physical structure, water quality) [excluding processes]	√	√
Landscape Context	landscape structure and extent (pattern, connectivity, *e.g.*, measure of fragmentation/ patchiness, measure of genetic connectivity)	√	√
	condition of the surrounding landscape (*i.e.*, development/maturity, species composition and biological structure, ecological processes, abiotic physical/chemical factors)	√	√

5.3.1 Size

Size is a quantitative measure of the area and/or abundance of an occurrence. Components of this factor are:

a) area of occupancy;

b) population abundance, (*i.e.*, total count or qualitative estimate) (for species);

c) population density (for species);

d) population fluctuation (for species).

For communities, size is equal to the area of the occurrence. For species, the (population) size of an EO can be determined in several ways. Most commonly, information on both population abundance and the area of occupancy is used to calculate population size; however when appropriate (*e.g.*, for territorial and colonial species), population abundance alone can be used as the EO (population) size. If population density is to be used in determining the population size of a species occurrence (*e.g.*, when sampling a population in order to estimate its size), density must be used in combination with the area of occupancy. In addition, information on population fluctuations can be considered when calculating EO population size, particularly for species known to typically have high fluctuations in population.

When using abundance as a measure of the size of an occurrence, the units to be counted for the Element (*e.g.*, juveniles, adults, eggs, seeds) should be identified. In addition, whether genetic individuals can and/or should be counted (particularly for clone-forming organisms) is important to consider. In such cases, a more practical and repeatable unit, such as spatially separated clumps or flowering stems (*e.g.*, ramets) should be specified if more appropriate.

Many species (*e.g.*, insects) have populations that fluctuate through one or more orders of magnitude over a 20-year period due to unsuitable weather conditions, drought, flood, fire, and/or biotic factors. For these Elements, populations occasionally crash to a level below 5% of their average size. EO rank specifications for such Elements must be developed with consideration of exceptionally bad years (*e.g.*, “A” and “B” rank specifications might be based on an average population size that is large enough to withstand a 95% crash without becoming more extinction-prone due to demographic stochasticity [see Section 5.5, Establishing the EO Rank Scale]).

Populations of some species may appear to fluctuate despite a relatively constant number of dormant individuals (*e.g.*, in a seed bank); the aboveground visibility of individuals varies with respect to environmental conditions. For these Elements, information on widely fluctuating aboveground abundance should be considered when developing EO rank specifications. In addition, size should not be the sole factor used for ranking occurrences of these Elements; large numbers of individuals may not indicate a high EO rank if conditions for that event very rarely occur or result from anthropogenic disturbance.

EO size varies as a function of both natural and anthropogenic factors. Larger EOs are generally presumed to be more valuable for conservation purposes, all other rank factors being equal. Larger occurrences are typically less influenced by edge effects, and less susceptible to degradation or extirpation by stochastic events.

5.3.2 Condition

Condition is an integrated measure of the quality of biotic and abiotic factors, structures, and processes *within* the occurrence, and the degree to which they affect the continued existence of the EO. Components of this factor are:

a) reproduction and health (for species);

b) development/maturity (for communities);

c) ecological processes;

d) species composition and biological structure[19];

e) abiotic physical/chemical factors.

5.3.3 Landscape Context

Landscape context is an integrated measure of the quality of biotic and abiotic factors, structures, and processes *surrounding* the occurrence, and the degree to which they affect the continued existence of the EO. Components of this factor are:

a) landscape structure and extent, including genetic connectivity;

b) condition of the surrounding landscape (see components of "condition" listed above [Section 5.3.2], excluding reproduction).

In terms of EO rank, genetic connectivity refers to the degree of connectivity between different EOs. Although EOs for non-migratory species are delineated in part by the degree of genetic connectivity between adjacent populations (see Section 4.3, Separating EOs), there is usually some small amount of gene flow between adjacent EOs. If, due to an EO's isolation, there is virtually no genetic connectivity between a particular EO and any other EOs, the EO rank might be lowered. For example, the EO rank for spotted owl is influenced by the degree of isolation of a population from other populations.

5.3.4 Considerations Related to Predictions of the Future

EO ranks should be based only on *current* measures of size, condition, and landscape context. Because EO ranks are intended to reflect estimated viability, however, they must be based on components of these factors that are reliable predictors of the future. Accordingly, EO rank specifications should stipulate criteria for *current* measures only, and should consider components of those factors that provide the most reliable predictions of the future.

Factors should not be considered in developing rank specifications if they do not provide reliable predictions of the future. These include trend, expected future stresses, and considerations related to defensibility, manageability, and restorability.

5.3.4.1 Current Stresses and Trends

In general, current stresses and trends for a particular occurrence will be reflected in the current size, condition, and landscape context for that occurrence. Because the influence of trend on an

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[19] Although terrestrial communities are usually classified and assessed by analyzing their vegetation composition and structure, the zoological component of a community should be considered in determining EO rank specifications. For example, an "A"-ranked community should be large enough to sustain habitat-specific animal species that are characteristic of that community (*e.g.*, prairie chickens for prairie communities; edge-sensitive, forest interior birds for eastern forested communities). Note, however, that wide-ranging animal species (*e.g.*, bison) may be dependent on landscape or multi-community factors (*i.e.*, above the scale of the individual EO), and the rank specifications need not consider the ability of the community to support such species. Note also that the principle of "best EOs that are reasonably and conceivably achievable" may preclude setting "A"-rank specifications at levels to support all historically component species. For a particular community EO, evidence that the fauna currently present no longer represent the full suite of species to be expected (*e.g.*, due to past aerial spraying of pesticides, due to destruction of the upper soil horizons and litter layer) may be cause to significantly lower the condition rating of that community.

occurrence is already inherent in measures of the three primary EO rank factors, trend *per se* for a given occurrence should not be used in ranking an EO. Trends are notoriously changeable and may not provide a reliable basis for predicting the future. For instance, an occurrence of a community maintained by frequent low-intensity fire may not have burned recently, and, therefore, shows some signs of lack of fire. If the lower apparent condition is superficial (for instance, it could be easily reversed by one prescribed fire), then the occurrence should not be downranked based on a presumption of continued fire exclusion, since it cannot be assumed that a short-term fire exclusion will continue. However, if the fire exclusion has continued for such a length of time that the change in condition is not readily reversible, then the occurrence (or at least its condition) would be ranked lower.

On the other hand, if the same trend in population size or area has been observed consistently under particular circumstances, then those circumstances may serve as a reliable basis for predicting the future. In other words, EO rank specifications should detail current conditions whose impact on population size or area can reliably be projected into the future, such that the population or area will almost assuredly decline or increase (*e.g.*, a mussel population that has not reproduced in many years; a turtle population that will predictably decline from current population levels given a specified amount of habitat degradation within the area occupied). In these cases, the EO rank, following guidance that should be provided in the EO rank specifications, may be adjusted upward or downward to reflect the likely inevitable impact of those current conditions on future population size or area.

5.3.4.2 Defensibility, Manageability, Restorability, and Future Stresses

Other factors that have historically been considered as potential EO rank factors are future stresses, defensibility, manageability, and restorability. These factors relate to demonstrably uncertain predictions of the impacts of future actions, and do not represent the relative conservation value of an EO as it presently exists, based on known current and recent factors. As such, information related to these factors should not be considered in EO ranking, but may be handled in Element Occurrence record comments fields, and should be incorporated in Site selection and Site conservation planning.

For example, an occurrence of a fire-maintained community (or a tracked component species) should not be down-ranked because of a presumption that development occurring in the vicinity will preclude prescribed fire twenty years from now. This potential change should, however, be an important consideration in Site selection and Site conservation planning. In contrast, if surrounding development is already resulting in fire suppression at the Site, this will be incorporated in EO ranks via both condition and landscape context factors. Another example is a dam, proposed or under construction, that would destroy a mussel population upstream. The mussel EO should not be down-ranked as there is always a possibility that the dam will not be built or completed.

5.3.5 Naturalness

Naturalness is considered indirectly as a part of condition and landscape context in developing EO rank specifications. The degree of naturalness of an EO is inherent in several components of the rank factor “condition” (specifically species composition and structure, ecological processes, and abiotic physical factors), and so should not be considered as an independent EO rank factor. However, when ranking individual occurrences, those located in anthropogenic habitats lacking long-term stability (*i.e.*, the habitat requires regular maintenance or management practice to maintain its suitability for the Element) should be down-ranked by one rank, unless indicated otherwise in the rank specifications. For example, an occurrence of *Sida hermaphrodita* (Virginia mallow) along a highway may be dependent on an established mowing routine; thus, the condition of such an EO should be considered lower quality than that of a population in natural or semi-natural habitat to reflect this instability.

5.4 EO Rank Values

Different EO ranks reflect varying degrees of conservation value related to the viability of an occurrence. For purposes of sorting, selecting, and reporting on occurrences, EO ranks may be expressed in their original form, as rounded ranks, and/or as numerical rank sequence values.

5.4.1 EO Rounded Ranks

EO basic ranks and range ranks are assigned rounded ranks at a coarse scale, primarily to support easier interpretation of EO ranks for a wide audience, including land managers, policy makers, and the general public. In determining rounded ranks, first any “?” qualifiers and the “r” subrank, if present, are removed. One-point spreads (*i.e.*, “AB”, “BC”, and “CD” ranks) are rounded upward (*e.g.*, “AB” range rank = “A” rounded rank)[20], while two-point spreads are rounded to the median value (*e.g.*, “AC” range rank = “B” rounded rank). For “H”, “F”, and “X” ranks, the “i” subrank, if present, is removed; for other ranks, the “i” subrank is not removed. All invalid ranks are given the rounded rank of “*”.

5.4.2 EO Rank Sequence

EO ranks can be arranged in a hierarchical sequence to permit assessment of an EO’s relative conservation importance. The sequence ranges from “A”-ranked EOs having highest conservation value (*i.e.*, “excellent” viability) to “X”-ranked (extirpated) EOs of low concern, thereby enabling conservation efforts to target the most valuable EOs for protection or other conservation actions (*e.g.*, monitoring) through sorting and selection of EOs by their assigned rank.

The EO rank sequence includes both basic EO ranks and range ranks (see Section 5.2, EO Ranks). These ranks are assigned a numeric value to facilitate the precise identification and prioritization of EOs in conservation planning activities. Using the numeric values, EOs ranked “AC” and “B” are treated as equivalents in Natural Diversity Scorecard[21] reports, and EOs ranked “BD” and “C” are also treated as equivalents.

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[20] Traditionally (*e.g.*, in determining Site biodiversity significance rank), one-point spreads were rounded downward to reflect the lack of global EO rank specifications and the preponderance of locally derived EO rank specifications that were naturally somewhat inflated. With the application of global EO rank specifications developed according to this Standard, these EO range ranks should be rounded upward (as is done with Element range ranks) so as to give EOs the “benefit of the doubt” in general tabulations and summaries. However, exact ranks should be considered in individual cases in order to see the degree of uncertainty involved.

[21] Natural Diversity Scorecard reports list Elements and EOs in prioritized order according to Element rank and EO rank.

The EO rank sequence is determined according to a series of three steps, each of which arranges various subsets of occurrences hierarchically on the basis of relative conservation value. The steps of the EO sequencing process are described below:

a) native vs. not native
In the first step, occurrences are arranged according to origin status (see Section 5.2.3, Origin Status Subranks), or more specifically, according to whether the EOs are native. Occurrences that are located within their native range, having greater conservation value, are placed higher in the sequence than those that exist outside of their native range, which are of lower concern. In other words, EOs that are native and naturally occurring (*i.e.*, lacking an origin status subrank), and those that are reintroduced/restored (subrank = "r") are both positioned above introduced EOs (subrank = "i").

b) degree of viability
The second EO rank sequencing step positions EOs based on their estimated viability (EO rank). As estimated viability (and therefore, conservation value) decreases, so does position of the EO rank in the sequence. This means that EOs with "excellent" viability ("A"-ranked) are placed at the top of the group, and EOs with "poor" viability ("D"-ranked) are positioned at the bottom of EOs that are known to be extant. Due to a lack of information on "E" = "extant" occurrences, it is impossible to make a reasonable estimation of their viability; thus, because "E"-ranked EOs may have greater than "poor" viability, they are positioned above "D"-ranked occurrences. The "H" = "historical", "F" = "failed to find", and "X" = "extirpated" ranks occur at the bottom of the EO rank sequence because these EOs are not known to be extant, and hence are generally not used for site conservation priority setting (although they could be useful for targeting future survey work or evaluating sites for possible restoration). Thus, the sequence of EO ranks in this step, from highest to lowest, is: "A", "AB", "B" and "AC", "BC", "C" and "BD", "CD", "E", "D", "H", "F", and "X".

c) natural vs. not natural
The final step in establishing the EO rank sequence involves positioning occurrences on the basis of origin status, or more specifically, according to whether the EOs are naturally occurring. Occurrences that are natural in origin have greater conservation value than those that have been anthropogenically reintroduced or restored. Thus, within each initial rank, EO ranks are arranged so that natural occurrences (*i.e.*, EOs lacking an origin status subrank) are positioned higher than those that are reintroduced/restored (subrank = "r").

Table 5.6 indicates the hierarchical sequence of EO ranks, including rounded ranks. Note that invalid EO ranks will be assigned a sequence = 0 so that they will be placed highest in the sequence where they can be more readily detected and corrected. Also note that the use of "?" qualifiers with either "A" through "D" ranks or with origin status subranks does not affect the rank sequence value (*e.g.*, "A" and "A?" both have a sequence value = 1; "Ar", "Ar?", "A?r", and "A?r?" all have a sequence value = 2).

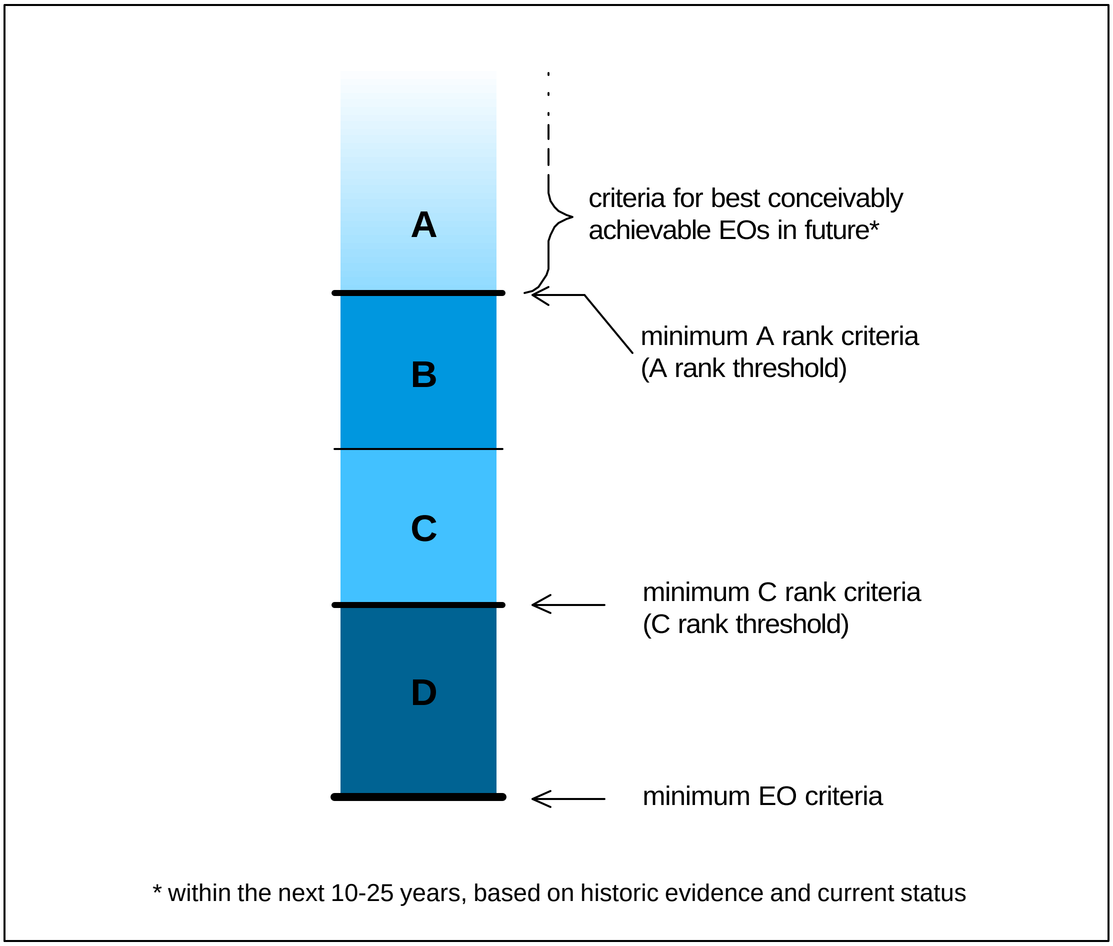
Table 5.6 - EO Rank Values

Initial Rank	Sequence	EO Rank	Rounded Rank
-	0	<any invalid rank>	*
A	1	A	A
	2	Ar	
AB	3	AB	
	4	ABr	
B and AC	5	AC	B
		B	
	6	ACr	
		Br	
BC	7	BC	
	8	BCr	
C and BD	9	BD	C
		C	
	10	BDr	
		Cr	
CD	11	CD	
	12	CDr	
E	13	E	E
	14	Er	
A	15	Ai	Ai
AB	16	ABi	
B and AC	17	ACi	Bi
		Bi	
BC	18	BCi	
C and BD	19	BDi	Ci
		Ci	
CD	20	CDi	
E	21	Ei	Ei
D	22	D	D
	23	Dr	
	24	Di	Di
H	25	H	H
	26	Hr	
	27	Hi	
F	28	F	F
	29	Fr	
	30	Fi	
X	31	X	X
	32	Xr	
	33	Xi	

5.5 Establishing the EO Rank Scale

In order to effectively prioritize EOs for conservation planning, EO rank specifications that establish a scale for distinguishing between “A”, “B”, “C”, and “D” occurrences should be developed. This scale should usually spread from a lowermost limit (the “D” rank or minimum EO threshold) up through the threshold for an “A” rank. In addition, the threshold delineating EOs with “fair” vs. “poor” viability must be identified. Figure 5.2 illustrates the rank scale for “A”, “B”, “C”, and “D”-ranked EOs.

Figure 5.2 - Model of the A, B, C, and D Rank Scale



* within the next 10-25 years, based on historic evidence and current status

Once the minimum criteria for determining what constitutes a valid EO has been developed (see Section 4, EO Specifications), a potentially useful approach to developing EO rank specifications is to then establish the threshold between EOs with “fair” and “poor” viability (the minimum “C” rank criteria). Next establish the criteria for the best EOs that are reasonably and conceivably achievable; generally, these will be the minimum “A” rank criteria unless the best reasonably achievable EOs have only “fair” or “poor” viability. Then, assuming the best EOs that are reasonably and conceivably achievable are at or above the “A” rank threshold, identify minimum “B” rank criteria that, in the absence of a population viability analysis, achieve a spread between “A” and “C”-ranked EOs. Finally, set “D” rank criteria that distinguish between extant occurrences with “poor” viability (*i.e.*, “D”-ranked EOs) and those for which there is simply not enough information to assign an “A” through “D” rank or range rank (*i.e.*, “E”-ranked EOs).

In the rare cases in which the best reasonably achievable occurrences of an Element are no better than extant EOs with “fair” viability, it may not be possible to set an “A” rank threshold. If the best EOs that are reasonably and conceivably achievable have only ”fair” viability (*i.e.*, a “C” rank), then the EO rank scale would be truncated at the “C” rank. Thus, in these cases EO rank specifications would be developed only for “C” and “D” occurrences, and other factors (*e.g.*, EO data, size) could potentially be used for prioritizing EOs for conservation planning. For example, the last remaining population of a mussel species existing only as a nonreproducing population living in the cold tail waters of a dam would be ranked “D.” However, both “C” and “D” rank specifications might be written for the species to suggest what would be required to achieve a population with “fair” viability (*i.e.,* a “C”-ranked EO).

An “A” rank need not be comparable to historical conditions. For example, bison will not conceivably exist again in their historical condition with herds numbering in the millions, but nevertheless a range of viable populations (*e.g.,* herds of differing sizes and conditions) might still be reasonably achievable. In other words, it is still necessary to conceive of a range of viable populations, although the range is truncated when compared to EO rank specifications that would have been written 150 years ago.

5.5.1 Establishing the “C” Rank Threshold

The distinction between EOs with “fair” viability (*i.e.,* “C”-ranked) and EOs with “poor” viability (“D”-ranked) is especially important for helping to prioritize occurrences for conservation planning. The context for developing minimum specifications for “C”-ranked EOs (*i.e.,* the “C” rank threshold) is described below for species and communities.

For species, the “C” rank threshold should be defined such that a “C”-ranked occurrence will have a 50% probability of persisting at or above a minimum threshold[22] for a period of either 20 years or five times the age of reproductive maturity, whichever is greater. This interval permits several generations to be included in estimating viability.[23] The minimum 20-year interval is suggested because it is a practical time frame for conservation planning and action, recognizing the rapid anthropogenic changes that are occurring in landscapes in many areas of the world. For some clonal or other long-persisting but nonreproductive species whose persistence cannot be assessed in terms of generations, a 100-year time frame may be appropriate as a practical substitute.

For communities, criteria for distinguishing occurrences with “fair” viability (“C”-ranked) from EOs with “poor” viability (“D”-ranked) should be based on the degree of negative anthropogenic disturbance rather than a specified probability of persistence over a given time period. In most cases, occurrences with severely altered composition, structure, and/or ecological processes should be ranked “D”; that is, few native species that comprise the community type are found on the site, and the ones present are some combination of resilient, common, species and less resilient species that appear unlikely to persist under current conditions. For these EOs, there may be little long-term conservation value without restoration, and such restoration may be difficult or uncertain.

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[22] This threshold may be as low as one mature pair of individuals (for dioecious) organisms.

[23] In the application of EO rank specifications to individual EOs for species having a longer period until reproductive maturity (typically greater than 4 years), the use of an interval longer than 20 years helps ensure that declines that may only be manifested after several generations will be reflected in the EO rank. In this manner, such EOs may be flagged for management attention while there still may be adequate time (*e.g.,* before the population is in its last generation) to affect demographic parameters.

5.5.2 Establishing the "A" Rank Threshold

The "A" rank threshold represents the cut-off for the best EOs that are reasonably and conceivably achievable for a particular Element within a foreseeable time frame (*e.g.*, 10 to 25 years). In setting the minimum criteria for "A"-ranked occurrences, all available knowledge, both historical and current, should be utilized in order to make the most accurate estimation for restorability of EOs for a given Element.[24] In addition, any current constraints on restoration should be taken into account.[25] As restoration techniques improve, the "A" rank threshold could be placed at higher levels, reflecting greater estimated restorability.

5.5.3 Use of PVA in Establishing EO Rank Criteria

If available and when appropriate, results from one or more population viability analyses (PVAs) may be used to help define minimum "A", "B", and "C" rank criteria. However, this should be done with great caution and a clear understanding of the underlying assumptions.[26] Although the reliability of PVAs has yet to be demonstrated, the increasing use of PVAs seems likely to lead in the future to the development of more robust EO rank specifications for particular species.

The probability of persistence of EOs (at a level equal to or above a "C" rank) should be conceptually based on a time interval of 20 years or five times the age of reproductive maturity, whichever is greater, as shown in the following table.

Table 5.7 - Suggested Probability of Persistence

EO Rank	Probability of Persistence (for 20 years or 5 x age of reproductive maturity)
A	98%
B	95%
C	50%

Note that the difference in probability of persistence between "A" and "B" ranks is relatively small (just 3%) over a span of 20 years (or 5 x the age of reproductive maturity). This small difference will lead to an increasingly divergent probability of persistence over longer time frames (see Figure 5.8, Total Probability of Extinction).

One potentially promising use of PVA is to help establish the population sizes that would meet the minimal conceptual persistence guidelines shown above. These population sizes could then be used in the "A", "B", and "C" rank specifications for those species. For example, one approach to PVA uses data on counts of the total number of individuals in a population, or in a well-defined subset that represents a constant fraction of the population (number of mature individuals is

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[24] The "A" rank threshold should not be based solely on historical information because: a) historical status often cannot be achievable; b) use of historical information could drastically truncate the rank scale for current EOs; and c) historical information is often not known.

[25] Note that, although "restorability" is not a factor in ranking a particular Element Occurrence, it is a factor in setting the "A" rank threshold. In order to set a threshold that is reasonably and conceivably achievable for "A"-ranked occurrences, it is necessary to consider restorability so that the threshold is not limited to EOs that are extant.

[26] Two general assumptions include the continuance of the current and/or recent demographic patterns, and the absence of landscape changes for the duration of the projected time period.

normally recommended), over a number of years (at least 10 is suggested). This method, developed by Dennis *et al.* (1991)[27], allows one to easily calculate the mean and variance of a population's annual multiplication rate, so as to estimate the following:

a) the probability of eventual extinction ; and
b) the cumulative probability[28] that extinction will have already occurred by a particular time in the future, given that it will occur eventually.

The product of these two probabilities is the total probability that extinction will have occurred by a given future time. The total probability of extinction by a given time is influenced by the critical extinction threshold population size[29] and by the initial (i.e. current) size of the population. One may insert different initial population sizes into the model to derive total extinction probability curves. These curves will show the probabilities of persistence of different sized populations at different times (*e.g.*, 20 years). The results from a hypothetical analysis are shown in Figure 5.3.

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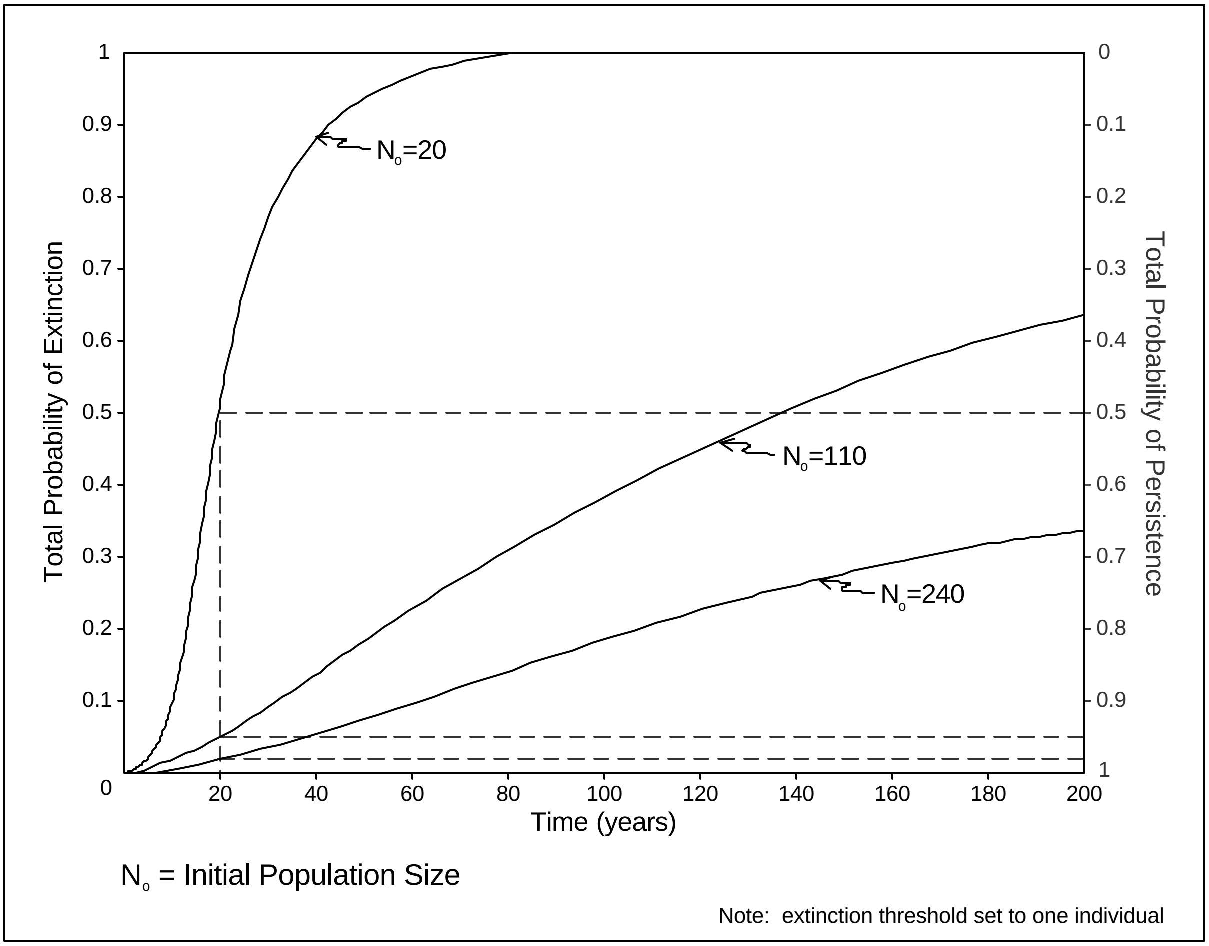
[27] This model assumes that variation in the data is real (due to the environment and not sampling error, such as from varying detectability or observer error) and it does not account for possible catastrophes or density-dependent growth or decline. The minimum 10-year time frame is suggested to reduce the confidence intervals around the estimates of extinction probabilities, although they may still be quite large.

[28] Because the cumulative probability of extinction only applies to those population trajectories that will eventually fall below the threshold (which will not apply to all trajectories if the population is experiencing an increasing trend), it is necessary to multiply the cumulative probability of extinction at time t by the probability of eventual extinction. See Morris *et al.* (1999) for details.

[29] The critical extinction threshold population size may be based on expert opinion. This number may be as few as two mature individuals if there are no significant Allee effects. An Allee effect is a reduction in population growth rate at low density, which may arise due to difficulty in finding mates or failure of group defense in populations at low density.

Figure 5.3 - Cumulative Probability of Extinction



For a hypothetical species for which simple count data is available over time, the three extinction probability curves in Figure 5.8 show the initial population sizes (N_o) necessary to provide an EO of that species with a 50%, 95%, or 98% chance of persistence (1 minus extinction probability) for 20 years. In this example, these probabilities correspond with 20 individuals for a minimal “C” rank population size, 110 individuals for a minimal “B” rank population, and 240 individuals for a minimal “A” rank population, respectively. It is important to determine the confidence intervals on the estimates of extinction probabilities as these intervals may be large for populations with high variability, or if the number of censuses is small (Dennis *et al.* 1991).

5.6 Ranking EOs

5.6.1 Species

For species occurrences, the size, condition, and landscape context factors are generally considered together in determining an EO rank. Thus, specifications for “A”, “B”, “C”, and “D” ranks may be entered into corresponding **EO RANK SPECIFICATIONS** fields. In many cases, where knowledge permits, size is the primary factor influencing EO rank, with condition and landscape context used secondarily (or not at all for some vertebrates). This is because a large size (*i.e.*, number) of breeding individuals would generally not occur without favorable a condition and landscape context, especially for relatively short-lived species. For species where little information on size is available to develop rank specifications (especially many plants and invertebrates), condition and landscape context factors may be relied upon more heavily.

Because the rank factors are considered together, it is especially important that EO rank specifications for species be mutually exclusive and collectively inclusive. Any known or reasonably expected EO should fall within a single rank (when data completeness permits), or at the worst be on the borderline of two adjacent ranks. For example, if the criteria for an “A”-ranked occurrence include “>10,000 mature individuals over >100 hectares”, then it should be made clear in criteria for other ranks which rank should be assigned to an EO comprised of >10,000 individuals over <100 hectares, or an EO comprised of <10,000 individuals over >100 hectares. When applying EO rank specifications to a particular occurrence, the rank specifications should be considered in sequential order from “A” to “D” such that anything that does not meet the criteria of a higher rank is then considered at the next lower rank. This ensures accurate application of rank specifications involving multiple criteria.

Population viability analyses (PVAs) are expected to be increasingly used in the determination of viability of individual occurrences. As discussed above in Section 5.5.3, just as a PVA may be used to help establish EO rank criteria, they may also be used to evaluate the viability of a given EO. Given only population counts over time (as discussed in Section 5.5.3), it is possible to estimate the probability of extirpation (or persistence) of an EO to some future time, or the time until a population falls below a critical threshold. (Given additional demographic data on fecundity and survivorship of different life stages over a period as short as 3 years, it is also possible to use PVA to more explicitly inform management decisions.) The sensitivity of persistence estimates from this approach to variation in growth rates, *etc.* has not been established, so at a minimum, confidence limits should be calculated for any estimate. However, due to the untested nature of PVAs and our lack of knowledge about factors that influence a particular population, when assigning a rank to a particular EO, the results of a PVA should not automatically override consideration of other factors specified in the EO rank specifications (*e.g.*, those factors that may be expected to cause a decline not yet detected). However, increasing use of PVAs seems likely to lead to increasing confidence in the resulting EO ranks for occurrences of many species.

5.6.2 Communities

Because of the greater complexity of communities, due in part to the interaction of species and successional change, it is difficult to consider the influence of all rank factors concurrently. Thus, each factor is assigned a separate “A”, “B”, “C” or “D” rating, sequenced and weighted according to priority, and combined in an algorithm to calculate a suggested EO rank value, which can be accepted or revised. The process for developing an EO rank for a community is described in detail below.

Specifications for determining “A”, “B”, “C”, and “D” ratings for condition, size, and landscape context factors should be entered into corresponding **EO RANK FACTOR SPECIFICATIONS** fields[30]. In addition, the prioritization sequence and weighting scheme used in calculating an EO rank should be documented in the EO rank specifications. There are general guidelines for the sequencing of rank factors to be used for calculating EO ranks. For most Elements, the general guidelines for the rank factor prioritization sequence are determined according to community pattern type (described in Section 5.6.2.1 below), while the general guidelines for weighting rank factors apply to any community, regardless of pattern type. In most cases, community EO rank specifications can simply incorporate these general guidelines. However, for Elements for which these general guidelines do not apply, the rationale for the specified alternative prioritization sequence and/or weightings should be included in the EO rank specifications.

While the procedure for ranking community EOs may seem complicated, the actual application of factor weightings and calculation of the final EO rank can be automated. EO ranks should be reviewed by an ecologist; in rare cases, adjustment of the rank may be necessary and the reasons for doing so documented.

5.6.2.1 Prioritizing EO Rank Factors

The first step in the process of developing EO rank specifications for a community is prioritizing the rank factors on the basis of the relative importance of each factor for that Element. The factor that is most important is considered the primary rank factor, the factor with less importance is the secondary rank factor, and the remaining factor, having the least importance, is the tertiary rank factor. Note that sometimes two of the factors, or all three, are considered to be of similar importance; this is addressed as part of the assignment of a weighting scheme (see Section 5.6.2.2 below).

EO rank specifications developed for a particular Element designate the prioritization sequence of the rank factors. The pattern type of the community (see Appendix C: Spatial Patterns of Different Community Types) may generally serve as a guide to determining the prioritization sequence of rank factors that is appropriate for the Element, but certain communities will differ from these guidelines. Especially when a prioritization sequence indicated in the rank specifications differs from these general guidelines, the developer of the EO rank specifications should provide a justification for the selected sequence. Table 5.8 summarizes the general guidelines for priority sequencing on the basis of community pattern type (described in a-d below).

Table 5.8 – General Rank Factor Prioritization Sequence Guidelines Based on Community Pattern Type

Community Pattern Type	Primary Rank Factor	Secondary Rank Factor	Tertiary Rank Factor
Matrix	size	landscape context	condition
Large Patch	condition	size	landscape context
Small Patch	condition	landscape context	size
Linear	landscape context	condition	size

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[30] Unless otherwise noted, further reference to “EO rank specifications” in this document will be intended to mean “A”, “B”, “C”, or “D” rank specifications for species, or “A”, “B”, “C”, or “D” rank *factor* specifications for communities.

a) Matrix Community Pattern Type

Size and landscape context are generally identified as the primary and secondary factors for a matrix community type. A matrix community, by definition, occupies a very large area with high connectivity to other community types; thus, size and landscape context are typically more important than condition, which could be quite variable (and in some cases, difficult to measure).

b) Large Patch Community Pattern Type

Condition and size are generally identified as the primary and secondary factors for a large patch community type; however, this sequence is quite flexible. Because this community type conceptually occupies the "middle ground" between matrix and small patch types, some large patch communities may be more similar to matrix types, while others more closely resemble small patch types, or linear types. In such cases, the general guidelines for rank factor prioritization for the community type most similar could be utilized for the large patch type.

c) Small Patch Community Pattern Type

Condition and landscape context are generally identified as the primary and secondary factors for a small patch community type. Small patch types vary less in size, often contain more specialized species, and, because of their small size, are sensitive to factors affecting landscape context. Thus, the variation that a small patch community exhibits in size may not be as significant to its viability as its condition and landscape context.

d) Linear Community Pattern Type

Landscape context and condition are generally identified as the primary and secondary factors for a linear community type. Linear types, having a large amount of edge and typically dependent on currents or flow regimes, are generally very sensitive to factors affecting landscape context. In addition, linear types often support very specialized species.

5.6.2.2 Weighting EO Rank Factors

Specifications for determining "A", "B", "C", and "D" ratings for condition, size, and landscape context factors should then be entered into the corresponding **EO RANK FACTOR SPECIFICATIONS** fields. Development of these specifications will then inform selection of a weighting scheme that will be applied to the three rank factors in the actual EO ranking process. The words "primary," "secondary," and "tertiary" imply a "stairstep" weighting, with primary (P) > secondary (S) > tertiary (T), but do not specify the relative weightings. Also, there are circumstances in which the best ranking scheme may equally weight two or more factors. The following weighting schemes cover the main possibilities, and should allow adequate flexibility to developers of EO rank specifications:

a) <u>Stairstep</u>. 45%: 33%: 22%. P>S>T. Primary is greater than secondary, which is greater than tertiary, but the three factors are only moderately different in importance. This is the default weighting scheme.

b) <u>Steep stairstep</u>. 57%: 33%: 10%. P>>S>>T. The primary factor is much more important than the secondary, which is much more important than the tertiary.

c) Extreme stairstep. 70%: 20%: 10%. P>>>S>T. The primary factor is very much more important than the secondary, which is slightly more important than the tertiary.

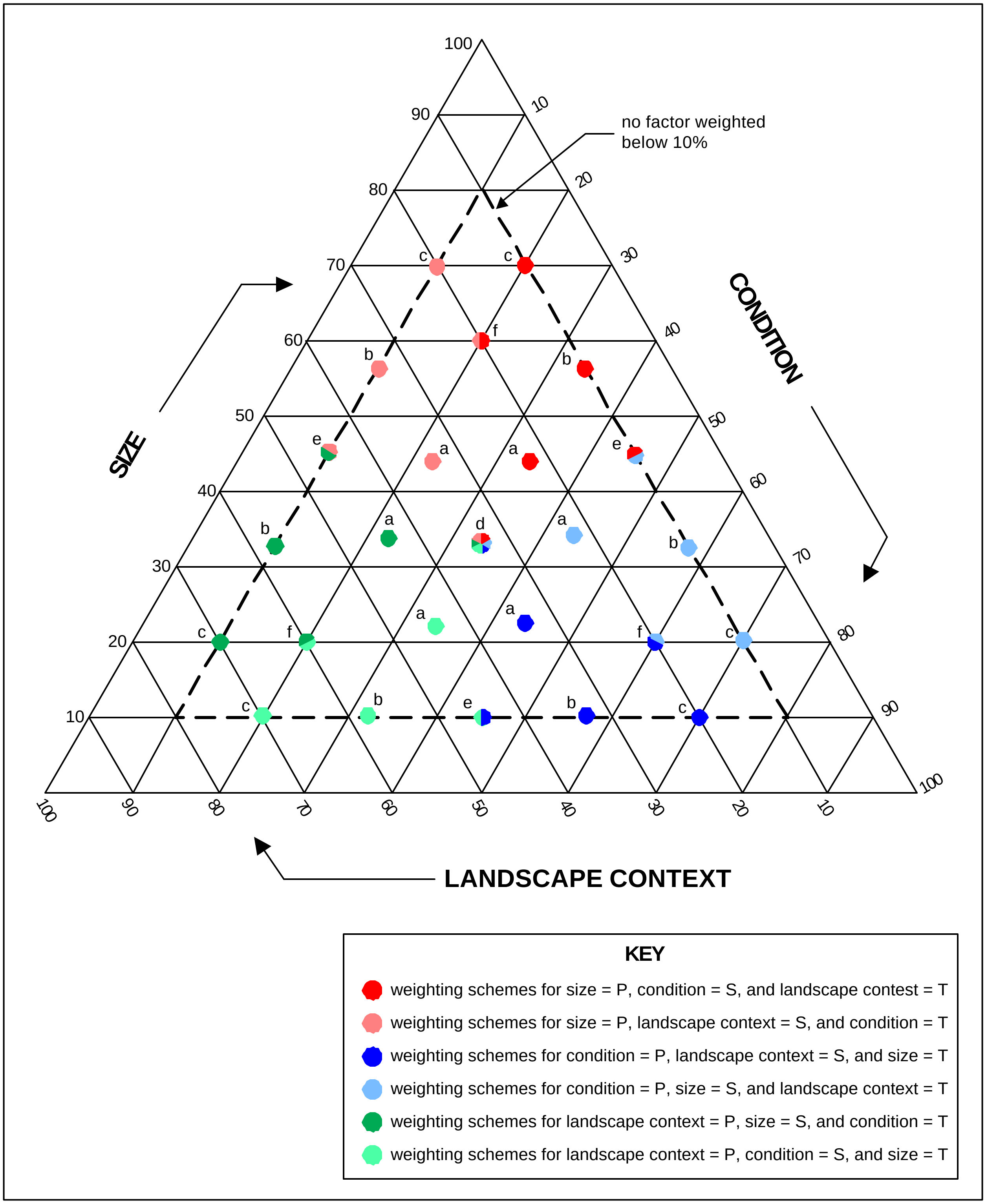
d) Even. 33.3%: 33.3%: 33.3%. P=S=T. The three factors are essentially of equal importance. There is no reason to believe that any factor is more important than the other two.

e) Tertiary of low weight. 45%: 45%: 10%. P=S>T. The primary and secondary are of similar importance, and they are considerably more important than the tertiary.

f) Primary of greatest weight. 60%: 20%: 20%. P>>S=T. The primary factor is very much more important than the secondary and tertiary, which are of similar importance.

Weighting schemes are based on the following assumptions: primary factor weighting (P) = secondary factor weighting (S) = tertiary factor weighting (T) (by definition), and the tertiary factor has a minimum value of 10%. This means that the weighting of the primary factor can range from 33% to 70%, the secondary factor from 20% to 45%, and the tertiary factor from 10 to 33%. In effect, this generates 25 different schemes that cover all significantly different permutations of factor prioritization and weighting. Figure 5.4 graphically illustrates the relationship between EO rank factors, with the weighting schemes described above corresponding to the points labeled (a) through (f) in the diagram.

Figure 5.4 – Graphic Representation of Weighting Schemes



5.6.2.3 Calculating an EO Rank Value

The prioritization (primary, secondary, and tertiary) of the rank factors (size, condition, and landscape context) and the selection of a weighting scheme for those factors are part of the development of EO rank specifications for communities. These now allow the numeric calculation of a suggested EO rank of an occurrence of that community, based only on "A"-"D" ratings assigned to the three rank factors. It is envisioned that calculation of a suggested EO rank will be automated, and/or that it can be looked up on a matrix. However, if any of the three rank factors lack an assigned rating, or have an assigned range rank (*e.g.*, "AB"), or a value other than "A", "B", "C", or "D" (*e.g.*, "E"), an automatic calculation will not be done, and the biologist determining the EO rank must make a subjective decision. This section provides an example of the formula utilized in the calculation of an EO rank, and the matrix derived from that formula for those interested in understanding the details of this approach.

In order to perform the calculation, numeric equivalents must first be assigned for "A", "B", "C", and "D" rank factor ratings as follows:

A rating = 4
B rating = 3
C rating = 2
D rating = 1

The following simple formula may then be used for the calculation:

$$[(P * x) + (S * y) + (T * z)] = \text{EO Rank Value}$$

where P = weighting assigned to primary rank factor
S = weighting assigned to secondary rank factor
T = weighting assigned to tertiary rank factor

and x = numeric equivalent for primary rank factor rating
y = numeric equivalent for secondary rank factor rating
z = numeric equivalent for tertiary rank factor rating

The suggested EO rank (derived from the assigned rank factors ratings applied to the appropriate weighting scheme) is shown in Table 5.9.

Table 5.9 – EO Rank Scale for Ranking Community Occurrences

EO Rank	Numeric Values
A	>3.25 and ≤4.00
B	>2.50 and ≤3.25
C	>1.75 and ≤2.50
D	>1.00 and ≤1.75

This can also be expressed as a matrix developed for the weighting scheme, based on the above-described formula. An example of a matrix for the default "stairstep" weighting scheme (P=45%, S=33%, T=22%) is shown in Table 5.10.

Table 5.10 –Matrix for Ranking Community Occurrences

rank factor ratings	calculated EO rank value	suggested EO rank	rank factor ratings	calculated EO rank value	suggested EO rank	rank factor ratings	calculated EO rank value	suggested EO rank	rank factor ratings	calculated EO rank value	suggested EO rank
AAA	4.00	A	BAA	3.55	A	CAA	3.10	B	DAA	2.65	B
AAB	3.78	A	BAB	3.33	A	CAB	2.88	B	DAB	2.43	C
AAC	3.56	A	BAC	3.11	B	CAC	2.66	B	DAC	2.21	C
AAD	3.34	A	BAD	2.89	B	CAD	2.44	C	DAD	1.99	C
ABA	3.67	A	BBA	3.22	B	CBA	2.77	B	DBA	2.32	C
ABB	3.45	A	BBB	3.00	B	CBB	2.55	B	DBB	2.10	C
ABC	3.23	B	BBC	2.78	B	CBC	2.33	C	DBC	1.88	C
ABD	3.01	B	BBD	2.56	B	CBD	2.11	C	DBD	1.66	D
ACA	3.34	A	BCA	2.89	B	CCA	2.44	C	DCA	1.99	C
ACB	3.13	B	BCB	2.67	B	CCB	2.22	C	DCB	1.77	C
ACC	2.90	B	BCC	2.45	C	CCC	2.00	C	DCC	1.55	D
ACD	2.68	B	BCD	2.23	C	CCD	1.78	C	DCD	1.33	D
ADA	3.01	B	BDA	2.56	B	CDA	2.11	C	DDA	1.66	D
ADB	2.79	B	BDB	2.34	C	CDB	1.89	C	DDB	1.44	D
ADC	2.57	B	BDC	2.12	C	CDC	1.67	D	DDC	1.22	D
ADD	2.35	C	BDD	1.90	C	CDD	1.45	D	DDD	1.00	D

5.6.3 Multi-Jurisdictional EOs

For an EO that crosses one or more jurisdictional boundaries, the EO rank should be based on the best available information on the full extent of the EO. This includes cases in which a multi-jurisdictional occurrence is not tracked in every jurisdiction. For example, an occurrence that occupies a very small area in one jurisdiction where it is tracked, but an extensive area in neighboring jurisdictions where it may or may not be tracked, should be ranked based on the full extent of the occurrence in all jurisdictions.

If more than one jurisdiction tracks the occurrence, the programs should collaborate on determining the EO rank. Although the rank should always be based on the full extent of the EO across jurisdictions, the spatial representation used by a particular program may not necessarily include portions of the occurrence outside of that jurisdiction. (See Section 7.18, Spatial Representation of Multi-Jurisdictional EOs for information on mapping such occurrences.)

5.7 Characteristics of Good EO Rank Specifications

To ensure accurate and consistent ranking of EOs (within the constraints of the information available), EO rank specifications should

a) have global application, addressing the Element throughout its range;

b) be specific, not ambiguous (*e.g.*, make units of counting clear); avoid the use of adjectives and/or phrases that could be interpreted differently, such as “large”, “small”, “good”, “fair”;

c) provide criteria, as applicable, for each rank (“A”, “B”, “C”, and “D”) for size, condition, and/or landscape context factors, and address any interactions between these factors; these criteria will usually involve multiple characteristics, and should specify which are the most important;

d) for communities, provide the prioritization sequence and weightings for EO rank factors and describe the process for calculating an EO rank using rank factor ratings;

e) be mutually exclusive and collectively inclusive;

f) help provide measurable criteria for ecological or biological monitoring;

g) provide justification for the distinction between occurrences with “fair” viability and those with “poor” viability (*i.e.*, the “C”/”D” threshold), including citation if available, when distinguishing criteria are based on historical evidence, research, literature, *etc.*;

h) provide justification for values used to establish the threshold for “A”-ranked occurrences, including citation if available (*e.g.*, historical precedents, current best-known occurrence, results of experimental restoration projects, current constraints on restoration);

i) address all potential location use classes;

j) be peer reviewed (along with EO specifications); all data centers within the range of the Element will be invited to review the EO rank specifications. Comments must be received from a minimum of two reviewers, including at least one from the appropriate Central/Regional Zoology, Botany, or Ecology program staff. In addition, review by other experts (either within or outside of the Heritage Network) familiar with the Element or the taxonomic group to which it belongs is encouraged;

k) include the author(s); and

l) include the date that the EO rank specifications were most recently substantially revised (such that previous versions are obsolete and occurrences should be re-ranked using the revised rank specifications).

The above characteristics may be used as a checklist when developing or reviewing EO rank specifications.

5.8 Developing EO Rank Specifications

In order to ensure that EOs having high conservation value are ranked as priorities, EO rank specifications must provide stringent guidelines for assigning consistent and appropriate “A” through “D” ranks to EOs. Specifications for each of the EO ranks should provide, as appropriate for the Element, criteria related to one or more of the three identified ranking factors: size, condition, and landscape context. Criteria for “D”-ranked EOs must be consistent with the minimum criteria in the EO specifications for that Element. Time frames for the persistence of viable EOs should be considered when writing EO rank specifications. For migratory Elements having multiple classes, EO rank specifications must specify “A” through “D” rank criteria for each location use class.

When developing EO rank specifications, an Element should be considered throughout its range. Characteristics of Elements may vary significantly in different parts of the range (*e.g.*, for species, different habitat use in different ecoregions; for communities, different pattern types in different ecoregions). In such cases, specific criteria related to the ranking factors could be provided in the EO rank specifications for the different portions of, or habitats in, the range; however, this should be done with great caution.

In the absence of global rank specifications for a particular Element, jurisdictions are encouraged to develop them in coordination with Central Zoology, Botany, or Ecology (rather than diverting resources into the development of multiple interim local guidelines). In situations where developing global EO rank specifications is not feasible, interim local guidelines can be recorded in optional fields in the Element national or subnational ranking file.

Central Zoology, Botany, and Ecology will maintain separate draft EO rank specifications while new editions of specifications are being developed and reviewed; this will ensure that they are not confused with the current operational EO rank specifications until the review process is completed and any revisions incorporated.

Criteria in EO rank specifications should be based on the scientific information available, including historical precedents, knowledge of current occurrences, results of experimental restoration projects, and current constraints on restoration. Justification for the criteria used in setting the “A” rank threshold should be documented. In addition, when available, justification for the “C”/”D” threshold (*i.e.*, the distinction between EOs with “fair” viability and “poor” viability) should also be provided. Justification for the “D” rank threshold (differentiating EOs from non-EOs) should be recorded in the EO specifications for that Element.

To prevent duplication of effort when developing EO rank specifications, it may be practical to develop a set of criteria that would be broadly applicable to an entire functional group of Elements, identified as a “rank specifications group”. Rank specifications groups may be particularly useful for grouping community associations (*e.g.*, as an alliance), and to a lesser extent for species (*e.g.*, cave amphipods). Because Elements within a particular rank specifications group have similar components of species biology or community processes, EO rank specifications for the Elements within that group would differ only minimally, if at all. The EO rank specifications developed for the group could later be modified as appropriate for a particular Element in the rank specifications group, at which point the Element would be removed from the group; the initial set of group EO rank specifications would continue to be applied to the Elements remaining in the rank specifications group, however. Central Zoology, Botany, and Ecology should maintain documentation on EO rank specifications developed for rank specifications groups.

In cases when the biology and ecology of a particular Element is poorly understood, it may be useful to identify another Element that is presumed or hypothesized to be functionally similar and base the EO rank specifications for the lesser-known Element on those of the better-known Element. Alternatively, if a rank specifications group comprised of functionally similar Elements can be identified, then the lesser-known Element could be added to the group and the EO rank specifications developed for the group utilized.

Ongoing reports of new biological and ecological information will likely cause the criteria developed for different EO ranks to undergo progressive modifications, particularly with respect to potential restorability (*i.e.*, the “A” rank threshold). As new EO rank specifications are created or received by data centers, it is recommended that copies be archived in manual files; as subsequent editions of rank specifications are developed for an Element, archived copies can provide information on the previous criteria used for ranking occurrences of that Element. To the degree possible, changes to EO rank specifications should be made in a manner that facilitates re-ranking affected EOs in a timely manner by all jurisdictions. Otherwise, the revision of the specifications will result in less (rather than more) consistent EO ranks across the range of the Element.

5.9 Templates for Writing EO Rank Specifications

Using a standard template when writing EO rank specifications may help ensure that they are consistent with the guidelines described above (Section 5.7). Figures 5.5 and 5.6 show templates that could be used when writing EO rank specifications for species. Figure 5.7 provides a template that could be used when writing rating criteria for ranking community EOs. (For examples of EO rank specifications developed using the templates, see Appendix D.) For species, rank specifications should be recorded in the “A” through “D” specifications fields. For communities, a set of rating specifications should be recorded in the “A” through “D” specifications fields for each of the three EO rank factors (*i.e.*, condition, size, and landscape context).

Figure 5.5 - EO Rank Specifications Template for Species Elements Having No Location Use Classes

EO Rank Specs

RANK SPECS GROUP (name of rank specifications group, if applicable)

A SPECS (minimum criteria for "**A**" rank size, condition, and/or landscape context factors)

B SPECS (minimum criteria for "**B**" rank size, condition, and/or landscape context factors)

C SPECS (minimum criteria for "**C**" rank size, condition, and/or landscape context factors)

D SPECS (minimum criteria for "**D**" rank size, condition, and/or landscape context factors)

RANK SPECS JUSTIFICATION (basis for "A" rank threshold and "C"/"D" threshold, including citations if available)

Edition

RANK SPECS AUTHOR (significant contributors to rank specifications)

RANK SPECS EDITION DATE (YYYY-MM-DD)

RANK SPECS NOTES (internal notes relating to development of rank specifications)

Figure 5.6 - EO Rank Specifications Template for Species Elements Having Location Use Classes

EO Rank Specs

RANK SPECS GROUP (name of rank specifications group, if applicable)

attributes below repeat for each location use class for the Element

LOCATION USE CLASS (specific class from list of classes for Element)

A SPECS (minimum criteria for “**A**” rank size, condition, and/or landscape context factors)

B SPECS (minimum criteria for “**B**” rank size, condition, and/or landscape context factors)

C SPECS (minimum criteria for “**C**” rank size, condition, and/or landscape context factors)

D SPECS (minimum criteria for “**D**” rank size, condition, and/or landscape context factors)

RANK SPECS JUSTIFICATION (basis for “A” rank threshold and “C”/”D” threshold, including citations if available)

Edition

RANK SPECS AUTHOR (significant contributors to rank specifications)

RANK SPECS EDITION DATE (YYYY-MM-DD)

RANK SPECS NOTES (internal notes relating to development of rank specifications)

Figure 5.7 - Template for Community EO Rank Factor Specifications

EO Rank Specs

RANK SPECS GROUP (name of rank specifications group, if applicable)

Rank Procedure

COMBINATION RULE MATRIX NAME (matrix to be used for weighting EO rank factor ratings to determine suggested EO rank, selected from set of general combination rule matrixes)

ALTERNATIVE WEIGHTING SCHEME (alternative scheme for weighting EO rank factor ratings to determine suggested EO rank)

JUSTIFICATION FOR ALTERNATIVE SCHEME (basis for use of alternative scheme)

PRIMARY (EO rank factor of highest importance, defaults based on community pattern type)

SECONDARY (EO rank factor of secondary importance, defaults based on community pattern type)

TERTIARY (EO rank factor of least importance, defaults based on community pattern type)

JUSTIFICATION FOR ALTERNATIVE SEQUENCE (basis for use of alternative sequence)

Condition

A RATING SPECS (minimum criteria for “A” rating for condition)
B RATING SPECS (minimum criteria for “B” rating for condition)
C RATING SPECS (minimum criteria for “C” rating for condition)
D RATING SPECS (minimum criteria for “D” rating for condition)
RANKSPECS JUSTIFICATION (basis for “A” rank threshold and “C”/”D” threshold for condition ratings criteria, including citations, if available)

Size

A RATING SPECS (minimum criteria for “A” rating for size)
B RATING SPECS (minimum criteria for “B” rating for size)
C RATING SPECS (minimum criteria for “C” rating for size)
D RATING SPECS (minimum criteria for “D” rating for size)
RANKSPECS JUSTIFICATION (basis for “A” rank threshold and “C”/”D” threshold for size ratings criteria, including citations, if available)

Landscape Context

A RATING SPECS (minimum criteria for “A” rating for landscape context)
B RATING SPECS (minimum criteria for “B” rating for landscape context)
C RATING SPECS (minimum criteria for “C” rating for landscape context)
D RATING SPECS (minimum criteria for “D” rating for landscape context)
RANKSPECS JUSTIFICATION (basis for “A” rank threshold and “C”/”D” threshold for landscape context ratings criteria, including citations, if available)

Edition

RANK SPECS AUTHOR (significant contributors to EO rank specifications)

RANK SPECS EDITION DATE (YYYY-MM-DD)

RANK SPECS NOTES (internal notes relating to development of EO rank specifications)

6 EO TRACKING

6.1 Purpose of EO Tracking

Element tracking and Element Occurrence (EO) tracking are closely related but distinct concepts. **ELEMENT LISTS** are compiled at global, national, and subnational levels to define the universe of Elements present in the jurisdiction. These lists may be complete (comprehensive) or partial (ad hoc), depending on the knowledge of that group. Comprehensive lists for a given group are comprised of all the Elements present in a jurisdiction (including demonstrably secure species, exotic species, and semi-natural community types), while ad hoc lists for a group tend to include only Elements of documented or probable conservation concern. See Appendix E for more detailed discussion of Element tracking.

An **EO TRACKING LIST** (also known as an Element Inventory List) is a subset of an Element List. EO Tracking Lists are compiled at national and subnational levels to define the set of Elements that are of sufficient conservation concern to warrant the accumulation and maintenance of detailed locational and status data (*i.e.*, EO records) on some or all occurrences. Element Occurrences tracked by Natural Heritage Programs and Conservation Data Centers serve as the foundation for environmental review, conservation planning, and conservation action, including land management. Thus, the purpose of EO tracking is to ensure that locational information is gathered for Element Occurrences having the greatest conservation significance. While decisions on which EOs to track should be based primarily on status and biogeographic considerations, political or jurisdictional considerations also need to be addressed. Guidelines for determining which EOs are meaningful from a conservation perspective, and thus should be tracked, are provided in this section.

The selection of which occurrences to track is, in essence, a decision about potential conservation targets in a particular jurisdiction. Selecting which occurrences to track is a three-step process. First, Elements present in a specific jurisdiction are compiled into an Element List (see Appendix E2, Element Lists). Second, Elements on the Element List for which occurrences will be inventoried are compiled into an EO Tracking List. Third, a distinction is made between those Elements on the EO Tracking List for which *all* occurrences will be tracked, and those for which only *selected* occurrences will be tracked. Decisions about which Elements are tracked, which occurrences of those Elements are tracked (see Section 6.3, Summary Guidelines for EO Tracking), and how the EOs are ranked and prioritized within a jurisdiction are fundamental for effective conservation. Conservation planning at various scales relies on the EO Tracking List and inventory results to determine conservation targets.

Although conservation decisions might ideally be based on comprehensive data on all Elements, practical considerations dictate that data is collected on only a selected set of Elements. Gathering data on EOs and maintaining this data in a database is expensive. Implicit in the concept of tracking occurrences is the need to maintain some degree of currency of the data for tracked occurrences, since only up-to-date information is of direct conservation application.[31] If the information about an occurrence is not regularly reassessed through field work or remote sensing, the data becomes stale and its use limited, especially for conservation planning and environmental review. However, information on former locations of EOs, or locations of uncertain status, are still useful for planning inventory work and environmental review. Tracking occurrences that are not priorities for conservation takes time and resources away from maintaining current data on occurrences that are most critical to conservation planning and action. Conversely, failure to track occurrences for Elements in need of conservation attention precludes their consideration in conservation decisions.

A **WATCH LIST** should be used for Elements of some current or potential conservation concern for which occurrences are not currently tracked. Watch List status is commonly assigned on the basis of lesser conservation concern than Elements that are EO tracked. Other reasons for assigning Elements to a Watch List include uncertainty about status (*e.g.*, taxonomic distinctness, uncertain Element rank, native status), and concerns related to threats or declining trends for Elements that are currently relatively secure. Additionally, Watch List status may be used for Elements for which EO tracking has been deferred due to limited program resources.

For Watch List Elements, maintaining at least minimal information on specific locations is desirable. Watch List status for Elements may involve the maintenance of an observations file, consisting minimally of a log sheet and/or completed field forms. Watch List status can provide more complete information for ranking and rangewide assessments, since it provides information from parts of the range that might not otherwise be represented with any data. However, the general absence of centralized electronic and mapped information on Watch List Elements in the EO database, and in any regional/national databases compiled or derived from that database, makes it difficult to access and use this information for either ranking or conservation planning. Use of the proposed observations database for Watch List species may allow better flexibility for data maintenance, transfer, and access than the use of manual observations files alone.

Resource limitations necessitate a selective approach to determining which Elements (and which occurrences of those Elements) to include on an EO Tracking List. Despite this limitation, excellent decisions on conservation priorities can be made on the basis of selective, carefully maintained, and cost-effective EO Tracking Lists.

6.2 Conceptual Process for Developing or Modifying an EO Tracking List

The current paradigm (employed by The Nature Conservancy and the Heritage Network) in conservation site selection is that the most efficient and effective way to attempt to conserve native biodiversity is to target all viable, native communities and all viable, vulnerable, native species. Vulnerable species are those that have a heritage global rank of G1, G2, G3, or GH (or T1, T2, T3, or TH). (See Appendix E3.2, Element Ranking Definitions.) This approach, sometimes called a “coarse filter/fine filter” approach to conservation site selection, is utilized to ensure that a broad, practical, and well-balanced representation of the biological diversity in an ecoregion or jurisdiction is protected. Communities may be viewed as a coarse filter; identification

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[31] The frequency of update of EO records depends on resource availability, but might ideally be related to both the global rank of the Element and the likelihood that the status of the EO has changed (*e.g.*, as a result of anthropogenic impact).

and protection of the best examples of *all* types of communities (*i.e.*, terrestrial, subterranean, freshwater, marine), regardless of vulnerability, will ensure that most species and ecological processes are conserved. However, some species that are imperiled or vulnerable "fall through" the coarse filter – due to their rarity, they are not reliably found in the habitats or communities where they might be expected for natural diversity; thus, a "fine filter" comprised of these species is needed. Targeting fine filter Elements for conservation along with communities ensures that a broad spectrum of biodiversity, including the imperiled and vulnerable Elements, will be preserved. Thus, minimally all G1, G2, G3, and GH (and T1, T2, T3, and TH) species, and all communities should be included in an EO Tracking List, although not necessarily all occurrences of these Elements will be tracked (see Section 6.2.2, EO Rank).

Additionally, it may be desirable (or legally or politically necessary [see Section 6.2.5.1, Political Jurisdictions]) on the basis of ecological and/or jurisdictional considerations to track additional species with lower (*i.e.*, G4 or G5) global ranks. These might include taxa that are disjunct to the ecoregion or jurisdiction, or taxa that are officially listed in the jurisdiction, or taxa that are imperiled, vulnerable, or otherwise of concern within the jurisdiction.

Therefore, to ensure that data collected and recorded will provide the best possible basis for conservation action, EO Tracking Lists should be developed and regularly re-evaluated on the basis of the following:

a) global Element rank;
b) global and regional threats and trends;
c) national or subnational Element rank;
d) EO rank (*i.e.*, spread and number of occurrences of an Element);
e) changes to the Element list (including additions);
f) taxonomic distinctness;
g) questionable origin of the taxon;
h) jurisdictional context; and
i) biogeographic context (including significant disjunction).

An Element belongs on the EO Tracking List when further attention to that Element (*i.e.*, tracking occurrences) would be beneficial to the goal of conserving natural diversity. Whether an Element is included on a national or subnational EO Tracking List is indicated in the EO tracking fields in the Element files through the use of "A" = "all extant", "P" = "partial"[32], "N" = "no", or "W" = "Watch List".

Generally, species that are globally historical, critically imperiled, imperiled, or vulnerable are included on the EO Tracking List (indicated by "A" in EO tracking fields). However, in some situations it may be useful to track only selected occurrences of an Element within a jurisdiction

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[32] Partial tracking of EOs is a relatively new concept, and thus not included in the previous standard documented in the Natural Heritage Program Model Operations Manual (The Nature Conservancy 1988).

(indicated by “P” in EO tracking fields). Below are four potential reasons for the partial tracking of EOs:

a) tracking occurrences having specific EO ranks (see Section 6.2.2, EO Rank);

b) tracking disjunct occurrences (see Section 6.2.6, Biogeographic Context);

c) tracking occurrences only in selected geographic areas, such as watersheds, ecoregions, or other biogeographic units (see Section 6.2.6, Biogeographic Context); and

d) tracking occurrences only on selected sites determined by present or prospective conservation status (see Section 6.2.5.2, Sites and Managed Areas).

It is important to distinguish between Elements for which all extant occurrences are tracked (indicated by “A” in EO tracking fields), and those Elements for which certain extant occurrences are tracked, depending on whether their EO rank and/or location meet specific criteria (indicated by “P” in EO tracking fields). Although partial tracking on the basis of EO rank is not a new concept (it has been the rule for communities), decisions on which occurrences to track have rarely been well documented. In situations where EOs are partially tracked on the basis of EO rank or location, information on which EOs are tracked and the reasons for this should also be recorded in a tracking comment field in the Element file. In either situation (*i.e.*, EO tracking = “A” or “P”), it is useful to record information on whether “H” and “F”-ranked EOs are also tracked.

6.2.1 Element Ranks and Status

Element ranks should be used as one of the principal factors for determining which Elements should be added to the EO Tracking List. Global ranks (GRANKs, including infraspecific taxon ranks [“T” ranks]) provide information on the relative risk of extinction of an Element, based on a five-point hierarchical scale. At a jurisdictional level, national and subnational Element ranks (NRANKs and SRANKs, respectively) provide information on the relative risk of extirpation within a jurisdiction. Each of these Element ranks may be modified by qualifiers or incorporated in ranges reflecting more detailed information on the status of the Element. To facilitate interpretation, ranks may be rounded to the five-point scale. (See Appendix E3, Element Ranking for a summary of rules on assigning Element ranks and rounded ranks.)

The following three sections may refer to Elements with rounded global ranks (or the equivalent rounded global infraspecific taxon ranks).

6.2.1.1 G1, G2, and GH Elements

Elements that are imperiled throughout their range have global ranks of G1, G2, or GH. Many G1 and G2 Elements have obvious and active threats that contribute to their global rank. However, even if the threats are not overt or currently active, G1 and G2 Elements are considered intrinsically vulnerable because of their existence in low numbers or at few locations. Because GH Elements may still be extant, they should be treated similarly to G1 and G2 Elements.

Because of their vulnerability to extinction, all G1 and G2 Elements are considered conservation targets. If rediscovered, GH Elements are also considered conservation targets. Thus, G1, G2, and GH Elements should always be included on an EO Tracking List (unless extirpated from the jurisdiction, not native to the jurisdiction, or highly questionable taxonomically).

6.2.1.2 G4 and G5 Elements

At the other end of the global rank spectrum, Elements ranked G4 and G5 are generally considered to be widespread, abundant, and at least apparently secure. They are rarely subjected to serious threats throughout their range; if such Elements are determined to be seriously threatened rangewide, their global rank should be changed to G3. However, most G4 and G5 Elements are threatened and/or vulnerable somewhere in their range. Decisions on tracking occurrences of G4 and G5 species should be based on biogeographic context, as well as on local jurisdictional considerations (see Section 6.2.6, Biogeographic Context, and Section 6.2.5, Jurisdictional Context).

In contrast, G4 and G5 communities should always be included on an EO Tracking List. In jurisdictions where they are most widespread or abundant (*e.g.*, matrix communities), emphasis should be placed on tracking the highest quality examples (*i.e.*, those with the highest EO ranks). (See Section 6.2.2, EO Rank.)

6.2.1.3 G3 Elements

At the middle of the global ranking scale, G3 Elements are generally considered to be vulnerable to extinction. Although not imperiled rangewide, G3 Elements are typically important conservation targets.

In general, G3 Elements should be included on EO Tracking Lists. However, tracking all EOs for G3 Elements often requires a large amount of resources, especially in those regions having high biodiversity. In situations where it is currently not practical to track all the occurrences of G3 Elements, decisions about which EOs to track will require careful analysis. Higher quality EOs should be tracked for most, if not all, G3 Elements (see Section 6.2.2, EO Rank). In addition, consideration should be given to tracking all occurrences of G3 Elements considered to be of higher conservation concern due to relatively greater vulnerability or various other factors, including disjunct distribution or legal status.

6.2.1.4 Threats and Trends

Elements that are too common and widespread to require inventory and conservation protection should not be included on the EO Tracking List (indicated by “N” in the EO tracking fields of the Element file). However, judgment will often have to be used in borderline cases (*e.g.*, G4 Elements with significant downward trends or increasing threats). Such Elements should be placed on a Watch List (indicated by “W” in EO tracking fields) and periodically reviewed for evidence of changes in status. This will make additional resources available for inventory and monitoring of more threatened, higher-priority Elements.

Decisions on whether to track occurrences of G3 and G4 Elements that are threatened by epidemic disease or exotic pest infestations are difficult to make. Because the threat is evident but unrelated to land conservation, locational data on occurrences generally cannot be used as a basis for effective conservation action. In most cases, tracking of EOs is not recommended; however, partial tracking of very high quality or relatively healthy occurrences should be considered.

Alternatively, information on the location of relatively healthy populations could be maintained in an observations database or manual file.

Example:

- *Juglans cinerea* (butternut or white walnut) is threatened throughout its extensive distribution in eastern North America by a fatal canker disease, apparently introduced from abroad. In some states and provinces, the number of historical (and even current) locations for *J. cinerea* may be in the hundreds. Comprehensive EO data is unlikely to aid in the conservation of this species, although recording locations of large or apparently healthy populations (*i.e.*, "A"-ranked occurrences) might be of use to researchers. Information on other populations could be recorded in an observations database or manual file.

6.2.2 EO Rank

EO rank is a useful and desirable filter on which to base decisions about which EOs to track. Because communities blanket the landscape, it has long been the desired practice to only track the most viable occurrences of common (*e.g.*, G4 and G5) communities.

In contrast, selective EO tracking on the basis of EO rank has not been generally practiced for species. As a result, occurrences of many vulnerable (*e.g.*, G3) species are not tracked in high biodiversity jurisdictions where the species may be most abundant and protectable. While the coarse filter approach of conservation of communities may protect many of these vulnerable species, specific information on all, or at least the most viable, occurrences of vulnerable species is of great value in conservation planning.

It may not be practical, particularly in regions having high biodiversity, to attempt to track (and keep data current for) all occurrences of all species on an EO Tracking List, especially species that are not imperiled (*i.e.*, not G1, G2, or GH) and may, therefore, have many EOs. For vulnerable (G3) species, minimally all "A"-ranked occurrences should be tracked, and it is strongly recommended that all "B", "C", and "E"-ranked occurrences be tracked as well. If resources do not permit tracking of these occurrences for a G3 species in a jurisdiction, the decision about which EOs to track for a species should ideally be made in a biogeographic context. For example, in order to support ecoregional planning, the tracking of "A"-ranked occurrences of a particular Element in any portions of jurisdictions within that ecoregion would ensure that the most viable EOs are identified for conservation purposes.

Partially tracking occurrences on the basis of EO rank is particularly useful for more common Elements, especially for G3, G4, and G5 communities, and for G3 species. Tracking the best EOs (*i.e.*, occurrences having a high EO rank) of common communities and G3 species can overcome the bias and lack of depth of a conservation portfolio based on only imperiled Elements, and will result in a more complete representation of biodiversity.

In general, if "A", "B", and "C"-ranked occurrences of a species are tracked, then "E"-ranked occurrences of that species are recommended for tracking since many of these occurrences will be ranked "C" or higher when further information is obtained. Occurrences ranked "D", "H", and "F" usually have lower priority for tracking than "A", "B", and "C"-ranked occurrences.

It is generally not advisable to spend limited resources tracking “X”-ranked EOs, especially where the habitat is destroyed. Knowledge of these occurrences will typically be very incomplete, and resources are better spent increasing the depth and/or currency of data on extant, or possibly extant, EOs for which conservation actions are possible. However, maintaining information on “X”-ranked occurrences of extant Elements in manual or electronic files may be valuable in documenting the decline and former extent of the Element. In those situations where information is more complete, storing such information in electronic files may be preferable. Information on extirpated occurrences provides evidence of locations where the Element formerly existed, which may be valuable in guiding inventory and recovery efforts, and in environmental review.

Partial tracking of occurrences on the basis of EO rank can create complexities and difficulties, in comparison to the simplicity of an “all or nothing” approach to the tracking of Elements. Partial EO tracking puts a premium on the existence of EO rank specifications, and on the relatively consistent application of those specifications by individuals and programs. Partial tracking of occurrences may mean that global, national, and subnational Element ranks cannot be based strictly on the number of occurrences of an Element in the database; however, this is currently rarely possible. Furthermore, partial EO tracking may mean that an EO Tracking List requires additional information on precisely which occurrences of an Element should be tracked (*e.g.*, all viable occurrences of the Element should be recorded). All of these potential difficulties and complexities are minor compared to the alternative: the absence of data on critically important, priority occurrences of conservation targets.

6.2.3 Discoveries and Taxonomic Changes

In order to best preserve the existing biodiversity in a jurisdiction, the EO Tracking List should be regularly evaluated and changes made to reflect advances in knowledge and increased understanding of biodiversity. For example, additions and other changes to the Element List, and revisions to Element ranks, should be evaluated for their impact on the EO Tracking List.

6.2.4 Questionable Taxonomy and Origin

6.2.4.1 Questionable Taxonomy

In general, decisions on whether to include Elements considered to be questionably taxonomically distinct[33] on an EO Tracking List should be based on the same criteria (*e.g.*, global rank, EO rank, and biogeographic factors) as for any clearly distinct Element. If there is a reasonable expectation that such an Element may be taxonomically valid, it is preferable to track its occurrences because the potential irreparable loss of a taxonomically valid Element outweighs the costs incurred in data management. However, if the taxonomy is highly questionable, with little expectation that the Element may be taxonomically valid, it may be appropriate to place it on a Watch List (*e.g.*, apomictic microspecies sometimes recognized in the plant genus *Rubus*).

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[33] Uncertainty concerning the taxonomic classification of a particular Element is reflected in the taxonomic status (for species) or confidence (for communities) fields in the Element files (not necessarily by the assignment of a “Q” qualifier to the global rank). See Appendix E2.2.8, Questionably Distinct Elements.

6.2.4.2 Questionable Origin

It is sometimes difficult to determine whether a species is native to a particular jurisdiction or biogeographic region. For plant species in particular, determination of origin status may be very ambiguous. In general, such species have weedy or opportunistic capabilities, and are globally ranked G4 or G5.

Occurrences of species that are not native (*i.e.*, are introduced) should not be tracked unless the Element is globally critically imperiled and the occurrence is critical to the survival of the species (see Section 5.2.3, Origin Status Subranks). For Elements of questionable origin, decisions about which occurrences to track should be informed by multi-jurisdictional or biogeographic considerations; this will help ensure consistency in EO tracking among the jurisdictions within the Element's range.

6.2.5 Jurisdictional Context

6.2.5.1 Political Jurisdictions

Natural Heritage Programs and Conservation Data Centers often have missions that involve the conservation of Elements of biodiversity within their jurisdictions. Programs working under the mandate of national or subnational government may be required to track occurrences for all species that are at risk in a given jurisdiction, typically occurrences of species that are ranked S1 or S2.

Additionally, there are legitimate biological arguments for tracking occurrences of some species that are imperiled in a given jurisdiction (NH, N1, or N2; or SH, S1, or S2) but secure globally (G4 or G5). Tracking and maintaining currency for such EOs will inevitably compete for resources that could be directed towards tracking occurrences of globally imperiled and/or vulnerable (GH, G1, G2, or G3) species. However, there may be value in tracking occurrences of G4 or G5 species that are locally at risk (NH, N1, or N2; or SH, S1, or S2) on the basis of the known or hypothesized genetic distinctness of peripheral populations. It has also been argued that species should be conserved before they collapse to a small portion of their original range.

Because a limited jurisdictional perspective of a species' rarity may be misleading, the best conservation decisions should be based on broader analyses of biodiversity needs. Consequently, decisions on whether to include species that are globally secure (G4 or G5) and locally imperiled (NH, N1, or N2; or SH, S1, or S2) on an EO Tracking List are better made from a regional or rangewide perspective (see Section 6.2.6, Biogeographic Context).

Example:

- *Polymnia canadensis* (white-flower leafcup) is abundant (S5) in Tennessee, primarily on calcareous substrates. In immediately adjacent North Carolina, *P. canadensis* is more imperiled (S2), with few occurrences. Thus, this species might be described as "trivially rare" in North Carolina, and EOs should not be a priority for tracking in that state, where it has no legal status. Resources spent tracking occurrences of this species would be better spent maintaining currency on species that are globally at risk and exemplary communities.

6.2.5.2 Sites and Managed Areas

In some cases it may be necessary to track occurrences of particular Elements on selected Sites or Managed Areas without tracking occurrences of those Elements in the remainder of the jurisdiction. Tracking EOs on Sites or Managed Areas exclusively (indicated by "P" in EO tracking fields) may be appropriate for certain research and/or contract-related projects.

6.2.6 Biogeographic Context

Decisions regarding the EO tracking of G3, G4, and G5 species (or T3, T4, and T5 infraspecific taxa) should be informed by biogeographic context. The rangewide distribution and status of the Element provides an important perspective on the conservation significance of occurrences of the Element in that jurisdiction, for example when disjunction is involved. There are various large geographic units (*e.g.*, physiographic provinces, ecoregions, major watersheds, floristic regions) that can provide a perspective on biogeographic context independent of jurisdictional boundaries.

For many Elements, taxonomy or classification will effectively account for disjuncts through the recognition of genetically distinct plant or animal populations, or geographically distinct community associations. However, this is not always the case, especially for plant and animal populations. Disjunction should be an important consideration in tracking occurrences of G4 and G5 species. This is particularly true for plants, which often have relict fragmented distributions; the disjunct portions of the range often represent populations distinct in biogeographic history and possibly genetics.[34]

EOs that represent peripheral populations of G4 and G5 species are generally not considered to be of great conservation importance in jurisdictions where they are rare, unless they are geographically disjunct. Tracking decisions related to such occurrences should not be affected by the hypothetical shifting of political boundaries.

Example:

- *Trichophorum cespitosum (Scirpus cespitosus),* an G5 sedge abundant in arctic regions of the northern hemisphere, extends south in eastern North America to scattered populations on alpine summits and in fens located in northern New York (in the Northern Appalachian Ecoregion). It then reappears as disjunct populations on about a dozen sites in the Southern Blue Ridge Ecoregion, specifically in western North Carolina (S2), eastern Tennessee (S1), and northeastern Georgia (S1). Rangewide or ecoregional analysis would suggest that conservation of these relict southern populations is important, and that all three states in the Southern Blue Ridge Ecoregion should track occurrences of this species.

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[34] Ecological distinctiveness of an occurrence may have similar significance to geographic disjunction (*e.g.*, a rare instance of a lowland plant occurring at a high elevation in the same geographic area, or a plant commonly found on limestone that has a single occurrence on acidic sandstone).

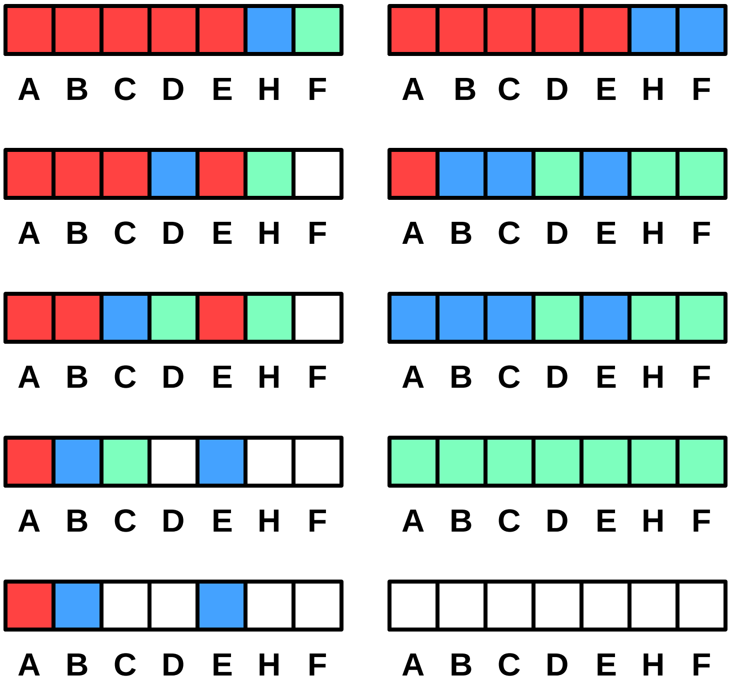
6.3 Summary Guidelines for EO Tracking

6.3.1 EO Tracking Decisions

Inclusion of an Element on an EO Tracking List indicates that occurrences of that Element should be inventoried. However, in many cases it is not practical (or even possible) to track *all* the occurrences of a given Element within a particular jurisdiction or biogeographic region. Decisions on partial tracking of occurrences are ideally based on multiple factors, including global and subnational ranks, EO rank, decline, and biogeographic distribution.

An illustration of the summary guidelines for making EO tracking decisions is provided in Figure 6.1. These guidelines are primarily intended for making decisions related to processing data on new occurrences. (Decisions on the retention, archiving, or deletion of existing EO records may differ from these guidelines depending on the potential value of the records, database use and maintenance issues, and other factors.) While the EO tracking guidelines are intended for global use, it should be noted that decisions on tracking occurrences will frequently be made at the national or subnational level on the basis of the specific political, financial, and biological concerns of that jurisdiction. Whenever possible, the rangewide distribution of occurrences should be considered when making decisions on EO tracking; this will help to ensure conservation of disjunct occurrences and the most viable occurrences within various jurisdictions or biogeographic areas.

Figure 6.1 - Summary Guidelines for EO Tracking



GLOBAL ELEMENT RANK*	SUBNATIONAL ELEMENT RANK**	COMMUNITIES							SPECIES						
		A	B	C	D	E	H	F	A	B	C	D	E	H	F
G1/G2/GH	S1/S2/SH	🟥	🟥	🟥	🟥	🟥	🟦	🟩	🟥	🟥	🟥	🟥	🟥	🟦	🟦
G3	S1/S2/S3/SH	🟥	🟥	🟥	🟦	🟥	🟩	⬜	🟥	🟦	🟦	🟩	🟦	🟩	🟩
G4/G5	any S rank *significant disjunct (primarily species)*	🟥	🟥	🟦	🟩	🟥	🟩	⬜	🟦	🟦	🟦	🟩	🟦	🟩	🟩
G4/G5	S1/S2/SH	🟥	🟦	🟩	⬜	🟦	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩
G4/G5	S3/S4/S5	🟥	🟦	⬜	⬜	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜

EO RANK

SEE TEXT FOR MORE DETAILED EXPLANATION, PARTICULARLY FOR G3 ELEMENTS, AND FOR G4/G5 - S1/S2 ELEMENTS.

NOTE: Tracking all occurrences of government listed species may be required, regardless of Element rank or EO rank.

* or Global Infraspecific Taxon Rank (T1, T2, T3, T4, T5, TH)

** or National Element Rank (N1, N2, N3, N4, N5, NH)

KEY

🟥 **VERY HIGH** - EOs that *should* be tracked

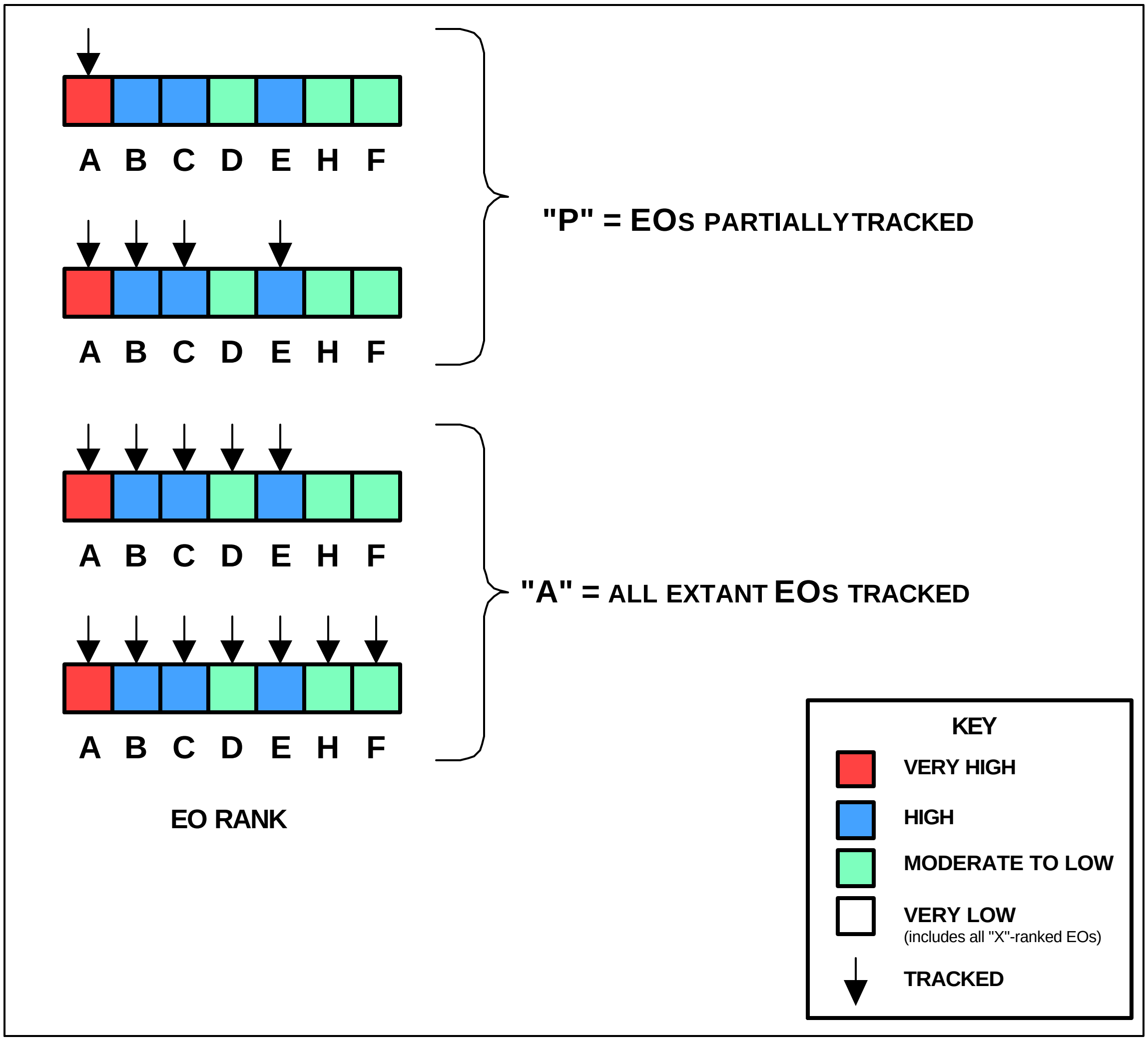
🟦 **HIGH** - EOs that are *strongly recommended* for tracking (though sometimes precluded by impracticality in regions with very high biodiversity)

🟩 **MODERATE TO LOW** - EOs that are recommended for tracking *under some circumstances* (reflecting political and biogeographic considerations [see Section 6.2.5.1])

⬜ **VERY LOW** - EOs of little regional, national, or global tracking value, generally *not recommended* for tracking (includes all "X"-ranked EOs)

In addition to Element factors (*e.g.*, ranks, threats, decline) and EO rank, decisions on partial tracking of occurrences of a particular Element are also influenced by the abundance of biodiversity existing in the jurisdiction. For example, when tracking a G3 S1 species, a jurisdiction having low biodiversity may track all occurrences known to be extant, or possibly all but the extirpated occurrences; in contrast, a jurisdiction having high biodiversity may only have the ability to track a subset of the viable occurrences of the species (shown in Figure 6.2). Thus, in some cases EO tracking decisions will be more strongly influenced by the biodiversity existing within a jurisdiction rather than on other more global factors.

Figure 6.2 - Example of Partial EO Tracking of a G3 S1 Species



6.3.2 Communities

According to the EO tracking guidelines, at least some occurrences of all natural communities should be tracked, including occurrences of common natural communities. Rarely, if ever, are cultural (or even semi-natural) communities tracked. Tracking natural communities serves as a "coarse filter" for natural diversity, providing for the conservation of many unknown species, as well as ecological processes operating at a community or ecosystem scale. Tracking the high quality occurrences of common communities is important for long-term conservation of biodiversity through preservation of the best remaining natural areas before they become critically threatened. Although not all communities are rare, nearly all have been substantially altered and/or reduced from their former natural extent and function (in particular, formerly widespread matrix communities which exist primarily in a fragmented and degraded condition). Thus, high quality and viable occurrences of common communities are often rare and there is a premium on the identification and conservation of such occurrences while they still exist.

6.3.3 Species

The majority of species should theoretically be conserved through the preservation of communities as a "coarse filter" for biodiversity. This does not hold true for imperiled and vulnerable species that, because of their inherent or induced rarity, are not reliably found in communities where they might otherwise be expected to occur. Thus, according to the EO tracking guidelines, all occurrences of imperiled and vulnerable species should be tracked as a "fine filter" for biodiversity. Because of their potential genetic distinctness, viable disjunct populations of more secure (G4 or G5) species should also be tracked.

7 EO SPATIAL REPRESENTATION

Although locational information related to EOs may be recorded in tabular form, spatial representation of occurrences on maps provides much greater information that can be useful in guiding conservation decisions. Mapping EOs provides a more accurate basis for identifying relationships with other landscape features including habitat, watershed, observations, and other occurrences, as well as with tracts, protected areas, managed areas, geopolitical units, and various land use planning areas.

The spatial data model described in this Standard provides a method for deriving and managing an EO representation. The model relies on the formal representation of occurrences with polygons (*i.e.,* features with areal dimension).[35] In addition, the model provides a methodology for developing EO representations from one or more source features, each of which delineates a discrete observed area based on survey information (*i.e.,* an observation[36]) and incorporates any uncertainty associated with the location of the observation. Although the spatial model allows for the use of either a manual mapping system or a geographic information system (GIS), managing information in a GIS permits spatial operations that facilitate the analysis of relationships between occurrences and other mapped features.

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[35] In order to more easily manage EO spatial data with current GIS technology, polygon representations are necessary.

[36] Until further analysis and design related to observation data occurs, the interim solution for managing observation data in conjunction with the EO model is based on the assumption that an observed area is equivalent to an observation.

7.1 Locational Properties of Spatial Data

Elements may occupy very specific locations in various, often complex, ways reflecting the its biology and differences in physical and environmental factors (*e.g.,* substrate, habitat, hydrologic regime). These diverse patterns of occurrence by a particular Element, or by multiple Elements, at a given location often create specific challenges in spatial representation.[37] In all cases, however, feature boundaries should be delineated to encompass only the full known extent of the Element, based on information from current field surveys or historical accounts without extrapolation that includes presumed potential habitat.[38]

7.1.1 Multiple Elements at a Location

Multiple occurrences of different Elements are often located concurrently at a particular place. Two locational properties have been identified for such situations, described in a) and b) below and illustrated in Figure 7.1.

a) Observed areas of different Elements may *overlap*.[39]

<u>Example</u>:

- areas observed to be occupied by a cactus, a lizard, a small rodent, and a snake in the desert may overlap in location

b) Observed areas of different Elements may *coincide* (*i.e.*, share the same location and boundaries).

<u>Example</u>:

- a fish and an aquatic invertebrate may both occur throughout a lake, with observed areas defined by the boundaries of the lake

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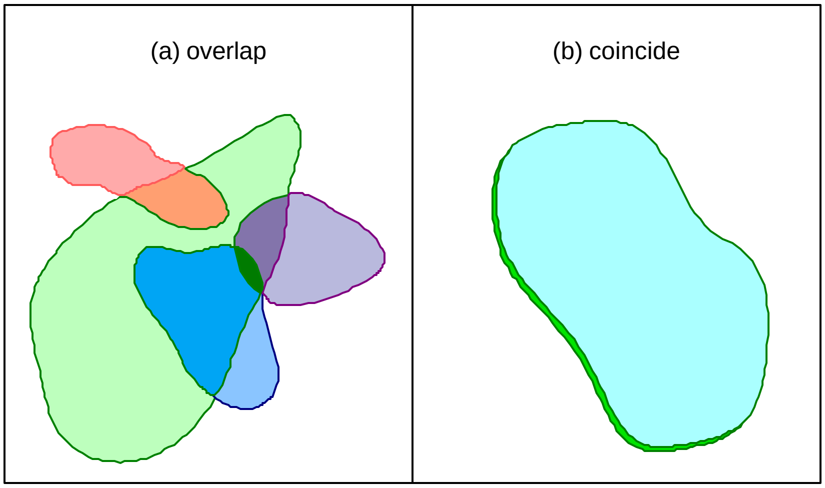
[37] These complexities were originally described by the California Natural Diversity Database program (Gaul, 1997) as they relate to the GIS spatial data model used by that program.

[38] EOs should be delineated strictly on the basis of actual field observations and survey information. EO boundaries should *not* be expanded to include proximate suitable habitat when there is a lack of field survey information confirming the actual presence of the Element at that proximate location (see Section 7.17.2 for the single exception to this model). Nor should EO boundaries be expanded outward a prescribed distance from the actual area occupied to capture presumed territory, range, or movement (*i.e.*, “biological buffers” should not be used in delineating EOs).

[39] In some cases, principal EOs of the *same* Element may overlap if the occurrences are based on different levels of information (see Section 7.12.2, Overlapping Principal EOs).

Figure 7.1 – Properties of Multiple Elements at a Location



7.1.2 A Single Element at a Location

A single occurrence of an Element may represent a complex spatial pattern. Three locational properties have been identified for complex EOs, described in c) through e) below and illustrated in Figure 7.2.

c) An observed area may *contain "voids"* (*i.e.*, areas where the Element is not found).

Example:

- an occurrence of a high-altitude alpine plant may be delineated at a specific elevation around mountain peaks, but exclude the rocky summits

d) An occurrence may *consist of noncontiguous areas* (*i.e.*, discrete observations) close enough to each other to be considered one EO, based on separation distances defined for the Element (see Section 4.3.2, Separation Distances).

Example:

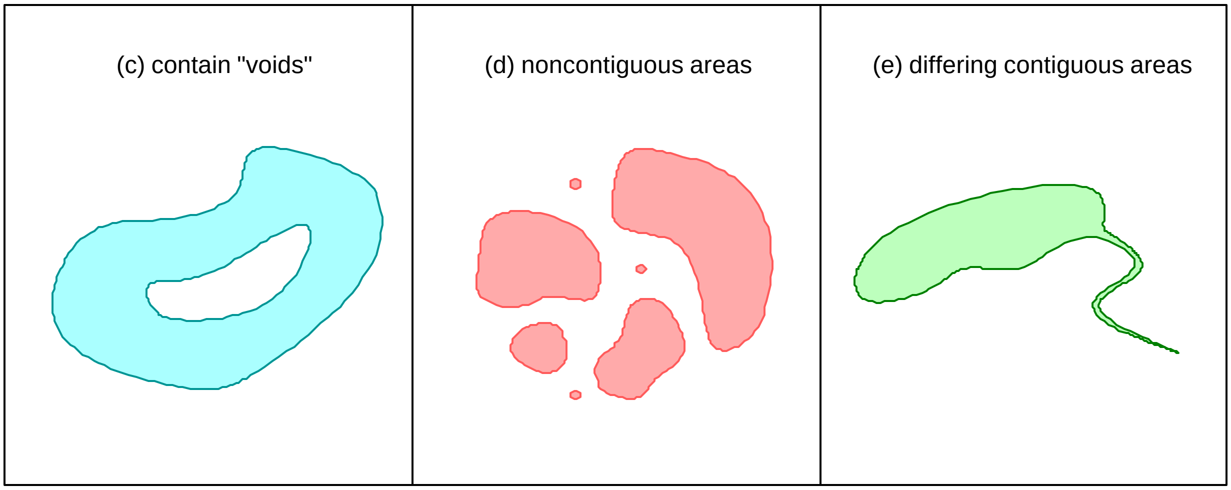
- an occurrence of a pothole pond community may be comprised of two or more distinct ponds whose separation distance does not exceed that specified for the community

e) An occurrence may be *comprised of differing, contiguous areas* (*e.g.*, an area with a linear extension).

Example:

- an occurrence of a fish may include both a pond and a stream

Figure 7.2 – Properties of Single Element at a Location



See Section 7.11 for additional details on complex EOs.

7.2 Minimum Mapping Unit

Representing patterns of occurrence on a map requires translating field observations and measurements into map symbols and units. In essence, the observed feature must be represented at a reduced scale so that it can be symbolically depicted on a map. The degree of scale reduction and the accuracy of representation (*i.e.*, the EO shape and boundary) will depend in part on the size of the occurrence and the scale of the map used to portray it.

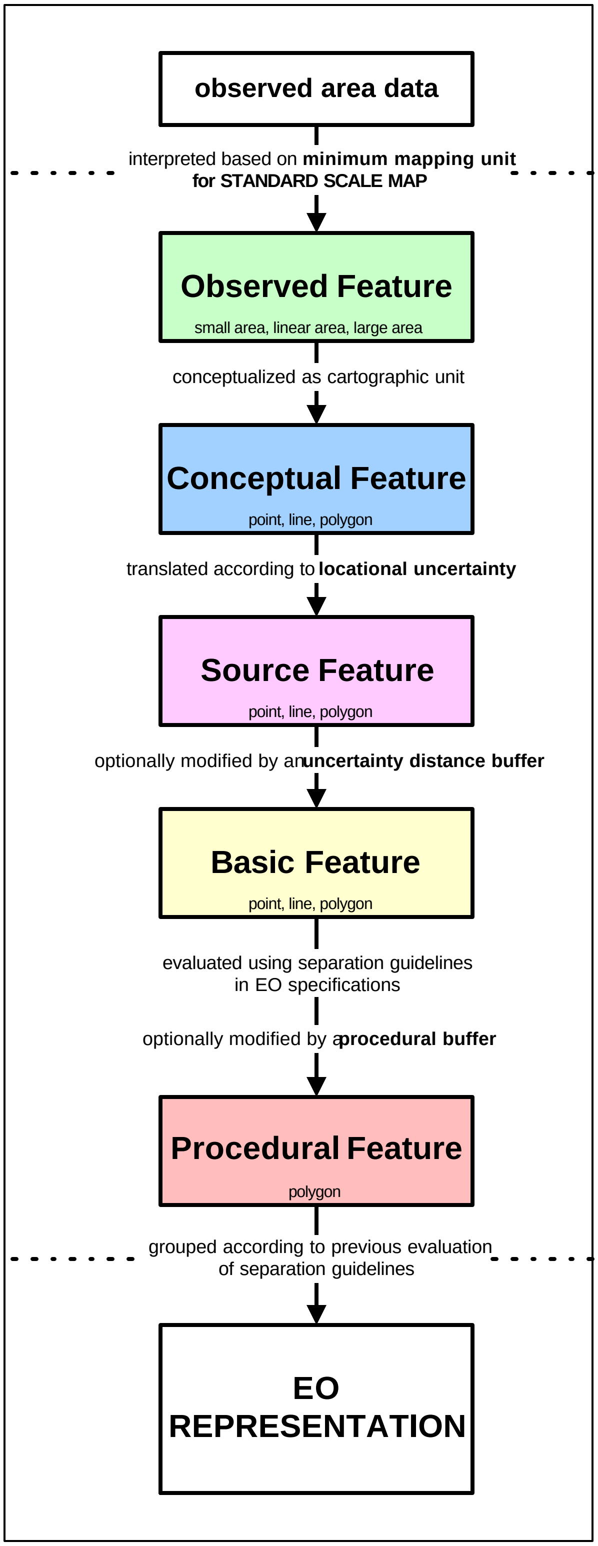
A limiting factor in any representation is the **MINIMUM MAPPING UNIT** for the map being used. The minimum mapping unit is the size of the smallest feature for which boundaries will be delineated on a map of a particular scale. The boundaries of an occurrence whose dimensions are smaller than the minimum mapping unit is not mapped as a polygon. For example, if the diameter of the recommended minimum mapping unit for a 1:24,000 map is 12.5 m, an occurrence must be ≥12.5 m in both dimensions (*i.e.*, length and width) for boundaries to be mapped. In cases where the EO is smaller than the minimum mapping unit in both dimensions, the occurrence may be conceptually represented by a point (see Section 7.13, EO Point Representations).

7.3 Stages in Developing an EO Representation

In order for conservation to be most effective, the spatial representation of data should be as accurate and detailed as practical and/or possible. The mapped boundaries of an occurrence must capture both the known occupied habitat and any area of locational uncertainty associated with that location. Consistency in EO representations across the range of an Element is particularly important for multi-jurisdictional and rangewide planning. Inconsistent and inaccurate spatial representation of occurrences may result in a failure to correctly identify their actual locations; consequently, these locations may not be included in areas targeted for conservation, and valuable resources may be expended conserving locations where the EOs are falsely depicted. Accurate representation of occurrences will help ensure that the EOs targeted for conservation are actually located within the areas selected for conservation.

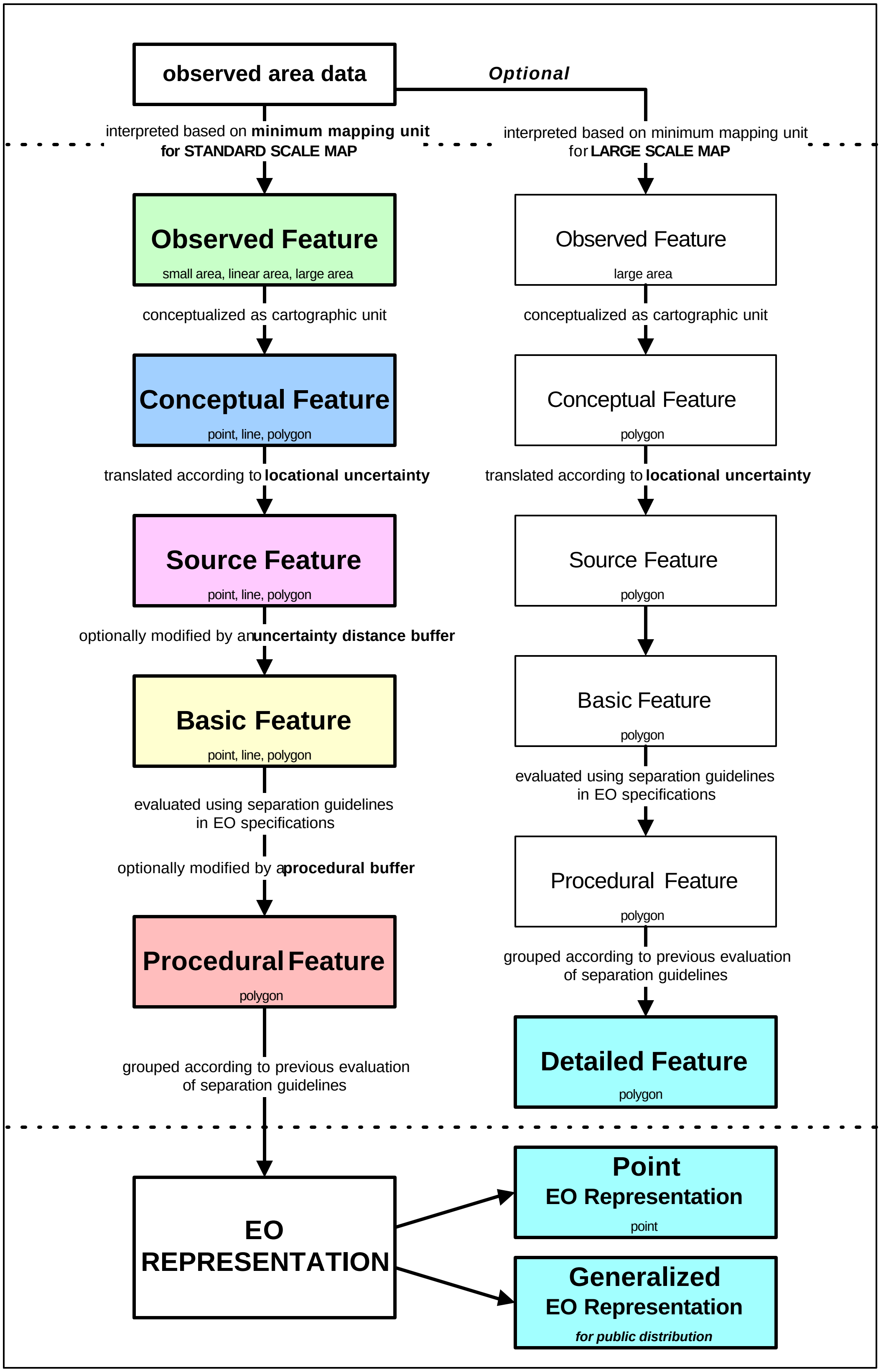
Developing consistent and accurate spatial representations from survey information requires five stages, each of which is characterized by a feature. Each stage builds on the previous one, resulting in progressive modifications of the representation. The process begins with an **OBSERVED FEATURE** based on field survey information, a museum collection, or literature report that describes the observed area. This observed feature is characterized as a **CONCEPTUAL FEATURE** through cartographic conceptualization. The feature is next translated into a **SOURCE FEATURE**, and then a **BASIC FEATURE,** based on the type of locational uncertainty associated with the data. Finally, the basic feature may be further modified through the addition of a procedural buffer, resulting in a **PROCEDURAL FEATURE.** An EO representation is comprised of one or more procedural features, depending on separation guidelines provided in the EO specifications for the Element. While the observed feature directly reflects the actual area of an observation, the source feature, basic feature, and procedural feature are based on an interpretation of locational information related to the data. The stages in developing spatial representations are illustrated in Figure 7.3 and discussed in Sections 7.4 through 7.8. These sections describe the development of the progressive features that would comprise an EO derived from a single observation; Section 7.11, Developing a Complex EO Representation, addresses issues involving EOs that are based on multiple discrete observations.

Figure 7.3 - Essential Stages in Developing an EO Representation



While the fundamental process for developing an EO representation is characterized by five features, an EO may also be depicted using other features. An **EO POINT REPRESENTATION** is used to denote an EO at any map scale small enough that the boundary of the occurrence is not apparent. A **GENERALIZED EO REPRESENTATION** may be used to protect the precise location of an EO on a map to be used for public distribution. **DETAILED FEATURES** may be used to represent observation data at a scale larger than the standard map scale. These additional features are illustrated in Figure 7.4 and described in Sections 7.13, 7.14, and 7.15.

Figure 7.4 - Additional Features Associated with an EO Representation



7.4 Observed Feature

An observed feature is based on a discrete observation obtained from a field survey or historical account, and serves as the foundation from which an EO representation is developed. An observed feature may be one of three types (small area, linear area**,** or large area), depending on the size of the area represented by the data compared with the minimum mapping unit (mmu) for the standard scale map. Features extending in a linear dimension (*e.g.*, along a ridge or stream) a distance greater than the diameter of the mmu, but having a width less than the mmu, are linear area features. Other observed features are categorized as either small areas or large areas, depending on whether the size of the feature (*i.e.*, measures of both length and width) is smaller or larger, respectively, than the mmu for the particular map being used.

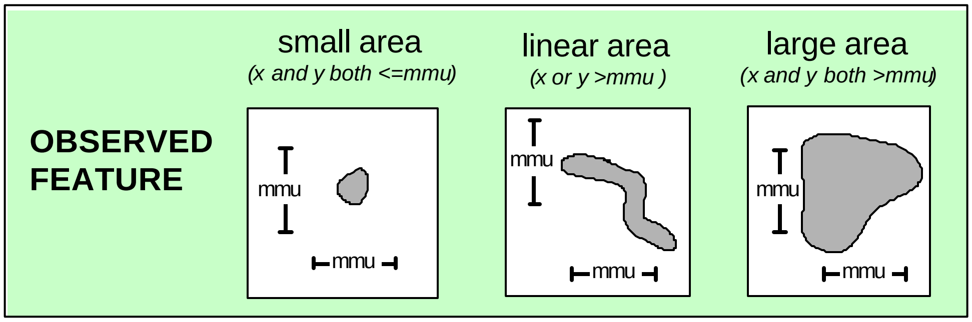
Examples:

Note that the mmu = 12.5 m for the standard 1:24,000 scale map.

- **Small area:** an observation of a nest
- **Linear area:** multiple samples of a fish collected a distance of 30 m along a stream 8 m wide
- **Large area:** information on a breeding territory approximately 50 m in diameter in all dimensions

The types of observed features are illustrated in Figure 7.5, where *x* and *y* are used to label the two dimensions, and mmu represents a distance equivalent to the diameter of the minimum mapping unit for the standard scale map.

Figure 7.5 - Types of Observed Features



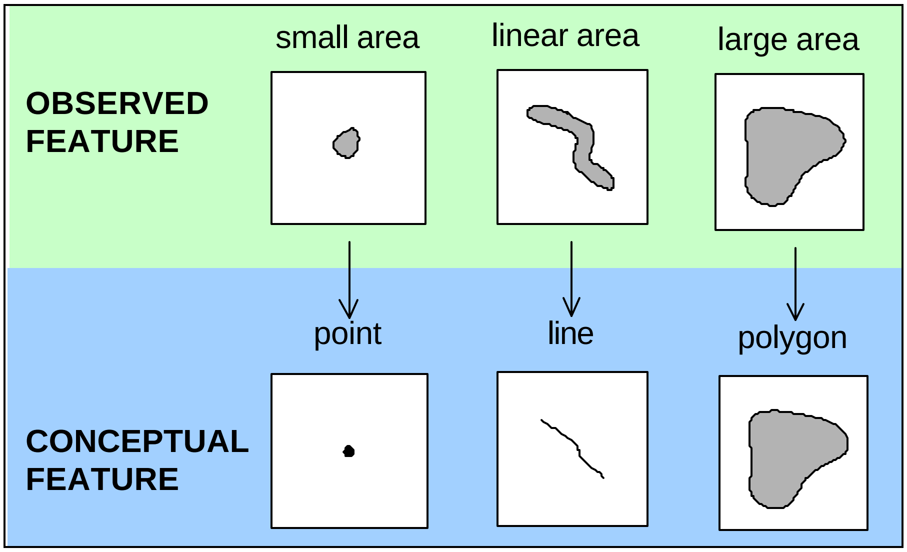
7.5 Conceptual Feature

In the second stage of the process, an observed feature is conceptually characterized as a simplified cartographic unit (a point, line, or polygon) that can be easily drawn on a map or in a GIS. The type of conceptual feature is determined according to the type of observed feature:

- **Point:** conceptualization of a small area observed feature
- **Line:** conceptualization of a linear area observed feature
- **Polygon:** conceptualization of a large area observed feature

Figure 7.6 illustrates the characterization of observed features to conceptual features.

Figure 7.6 - Derivation of Conceptual Features



7.6 Source Feature

A source feature results from the translation of a conceptual feature to a tangible form, and serves as the initial mapped spatial component developed from a discrete unit of observation data. Creation of the source feature requires an interpretive process. The likely location and extent of an observation is determined through consideration of the nature of any uncertainty associated with the location of the observation data. In most cases, the source feature is delineated to encompass locational uncertainty.

As with conceptual features, there are three types of source features (points, lines, and polygons), although there is not a simple correspondence between like types of the two features. The type of source feature developed depends on both the preceding conceptual feature type and the locational uncertainty associated with the feature.

7.6.1 Locational Uncertainty

The location of an EO is determined on the basis of underlying observation information that is frequently imperfect or incomplete. The quality and reliability of locational data may vary due to many factors, including the level of expertise of the data collector, differences in survey techniques and equipment used, and the amount and type of information obtained. Consequently, the recorded location of an observed area may vary from its true location, reflecting a certain measure of uncertainty associated with that location. To ensure the accuracy of mapped features, the spatial representation of data should reflect the full observed extent of that Element at that location, including any uncertainty associated with the location. Since the recorded location of an observation may vary from its actual location, a mapped feature that fails to incorporate uncertainty would misrepresent the location of the underlying data.

There are four major types of **LOCATIONAL UNCERTAINTY**: negligible, linear, areal delimited, and areal estimated. Uncertainty type is dependent on both the degree (*i.e.*, the amount/magnitude) and direction of locational variability of the data.

7.6.1.1 Negligible Uncertainty

Locational information based on a comprehensive field survey with high quality mapping has a high degree of associated certainty. In cases where the amount of variability between the actual and recorded location of an observation is less than or equal to half the diameter of the minimum mapping unit (*i.e.*, ≤ 6.25 m on a 1:24,000 scale map), the locational uncertainty is **NEGLIGIBLE.** To be categorized as having negligible uncertainty, the entire feature (*i.e.*, all of the boundaries) must meet this variability criteria.

Source features with negligible uncertainty are derived from point, line, and polygon conceptual features, and are delineated to include the uncertainty. Because it is likely that the recorded location of observation fairly accurately reflects its actual location, no interpretation or modification is necessary when translating the conceptual feature to a source feature. So, although negligible uncertainty is incorporated in a source feature, the source feature is mapped as the conceptual feature without any change.

<u>Examples of data that would qualify for negligible uncertainty</u>:

Point conceptual feature translated as point source feature:

- a plant specimen location based on corrected GPS data

Line conceptual feature translated as line source feature:

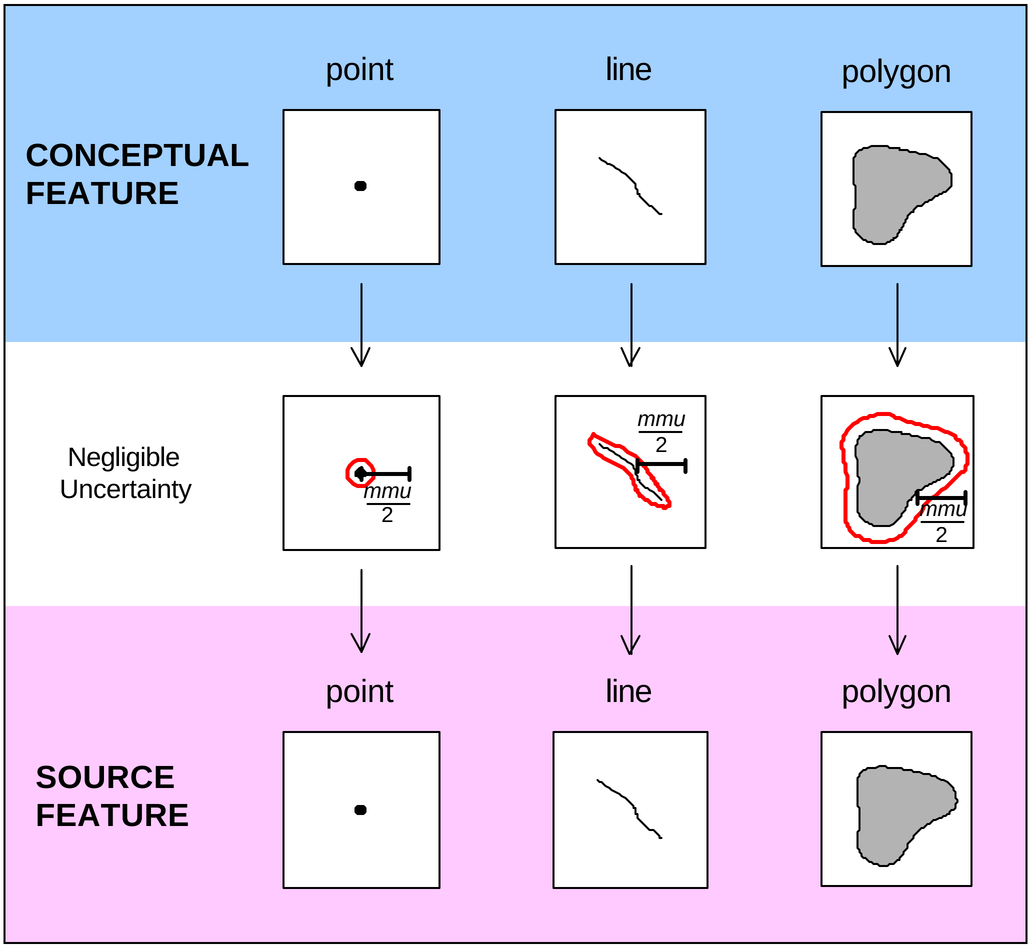
- mussel specimens observed along a stream a measured distance at a known location

Polygon conceptual feature translated as polygon source feature:

- a rodent occupied habitat with boundaries determined by thorough field survey work

Conceptual features having negligible uncertainty and the resulting source features are shown in Figure 7.7. The locational uncertainty associated with the underlying observation data is indicated by heavy solid lines.

Figure 7.7 - Derivation of Source Features with Negligible Uncertainty



7.6.1.2 Linear Uncertainty

Data having locational uncertainty greater than negligible that varies in one dimension (*i.e.*, along an axis) has **LINEAR UNCERTAINTY**. [40] In such cases, the recorded location of the observation falls within a linear range, but its position within that range is not known; thus, the true location of the observation may be visualized as effectively “sliding” within a linear span that delineates the uncertainty.

The endpoints of a source feature with linear uncertainty are delineated on the basis of

a) referenced features (*e.g.*, natural features [including shorelines, ridges, streams], anthropogenic structures [such as roads, dams, bridges, trails], local political jurisdictions, official land survey units);

b) field biologist’s determination of extent; and/or

c) an estimate of uncertainty distance(s).

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[40] In a strict sense, linear uncertainty is not limited to one dimension since it may follow the path of a curved line.

Note that any combination of these factors may define the limits of a linear range of uncertainty. Regardless of the basis, however, a conceptual feature having linear uncertainty is modified as a source feature to encompass the linear range within which the observation is known to be located.

Source features with linear uncertainty are derived from point and line conceptual features only. Since the dimensions (length and width) of polygon conceptual features already exceed the minimum mapping unit, the locational uncertainty associated with these features cannot be linear. Because source features with linear uncertainty are delimited to include the uncertainty, a point conceptual feature having linear uncertainty becomes a line source feature. A line conceptual feature having linear uncertainty also becomes a line source feature, but the addition of locational uncertainty results in a lengthening of the line.

<u>Examples of data that would qualify for linear uncertainty</u>:

Point conceptual feature translated as line source feature:

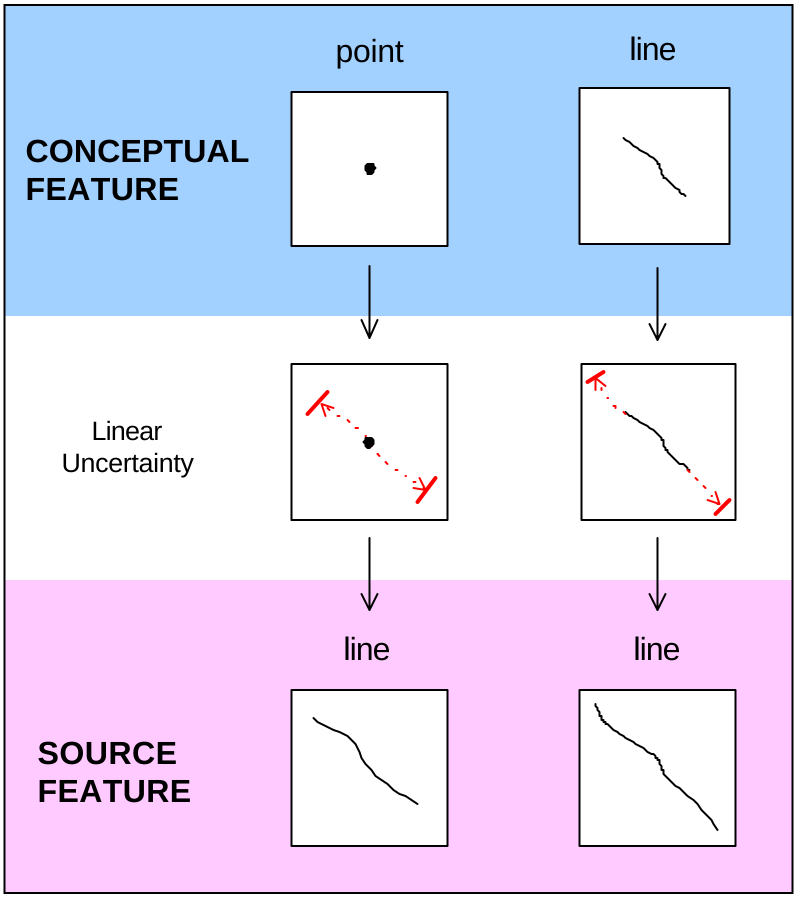
- fish specimen observed at poorly determined position in a stream known to be located somewhere between two bridges
- dragonfly specimen observed along a shoreline at a position determined by the biologist

Line conceptual feature translated as line source feature:

- plant specimens observed on a ridge along a stretch known to begin at a particular trail and extend about 1 km

Figure 7.8 illustrates source features derived from conceptual features having linear uncertainty (indicated by dotted lines extending to the limits of the range of uncertainty of the underlying observation data).

Figure 7.8 - Derivation of Source Features with Linear Uncertainty



7.6.1.3 Areal Delimited Uncertainty

Data having locational uncertainty greater than negligible that varies in two dimensions (*i.e.*, in any direction) and for which boundaries can be drawn has **AREAL DELIMITED UNCERTAINTY.**[41] In such cases, the recorded location of the observation falls within an area having known extent, but the precise position of the observation within that area is not known; thus, the true location of the observation may be visualized as effectively "floating" within a specific area.

The boundaries of the source feature with areal delimited uncertainty are delineated on the basis of

a) referenced features (*e.g.*, natural features [including shorelines, ridges], anthropogenic structures [such as roads, dams, bridges, trails], local political jurisdictions, official land survey units); and/or

b) field biologist's determination of extent.

Note that any combination of these factors may define the extent of uncertainty. Regardless of the basis, however, a conceptual feature having areal delimited uncertainty is modified as a source

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[41] Many existing EOs with the value "U" = unmappable in the PRECISION field of the EO record (EOR) will have areal delimited uncertainty under this Standard. Boundaries for the area within which an unmappable occurrence was observed can frequently be delineated (*e.g.*, watershed, county, national park).

feature to encompass the area within which the observation is known to be located. Thus, all conceptual features having areal delimited uncertainty become polygon source features.

<u>Examples of data that would qualify for areal delimited uncertainty</u>:

Point conceptual feature translated as polygon source feature:

- orchid specimen observed at an indeterminate location somewhere within a particular swamp

Line conceptual feature translated as polygon source feature:

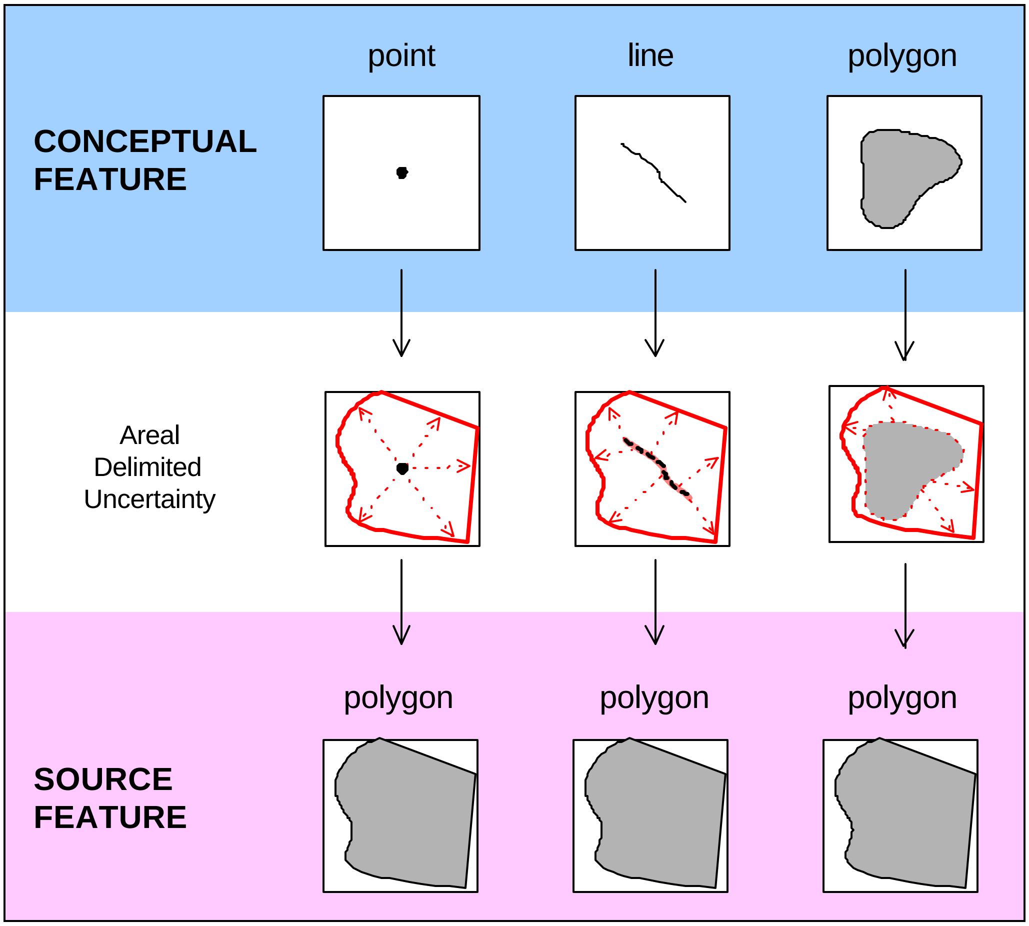
- mussel specimens observed along a small intermittent stream that doesn't appear on any map, but is known to be in a particular county

Polygon conceptual feature translated as polygon source feature:

- three hectares of rodent occupied habitat described at an indeterminate location that is known to be within a specific area bounded by roads on two sides, with the remaining boundaries determined by the biologist

Figure 7.9 illustrates source features derived from conceptual features having areal delimited uncertainty. In this figure, a heavy solid boundary line delineates the known extent within which the location of the observation varies.

Figure 7.9 - Derivation of Source Features with Areal Delimited Uncertainty



7.6.1.4 Areal Estimated Uncertainty

Data having locational uncertainty greater than negligible that varies in two dimensions (*i.e.*, in any direction), but for which boundaries cannot be delimited has **AREAL ESTIMATED UNCERTAINTY.** In such cases, the actual location of the observation is uncertain, or the full extent of the observation is not known; thus, the true location of the observation may be visualized as effectively "floating" within some area for which boundaries cannot be specifically delimited. When developing features with areal estimated uncertainty, a distance representing the locational uncertainty is estimated by the biologist.

Source features with areal estimated uncertainty are derived from point, line, and polygon conceptual features, and the uncertainty applies to the entire feature (*i.e.*, the uncertainty extends in all directions). However, unlike conceptual features with negligible, linear, or areal delimited uncertainty, conceptual features with areal estimated uncertainty are not modified to incorporate uncertainty during translation to source features. Because the actual location of an occurrence with areal estimated uncertainty is uncertain, by definition its boundaries must be approximated; this is best accomplished by applying a buffer for the estimated uncertainty distance around a feature. However, a buffer can only be applied to a tangible feature that is already on a map, so the source feature is delineated to directly reflect the conceptual feature, capturing only the essential information needed (a point, line, or polygon) to anchor the observation to a location.[42] Essentially, the source feature is used as a construction device (locational "tag") that will have an estimated uncertainty distance applied during the next step in the process for developing a spatial representation (see Section 7.7.1, Adding Uncertainty Distance). Since uncertainty is not included in source features with areal estimated uncertainty, a point conceptual feature results in a point source feature, a line conceptual feature results in a line, and a polygon results in a polygon.

<u>Examples of data that would qualify for areal estimated uncertainty</u>:

Point conceptual feature translated as point source feature:

- historical record of a plant specimen located north of a lake

Line conceptual feature translated as line source feature:

- plant specimens observed along a small intermittent stream at an indeterminate unmapped location

Polygon conceptual feature translated as polygon source feature:

- information describing a prairie dog town southwest of a landmark

Figure 7.10 illustrates source features derived from conceptual features having estimated areal uncertainty (indicated by dotted lines).

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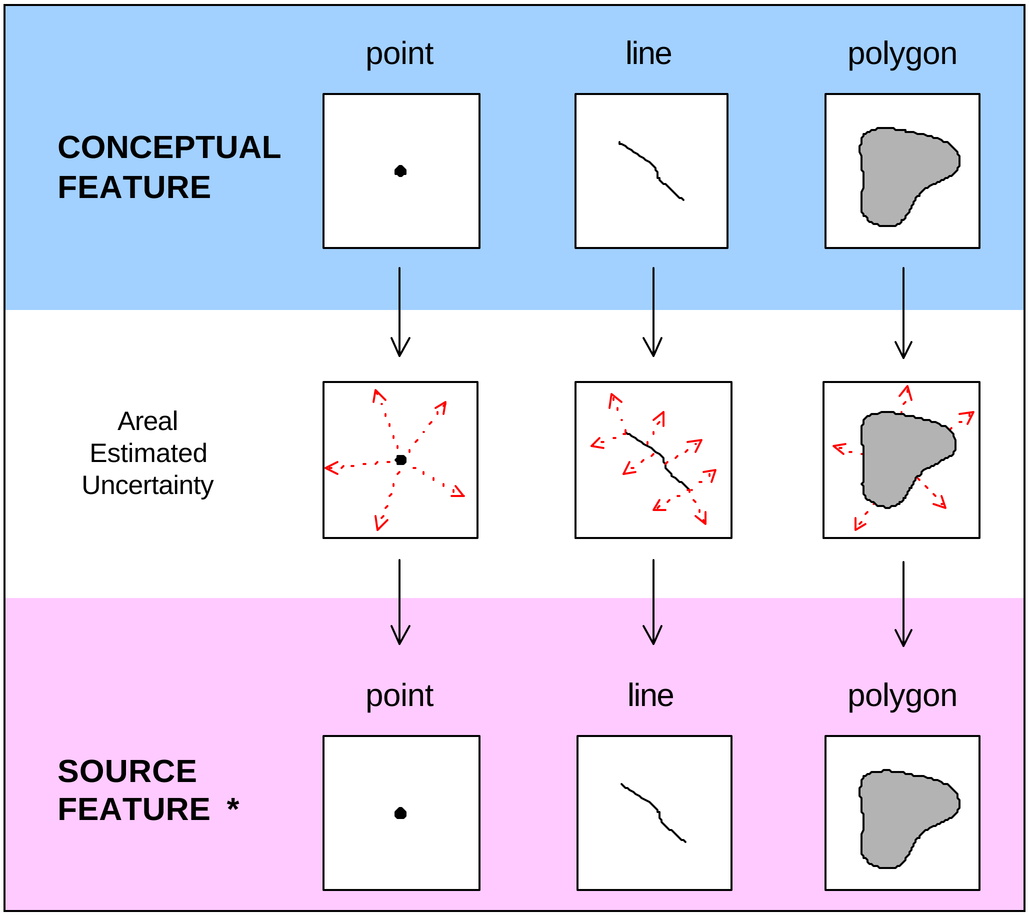
[42] The derivation of source features unmodified by areal estimated uncertainty may be especially important for occurrences having shared boundaries (*e.g.*, tessellated communities); the addition of uncertainty and the resulting approximation of boundaries for such source features would obscure the definitive boundaries between them.

Figure 7.10 - Derivation of Source Features with Areal Estimated Uncertainty



* Locational uncertainty will be added to the source feature at a later step.

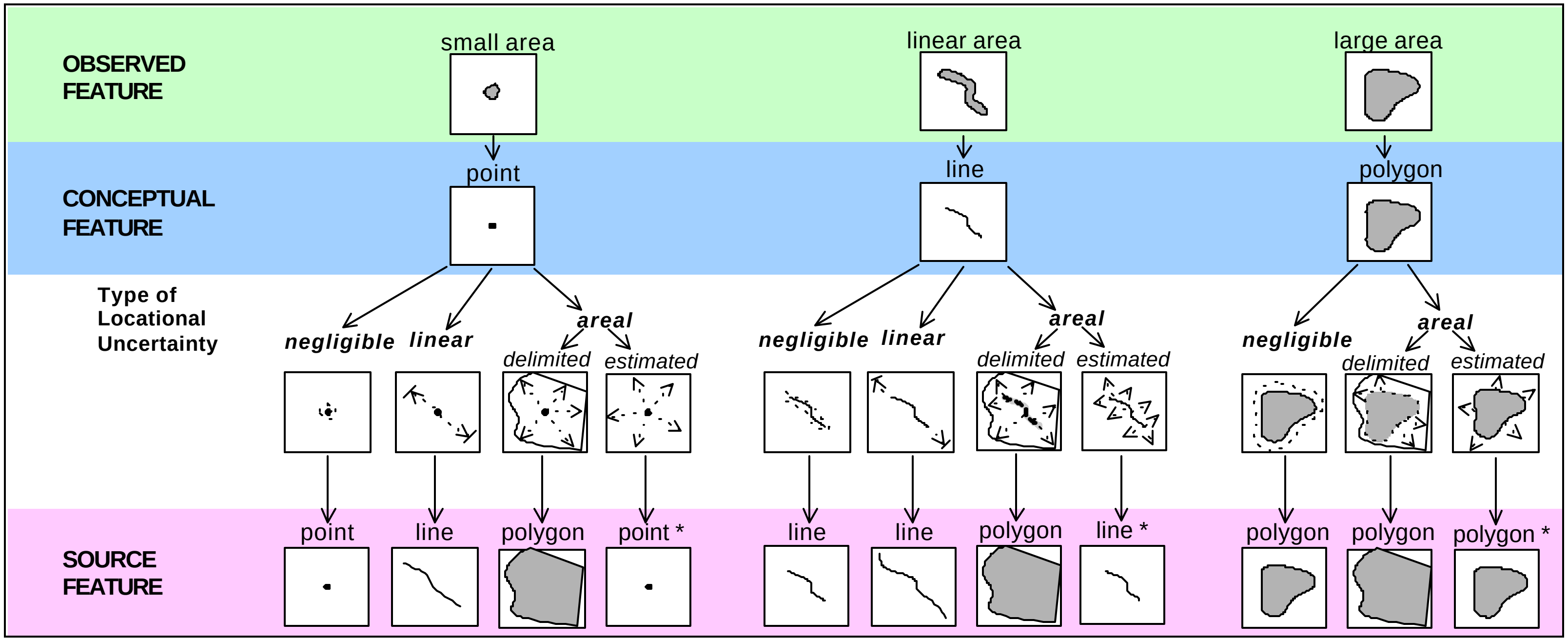
7.6.2 Summary of Source Feature Derivation

As described above, a source feature is the initial mapped spatial component developed from a discrete observation. It is derived through a process that begins with an observed feature based on field survey information (small area, linear area, or large area); next, an observed feature is cartographically characterized as a conceptual feature (point, line, or polygon). A conceptual feature is then developed into a source feature according to the locational uncertainty associated with the underlying observation.

A conceptual feature having negligible, linear, or areal delimited uncertainty is delineated to encompass uncertainty during translation to a source feature. However, a conceptual feature with areal estimated uncertainty is *not* delineated to include uncertainty during translation to a source feature; an estimated uncertainty distance is applied to such features during the next step in the process of developing a spatial representation.

Figure 7.11 and Table 7.1 summarize the derivation of a source feature beginning with an initial observed feature, its characterization as a conceptual feature, and subsequent modification of that feature according to the associated type of locational uncertainty.

Figure 7.11 - Graphic Summary of Source Feature Derivation



* For conceptual features with areal estimated uncertainty, an estimated uncertainty distance will be added to the associated source feature during translation to a basic feature.

Table 7.1 - Tabular Summary of Source Feature Derivation

Observed Feature	small area (x and y both = mmu)				linear area (x or y > mmu)				large area (x and y both > mmu)		
Conceptual Feature	point				line				polygon		
Type of Locational Uncertainty	negligible	linear	areal		negligible	linear	areal		negligible	areal	
			delimited	estimated			delimited	estimated		delimited	estimated
Locational Uncertainty Incorporated	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N
Source Feature	point	line	polygon	point	line	line	polygon	line	polygon	polygon	polygon

* For conceptual features with areal estimated uncertainty, an estimated uncertainty distance will be added to the associated source feature during translation to a basic feature.

7.7 Basic Feature

A **BASIC FEATURE** results from the translation of a source feature to a basic geometric shape (point, line, or polygon) that represents the observation data and its locational uncertainty without the addition of any procedural or programmatic buffers.[43] Because of this, it is basic features that are evaluated according to separation guidelines in the EO specifications to determine whether the features should later be grouped into a single occurrence or processed as separate EOs (see Section 4.3, Separating EOs). Although this determination is made at the basic feature stage, any grouping of features occurs after the final stage in the spatial representation development process.

In most cases, a conceptual feature is modified to incorporate locational uncertainty during translation to a source feature. Specifically, a source feature with negligible, linear, or areal delimited uncertainty is derived through inclusion of locational uncertainty. In contrast, source features with areal estimated uncertainty are translated directly from conceptual features without the addition of locational uncertainty (see Section 7.6.1.4). These source features must be modified to encompass locational uncertainty during translation to basic features.

7.7.1 Adding Uncertainty Distance

The actual location of an occurrence with areal estimated uncertainty is unknown, and the associated locational uncertainty applies to the entire feature (*i.e.*, extends in all directions). In order to incorporate a measure of uncertainty during the derivation of a basic feature, the field biologist approximates the extent of the area within which the actual location of the observation is most likely to be contained. This is accomplished through estimation of a distance that can be uniformly applied outward in all directions from the feature to define the range of extent, resulting in a polygon; GIS tools may be used to facilitate this process. In cases when it is difficult to estimate a distance to be applied to a source feature, selection of a distance range from a set of specified uncertainty distance classes may simplify the process. If a distance class is specified, the largest value in the class would be used to buffer the source feature. Value ranges for uncertainty distance classes are shown in Table 7.2.

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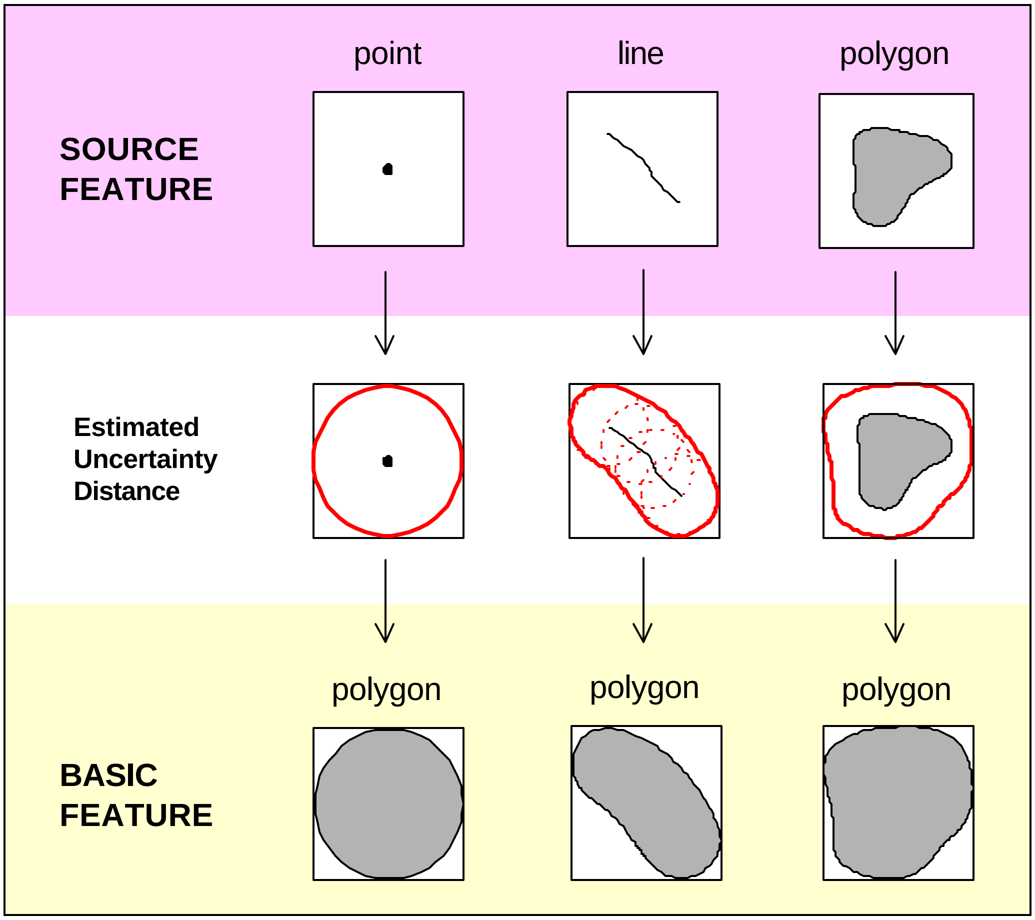
[43] Depending upon the GIS used, in the future it may be possible to derive a standard EO representation directly from the basic feature without any further modification.

Table 7.2 – Uncertainty Distance Classes

Value Range (in meters)
>6.25 – 25
>25 – 50
>50 – 100
>100 – 200
>200 – 400
>400 – 800
>800 – 1500
>1500 – 4000

Figure 7.12 illustrates basic features derived from source features with areal estimated uncertainty, modified to encompass an estimated uncertainty distance (shown as solid red lines).

Figure 7.12 - Derivation of Basic Features from Source Features with Areal Estimated Uncertainty



7.7.2 Summary of Basic Feature Derivation

As described above, a basic feature is a simple geometric shape that represents an observation delineated to include locational uncertainty. It is derived through a process that begins with an observed feature based on field survey information (small area, linear area, or large area). An observed feature is then cartographically characterized as a conceptual feature (point, line, or polygon). Next, a source feature (point, line, or polygon) is developed from a conceptual feature according to the locational uncertainty associated with the underlying observation data. Finally, a basic feature is derived from a source feature through the addition of an estimated uncertainty distance, if locational uncertainty has not already been incorporated in the feature.

Source features with estimated areal uncertainty are modified to encompass an estimated uncertainty distance during translation to basic features. Source features that result from conceptual features having negligible, linear, or areal delimited uncertainty are translated to basic features without modification; such source features already include locational uncertainty.

Because they capture simply the location and associated locational uncertainty of the data, basic features are evaluated according to separation guidelines in the EO specifications to determine whether the features should be subsequently grouped into a single occurrence or processed as separate EOs. However, any grouping of features occurs after the final stage in the process of developing an EO representation.

Figure 7.13 and Table 7.3 summarize the derivation of basic features beginning with an initial observed feature, its characterization as a conceptual feature, modification according to locational uncertainty in developing a source feature, and subsequent translation or modification according to the type of associated locational uncertainty.

Figure 7.13- Graphic Summary of Basic Feature Derivation

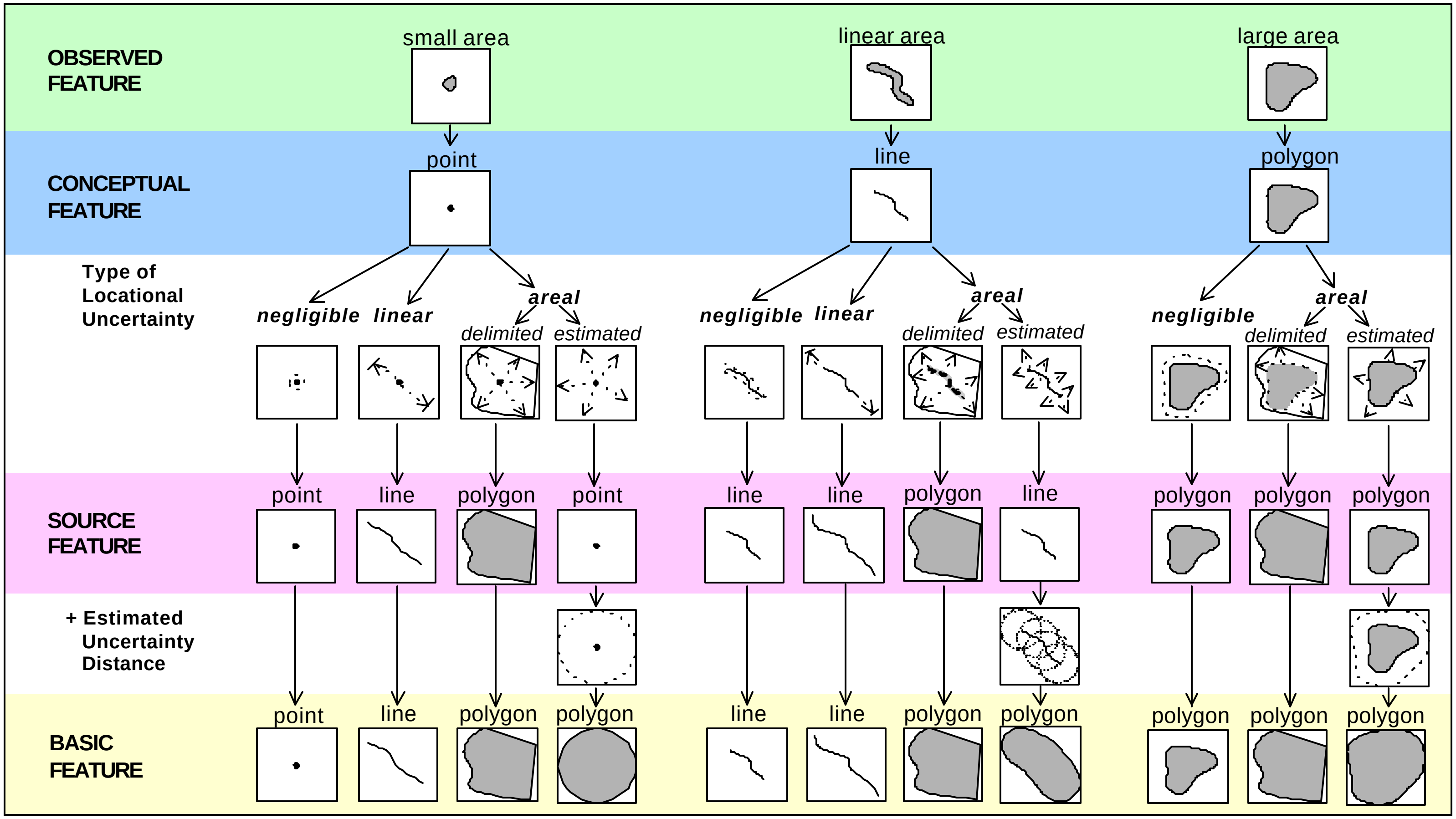


Table 7.3 - Tabular Summary of Basic Feature Derivation

Observed Feature	small area (x and y both = mmu)				linear area (x or y > mmu)				large area (x and y both > mmu)		
Conceptual Feature	point				line				polygon		
Type of Locational Uncertainty	negligible	linear	areal		negligible	linear	areal		negligible	areal	
			delimited	estimated			delimited	estimated		delimited	estimated
Locational Uncertainty Incorporated	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N
Source Feature	point	line	polygon	point	line	line	polygon	line	polygon	polygon	polygon
Estimated Uncertainty Distance Added	N	N	N	Y	N	N	N	Y	N	N	Y
Basic Feature	point	line	polygon	polygon	line	line	polygon	polygon	polygon	polygon	polygon

7.8 Procedural Feature

In order to more easily manage spatial data with the current technology, polygon representations are necessary. In a GIS, the use of polygons facilitates management of features in a single geographic data set. A **PROCEDURAL FEATURE** results from translation of a basic feature to a shape that represents an observation and its locational uncertainty as a polygon on a standard scale map.[44] All procedural features are polygons.

In cases where the basic feature is a polygon, no further modification is needed during translation to a procedural feature. However, a basic feature smaller than the minimum mapping unit in any dimension requires the addition of a **PROCEDURAL BUFFER** to produce a polygon on a standard scale map.

EO representations are developed from one or more procedural features. The determination as to whether an EO representation is comprised of a single or multiple procedural features is based on an evaluation of the preceding basic features according to guidelines for separating occurrences provided in EO specifications for the Element.

7.8.1 Adding a Procedural Buffer

Whether a procedural buffer should be applied to a particular basic feature is dependent on the type of basic feature. Point and line basic features require the application of a procedural buffer equal to half the minimum mapping unit (*i.e.*, mmu/2 = 6.25 m on a 1:24,000 scale map) during the translation process to establish areal dimension of the procedural feature. The addition of procedural buffers will maximize the number of occurrences that would be selected during environmental review.

Figure 7.14 illustrates procedural features derived from basic features modified to include procedural buffers (shown as heavy solid lines).

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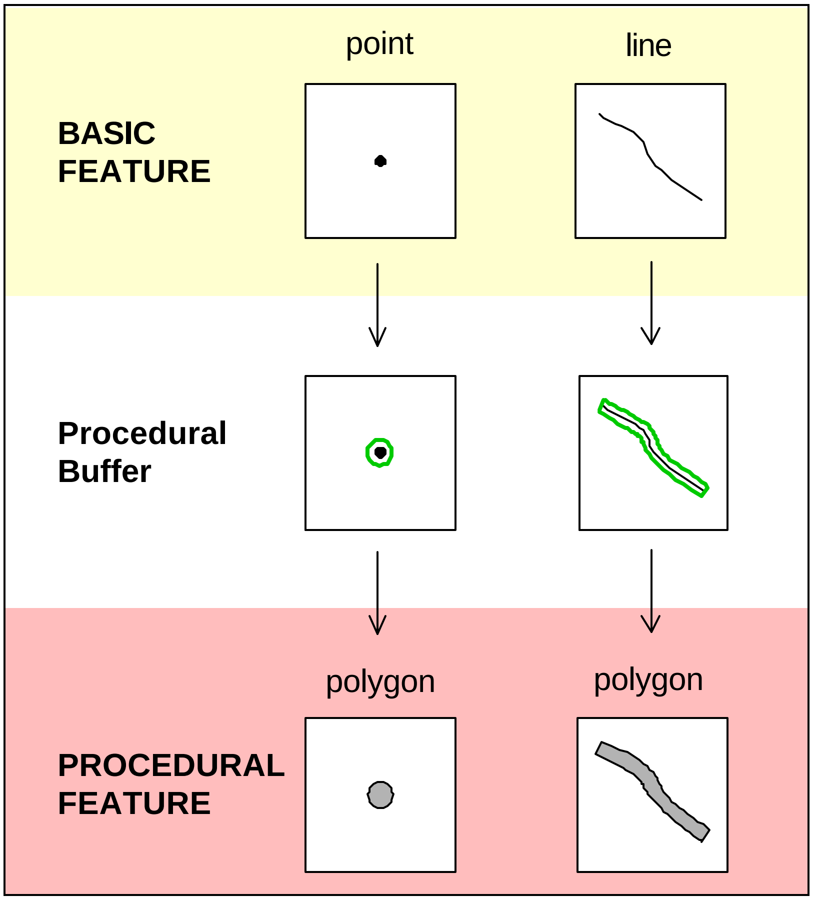
[44] If future advances in GIS technology permit the management of point, line, and polygon features in the same geographic data set, then the procedural feature may become unnecessary as the standard EO representation.

Figure 7.14 - Derivation of Procedural Features from Point and Line Basic Features



7.8.2 Summary of Procedural Feature Derivation

As described above, a procedural feature is a polygon on a standard scale map. It is derived through a process that begins with an observed feature based on field survey information (small area, linear area, or large area). An observed feature is then cartographically characterized as a conceptual feature (point, line, or polygon). Next, a source feature (point, line, or polygon) is developed from a conceptual feature according to the locational uncertainty associated with the underlying observation data. Then a basic feature is derived from a source feature through the addition of an estimated uncertainty distance, if locational uncertainty is not already included in the feature. Finally, a procedural feature is derived from a basic feature through the addition of a procedural buffer (mmu/2) if necessary to establish areal dimension and ensure visibility on a standard scale map. Point and line basic features require modification to include a procedural buffer during translation to procedural features. Procedural features are used to develop EO representations according to an evaluation of the preceding basic features according to separation guidelines provided in the EO specifications for the Element.

Figure 7.15 and Table 7.4 summarize the derivation of procedural features beginning with an initial observed feature, its characterization as a conceptual feature, modification according to locational uncertainty in developing a source feature, translation or modification to include an estimated uncertainty distance in deriving a basic feature, and subsequent translation or modification according to the type of basic feature.

Figure 7.15 - Graphic Summary of Procedural Feature Derivation

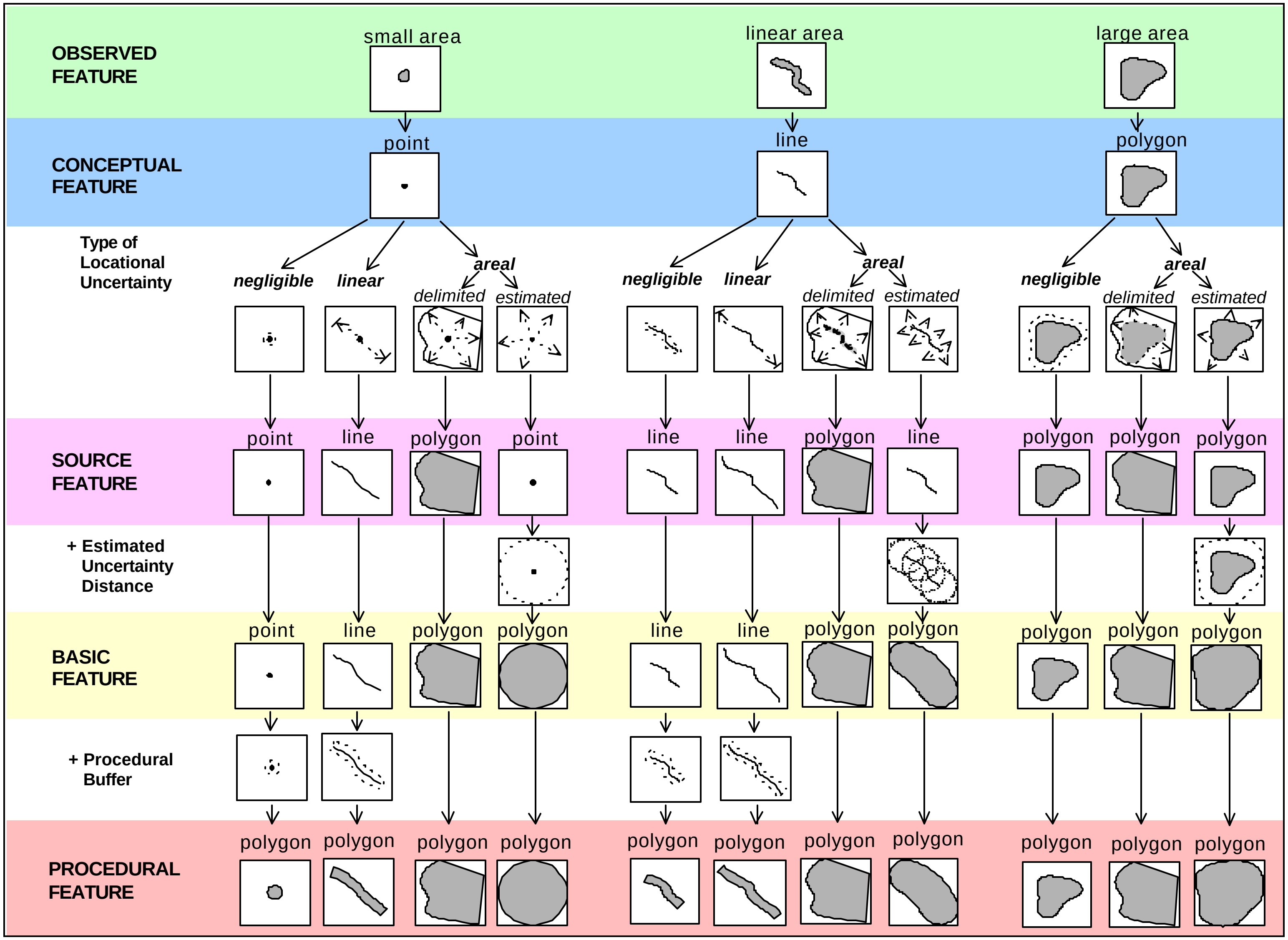


Table 7.4 - Tabular Summary of Procedural Feature Derivation

Observed Feature	small area (x and y both = mmu)				linear area (x or y > mmu)				large area (x and y both > mmu)		
Conceptual Feature	point				line				polygon		
Type of Locational Uncertainty	negligible	linear	areal		negligible	linear	areal		negligible	areal	
			delimited	estimated			delimited	estimated		delimited	estimated
Locational Uncertainty Incorporated	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N
Source Feature	point	line	polygon	point	line	line	polygon	line	polygon	polygon	polygon
Estimated Uncertainty Distance Added	N	N	N	Y	N	N	N	Y	N	N	Y
Basic Feature	point	line	polygon	polygon	line	line	polygon	polygon	polygon	polygon	polygon
Procedural Buffer (mmu/2) Added	Y	Y	N	N	Y	Y	N	N	N	N	N
Procedural Feature	polygon	polygon	polygon	polygon	polygon	polygon	polygon	polygon	polygon	polygon	polygon

7.9 Process for Developing an EO Representation

[This section under development.]

7.9.1 Steps in the Process

[This section under development.]

7.9.1.1 Feature Development

[This section under development.]

7.9.1.2 EO Determination

[This section under development.]

7.10 Accuracy of EO Representations

The procedural features that comprise EOs are derived from observed features through a series of steps that translate observation data into mapped features. This translation process may complicate interpretation of the data since the final polygon EO representations include locational uncertainty that is not readily apparent in the mapped features. In many cases, EO representations will appear to be similar on a map despite having very different amounts of associated locational uncertainty. For example, two identical EO representations derived from line source features could have very different amounts of incorporated locational uncertainty if one was developed from a point conceptual feature and the other from a line conceptual feature.

To facilitate the proper interpretation of data when making comparisons between mapped EOs, a measure reflecting the accuracy of each feature, that is the amount not attributable to added locational uncertainty, should be provided for every EO. This measure, referred to as **REPRESENTATION ACCURACY** (RA), should be displayed using appropriate symbology when EOs are mapped. RA can be either calculated or estimated, depending on the process utilized for determining the value.

7.10.1 Calculated Representation Accuracy

Calculated RA can be determined through computation of a ratio between two areas associated with an EO: the observed area (the surveyed size of the underlying observed area[s] that comprise the occurrence) and the procedural area (the area of the procedural feature[s] derived through the spatial representation process)[45]; the resulting value is then multiplied by 100 to indicate the percentage of the procedural area that reflects the actual size of the initial field observation(s).

$$[\text{Observed Area } (A_O) \div \text{Procedural Area } (A_P)] \times 100 = \text{Calculated RA}$$

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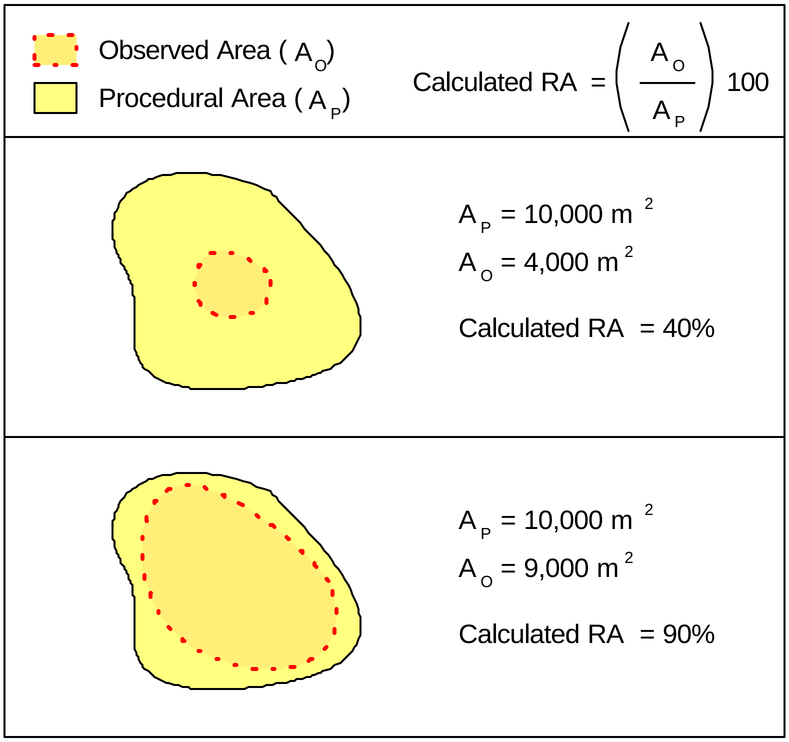
[45] Note that RA is a ratio between two areas rather than the probability of finding the Element at any single specific location within the boundaries of the procedural area.

A feature having a procedural area that closely approximates the observed area has a calculated RA that approaches 100%; there is little locational uncertainty associated with the occurrence and thus, its derived EO representation has high accuracy. Conversely, a feature with a larger procedural area relative to observed area has a relatively low RA since the feature was modified to encompass a significant amount of associated locational uncertainty. Figure 7.16 illustrates two EO representations of the same size (*i.e.*, with the same procedural area) that have differing calculated RA values.

Figure 7.16 - Example Showing Similar EO Representations Having Different Calculated RA Values



Calculating RA for EO representations derived from point and line features is not as straightforward. For point source features, the size of the occurrence is less than the minimum mapping unit. In such cases, the observed area should not be defined as the surveyed size of the observation; rather, the observed area should be defined as the area of a circle equal to the minimum mapping unit. This ensures a baseline calculated RA equal to 100% for point features with negligible uncertainty.

Similarly, for line source features, one dimension of the occurrence is less than the diameter of the minimum mapping unit. Thus, the observed area should not be defined on the basis of the surveyed size of the observation; rather, the observed area should be defined as the area of a rectangle derived from the observed length of the occurrence buffered to the width of the minimum mapping unit. Again, this ensures a baseline calculated RA equal to 100% for line features with negligible uncertainty.

7.10.2 Estimated Representation Accuracy

A practical problem in calculating RA occurs when there is a lack of information available on the size of the field observation. In such cases, there is no value to be used as the observed area, which makes it impossible to compute a calculated RA (unless the feature was derived from a conceptual point or line with negligible uncertainty, as described above). However, an estimate of RA (*i.e.*, a percentage range selected from a scale) can be assigned to every EO by a biologist. Thus, until the underlying data for all EOs provides an observed area measurement obtained through field survey work, estimated RA should be utilized as the common method for comparing the accuracy of EO representations. In cases where a calculated RA can be computed for an EO, that value can be used to determine the appropriate category of estimated RA to be assigned.

The estimated RA scale provides the biologist with five categories from which to select: “very high accuracy”, “high accuracy”, “medium accuracy”, “low accuracy”, and “unknown”. Table 7.5 illustrates the percentage ranges associated with the categories in the estimated RA scale.

Table 7.5 – Estimated RA Scale

Categories of Accuracy	Percentages
very high accuracy	>95%
high accuracy	>80% - 95%
medium accuracy	>5% - 80%
low accuracy	0 - 5%
unknown	?

Features developed with minimal added locational uncertainty have “very high accuracy”, and the accuracy category declines as a greater portion of an EO representation is attributable to added uncertainty. The use of the “unknown” category should be restricted to only those few cases when none of the other categories can be reasonably assigned by a biologist.

7.11 Developing a Complex EO Representation

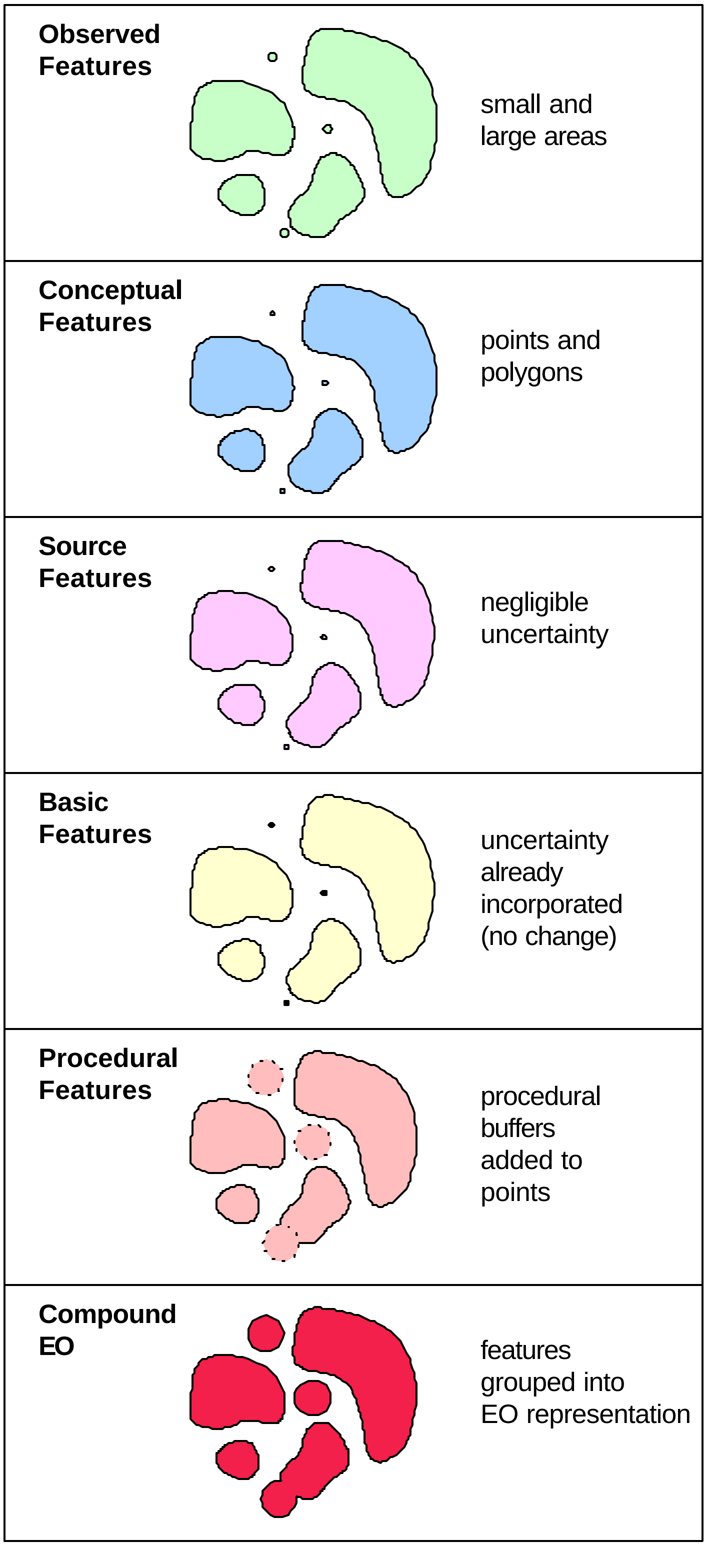
An EO may occupy a location in various complex spatial patterns, depending on the biology of the Element, and different physical and environmental factors (*e.g.*, suitability of habitat). In general, two types of complex EOs have been identified (compound and composite), depending on whether the multiple features that comprise such EOs are discrete or contiguous.

7.11.1 Compound EOs

An occurrence consisting of noncontiguous areas close enough to each other to be considered one EO (based on separation guidelines defined for the Element) is a **COMPOUND EO**. An example of a compound EO would be a pothole pond community comprised of two or more distinct ponds with intervening distances that do not exceed the separation distances specified for the community in EO specifications.

In developing a spatial representation of a compound EO, each discrete observation that comprises the occurrence should proceed through the process described in Sections 7.4 through 7.8 above. Thus, each observation is first categorized as a small, linear, or large area observed feature according to its size in comparison with the minimum mapping unit for the standard scale map. Next, each feature is conceptually characterized, and then further interpreted to encompass associated locational uncertainty, if appropriate, during translation to a source feature. Each source feature may then be optionally modified to encompass an estimated uncertainty distance during the derivation of a basic feature. Finally, during translation to a procedural feature, each component feature may be optionally modified to include a procedural buffer. Multiple procedural features are then grouped to create the EO representation. Note that the addition of estimated uncertainty distances and procedural buffers may result in features that abut or overlap; in such cases, these features would be merged into a single feature. Figure 7.17 illustrates the process of developing a compound EO representation using an example of an occurrence comprised of discrete observations (*i.e.*, patches) of a plant.

Figure 7.17 - Example Showing the Derivation of a Compound EO Representation



Some compound EOs may be comprised of a very large number of distinct features due to many observations. In cases where the number of features comprising an occurrence is excessive, it may be more practical (particularly for mobile animals) to define a single boundary for the EO that encompasses all the features rather than retaining the individual components. When creating such an inclusive polygon (which would be an additional source feature for the EO), the boundaries should be delineated to include only the existing associated basic features and any intervening area that is appropriate habitat only (*i.e.*, interpolation), without incorporating any additional area.[46] Decisions as to whether to delineate a single EO boundary or retain distinct features defining a complex EO are dependent on many factors, including characteristics of the Element, the nature of the intervening area between the features, and resource considerations of the program.

For animals that occur in linear patterns, particularly aquatic species, it may be valid to create a single polygon once there are at least two distinct features that comprise a single occurrence, based on separation guidelines provided in the EO specifications. For animals that do not typically occur in a linear pattern, it may be more reasonable to create a single polygon when there are three or more distinct features that comprise an EO; delineating a boundary based on only two features for such Elements would essentially define a "path" between the two locations, which would likely be an inaccurate representation of the actual occupancy.
[this section on grouping features under development]

7.11.2 Composite EOs

An occurrence comprised of different contiguous areas reflecting different categories of observed features is a **COMPOSITE EO**. An example of a composite EO would be a fish population observed in both a section of stream (a linear area) and a pond (a large area).

In developing a spatial representation of a composite EO, the occurrence should initially be separated into the different types of observed features from which it is constituted. Similar to the compound EO representation described above, each feature of a composite representation should be processed according to the steps summarized in Sections 7.4 through 7.8. The procedural features derived through this process should then be rejoined to create an EO representation. Figure 7.18 illustrates the process of developing a composite EO representation using an example of an occurrence comprised of a lake and a portion of an outlet stream occupied by a fish.

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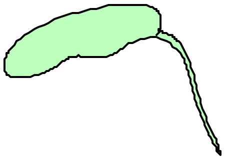
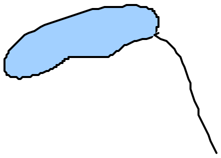
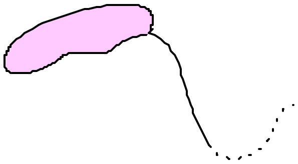
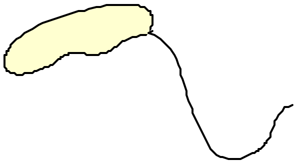
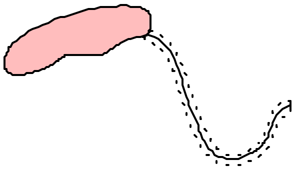
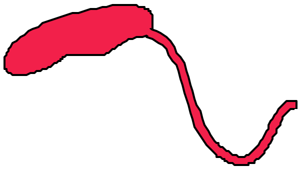
[46] EO boundaries should not be expanded outward a prescribed distance from the actual area occupied to capture presumed territory, range, or movement (*i.e.*, "biological buffers" should not be used in delineating EOs).

Figure 7.18 - Example Showing the Derivation of a Composite EO Representation

Observed Features		linear area and large area
Conceptual Features		line and polygon
Source Features		line with linear uncertainty; polygon with negligible uncertainty
Basic Features		uncertainty already incorporated (no change)
Procedural Features		procedural buffer added to line
COMPOSITE EO		features grouped into EO representation

7.12 Multiple EO Representations of a Single Element

7.12.1 Different Kinds of EOs

Both principal EOs and sub-EOs may be represented spatially. Regardless of which kind of EO is defined by the underlying information, the process for developing spatial representations is exactly the same (described in Sections 7.4 through 7.8). Each occurrence begins as an observed feature based on the minimum mapping unit for the standard scale map, is next characterized as a conceptual feature, translated according to locational uncertainty to a source feature, optionally modified with an estimated uncertainty distance to become a basic feature, and finally optionally modified with a procedural buffer during translation to a procedural feature. After the procedural features have been developed for both kinds of occurrences, EO representations and associated records are created.

In order to be considered a sub-EO, the derived procedural feature must be located entirely within the boundaries of another procedural feature for that Element, or must be one of the procedural features that comprise a complex (*i.e.*, multi-source) EO. The nesting relationship between a parent and sub-EO is established through a link in the records associated with the features. Sub-EOs are identified and linked to the parent EO through insertion of the parent identification number in each sub-EO record.

A sub-EO should be identified only when there is specific information related to a component of an occurrence that is better tracked in a record separate from that of the parent EO. Otherwise, it is preferable to simply create an EO from multiple source features (see Section 7.11, Developing a Complex EO Representation) rather than processing each source into a separate EO and then establishing a linkage between the parent and sub-EO.

7.12.2 Overlapping Principal EOs

In some situations a principal EO can overlap or contain another principal EO of the same Element. However, in such cases, the features must have different types of associated locational uncertainty and/or different representation accuracy values. Generally, an initial principal EO (typically based on historical or secondary source information) has more added locational uncertainty than any subsequent principal EOs; as additional survey work is performed over the area delineated by the original principal EO, more current principal EOs with less associated uncertainty may eventually replace the older occurrence.

Example:

- A principal EO is initially be created from an herbarium record describing a patch of *Rugelia nudicaulis* (Rugel's ragwort) on the slope of a mountain, with the information processed as a point with areal delimited uncertainty and boundaries delineated to encompass the entire slope. When a new, detailed field survey records a sighting of the plant on a small portion of the same slope, the information becomes a second principal EO. Depending on the size of the observation and the survey technique, this second EO may be processed as either a point or polygon conceptual feature with either negligible or areal

> delimited uncertainty. (If the latter, the area delineated is significantly smaller than the original herbarium EO representation, and thus, has a higher RA value.) It would likely be desirable to retain both records as principal EOs; because the new survey covered just a portion of the area identified in the herbarium record, it cannot necessarily be assumed that the new occurrence at a very specific location within the larger principal EO replaces that original occurrence. When additional fieldwork covering the entire slope is completed and any occurrences of the Element are mapped, the initial principal EO derived from the herbarium record could be deleted.

7.13 EO Point Representations

Every EO representation should have an associated reference point located within the boundaries of one of the underlying procedural features. An **EO POINT REPRESENTATION** (*i.e.*, the reference point) is used to represent an EO at any map scale small enough that the boundary of the occurrence is not apparent. When using a GIS, reference points are typically generated automatically. However, in some cases it may be desirable to manually position the reference point at a particular location within a procedural feature. For example, a point automatically generated for an EO representation for a particular animal may fall in an area used for transient activities; in this instance, it may be more desirable to manually position the reference point near an area with a consistently high concentration of individuals, such as a den site.

7.14 Generalized EO Representations

One of the major uses of EO information, particularly spatial representations, is distribution to private business, conservation organizations, government agencies, and to the general public. These clients often do not need (and arguably should not always have) information on the precise locations of occurrences; instead, EO representations distributed to clients should show only general locations where Elements are likely to be found. A **GENERALIZED EO REPRESENTATION** that blurs the boundaries and/or offsets the position of an EO may be used to protect information on the location of a sensitive Element on a map to be used for public distribution (*e.g.*, maps showing EOs by watershed or by county).

7.15 Detailed Features

In some cases, very precise locational information is known for a particular EO. Given the scale of a standard map, the procedural feature(s) derived for such an occurrence may generalize the feature to such a degree that detailed spatial information is not discernible (*e.g.*, a circular polygon may result from very precise information for a small area). In such cases, a **DETAILED FEATURE** may be used to represent the data at a scale larger than that of a standard map, thus retaining the most complete, accurate, and specific spatial information for that occurrence (see Figure 7.4, Additional Features Associated with an EO Representation).

The process for generating a detailed feature differs from the standard procedure for developing an EO representation (described in Sections 7.4 through 7.8 above) only in the use of a larger scale map and smaller minimum mapping unit. Thus, a detailed feature begins as one or more large area observed features. The observed features are next characterized as polygon conceptual features, and then translated according to locational uncertainty (either negligible or areal delimited) to polygon source features. The source features are translated without modification to basic and procedural features, with evaluation of separation distances according to EO specifications determining if and how features should be grouped to denote an EO.

Because a detailed feature is developed on a larger scale map than the standard, it is not comparable with EOs developed using the process for developing an EO representation. In order to translate a detailed feature into an EO representation, the underlying observation data must proceed through the steps for developing an EO representation using a standard scale map, described in Sections 7.4 through 7.8. Specifically, using the standard scale map, the data is interpreted as one or more observed features based on the minimum mapping unit, each of which is characterized as a conceptual feature, translated according to locational uncertainty to a source feature, optionally modified with an uncertainty distance to become a basic feature, optionally modified with a procedural buffer during translation to a procedural feature, and then grouped (according to evaluation of separation distances in the EO specifications) to create an EO representation.

7.16 Observations

[Although this section is included here, it is not part of the Draft EO Data Standard developed through a formal design and acceptance process by the EO Working Group. It is based on information obtained during an EO workshop convened in September, 1999, to collect requirements for a Heritage Data Management System (HDMS) currently under development. Approximately half of the participants at this workshop were members of the EO Working Group.]

In order to constitute a valid EO, information on observed areas for an Element must meet minimal criteria provided in the EO specifications for that Element. However, it may be useful to track the spatial location and minimal data on an observation that does not meet the specifications, and is thus, not a component of an EO. Over time, such independent observations may ultimately be combined with other data on observed areas to define an EO.

Although a formal methodology for creating and managing observation data has yet to be developed, an interim solution has been proposed that would utilize source features to track observed areas, regardless of whether such observations are to be associated with an EO in the foreseeable future. This model is based on the assumption that an observed area (*i.e.*, observation) is represented by a single source feature. Minimal information could be associated with the source feature (*e.g.*, observer, date, brief description of the observation), and the feature would be identified as an independent observation rather than a feature that is to be linked immediately to an EO representation. The independent observation/source feature could later become a component of an EO when deemed appropriate based on EO specifications, typically when further information on the Element at that location is obtained, or when sufficient additional observations of the Element within the appropriate separation distance have been made to accurately define the boundaries of an EO.

7.17 Spatial Requirements for Animals

[Although this section is included here, it is not part of the Draft EO Data Standard developed through a formal design and acceptance process by the EO Working Group. It is section is based on information obtained during an EO workshop convened in September, 1999, to collect requirements for a Heritage Data Management System (HDMS) currently under development. Approximately half of the participants at this workshop were members of the EO Working Group. Subsequent information on this topic has been provided by zoologists Larry Master and Geoff Hammerson.]

Many animal species, especially terrestrial vertebrates, have significant requirements for space in order to find sufficient food for themselves and/or their offspring. These spatial requirements are sometimes referred to as the animal's "home range". Considerable research has been conducted to characterize the movement patterns of animal species, and results indicate that the spatial requirements (or home range size) for an individual of a particular species may vary temporally and spatially depending on a number of factors, including availability of resources, season, and sex of the individual. Despite this variability, it is possible to determine an average home range requirement for many species that would be included in the characterization information for the Element.

Frequently, the spatial requirement of an individual (based on evaluation of the home range) exceeds the size of the EO that is being developed from field survey information. In most cases, the EO representation is developed according to the process described in Sections 7.4 through 7.8 above, and the fact that the representation delineates an area less than the likely extent of the Element (based on average spatial requirements) is generally indicated through a confidence extent of "N" = confidence that the full extent of the EO is not known. (See Section 2.1 for further discussion on principal EOs and confidence extent.)

7.17.1 Inferred Extent (IE)

Most EOs are located in an area of suitable habitat that exceeds the spatial requirements for the Element. However, EO representations are developed on the basis of what was actually observed in the field, without inclusion of any unsurveyed but available suitable habitat at that location (see Section 7.17.2 for the single exception to this model). While EO representations accurately reflect what is known from underlying survey information, an EO representation with a confidence extent = "N" (or perhaps "?") may not effectively illustrate the likely extent of the Element at that location. In such cases, after the EO representation has been developed, a separate inferred extent (IE) feature could be generated to better represent potentially/probably occupied habitat for some animals, and could be utilized in analyses for which estimates of occupied area would be useful (*e.g.*, conservation planning, environmental review).

In order to generate an IE feature, the following criteria must be met:

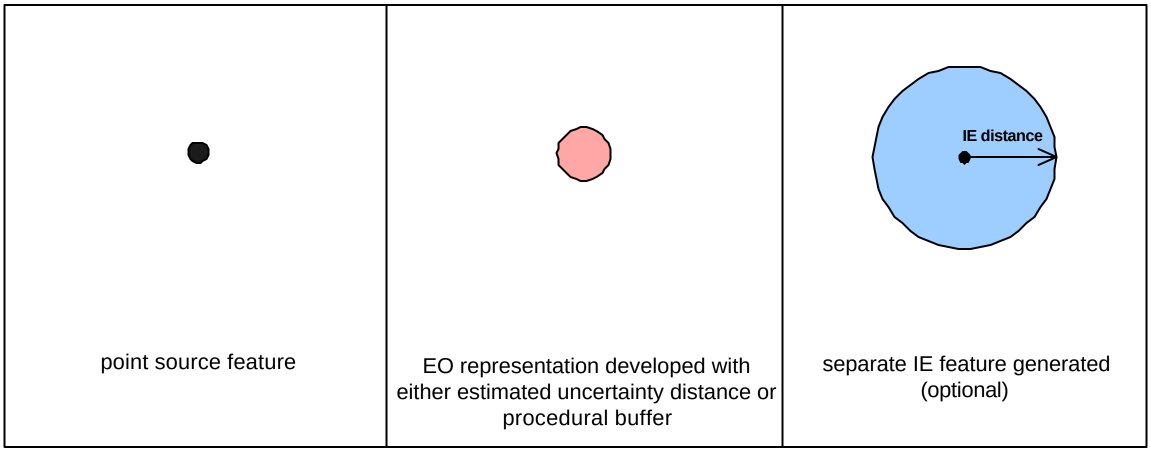
- the EO specifications for the Element provide an IE distance value;
- the EO representation was developed from one or more <u>point</u> source features; and

- the size of the final EO representation (incorporating an uncertainty distance or procedural buffer) is smaller than the IE feature will be.

An IE feature is generated by buffering the underlying source feature(s) of a principal EO representation by the specified IE distance for the Element. IE distance is an approximate spatial requirement for a particular species, typically based on the average home range (specifically, a distance equal to the diameter of the median home range). However, for some animals (*e.g.*, pond-breeding amphibians, rattlesnakes moving from a den) the IE distance represents the distance from an initial location (in any direction) that would encompass the ultimate destination of 75-90% of the dispersing adult individuals.

Habitat known to be unsuitable and/or unused can be edited (removed) from an IE feature after it has been generated. Note that IE features are retained and managed in a GIS separately from EO representations. Figure 7.19 illustrates the process for generating an IE feature from a source feature.

Figure 7.19 – Generating an IE Feature



point source feature

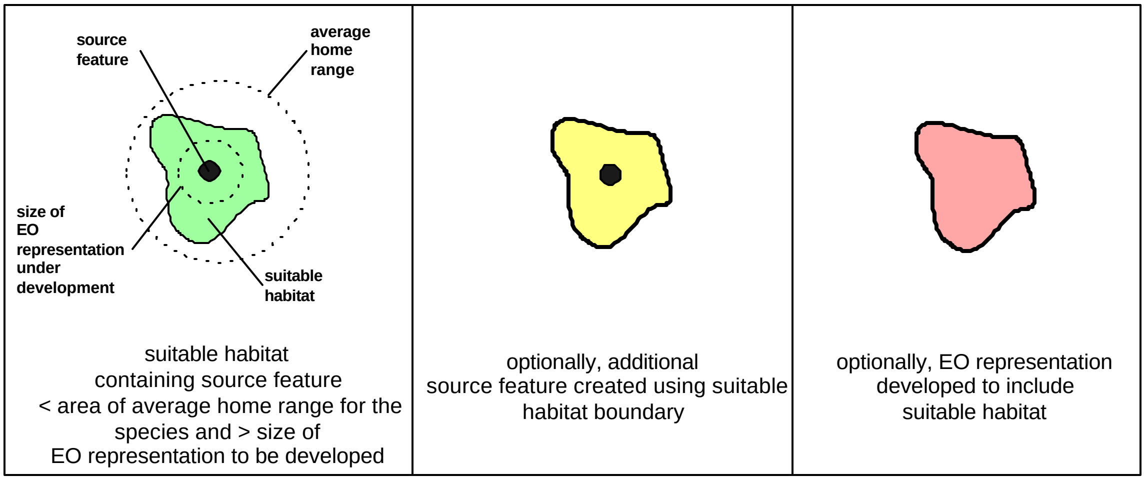
EO representation developed with either estimated uncertainty distance or procedural buffer

separate IE feature generated (optional)

7.17.2 Inclusion of Home Range

In rare cases, a source feature is located in an area of known suitable habitat smaller than the average home range for the animal; further, the EO representation being developed from that source feature (including either an estimated uncertainty distance or procedural buffer) will be smaller than the available suitable habitat. Since the average spatial requirement of the individual exceeds the available suitable habitat surrounding such an EO representation, it would be appropriate to assume that the individual is utilizing all of the suitable habitat at that location to survive. In such cases only, an additional source feature matching the boundary of the available suitable habitat could be included when developing the EO representation. If the available suitable habitat is comprised of discrete patches, only the patch within which the source feature is located could be used as an additional source feature, since it cannot be determined which other patches are being utilized by the animal without additional survey work. Figure 7.20 illustrates the rare case when an additional source feature based on available suitable habitat could be included when developing an EO representation.

Figure 7.20 – Optional Incorporation of Home Range When Developing an EO Representation



suitable habitat containing source feature < area of average home range for the species and > size of EO representation to be developed

optionally, additional source feature created using suitable habitat boundary

optionally, EO representation developed to include suitable habitat

7.18 Symbology for Spatial Data

[This section under development.]

7.19 Map Scale Considerations

[Although this section is included here, it is not part of the Draft EO Data Standard developed through a formal design and acceptance process by the EO Working Group. It is based on information obtained during an EO workshop convened in September, 1999, to collect requirements for a Heritage Data Management System (HDMS) currently under development. Approximately half of the participants at this workshop were members of the EO Working Group.]

Features digitized in a GIS may have different levels of associated map accuracy, depending on the scale of the reference maps utilized for mapping the observation locations. Generally, the larger the scale of a map, the higher its accuracy. The scale at which an observation is mapped is important information that needs to be recorded with the associated source feature.

Different jurisdictions frequently utilize different scale reference maps for mapping spatial data. Currently, in the United States, most Heritage Programs map observed area locations based on 1:24,000 reference maps; however, in Canada, most Conservation Data Centers map observed area locations based on 1:50,000 reference maps. In addition, some programs utilize other reference map data, such as satellite imagery or aerial photography, which can be at any scale (*e.g.*, 1:10,000; 1:30,000).

Differences of map scale can also occur within a jurisdiction. For example, a state may have large scale aerial photography available for a portion of state, and utilize 1:24,000 USGS topographic quadrangle maps for the remainder of the state. In this case, data mapped using the aerial photography will be more accurate than data mapped using the quadrangle maps.

When comparing spatial representations, it is important to ensure that all the features have been mapped at the same scale. Features mapped using different scale reference maps have different levels of associated map accuracy, and cannot be compared without first translating all the features to the smallest scale map utilized for mapping any of the data under evaluation. This translation would be accomplished by processing the observation data through the stages described in Sections 7.4 through 7.8. Note that translation of features to a smaller scale map may result in the loss of detailed boundary information associated with features originally mapped at a larger scale. For example, a large area observed feature translated to a polygon source feature with a precisely delineated boundary may be replaced by a small area observed feature translated to a point source feature, and eventually a circular polygon due to the larger minimum mapping unit associated with the smaller scale map.

7.20 Spatial Representation of Multi-Jurisdictional EOs

Because the location of an occurrence reflects Element biology and various physical and environmental factors (*e.g.*, substrate, habitat, hydrologic regime), EO representations can cross jurisdictional boundaries. Multi-jurisdictional EOs pose special challenges for data management, since information on the occurrence in a neighboring jurisdiction may be lacking, and/or the base maps for the neighboring jurisdiction may be in a different scale or projection, may not have edges matched, or may be unavailable. To ensure that programs tracking a multi-jurisdictional EO have accurate and complete information on the full extent of the occurrence, collaboration between the relevant jurisdictions is important. Such collaboration includes determining which jurisdiction has lead responsibility for maintaining information on the occurrence, and sharing data among the jurisdictions involved. Notes on collaborative efforts between relevant jurisdictions may be documented in the EO record.

To facilitate appropriate interpretation of an EO record, occurrences that cross one or more jurisdictional boundaries should be flagged “multi-jurisdictional”. The tabular information in these records (*e.g.*, EO rank, EO data, description) should reflect the full multi-jurisdictional extent of the occurrence, regardless whether that full extent is represented spatially on the associated maps. In addition, for a multi-jurisdictional EO, the EO record should indicate whether or not the spatial representation delineates the full multi-jurisdictional extent of the occurrence.[47]

Ideally, the spatial representation of a multi-jurisdictional EO should also delineate the full extent of the occurrence across jurisdictions. However, this may not be possible or practical, particularly in situations where the Element is not tracked in all jurisdictions in which the occurrence is located. As a result, the representation developed by a particular jurisdiction may not necessarily include portions of the occurrence outside of that jurisdiction.

[Although the following section is included here, it is not part of the Draft EO Data Standard developed through a formal design and acceptance process by the EO Working Group. It is based on information obtained during an EO workshop convened in September, 1999, to collect requirements for a Heritage

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[47] Information on the extent of an EO spatially represented should not be confused with information related to whether the full extent of an EO is known (described in Section 2.1, Principal EOs).

Data Management System (HDMS) currently under development. Approximately half of the participants at this workshop were members of the EO Working Group.]

In cases where the Element is tracked in all jurisdictions in which a multi-jurisdictional EO is located, the concept of principal and sub-EOs may be useful for managing such occurrences, and could be applied as follows. Each program having a significant portion of a multi-jurisdictional EO within its jurisdiction would initially create a principal EO. One of the programs would assume the responsibility for creating and maintaining a principal EO that encompasses the entire extent of the EO (*i.e.*, across jurisdictions), and each of the associated programs would provide a copy of their EO record to the designated lead program. The lead would create a single multi-jurisdictional principal EO based on the principal EO records received, and then each of these initial principal EOs would become sub-EOs. The multi-jurisdictional principal EO record would contain minimal attribute data since more detailed information would be retained in the sub-EO records. Key attributes for the multi-jurisdictional principal EO would need to be determined cooperatively, and any changes to the boundary of the EO would also require a collaborative effort.

8 EO DATA MANAGEMENT

8.1 Benchmark Standards

8.2 Transcription

8.3 Quality Control

--*to be written*

9 OBSERVATIONS AND EOs

9.1 Information Contained in the Observations Database

EO specifications delineate the minimal criteria that must be met in order for data on a particular Element to constitute an EO. Information that does not meet the specifications for that Element (*i.e.*, information that is insufficient for an EO) may be recorded in an observations database.

Transcribing non-EO data in the observations database may be useful in defining occupied habitats for animal Elements, as well as for other analyses. However, use of this database to track data is entirely optional.
[this section under development]

9.2 Evaluating Observation Data to Delineate EOs

--*to be written*

APPENDIX A: Migratory Status and Location Use Class

An animal Element may be categorized according to its seasonal patterns of movement. Animals that do not make significant seasonal movements to and from different habitats are characterized in this document as nonmigratory.[48] Animals that make significant seasonal movements (*e.g.*, to breeding or wintering grounds) are characterized as migratory. These movements typically coincide with climatic and/or breeding seasons, and usually relate to the availability of food, shelter, or breeding sites. Migratory animals include many birds, fishes, bats, marine mammals, sea turtles, amphibians, and insects such as butterflies and dragonflies.

The seasonal movement patterns of a population influence the delineation of principal EOs for that Element (see Section 2.1, Principal EOs). In order to include all habitat necessary for the survival of a migratory Element throughout its life cycle, consideration of different seasonally occupied habitats as well as any migratory corridors is imperative. Based on different seasonal movement patterns, migratory Elements may be divided into two general categories. Elements in the first group, terrestrial and freshwater species, have a single principal EO for a given population encompassing different seasonally occupied habitats and any migratory corridors. Because principal EOs for this group tend to be quite large, tracking sub-EOs may be useful for identifying specific areas within them (see Section 2.2, Sub-EOs). These sub-EOs may be described using different feature labels (see Section 2.3, Feature Labels).

Elements in the second group, aerial, marine, and anadromous species, have multiple seasonally disjunct principal EOs, each encompassing only one seasonally occupied habitat. For this group of migrants, location use classes must be used to indicate the seasonal usage of principal EOs (see Section 2.4, Location Use Classes).

Commonly recognized location use classes include

breeding
nonbreeding
adult foraging area
juvenile foraging area
nesting area
calving area
nursery area
migratory stopover

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[48] Some species have both migratory and nonmigratory populations. Such species shall be treated here as migratory Elements, and should include a “nonmigratory” class. Note also that dispersal of juveniles from a population does not qualify as migration unless it is part of a seasonal cycle involving departure and return.

migratory corridor
staging area
hibernaculum
maternity colony
bachelor colony
freshwater
estuarine
marine
nonmigratory
undetermined

An Element would typically have two classes, but may have up to four. Note that there is not necessarily a one-to-one correspondence between location use class and breeding/nonbreeding status (*e.g., Myotis grisescens* [gray bat] may be considered to be breeding in all classes except “bachelor colony” [example in A2.2.2 below]).

A1 Nonmigratory Elements

A population of a nonmigratory Element occurs in one area throughout the life cycle of the individual species, not including initial dispersal. Because a nonmigratory species’ population exists in essentially the same location throughout its lifetime, only this location can be designated as the occupied habitat. Thus, for a given population, a nonmigratory Element may have only one principal EO described by an “occupied habitat” feature label; multiple sub-EOs may also (optionally) be delineated. Location use classes are not applicable for nonmigratory Elements.

Example:

- *Vulpes macrotis,* kit fox

Location Use Class	Potential Feature Labels
(none)	den occupied habitat*

* The “occupied habitat” feature label is typically not used.
(See Section 2.3 for a discussion of the use of feature labels.)

A2 Migratory Elements

A2.1 Terrestrial and Freshwater Migrants

Some migratory animals move within defined terrestrial or freshwater aquatic corridors, typically between breeding and nonbreeding areas of occupancy. Examples include caribou, short-distance altitudinal mammal migrants, and some freshwater fishes that migrate (typically upstream) to spawn. These animals are dependent not only on the habitats they use for breeding and nonbreeding, but also on the habitats in the corridor that connect these areas. If a major highway or an impassable dam is constructed that blocks the corridor, the population may be effectively destroyed even though both the breeding and nonbreeding habitats are protected. Thus, in order to conserve a population of these corridor migrants, it is necessary to protect the entire area that is contiguously occupied during their life cycle. For these species, the contiguously occupied habitat, including the corridors between breeding and nonbreeding/wintering areas, should be treated as a single principal EO. If useful, sub-EOs may be optionally tracked and described using feature labels.

Examples:

- *Rangifer tarandus*, caribou

Location Use Class	Potential Feature Labels
(none)	calving ground wintering area migratory corridor occupied habitat*

* The “occupied habitat” feature label is typically not used.

- *Emydoidea blandingi*, Blanding's turtle

Location Use Class	Potential Feature Labels
(none)	nesting area occupied habitat*

* The “occupied habitat” feature label is typically not used.

- *Acipenser fulvescens*, lake sturgeon, and
  Ptychocheilus lucius, Colorado squawfish

Location Use Class	Potential Feature Labels
(none)	spawning area occupied habitat*

* The “occupied habitat” feature label is typically not used.

A2.2 Aerial and Marine Migrants

A2.2.1 Long Distance

Most aerial and marine aquatic migratory animals move between breeding and nonbreeding (*e.g.*, wintering) habitats by flying over or swimming through broad areas of intervening habitat. It is not critical to protect *all* of the intervening habitat in order to conserve the populations of a species for such migrants, as they can potentially fly over or swim around unsuitable areas. Examples include some birds, bats, butterflies, dragonflies, sea turtles, whales, and seals.[49]

The geographically and seasonally occupied disjunct habitats between which these species travel are typically used either for breeding, wintering, or staging/refueling (during migration), and each has conservation value for the species. Because these areas may differ in conservation importance, it is necessary to identify those seasonally occupied habitats that are significantly utilized by individuals of the species during the year in order to ensure survival of the species (see Appendix B: Persistence and Practical Conservation Value). Conservation of only one of these habitats (*e.g.*, breeding) for a species would be insufficient to conserve the species if the other seasonally occupied habitats (*e.g.*, nonbreeding) were destroyed or degraded. In order to classify these disjunct areas according to their conservation value, EOs for these aerial or noncorridor migratory species must be assigned to a location use class (*e.g.*, breeding, nonbreeding, migratory stopover) that describes the usage of the area by the species.

In some cases, the occupied-habitat EOs for some Elements during a given season may be unknown, such as may be the case for long-distance aerial migrants where the occupied habitat for one season is located on another continent. When entering the ocean, anadromous fishes become marine migrants whose nonbreeding concentration areas, if any, are mostly unknown (see Appendix A2.3, Anadromous Migrants). To conserve these species, it will ultimately be necessary to identify and ensure the protection of these currently unknown habitats.

Examples:

- *Haliaeetus leucocephalus*, bald eagle

Location Use Class	Potential Feature Labels
breeding	nest site breeding territory occupied habitat *
nonbreeding	roosting area feeding area occupied habitat *

* The “occupied habitat” feature label is typically not used.

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[49] Note that there is evidence that some marine species (*e.g.*, whales, loggerheads [sea turtles]) may, at times, follow fairly narrow migration routes in the open ocean after they leave their seasonally occupied feeding or breeding/nesting areas. These corridors should be recognized as belonging to a distinct location use class if they are long (*e.g.*, hundreds of kilometers). Some bird migrants (*e.g.*, altitudinal bird migrants in the tropics) may follow narrow corridors and/or be reluctant to cross even small patches of unsuitable habitat. For these Elements, it is critical to protect the area between seasonally occupied habitats. This area may be appropriately included as part of a single EO, although feature labels may be used if desired to distinguish breeding, nonbreeding, and transient areas.

- *Myotis grisescens*, gray bat

Location Use Class	Potential Feature Labels
hibernaculum	cave mine occupied habitat*
migratory stopover	cave mine bridge
maternity colony	cave mine bridge occupied habitat*
bachelor colony	cave mine bridge occupied habitat*

* The “occupied habitat” feature label is typically not used.

- *Chelonia mydas*, green turtle

Location Use Class	Potential Feature Labels
breeding	nesting beach
nonbreeding	juvenile feeding area occupied habitat *

* The “occupied habitat” feature label is typically not used.

- *Eschrichtius robustus*, gray whale

Location Use Class	Potential Feature Labels
breeding	occupied habitat *
nonbreeding	occupied habitat *
migratory corridor	migratory corridor

* The "occupied habitat" feature label is typically not used.

A2.2.2 Short Distance

Some migratory animals fly only a short distance, typically on a seasonal basis, between areas used for seasonal feeding or breeding purposes. Many of these are altitudinal migrants that migrate up and downslope depending on season and food availability. Some species migrate only a short distance such that breeding and nonbreeding areas may be contiguous or nearly so. These species should be treated as if they were terrestrial migrants (*i.e.*, with no location use classes).

Example:

- *Lagopus leucurus*, white-tailed ptarmigan

Location Use Class	Potential Feature Labels
(none)	breeding area occupied habitat*

* The "occupied habitat" feature label is typically not used.

Other short distance migrant species migrate somewhat longer distances such that there may be some separation between breeding and nonbreeding habitats. Many of these species are known to readily cross patches of unsuitable habitat. If it is thought that the habitat suitability of the intervening area between seasonally occupied breeding and feeding areas is inconsequential to a species, the species should be treated as if it were a long distance migrant. The species should have breeding and nonbreeding location use classes, and intervening areas of transit between seasonally occupied habitats should not included as part of any (breeding or nonbreeding) EO.

Example:

- *Procnias tricarunculata*, three-wattled bellbird

Location Use Class	Potential Feature Labels
breeding	occupied habitat*
nonbreeding	occupied habitat*

* The "occupied habitat" feature label is typically not used.

A2.3 Anadromous Migrants

Anadromous fishes breed in freshwater and move downstream to live as nonbreeding individuals in marine environments before returning some years later to breed in the same freshwater streams where they hatched. Upstream habitats used for breeding may sometimes be interspersed in the migratory corridor when the areas used for breeding may not readily or practicably be distinguished from areas used solely for passage.

Anadromous species (*e.g.*, salmon) are both corridor and noncorridor migrants. While in freshwater habitats, they are naturally restricted to stream channels. When they enter marine environments these species are thought to be more widely dispersed and not confined to a corridor.

Like freshwater migrants (see Appendix A2.1, Terrestrial and Freshwater Migrants), the construction of an impassable dam that blocks the freshwater migratory corridor for anadromous species can cause loss of the population, even though the upstream breeding habitat may be protected. Thus, the entire contiguously occupied freshwater stream system used by a given population that spawns at a particular season should be treated as a principal EO. In delineating the contiguously occupied freshwater habitat of an anadromous fish population, it is possible that an entire stream network may be defined as the principal EO. In such cases, it may be of practical benefit to identify sub-EOs, such as breeding areas, basin subpopulations, or migratory corridors. For some Elements, the lower portions of a watershed may contain many overlapping EOs of different breeding populations that separate, either spatially into distinct headwater streams to spawn, or temporally by spawning at different times.

In principle, there are two classes of EOs for anadromous fishes: freshwater and marine.[50] However, when in the marine environment, the whereabouts of many anadromous species is largely unknown, and like aerial migrants, they are likely somewhat dispersed. As nonbreeding concentration areas become known, these should be treated as a second class of principal EOs. In practice, EOs are generally delineated only for freshwater or estuarine locations of anadromous fishes.

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[50] Catadromous species (*e.g.*, eels), which breed in marine environments and occur in freshwater habitats as nonbreeders, are treated similarly.

Example:

- *Oncorhynchus tshawytscha*, Chinook salmon or king salmon

Location Use Class	Potential Feature Labels
freshwater	spawning area migratory corridor basin, (*i.e.*, hydrological division of entire occupied habitat) occupied habitat *
marine	[unknown – typically not tracked]

* The "occupied habitat" feature label is typically not used.

A2.4 Multiple Species in Migratory Concentration Areas

Some areas are utilized for limited time periods by a large number of migrating animals. Migratory stopover areas should be tracked as EOs if they contain a significant (*i.e.*, according to Element-specific EO specifications) aggregation of the species. Similarly, migratory corridors should be protected only if the corridor has practical conservation value (*i.e.*, is vital for migration of the species between seasonally occupied habitats).

Although a particular migratory concentration area may not contain a significant number of individuals of any species of conservation concern (and hence would not be tracked as an EO), the area may nonetheless contain a significant aggregation of multiple species. Such significant transient assemblages of multiple species should be tracked as EOs. In this case, the Element of concern is not an individual species but is an Element in the "other"[51] group. Examples include migratory shorebird concentrations, waterfowl concentrations, and bat hibernacula.

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[51] According to the standard documented in the Natural Heritage Program Model Operations Manual (The Nature Conservancy 1988), Elements are divided into the following groups: vascular plants, nonvascular plants, vertebrate animals, invertebrate animals, communities, and "other". "Other" Elements were defined to include transient aggregations of mixed species. Although vague, the term "other" has been used because no standard classification or tracking system has yet been developed for transient animal communities. This is an area that needs to be addressed by the Heritage Network in the future.

<u>Examples</u>:

- Western hemisphere shorebird aggregation

Location Use Class	Potential Feature Labels
(none)	roosting area feeding area occupied habitat*

* The "occupied habitat" feature label is typically not used.

- North American mixed bat species assemblage

Location Use Class	Potential Feature Labels
(none)	Cave mine bridge building occupied habitat*

* The "occupied habitat" feature label is typically not used.

APPENDIX B: Persistence and Practical Conservation Value

B1 Persistence[52]

A primary purpose for delineating EOs is to guide conservation (*e.g.,* site protection, environmental review, inventory, recovery efforts, research) for the Elements represented by those occurrences. It is therefore critical that EOs have **PRACTICAL CONSERVATION VALUE** for the Elements they represent. Persistence at a specific location typically establishes the conservation value of that location.

Generally, in order to qualify as an EO, the potential continued presence and/or regular recurrence of an Element at a given location is necessary. In other words, an Element must potentially persist at a location in order to be designated an EO. Evidence of likely ephemeral presence of an Element at a location, lacking persistence, should not result in the designation of an EO. For most Elements (especially perennial plant species, stable communities, and nonmigratory animal species), persistence is presumed to be established by evidence of presence. More specifically, for community Elements, stability is judged as persistence under natural processes for a time period specific to that Element.

For some plant species (*e.g.,* those with long-term seed dormancy or other dormant stages), very dynamic communities, and migratory animal species, persistence is often defined by real or apparent recurrence. This recurrence may be due to return migrations, periodic disturbance, or fluctuating environmental conditions. For aerial migrants during their migration, the designation of an EO requires temporary (*e.g.,* a week or more) presence in a given season, significant aggregation, and likely recurrence in different years.

B2 Ephemeral Presence

Evidence of likely ephemeral presence of an Element should not result in the designation of an EO. Habitat occupied in an ephemeral, irregular, transitory, or dispersed manner that does not routinely or irreplaceably contribute to the survival or persistence of an Element at that location lacks conservation value and should not be designated as an EO. Typically, this will be the case for dispersing large mammals, or dispersed long-distance migrants (often assigned an “NZN” or “SZN” Element rank for “zero EOs” in a given jurisdiction).

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[52] Appendix B1 also appears above as Section 2.5, Persistence and Practical Conservation Value, and is repeated here for reference.

Examples:

- Large mammals pass through numerous areas as they disperse; if other routes are just as likely to be utilized in the future, the locations fail to contribute routinely to persistence of the Element and should not be considered EOs.
- Areas used ephemerally or irregularly by relatively low numbers of individuals during long-distance migration should not be considered EOs, since the presence of the Element at a particular time does not indicate persistence of the Element at that specific location, nor does it have particular conservation value for that Element.

B3 Recurrence

In some cases, evidence of ephemeral presence of an Element may establish practical conservation value of a location due to recurrence. In other words, any periodicity of an Element (*i.e.*, recurring presence of the Element at a location, usually in relatively large numbers, either due to migratory behaviors, environmental factors, or intermittent dormancy) should be considered in defining persistence.

Examples:

- Despite occupation for ephemeral periods of time, a significant annual migratory concentration area for shorebirds (*e.g.*, >1000 individuals for some species; see Element-specific EO specifications) should be designated an EO since the location has practical conservation value, ensuring the successful migration and continued survival of the species.
- Seed-banking annual plants are often dependent on specific environmental conditions, which may not appear for numerous years. Examples are desert annuals dependent on moisture, or coastal plain pond annuals (such as *Rhexia aristosa*) dependent on drawdown of the water table and exposure of the substrate at a particular season. Note that these plants actually permanently occupy the site; it is only their aboveground appearance that is recurrent, with intervening periods where they may be present exclusively as propagules.
- Many grassland bird species breed only in prairie grasslands of a certain height or density (a short-term cyclic phenomenon, probably originally driven by fire, drought, bison, and prairie dogs). *Ammodramus bairdii* (Baird's sparrow) may only breed at a location for a year or two, and then not reappear for perhaps a decade; however, previously occupied breeding locations not currently in use should be considered EOs to ensure protection of adequate areas for breeding.
- Some communities are of short duration at a given point in a landscape, but are consistently present within the landscape as a result of establishment by disturbance (such as fire or flooding). Aspen forests in a fire landscape, point bar willow communities, and jack pine forests are pertinent examples. Within an area (determined for the Element), shifting patches of a given community could be considered an EO, even though the existence of any given patch (polygon) may be predictably short.

- In some parts of their range, *Loxia leucoptera* (white-winged crossbills) require large crops of spruce cones to successfully breed. Although these seed crops and their associated crossbills may only re-occur every few years, these locations should be considered EOs.

B4 Recurrence Without Survival

The recurrent presence of an Element at a particular breeding location where it is unable to survive has little or no conservation value, and should not be considered an EO.

Examples:

- Some butterflies successfully breed over large areas at the far northern edge of their range during the summer. These populations should not be considered EOs if there is no known return southward migration and any overwintering stages perish due to frost, so that the progeny never survive to contribute to future generations. As a result, the habitat is repopulated, sometimes annually, through immigration. These habitats should not be considered EOs for such Elements.
- Some plants regularly disperse long distances, but fail to survive and reproduce because of unsuitable conditions (*e.g.*, climate). Red mangrove (*Rhizophora mangle*) or coconut (*Cocos nucifera*) propagules regularly reach temperate shores, but cannot survive and reproduce. Such short-term localities should not be considered EOs.

B5 Presence Without Reproduction

An Element at a location without evidence of successful reproduction may have conservation value as a potential source for continued survival of the Element, and thus could be considered an EO.

Examples:

- The last known individuals of the white wartyback (mussel), *Plethobasus cicatricosus*, exist as an old, nonreproducing “population” living in the cold tailwaters (too cold to support their host fishes) resulting from hypolimnetic dam discharges. Such populations should be tracked as EOs as they represent the last known populations and last hope for recovering the species (*e.g.*, should conditions improve).
- Due to fragmentation effects (*e.g.*, increased predation and parasitism), birds at some locations may fail to produce offspring most years. Nonetheless, the habitat may rarely contribute individuals to the regional population, or it may serve as habitat for pre-reproductive birds, or it may potentially be restored, or the causes of reproductive failure could lessen. Such locations could be tracked as EOs.

B6 Persistence in a Landscape Context

Some Elements, including short-lived species, transient communities, and their dependent species, are unable to persist at exactly the same site for extended periods of time. However, these Elements do remain present within the larger landscape in shifting patterns. For such Elements, persistence, and therefore determination of occurrences, should be judged within a temporal and landscape context (see Section 4.3.2.5[d], Temporal Patterns of Occurrence).

Example:

- Some communities dependent on fire processes having short return intervals may shift in location. For example, in some areas, *Pinus banksiana* (jack pine) and *Picea mariana* (black spruce) forest types have fire regimes where crown fires or high-intensity surface fires kill most or all trees over large areas. Typical return intervals for some stands are in the range of 40-100 years, but some stands may re-burn and reproduce only 15-20 years after a fire, while others may not recur for 200 years or more (Heinselman 1996). A large principal EO comprised of a shifting mosaic of stands can be defined within the landscape; fires may alter the shifting patchwork but may not significantly change the boundaries of the principal EO.

APPENDIX C: Spatial Patterns of Different Community Types

Within an ecoregion, natural terrestrial communities may be categorized into four functional groups on the basis of their current or historical patterns of occurrence, as correlated with the distribution and extent of landscape features and ecological processes. These groups are identified as matrix communities, large patch communities, small patch communities, and linear communities.

C1 Matrix Communities

Communities that form extensive and often contiguous cover may be categorized as matrix (or matrix-forming) community types. Matrix communities occur on the most extensive landforms and typically have wide ecological tolerances. Individual Element occurrences of the matrix type typically range in size from 2000 to 405,000 hectares (approximately 5000 to 1,000,000 acres). In a typical ecoregion, the aggregate of all matrix communities covers, or historically covered, as much as 75-80% of the natural vegetation of the ecoregion. Any matrix occurrence is likely to have large patch and small patch occurrences embedded within it. Matrix community types are often influenced by large-scale processes (*e.g.*, climate, fire), and are important habitat for wide-ranging or large area-dependent fauna, such as large herbivores or birds (*e.g.*, bison, prairie chickens).

C2 Large Patch Communities

Communities that form large areas of interrupted cover may be categorized as large patch community types. Individual EOs of this community type typically range in size from 20 to 2000 hectares (approximately 50 to 5000 acres). Large patch communities are associated with environmental conditions that are more specific than those of matrix communities, and that are less common or less extensive in the landscape. In a typical ecoregion, the aggregate of all large patch communities covers, or historically covered, as much as 20% of the natural vegetation of the ecoregion. Like matrix communities, large patch community types are also influenced by large-scale processes, but these tend to be modified by specific site features that influence the community.

C3 Small Patch Communities

Communities that form small, discrete areas of cover may be categorized as small patch community types. Individual EOs of this community type are typically 20 hectares (approximately 50 acres) or less. Small patch communities occur in very specific ecological settings, such as on specialized landform types or in unusual microhabitats. In a typical ecoregion, the aggregate of all small patch communities covers, or historically covered, only as much as 5% of the natural vegetation of the ecoregion. Small patch community types are characterized by localized, small-scale ecological processes that can be quite different from the large-scale processes operating in the overall landscape. The specialized conditions of small patch communities, however, are often dependent on the maintenance of ecological processes in the surrounding matrix and large patch communities. In many ecoregions, small patch communities contain a disproportionately large percentage of the total flora, and also support a specific and restricted set of associated fauna (*e.g.*, invertebrates, herpetofauna) dependent on specialized conditions.

C4 Linear Communities

Communities that form as linear strips are often, but not always, ecotonal between terrestrial and aquatic systems. Examples include coastal beach strands, bedrock lakeshores, and narrow riparian communities. Similar to small patch communities, linear communities occur in very specific ecological settings, and the aggregate of all linear communities covers, or historically covered, only a small percentage of the natural vegetation of the ecoregion. They also tend to support a specific and restricted set of associated flora and fauna. Linear communities differ from small patch communities in that both local scale processes and large scale processes, such as lake/ocean currents or riverine flow regimes, strongly influence community structure and function. This characteristic often leaves these communities highly vulnerable to alterations in the surrounding land and waterscape.

C5 Examples of Community Types in Different Ecoregions

The following examples illustrate matrix, large patch, and small patch communities in a diverse set of ecoregions. Note that the scale and pattern of communities designated in these four categories may vary considerably depending on the ecoregion and its scale and distribution of landscapes.

C4.1 Northern Tallgrass Prairie

Matrix:

- *Andropogon gerardii – Stipa spartea – Sporobolus heterolepis* Herbaceous Vegetation [Northern Mesic Tallgrass Prairie] on glacial lakeplains
- *Schizachyrium scoparium – Bouteloua curtipendula – Stipa spartea – (Pascopyrum smithii)* Hill Herbaceous Vegetation [Little Bluestem – Porcupine Grass Hill Prairie] on ground moraines

Large Patch:

- *Schizachyrium scoparium – Bouteloua* spp. – *Stipa spartea* Gravel Herbaceous Vegetation [Northern Little Bluestem Gravel Prairie] found on beach ridges associated with the edges of lakeplains
- *Carex lacustris* Herbaceous Vegetation [Lake Sedge Wet Meadow] and *Scirpus* spp. – *Typha* spp. Mixed Herbs Great Plains Herbaceous Vegetation [Great Plains Bulrush – Cattail Marsh] found in large wet basins of the lakeplain

Small Patch:

- *Carex prairea – Scirpus americanus – Rhynchospora capillacea* Herbaceous Vegetation [Great Plains Calcareous Fen] found in seeps along the beach ridges
- *Calamagrostis stricta – Carex sartwellii – Carex praegracilis – Plantago eriopoda* Saline Herbaceous Vegetation [Saline Wet Meadow] found in local saline upwellings in the lakeplain

Linear:

- *Fraxinus pennsylvanica - Ulmus americana - (Celtis occidentalis, Tilia americana)* Northern Forest [Northern Ash-Elm-Hackberry Floodplain Forest]

C4.2 Northern Appalachian/Boreal Forest

Matrix:

- *Picea rubens – Betula alleghaniensis* Forest [Red Spruce – Yellow Birch Forest]
- *Acer saccharum – Betula alleghaniensis – Fagus grandifolia / Viburnum lantanoides* Forest [Montane Northern Hardwoods Forest]
- *Picea rubens – Abies balsamea – Sorbus americana* Forest [Montane Spruce Fir Forest]

Large Patch:

- *Picea rubens – Abies balsamea – Betula papyrifera* Forest [Lowland Spruce Fir Forest]
- *Abies balsamea – (Betula cordifolia)* Forest [High Elevation Fir Forest]
- *Picea mariana / Pleurozium schreberi* Forest [Upland Black Spruce Forest]
- *Picea mariana / Ledum groenlandicum / Sphagnum* spp. Forest [Black Spruce / Labrador Tea / Sphagnum species Forest]

Small Patch:

- *Carex (interior, hystricina, flava) – Eriophorum alpinum* Herbaceous Vegetation [Northern Appalachian Short Sedge Fen]
- *Tofieldia glutinosa – Parnassia glauca* Herbaceous Vegetation [Circumneutral Riverside Seep]
- *Thuja occidentalis / Hylocomium splendens* Forest [Circumneutral Northern White Cedar Swamp]

Linear:

- *Polypodium vulgare* Acid Bedrock Cliff Sparse Vegetation [Common Polypody Acid Bedrock Cliff]

C4.3 East Gulf Coastal Plain

Matrix:

- several associations in the *Pinus palustris* Woodland Alliance [Longleaf Pine Woodland Alliance] and the *Pinus palustris* Saturated Woodland Alliance [Longleaf Pine Saturated Woodland Alliance]
- several associations in the *Pinus elliottii* Temperate Saturated Woodland Alliance [South Florida Slash Pine Temperate Saturated Woodland Alliance]

Large Patch:

- several associations in the *Taxodium ascendens* Seasonally Flooded Forest Alliance [Pond-Cypress Seasonally Flooded Forest Alliance]

Small Patch:

- several associations in the *Rhynchospora oligantha – Sarracenia* spp. – *(Aristida beyrichiana, Ctenium aromaticum, Muhlenbergia expansa)* Saturated Herbaceous Alliance [Feather-bristle Beaksedge – Pitcherplant species – (Southern Wiregrass, Toothache Grass, Savanna Hairgrass) Saturated Herbaceous Alliance]

Linear:

- *Cakile constricta* Sparse Vegetation [Gulf Sea-rocket Sparse Vegetation]

C4.4 Chihuahua Desert

Matrix:

- several associations in the *Larrea tridentata* Shrubland Alliance (including *Larrea tridentata / Erioneuron pulchellum* Shrubland and *Larrea tridentata – Euphorbia antisyphilitica* Shrubland) [Creosotebush Shrublands]

Large Patch:

- several associations in the *Pinus cembroides* Woodland Alliance [Pinyon Woodlands]
- several associations in the *Pinus ponderosa* Woodland Alliance [Ponderosa Pine Woodlands]
- *Atriplex obovata / Tidestromia carnosa* Dwarf-shrubland [Gypseous Clay Badlands]

Small Patch:

- several associations in the *Arbutus xalapensis – Acer grandidentatum – Quercus* spp. Forest Alliance [Xalapa Madrone – Bigtooth Maple – Oak species Forest Alliance]
- *Scirpus americanus – Flaveria chlorifolia – (Helianthus paradoxus)* Herbaceous Vegetation [Olney Threesquare – Clasping Flaveria – (Puzzle Sunflower) Herbaceous Vegetation]

<u>Linear</u>:

- several associations in the *Salix gooddingii* Temporarily Flooded Woodland Alliance [Goodding Willow Temporarily Flooded Woodland]
- several associations in the *Platanus wrightii* Temporarily Flooded Woodland Alliance[Arizona Sycamore Temporarily Flooded Woodland]
- *Panicum blubosum* - *Lycurus phleoides* Herbaceous Vegetation [Bulb Panic Grass - Common Wolf's-Tail Herbaceous Vegetation], among other herbaceous riparian communities

C4.5 Tropical Florida

<u>Matrix</u>:

- several associations in the *Cladium mariscus* ssp. *jamaicense* Seasonally Flooded Herbaceous Alliance [Sawgrass Marshes], *Muhlenbergia filipes* – *Rhynchospora microcarpa* – *Centella erecta* Herbaceous Vegetation [Muhly Prairie], and various mangrove alliances

<u>Large Patch</u>:

- several associations in the *Pinus elliottii* Tropical Woodland Alliance [Pine Rocklands], *Batis maritima* – *Sarcocornia perennis* Dwarf-shrubland [Batis Flats]

<u>Small Patch</u>:

- several associations in the *Bursera simaruba* – *Coccoloba diversifolia* – *Ocotea coriacea* – *Eugenia axillaris* Forest Alliance [Tropical Hardwood Hammocks], *Schizachyrium rhizomatum* – *Aristida purpurascens var. tenuispica* – *Eragrostis spectabilis* Herbaceous Vegetation [Rockland Glade]

<u>Linear</u>:

- several associations in the *Coccoloba uvifera* Shrubland Alliance [Sea Grape Shrubland Alliance] "coastal strand" and foredune communities

APPENDIX D: Examples of EO Specifications and EO Rank Specifications Using Templates

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D1 Species Elements

D1.1 Species Having No Location Use Classes

D1.1.1 *Acipenser brevirostrum*, shortnose sturgeon

D1.1.2 *Acronicta albarufa*, dagger moth

D1.1.3 *Amaranthus pumilus*, seabeach amaranth

D1.1.4 *Aphelocoma coerulescens*, Florida scrub-jay

D1.1.5 *Bufo boreas*, western toad

D1.1.6 *Gymnoderma lineare*, rock gnome lichen

D1.1.7 *Lycaeides melissa samuelis*, Karner blue butterfly

D1.1.8 *Lysimachia asperulifolia*, rough-leaf loosestrife

D1.2 Migratory Species Having Location Use Classes

D1.2.1 *Histrionicus histrionicus*, harlequin duck

D2 Community Elements

D2.1 Matrix Communities

D2.1.1 *Pinus ponderosa / Physocarpus monogynus* Forest,
ponderosa pine / mountain ninebark forest

D2.1.2 *Quercus alba – Quercus rubra – Quercus macrocarpa / Carpinus caroliniana* Forest,
white oak – red oak – bur oak / musclewood forest

D2.1.3 *Tsuga canadensis – (Betula alleghaniensis)* Mesic Forest,
eastern hemlock – (yellow birch) mesic forest

D2.2 Large Patch Communities

D2.2.1 *Artemisia tridentata* spp. *tridentata / Pseudoroegneria spicata* Shrub Herbaceous Vegetation,
basin big sagebrush / bluebunch wheatgrass shrub herbaceous vegetation

D2.2.2 *Thuja occidentalis – (Picea mariana – Abies balsamea) / Alnus incana* Wetland Forest,
eastern white cedar – (black spruce – balsam fir) / speckled alder wetland forest

D2.3 Small Patch Communities

D2.3.1 *Carex lasiocarpa – Carex buxbaumii – Scirpus cespitosus* Boreal Herbaceous Vegetation,
wiregrass sedge – sedge sp. – bulrush sp. boreal herbaceous vegetation

D2.4 Linear Communities

The following examples of specifications utilize templates described in Section 4, EO Specifications and Section 5, EO Ranks and EO Rank Specifications, above. These have been chosen to represent a range of Element groups, life histories, ecological settings, and levels of understanding. Note that for brevity, the citations referenced in these examples are not included in the Bibliography of this document.

D1 Species Elements

D1.1 Species Having No Location Use Classes

D1.1.1 *Acipenser brevirostrum*, shortnose sturgeon

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA
An occurrence is defined by any collection or observation of single or multiple individuals. Although this species is migratory, breeding and nonbreeding areas are linked by narrowly defined, continuous corridors (rivers) which must be used for each upstream and downstream migration. Ideally, an occurrence should include the entire portion of a river (from the downstream estuary to the point of furthest upstream passage) utilized by the fish in a specific drainage over the course of an entire breeding cycle. Thus, the occurrence will include areas used for spawning and overwintering as well as the migratory corridor. Specific breeding and nonbreeding areas may be optionally tracked as sub-EOs.

EO Separation

SEPARATION BARRIERS
Barriers that would restrict all, or nearly all, fish passage include anthropogenic barriers (*e.g.*, dam, impoundment) or natural barriers (*e.g.*, high waterfall).

SEPARATION DISTANCE – UNSUITABLE HABITAT

SEPARATION DISTANCE – SUITABLE HABITAT

ALTERNATE SEPARATION PROCEDURE
All observations or collections within the same river drainage will be considered part of the same occurrence unless there is an intervening barrier which restricts fish passage, regardless of the distance between observation or collection points.

SEPARATION JUSTIFICATION
Because these migratory fish move from downstream estuaries to upstream spawning areas over the course of their annual cycle, there is no distance of unsuitable or suitable habitat within a given drainage for differentiating EOs.

FEATURE LABELS
Spawning Area
Nonbreeding Concentration Area

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP
Novak, P.G.

GSPECS DATE
1997-01-02

GSPECS NOTES

RANKSPECS GROUP

A SPECS
Population estimates of >10,000 adult fish, and positive evidence of reproduction indicated by the collection of females in spawning condition, larvae with yolk sacs, and/or a multiple age/size class distribution within the last 10 years.

B SPECS
Population estimates of 1,000-10,000 adult fish, and positive evidence of reproduction indicated by the collection of females in spawning condition, larvae with yolk sacs, and/or a multiple age/size class distribution within the last 10 years.

C SPECS
Population estimates of 100-999 adult fish, and positive evidence of reproduction indicated by the collection of females in spawning condition, larvae with yolk sacs, and/or a multiple age/size class distribution within the last 10 years.

D SPECS
Population estimates of less than 100 adult fish, or river systems where fish have been observed or collected within the past 10 years, but are not currently known to be breeding (*i.e.*, there are no known active spawning areas, no larval fish with yolk sacs have been taken within the past 10 years, there are no young fish in the age/size class distribution of the individuals which have been captured).

RANKSPECS JUSTIFICATION
"A"-rank threshold: At least two of the best known EOs recently had population estimates in excess of 10,000 adults and have documented spawning areas which are used annually (Dadswell *et al*. 1984).

"C"/"D" threshold: One occurrence with a population estimate in this range has persisted in an essentially landlocked situation for over 100 years, and spawning grounds have been documented (Dadswell *et al.* 1984, Taubert 1980). This indicates that even at this low population level, a viable population may be maintained as long as a spawning site is available.

GRANKSPECS AUTHORSHIP
Novak, P.G.

GRANKSPECS DATE
1997-01-02

GRANKSPECS NOTES

D1.1.2 *Acronicta albarufa*, dagger moth

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA
Collections of one or more specimens, unless habitat is obviously inappropriate (see habitat comments in the Element database).

EO Separation

SEPARATION BARRIERS

SEPARATION DISTANCE – UNSUITABLE HABITAT
1 km

SEPARATION DISTANCE – SUITABLE HABITAT

ALTERNATE SEPARATION PROCEDURE
For apparently suitable habitat, the separation distance is 2 km where surveys have failed to find the Element, or 5 km if the habitat is not known to be occupied.

SEPARATION JUSTIFICATION
There is no information to suggest what would be a barrier to dispersal. EO separation distances are based on very limited information; however, strays away from normal habitats are virtually unknown east of MO. The 1 and 2 km distances are best estimates; the 5 km distance reflects the fact that most, if not all, known EOs are substantially larger than 1 square km. All of these figures are based primarily on experience of D.F. Schweitzer with this Element and its habitats.

This species is known to have persisted after large (>4000 hectares [approximately >10,000 acres]), but very infrequent, wildfires in MA, although not all habitat was burned. One current NJ occurrence where adult density appears to be very low is subject to very frequent, patchy, partial, unplanned burns, with some fires occurring in most years.

FEATURE LABELS

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP
Schweitzer, D.F.

GSPECS DATE
1997-01-16

GSPECS NOTES

RANKSPECS GROUP

A SPECS
Either of the following criteria must be met for an “A”-ranked EO:

a) >2000 hectares (approximately >5000 acres) of apparently occupied habitat, usually xeric open oak woodland (including barrens) or denser oak forest; or

b) evidence of occupation based on blacklight samples from a minimum of three sites per 800 hectares (approximately 2000 acres) of presumed habitat, with an average of >1 adults per 15-30 watts of blacklight per night during peak season.

B SPECS
Any one of the following criteria must be met for a “B”-ranked EO:

a) 800-2000 hectares (approximately 2000-5000 acres) of apparently occupied habitat with capture rate of >1 adult per night per blacklight sample; or

b) 400-800 hectares (approximately 1000-2000 acres) of apparently occupied habitat where capture rates average 10 adults per blacklight sample in more than one year; or

c) >2000 hectares (approximately >5000 acres) of apparently occupied habitat where capture rates average 0.1-0.9 adults per blacklight sample.

C SPECS
Any one of the following criteria must be met for a “C”-ranked EO:

a) 200-400 hectares (approximately 500-1000 acres) of apparently occupied habitat where average capture frequency is >=1 adult per 10 blacklight samples at peak season; or

b) 40-200 hectares (approximately 100-500 acres) of apparently occupied habitat with evidence that the species has persisted for more than 10 years, and is not declining; or

c) 800-2000 hectares (approximately 2000-5000 acres) of apparently occupied habitat where average capture frequency is 0.1-0.9 adult per blacklight sample; or

d) >2000 hectares (approximately >5000 acres) of apparently occupied habitat, but trap catches consistently average <1 adult per 10 blacklight samples.

D SPECS
Sites <200 hectares (approximately <500 acres) where the species is present, and not meeting “C”-rank specifications.

RANK SPECS JUSTIFICATION
“A”-rank threshold: A capture rate of >1 adult per night with blacklight traps would suggest adult densities of several per acre. Since this species has a long flight season and apparently short adult life (*ca.* 1 week in captivity - Schweitzer), most individuals of a given brood will not be present on a given night.

Some habitats are known to be 2000 hectares (approximately 5000 acres), but most are smaller. This species seldom turns up in small habitat patches (see “C”-rank specifications) so “A”-rank specifications need to be high to identify exceptional EOs.

“C”/”D” threshold: This species seldom, if ever, occurs in small (<400 hectare [approximately <1000 acre]) habitats, and is absent from most apparently suitable larger habitats east of MO. Schweitzer believes these specifications will probably define a potentially viable population. The area criteria may be slightly low, but Schweitzer feels it is best to leave some margin for error.

The likely high (but rarely 100%) mortality during fires should be considered in rank specifications. In many cases (*e.g.*, all but the coolest dormant season fires; or in some habitats any summer fire), burned areas should not be considered currently occupied, but will almost certainly be recolonized. Thus, occupied habitat should exclude the average percentage subject to such burns each year. Schweitzer suggests fire should not be considered if:

a) individual burns seldom affect >10% of any size habitat in any given year; or

b) fires affect less than 75% of a >800 hectare (approximately >2000 acre) habitat at intervals of 25 years or longer; or

c) the unburned refugia will be >=2000 hectares (approximately >=5000 acres) in all years.

GRANKSPECS AUTHORSHIP
Schweitzer, D.F.

GRANKSPECS DATE
1997-01-16

GRANKSPECS NOTES

D1.1.3 *Amaranthus pumilus,* seabeach amaranth

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA
Any occurrence of one or more plants. This is a fugitive annual species that occurs in an unstable and shifting habitat. In addition, populations may be present even though plants are not visible for one or more years. This species seed-banks, and may not appear in a given year if seeds are covered over too deeply.

EO Separation

SEPARATION BARRIERS
A barrier to dispersal of the species would be any distance of estuarine water >100 m at low tide (*i.e.*, populations on separate islands are separate EOs).

SEPARATION DISTANCE – UNSUITABLE HABITAT
1 km

SEPARATION DISTANCE – SUITABLE HABITAT
5 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
The distance for unoccupied but suitable habitat is set at such a great distance because of the fugitive nature of *Amaranthus pumilus*, and the likelihood that intervening "suitable but unoccupied" habitat will likely be occupied at some time in the near future (*i.e.*, two apparently separate EOs will become connected, leading to instability of EOs). Unsuitable habitat is categorized on the basis of unsuitability for the foreseeable future, such as riprap, sea walls, or barren beach areas (with beach-grooming or extremely heavy recreational use). Note that scarped and eroding foredunes should not be considered unsuitable for the foreseeable future, as new deposition of sand may quickly change its suitability. EO specifications (*e.g.*, separation distances) should be determined as much as possible by the spatial distribution of plants. Plant distribution should be based on recent (*i.e.*, within the past 5 years) repeat surveys performed subsequent to any major catastrophic change in habitat occurring during that period.

FEATURE LABELS

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP
Weakley, A.

GSPECS DATE
1997-01-02

GSPECS NOTES

RANKSPECS GROUP

A SPECS
1000 or more individuals on average, based on all censuses in the last 5 years and subsequent to any major catastrophic change in the habitat.

B SPECS
100-999 individuals on average, as above.

C SPECS
10-99 individuals on average, as above.

D SPECS
1-9 individuals on average, as above.

RANK SPECS JUSTIFICATION
“A” rank threshold: It is not anticipated that future occurrences will exceed the best that currently exist. Thus, “A”-rank criteria are set such that the largest, most stable, and most viable occurrences currently in existence are so designated.

“C”/”D” threshold: Populations with fewer than 10 individuals average (based on repeat census) may be temporarily small but viable populations; they are re-ranked upwards (by specifications above) if they produce more individuals. In contrast, such populations may represent temporary waifs in generally unsuitable situations.

GRANKSPECS AUTHORSHIP
Weakley, A.

GRANKSPECS DATE
1997-01-02

GRANKSPECS NOTES

D1.1.4 *Aphelocoma coerulescens*, Florida scrub-jay

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA
Occurrences of the Florida scrub-jay are defined by one or more territorial pairs.

EO Separation

SEPARATION BARRIERS
A barrier to dispersal of the species would include open water, especially with forested margins, and closed-canopy forest.

SEPARATION DISTANCE – UNSUITABLE HABITAT
3.5 km

SEPARATION DISTANCE – SUITABLE HABITAT
3.5 km

ALTERNATE SEPARATION PROCEDURE
Note that separation distances are assessed between territorial borders.

SEPARATION JUSTIFICATION
This relatively sedentary species is described as occurring in metapopulations, which Stith *et al*. (1996) delineated by buffering all territories with a 12 km buffer, a distance beyond which dispersal is negligible. The researchers also selected 3.5 km as a dispersal buffer to delineate subpopulations after they found that 80% of documented dispersals are 1.7 km or less, and 85% are within 3.5 km.

Subpopulations, rather than metapopulations, are principal EOs for this species. In part this derives from a recommendation that the highest conservation priority is to preserve the large subpopulations (Stith *et al*. 1996). Also, some of the metapopulations appear to be impracticably large conservation targets (*e.g.*, 200 km of coastal central Florida). The metapopulation context of a subpopulation is taken into account in the “B” and “C” EO ranks below, and should be taken into account in site selection and design.

Only one distance is used for both suitable and unsuitable habitat, in part because Stith *et al.* (1996) did not distinguish dispersal across unsuitable (other than the “barriers” listed above) versus suitable habitat, and in part because dispersing jays appeared to cue on other resident jays more strongly than on habitat.

FEATURE LABELS

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP
Master, L.L.

GSPECS DATE
1997-01-06

GSPECS NOTES

RANKSPECS GROUP

A SPECS
>=400 pairs.

B SPECS
Either 100-399 pairs; or 50-99 pairs that are part of a metapopulation of >=100 pairs (all within 12 km of each other).

C SPECS
Either 10-99 pairs; or <10 pairs that are part of a metapopulation of >=50 pairs (all within 12 km of each other). The key ecological process, fire, must be reasonably intact or restorable.

D SPECS
1-9 pairs or not otherwise meeting "C" rank specifications.

RANK SPECS JUSTIFICATION
"A" rank threshold: This number is considered to convey a very low probability of extinction (Fitzpatrick *et al*. in prep). Although historical populations were likely much larger, three geographically separate subpopulations met this criterion in 1993 (Stith *et al*. 1996). Given continued development pressures and fire suppression, the present large populations are possibly the best achievable. Condition and landscape factors are considered to be partially intact, at least temporarily, if this size criterion is met. Stith *et al*. (1996) discussed the need to maintain fire as a key ecological process, and landscape connectivity so that large populations do not become fragmented.

"C"/"D" threshold: The results of the model by Stith *et al*. (1996) indicate that a population of 10 pairs has approximately a 50% probability of extinction within 100 years.

GRANKSPECS AUTHORSHIP
Master, L.L.

GRANKSPECS DATE
1997-01-06

GRANKSPECS NOTES

D1.1.5 *Bufo boreas,* western toad

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA

Occurrences are defined by any collection or observation of one or more individuals. When a breeding site is known, the EO minimally includes breeding site(s) and the surrounding area of suitable upland habitat extending 500 m from breeding sites.

EO Separation

SEPARATION BARRIERS

A major barrier to dispersal would be a busy interstate highway without culverts.

SEPARATION DISTANCE – UNSUITABLE HABITAT

SEPARATION DISTANCE – SUITABLE HABITAT

ALTERNATE SEPARATION PROCEDURE

EOs should be evaluated using a 5 km separation distance between drainages in mountainous terrain, or a 10 km separation distance in low elevation areas or within a drainage in mountainous terrain.

SEPARATION JUSTIFICATION

Recent radiotelemetry evidence strongly suggests that movements away from breeding sites of up to 2 km are common (C.R. Peterson, pers. comm.). S. Corn (pers. comm.) found that several males and females per generation moved between two breeding sites 10 km apart, and many moved between breeding sites 2 km apart, even within the same season. These movements were within a drainage in mountainous terrain, but movements between drainages may be less common (S. Corn, pers. comm.). Additionally, radiotelemetry and mark-recapture data for western toads and *Rana pretiosa* complex frogs suggest they readily move across seemingly inhospitable habitat (*e.g.*, Nevada desert, high elevation granite slabs), apparently during wet weather (various papers presented at the Conference on Declining and Sensitive Amphibians in the northern Rocky Mountains and the Pacific Northwest held 7-8 Nov. 1996, in Boise, Idaho, by researchers including D.A. Patla, C.R. Peterson, D. Pilliod, J. Reiser, and P. Ritson).

What constitutes a major barrier remains poorly known. In Yellowstone National Park, a major highway effectively eliminated regular use of one part of a *Rana pretiosa* occurrence that had been regularly used historically (C.R. Peterson and D.A. Patla, pers. comm.).

EO rank depends mainly on population attributes enumerated in the following rank specifications. For all ranks, the EO may be either one polygon, or multiple polygons if separated by distances no larger than specified above. Population estimates may be based on careful judgment if adequate data is unavailable; use recent median population size if data is available from multiple years.

FEATURE LABELS

Breeding Site
Hibernation Site

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP

Reichel, J.D. and G.A. Hammerson

GSPECS DATE

1997-01-31

GSPECS NOTES

RANKSPECS GROUP

A SPECS
EO includes >500 breeding females.

B SPECS
EO includes 50-500 breeding females.

C SPECS
EO includes 5-49 breeding females.

D SPECS
EO includes <5 breeding females.

RANK SPECS JUSTIFICATION
“A” rank threshold: Single breeding pond/lake populations of 200-400 females have been reported in the literature (Nussbaum *et al.* 1983, Olson 1989, Blaustein *et al*. 1994). It seems likely that by combining adjacent (<10 km apart) breeding populations into a single occurrence, some occurrences would qualify for “A”-rank status. These numbers may be revised upward if:

a) it is found that many EOs are larger when applying the current EO specifications across the range of the toad; or

b) PVA models show that substantially larger numbers are needed to maintain EOs (thereby increasing the numbers needed for “C”-rank status).

“C”/”D” threshold: While western toads are relatively long-lived (up to 9 years; Campbell 1976), it seems unlikely that isolated populations of less than 5 breeding females could survive for 100 years. However, S. Corn (pers. comm.) has seen small populations (2-5) females lasting at least 10 years. PVA modeling should be used to better determine this number.

GRANKSPECS AUTHORSHIP
Reichel, J.D. and G.A. Hammerson

GRANKSPECS DATE
1997-01-31

GRANKSPECS NOTES

D1.1.6 *Gymnoderma lineare*, rock gnome lichen

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA

Any naturally occurring population. This species occurs in several different habitats:

a) exposed or semi-exposed high-elevation cliff faces;

b) small to medium rock outcrops under full canopy in high elevation forests, or at low to moderate elevations in forests in extremely humid gorges, especially near waterfalls; or

c) rock outcrops and boulders in high to moderate elevation streams.

EO Separation

SEPARATION BARRIERS

SEPARATION DISTANCE – UNSUITABLE HABITAT

SEPARATION DISTANCE – SUITABLE HABITAT

ALTERNATE SEPARATION PROCEDURE

The separation distance for occurrences in different habitats (see above) is 1 km, or between occurrences in the same habitat is 2 km. Patches located closer than these distances can be recorded as sub-EOs.

SEPARATION JUSTIFICATION

It is difficult to survey this species (and its rock outcrop habitat) reliably. EO separation distances are, therefore, relatively long. Occurrences in different habitats have very different dynamics. Thus, it is desirable to keep these separate unless in closer proximity (<1 km separation distance).

FEATURE LABELS

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP

Weakley, A.

GSPECS DATE

1997-01-25

GSPECS NOTES

RANKSPECS GROUP

A SPECS

>50 square meters cover and <10% showing necrosis.

B SPECS

10-50 square meters cover and <10% showing necrosis; or >50 square meters with 10-30% showing necrosis.

C SPECS

2-10 square meters cover and <10% showing necrosis; or 10-50 square meters and >10% showing necrosis; or >50 square meters and >30% showing necrosis.

D SPECS

Less than 2 square meters cover; or <10 square meters and 10-90% necrosis.

RANK SPECS JUSTIFICATION
“A” rank threshold: The “A” rank criteria emphasize substantial cover and apparent vitality.

“C”/”D” threshold: EOs not meeting “C” rank specifications have considerable probability of extirpation, either from intrinsic low size and susceptibility to accident, or from moderate to small size in combination with obvious decline.

GRANKSPECS AUTHORSHIP
Weakley, A.

GRANKSPECS DATE
1997-01-25

GRANKSPECS NOTES

D1.1.7 *Lycaeides melissa samuelis*, Karner blue butterfly

[The following specifications are based on a U.S. Fish and Wildlife Service Draft Recovery Plan, and may need revision depending upon criteria adopted in the final, published Recovery Plan.]

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA

Any collection or observation of one or more individuals. EO boundaries will often approximate natural community boundaries and must contain adequate resources to sustain all life stages.

EO Separation

SEPARATION BARRIERS

Dispersal of the species would be inhibited by a barrier>=100 m that extends beyond the boundaries of the occurrence.

SEPARATION DISTANCE – UNSUITABLE HABITAT

1 km

SEPARATION DISTANCE – SUITABLE HABITAT

2 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION

Evidence suggests that long term viable populations of this species occur as metapopulations (*e.g.,* Givnish *et al.* 1988; Schweitzer 1994; U.S. Fish and Wildlife Service Draft Recovery Plan). Demes are typically separated by 50-100 m of unsuitable habitat, and may also be defined on the basis of mark-recapture (MRR) data. Where applicable, the metapopulation, rather than the subpopulation or deme, is the principal EO for this species. Principal EO boundaries usually approximate those of the associated barrens or savanna community, even though these communities may contain some habitat that is unsuitable for the Element.

What constitutes a major barrier remains poorly known. Any habitat discontinuity may deter movement of adults, but dispersers are known to cross busy two-lane highways, lawns, forest, parking lots, *etc*. A possible barrier should be considered only if there is evidence that it actually deters the movement of individuals.

EO separation distances are based on data from unpublished reports reviewed in the Draft Recovery Plan, and in Givnish *et al.* (1988) and Schweitzer (1994). Typically, few adults leave their original habitat patch; however, dispersal >=1 km has been documented repeatedly, and a few longer dispersal events are known. Generally, if substantial suitable contiguous habitat occurs between two known occupied habitat patches <2 km apart, it is very likely the intervening habitat will prove to be occupied.

In developing EO rank specifications, numbers can be accurately estimated only through use of MRR data (see Gall 1985); non-MRR estimates are likely to be somewhat low. It is known empirically that the total brood size will normally be approximately triple the census on a given day during peak season. Use of this tripling method is based on the assumption that the majority of adults are observed, which seldom occurs. Thus, the tripling method is usually inaccurate for determining brood size, particularly for large dispersed populations (consult Schweitzer [1994] or Recovery Plan to determine if tripling method might may be adequate). Numbers used in these specifications represent true brood size numbers (*i.e.,* determined from MRR data rather than census numbers).

For EO rank specification purposes, habitat burned subsequent to the preceding July 10th should be assumed to have been unoccupied for at least one year. This may affect estimation of numbers for "normal" or "worst" years.

FEATURE LABELS

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP
Schweitzer, D.F.

GSPECS DATE
1997-01-16

GSPECS NOTES

RANKSPECS GROUP

A SPECS
Each of the following criteria must be met for an "A"-ranked EO:

a) >20,000 adults in the larger annual brood (usually July), and >5,000 adults in the smaller brood (usually late May-June); and

b) >=5 demes meeting "C"-rank specifications, or >=4 meeting "B"-rank specifications, in normal years; and

c) occupying >800 hectares (approximately >2,000 acres) of appropriately managed habitat including lupine occurring in microhabitats having 0-60% shade or diverse topographic aspect.

In addition, the metapopulation must have >=1,000 adults in the smaller brood, and approximately 4,000 in the larger brood, in the worst possible year (*e.g.*, immediately after a wildfire, in a severe drought). There must be some gene flow between each of the demes described in (b) above and another deme. In addition, between some of the demes there should be lupine that is occasionally occupied by either adults or larvae.

B SPECS
Each of the following criteria must be met for a "B"-ranked EO:

a) >=10,000 adults in the larger brood, or >=2,500 smaller brood, of a normal year, but otherwise not meeting some of the "A" rank specifications; and

b) >=4 demes, 3 of which individually would meet "C"-rank specifications, and have gene flow with another deme; and

c) if there are no demes meeting "C"-rank specifications, there must be >=50 occupied habitat patches in most years, and >=20 in worst years, well distributed throughout the associated community or potential habitat.

In addition, the total associated community or potential habitat must be >400 hectares (approximately >1,000 acres), and the total metapopulation must be >=500 adults in smaller brood of the worst possible year.

C SPECS
The first criterion (a), and either one of the following two criteria (b or c), must be met for a "C"-ranked EO:

a) >3,000 adults in the larger annual brood in normal year, and >=100 adults in the smaller brood in the worst years; and

b) >=2 demes, with >=20% (or 1,000 adults in larger brood) of total population not being in the largest deme; or

c) population consisting of a single deme must occupy >=80 hectares (approximately >=200 acres), consist of >5000 adults in larger brood of a normal year, and >200 adults in smaller brood of worst year.

D SPECS
Any occurrence meeting minimum specifications for an EO but not meeting "C"-rank specifications.

RANK SPECS JUSTIFICATION
"A" rank threshold: All major references indicate a need for multiple demes and/or substantial habitat size to buffer the impact of catastrophic events (*e.g.*, uncontrolled fire). Variable aspect and shade conditions provide some protection from weather extremes such as drought and late spring freezes. Large population size also provides a buffer against population fluctuations caused by weather and other factors. The "A"-rank specifications should be set above the Large Viable Population criteria of the Recovery Plan.

"C"/"D" threshold: Several studies (*e.g.*, see Recovery Plan or Schweitzer 1994) show low survival rates over a period of 10-20 years, and even less for populations with >=1,000 July brood adults. Individual habitat patches are subject to catastrophic events (*e.g.*, weather) that can cause numbers to crash at least an order of magnitude. All extant EOs are likely to have been much larger historically.

The “C”-rank specifications should meet the Minimum Viable Population (MVP) criteria of the Recovery Plan. The Recovery Team believes a viable population generally must be >1,000, and may determine that 3,000 in a normal year is minimal. Single demes will probably not be considered viable in the Recovery Plan, but Schweitzer disagrees and considers such an EO to be potentially viable with careful management. The most stable documented population (with >20 years of observation) exists at the Saratoga Airport (NY) and seems to fit these criteria, with probably >10,000 in only one deme. Schweitzer has studied it in detail and believes that the habitat is large enough so that loss to catastrophic events (other than cessation of management) is unlikely.

GRANKSPECS AUTHORSHIP

Schweitzer, D.F.

GRANKSPECS DATE

1997-01-16

GRANKSPECS NOTES

D1.1.8 *Lysimachia asperulifolia*, rough-leaf loosestrife

SPECS GROUP

LOCATION USE CLASSES

MINIMUM EO CRITERIA
Any naturally occurring population.

EO Separation

SEPARATION BARRIERS

SEPARATION DISTANCE – UNSUITABLE HABITAT

SEPARATION DISTANCE – SUITABLE HABITAT
2 km

ALTERNATE SEPARATION PROCEDURE
The separation distance for EOs across unsuitable habitat (*e.g.*, upland pinelands) or altered and unsuitable areas is 1 km. However, in sandhills the separation distance may be as little as 0.5 km across a watershed break (in order to make watershed EO separations practical).

SEPARATION JUSTIFICATION
The rationale for this large a separation distance across suitable but apparently unoccupied habitat is to maintain stability of EOs. This species often occurs as apparently small and isolated populations in linear pocosins along sandhill streams, or in ecotones along peat dome pocosins. Owing to the difficulty of surveying for this species in fire-suppressed pocosin habitats, it can often be assumed that apparently unconnected populations will eventually be found to be more closely connected; these are best regarded as subpopulations. These subpopulations may be recognized, if desired, as sub-EOs.

FEATURE LABELS

Inferred Extent

IE DISTANCE

IE NOTES

GSPECS AUTHORSHIP
Weakley, A.

GSPECS DATE
1997-01-02

GSPECS NOTES

RANKSPECS GROUP

A SPECS
>=1000 stems (ramets); populations with all of the following: many genets flowering vigorously, in natural site, with natural processes (primarily fire and hydrology) approximating natural conditions. To receive an “A” rank, deep peat pocosin populations require infrequent fire, and intact or minimally affected site hydrology. To receive an “A” rank, ecotonal populations (sandhill/pocosin, flatwoods/pocosin, and savanna/pocosin) require frequent prescribed or natural (at least once per decade and preferably more frequent) fire, and minimal ground disturbance of the ecotone (as by fire plows).

B SPECS
300-1000 stems (ramets); populations with at least two of the following: many genets flowering vigorously, in natural site (fire regime natural, hydrology intact, ground disturbance minimal).

C SPECS
50-300 stems (ramets); populations lacking most of the following: many genets flowering vigorously, in natural site (fire regime natural, hydrology intact, ground disturbance minimal). Minimum criteria for "C" rank should state that the population is likely to be viable, with emphasis on the likelihood that processes necessary for *Lysimachia* will continue.

D SPECS
Less than 50 stems (ramets); populations with few genets flowering poorly, in site maintained by unnatural means (*e.g.*, mowing). Populations with >50 ramets may still be ranked "D" if in an unnaturally created and maintained situation (*e.g.*, a road ditch) with little likelihood of long-term viability.

RANK SPECS JUSTIFICATION
"A" rank threshold: It is not anticipated that future occurrences will exceed the best that currently exist. Thus, "A"-rank criteria are set such that the larger and more viable occurrences currently in existence are so designated. Habitat features (fire, hydrology, ground disturbance) are as important as documented population size.

"C"/"D" threshold: EOs not meeting "C"-rank criteria are likely to: be susceptible to extirpation through accident; have low population viability; and occur in degraded habitats with low long-term potential for survival.

GRANKSPECS AUTHORSHIP
Weakley, A.

GRANKSPECS DATE
1997-01-02

GRANKSPECS NOTES

D1.2 Migratory Species Having Location Use Classes

D1.2.1 *Histrionicus histrionicus,* harlequin duck

SPECS GROUP

LOCATION USE CLASSES
Breeding
Nonbreeding

BREEDING **LOCATION USE CLASS:**

MINIMUM EO CRITERIA
EOs are defined by a drainage, or portion of a drainage, where breeding is known or highly suspected. Minimally, this should be based on three or more independent observations of females or pairs (*e.g.*, one pair in three different years, three different pairs in one year).

EO Separation

SEPARATION BARRIERS
A barrier to dispersal of the species in the BREEDING class would include >2 km over a major divide.

SEPARATION DISTANCE – UNSUITABLE HABITAT
10 km

SEPARATION DISTANCE – SUITABLE HABITAT

ALTERNATE SEPARATION PROCEDURE
The separation distance (measured along watercourses) for both rarely used habitat (*e.g.*, lakes, <1% gradient rivers) and for apparently suitable habitat not known to be occupied is 20 km.

SEPARATION JUSTIFICATION
The barrier is based on lack of movements between streams separated by a 4-km (2.5-mile) rise over a major divide (Reichel and Genter 1997). Unsuitable habitat (*i.e.*, across land) separation is based on movements of up to 7 km over a low divide (Cassirer and Groves 1994). Movements along watercourses include a 21-km movement across a reservoir (Reichel and Genter 1995), while a few movements up to 31 km have occurred across mixed suitable and unsuitable habitat (Reichel and Genter 1996); all have either occurred between years or following a substantial disturbance. Home ranges average 7-10 km of stream length (Kuchel 1977, Cassirer and Groves 1992).

FEATURE LABELS

Inferred Extent

IE DISTANCE

IE NOTES

RANKSPECS GROUP

A SPECS
>=100 pairs within a single EO.

B SPECS
40-99 pairs within the EO.

C SPECS
3-39 pairs within the EO.

D SPECS
A yearly average of 1-2 pairs within the EO.

RANK SPECS JUSTIFICATION
"A" rank threshold: The largest currently known breeding class EO was calculated to include 215 adults on the Bow River, Alberta (Smith 1996). "A" rank specifications may need to be increased if data from Alaska shows substantially larger numbers within single EOs.

"C"/"D" threshold: Given the low productivity and high site fidelity, less than 3 pairs are not likely to be viable over a 100-year period. However, little data is available on numbers of ducks present versus the length of time an occurrence is maintained.

NONBREEDING **LOCATION USE CLASS:**

MINIMUM EO CRITERIA
EOs are defined by the presence of >=25 individuals using an area >1 week in most years on coastal waters, or >=5 individuals for interior staging areas.

EO Separation

SEPARATION BARRIERS

SEPARATION DISTANCE – UNSUITABLE HABITAT
20 km

SEPARATION DISTANCE – SUITABLE HABITAT
20 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
Of 89 females marked during late summer molt in coastal Alaska, 92% stayed within approximately 20 km of where they were marked through mid-February (Esler 1996).

FEATURE LABELS
Coastal Aggregation
Staging Area

Inferred Extent

IE DISTANCE

IE NOTES

RANKSPECS GROUP

A SPECS
>=3000 birds using an area >1 month yearly.

B SPECS
1000-2999 birds using an area >1 month yearly.

C SPECS
100-999 birds using an area >1 week in most years.

D SPECS
25-99 birds using an area >1 week in most years for coastal staging, wintering, and summer nonbreeding areas. 5-99 birds for interior staging areas.

RANK SPECS JUSTIFICATION
"A" rank threshold: Reports during the nonbreeding season of up to 5300 are known from Hornby Island, B.C. (Goudie 1996), however "A" rank specifications may need to be increased if data from Alaska shows substantially larger numbers.

“C”/”D” threshold: Given the low productivity and high site fidelity, less than 3 pairs are not likely to be viable over a 100-year period. However, little data is available on numbers of ducks present versus the length of time an occurrence is maintained.

GSPECS AUTHORSHIP
Reichel, J.D. and E.F. Cassirer

GSPECS DATE
1996-11-26

GSPECS NOTES

GRANKSPECS AUTHORSHIP
Reichel, J.D. and E.F. Cassirer

GRANKSPECS DATE
1996-11-26

GRANKSPECS NOTES

D2 Community Elements

D2.1 Matrix Communities

D2.1.1 *Pinus ponderosa / Physocarpus monogynus* Forest,

ponderosa pine / mountain ninebark forest

SPECS GROUP
Ponderosa Pine Forest and Woodland Alliances, Black Hills Group

MINIMUM SIZE
2 ha

EO Separation

SEPARATION BARRIERS
Barriers that would separate patches of this community include a major two-lane paved highway, urban development, and an open body of water.

SEPARATION DISTANCE – DIFFERENT NATURAL/SEMI-NATURAL COMMUNITIES
2 km

SEPARATION DISTANCE – CULTURAL VEGETATION
0.5 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
The separation distance for cultural vegetation is based on the suggested minimum value, since little is known about limitations on ponderosa pine or shrub and herb seed dispersal. Seeds of ponderosa pine are reported to travel as far as 120 m from the parent tree (Barret 1978 in Oliver and Ryker 1990). The separation distance for intervening natural or semi-natural communities seems to be a pragmatically useful distance.

FEATURE LABELS

GSPECS AUTHORSHIP
McAdams, A. and D. Faber-Langendoen

GSPECS DATE
1998-06-29

GSPECS NOTES

RANKSPECS GROUP

RANK PROCEDURE
Condition, size, and landscape context are weighted equally for this type because, although it is a matrix type, it occurs within a mosaic of other ponderosa pine community types that together comprise the matrix.

EO RANK FACTOR ***1st***
Condition

A SPECS

a) Overstory structure intact (*i.e.*, average of 25 trees per hectare greater than 40 cm dbh and/or more than 160 years old have not been cut [Mehl 1992]); crown shape mature, flattened; bark yellowish in character;

b) understory vegetation composed of native species;

c) shrub layer may or may not be present;

d) there is evidence of fire as a natural process, including potentially long intervals without fire (>45 years). Such evidence might include fire scars and scorching. Evidence of lack of natural fire patterns might include increased densities of small diameter trees, increased litter depth, and/or decreased herbaceous production;

e) stands may have been thinned with minimal disruption of understory (>20 years ago), but little or no exotics are present.

B SPECS

a) Old growth trees present over greater than 75% of occurrence (*i*.e. average of 25 trees per hectare greater than 40 cm dbh and/or more than 160 years old have not been cut (Mehl 1992) over most of the area;

b) if thinning of small diameter trees has occurred, there is little evidence of minimal disruption of understory vegetation;

c) some light grazing by livestock may have occurred;

d) exotic species may be present at low densities.

C SPECS

a) Heavily logged with only small diameter trees remaining and disturbance to understory vegetation (due to logging activities or grazing);

b) heavy grazing by livestock has severely altered ground layer composition;

c) some exotic species present (including such species as *Cirsium arvense* [Canada thistle] and/or *Euphorbia esula* [leafy spurge]).

D SPECS

a) Heavily logged and thinned, perhaps to the point of a clear-cut;

b) ground very disturbed with major disruptions to vegetation;

c) large proportion of exotic species, including *Cirsium arvense* (Canada thistle) and/or *Euphorbia esula* (leafy spurge).

RANK SPECS JUSTIFICATION
“A” rating threshold: Old growth criteria are based on those of Mehl (1992), who reviewed these criteria for ponderosa pine forests and other types throughout the Rocky Mountain region. Ponderosa pine forest systems generally depend on some form of fire to maintain overstory and understory composition. Brown and Sieg (1996) show that the range of fire in the Black Hills was between 1-45 years. Lack of fires within this time frame leads to structural changes in ponderosa pine, and alters ground layer composition and diversity. Fire intervals may be even longer in the northern Black Hills.

“C”/”D” threshold: Native ground layer composition is severely altered and unlikely to replace exotics. Recovery of ponderosa pine old-growth structure would take greater than 100 years.

EO RANK FACTOR *[2nd]*
Size

A SPECS
Very large (>=200 ha)

B SPECS
Large (50-199 ha)

C SPECS
Moderate (15-49 ha)

D SPECS
Small (<15 ha)

RANK SPECS JUSTIFICATION
“A” rating threshold: Stands this size would be able to support natural disturbance processes such as fire, and would contain sufficient internal variability to be representative of the type.

“C”/”D” threshold: Stands lack variability, and often are confined to specific aspects or slopes.

The minimum size, even for “D”-ranked occurrences, will rarely fall below 2 ha. Stands below 2 ha become difficult to judge in terms of stand homogeneity, and become heavily influenced by edge effects.

EO RANK FACTOR *[3rd]*
Landscape context

A SPECS
Highly connected – area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities (>2000 ha).

B SPECS
Moderately connected – area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities; landscape includes partially disturbed natural or semi-natural communities, some of it not high quality due to overgrazing or recent logging (>2000 ha).

C SPECS
Moderately fragmented – area around the EO is largely a combination of cultural and natural vegetation, with barriers between species interactions and natural processes across natural communities; EO is surrounded by a mix of intensive agriculture and adjacent forest lots.

D SPECS
Highly fragmented – area around the EO is entirely, or almost entirely, surrounded by agricultural or urban land use; EO is at best buffered on one side by natural communities.

RANK SPECS JUSTIFICATION
“A” rating threshold: Landscapes could sustain natural disturbance regimes. Definitions for minimum dynamic area (*i.e.*, the area of land necessary so that the proportion of the landscape in early, middle and late successional stages will remain constant over time, given the occurrence of windstorms and fires) proposed by Shugart (1984) – fifty times the average disturbance size, or Johnson and Van Wagner (1985) – two times the maximum disturbance size (see also Frelich 1995), can be used as a rough guide to landscape size. If disturbance regimes are virtually unknown, the minimum “C”-rated size (15-49 ha) can be used as a starting point and multiplied by fifty. Thus, “A”-rated ponderosa pine landscapes may need to be 750-2500 ha in size.

“C”/”D” threshold: Processes such as natural disturbances are essentially irretrievable.

GRANKSPECS AUTHORSHIP
McAdams, A. and D. Faber-Langendoen

GRANKSPECS DATE
1998-06-29

GRANKSPECS NOTES

D2.1.2 *Quercus alba – Quercus rubra – Quercus macrocarpa / Carpinus caroliniana* Forest,

white oak – red oak – bur oak / musclewood forest

SPECS GROUP
Quercus alba – (*Quercus rubra*, *Carya* spp.) Forest Alliance

MINIMUM SIZE
2 ha

EO Separation

SEPARATION BARRIERS
Barriers that would separate patches of this community include a four-lane highway, urban development, and an open body of water.

SEPARATION DISTANCE – DIFFERENT NATURAL/SEMI-NATURAL COMMUNITIES
4 km

SEPARATION DISTANCE – CULTURAL VEGETATION
0.5 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
The separation factors are based on seed dispersal of *Quercus* and *Carya* spp., which are dependent on squirrels and jays. These dispersers can move considerable distances between patches in intact or fragmented landscapes, from several hundred meters to 4 or 5 km (Harrison and Werner 1984, Crow 1988, Johnson and Webb 1989).

FEATURE LABELS

GSPECS AUTHORSHIP
Dunevitz, H. and D. Faber-Langendoen

GSPECS DATE
1998-06-29

GSPECS NOTES

RANKSPECS GROUP

RANK PROCEDURE
Condition, size and landscape context are weighted equally for this type. Although matrix types typically consider condition to be of less importance than size and landscape context, this community type has been extensively cleared throughout its range, and choosing among remaining examples requires a greater consideration of condition because of the potential for extensive alteration of the groundlayer.

EO RANK FACTOR *[1st]*
Condition

A SPECS
For types that attain old-growth status:

a) age of forest is typically old growth (120 years old or more);

b) human-induced disturbance is minimal, including light selective logging that occurred in the past (>80 years ago);

c) structure is all-aged with multi-layered canopies and some mesophytic species, such as *Acer saccharum* or *Fraxinus americana*, which may only be in the subcanopy or understory;

d) a proportion of the *Quercus* spp. exceed 70 cm diameter at breast height, depending on site condition;

e) few or no exotic species occur in the overstory or understory, with little evidence of livestock grazing within the last 80 years.

For types that do not attain old-growth status and require disturbance for regeneration:

a) forest is typically older (>100 years old or more) and of natural origin (regenerating following natural disturbance such as fire or wind-storm);

b) there is little or no human-induced disturbance, except natural area management such as prescribed burning or light selective logging that occurred in the past (>80 years ago);

c) structure is even or all-aged, with single or multi-layered canopies;

d) shrub layer is not composed predominantly of species that follow livestock grazing, but instead is composed of *Corylus americana* (hazel), *Prunus virginiana* (chokecherry), *Cornus* spp. (dogwood, including *C. florida*) and/or *Vaccinium* spp. (blueberry);

e) ground layer is composed of native species typical of oak forests;

f) there is evidence of fire in the last fifty years.

B SPECS

a) Typically a mature or nearly mature forest, younger than old-growth, but with intact canopy;

b) if logging occurred, it was either long ago (>60 years ago), very light selective cutting, or was done as a deliberate management strategy to approximate natural disturbance such as fire;

c) at most, very light livestock grazing occurred within the last 60 years.

C SPECS

a) EO may have been grazed by livestock, but not heavily enough to destroy groundlayer or result in dominance by armed shrubs that characteristically follow grazing;

b) selective logging may have recently occurred (20- 60 years ago), but community composition has remained intact and some tree regeneration (including *Quercus* spp.) is occurring;

c) also includes young second-growth (20-60 year old) stands that originated with good regeneration following clearcutting or burning.

D SPECS
Heavily cut or heavily grazed forest with a dense shrub layer of *Xanthoxylum americanum* (prickly ash), *Ribes* spp. (gooseberries), or *Rhamnus cathartica* (buckthorn), with a ground layer generally containing low diversity, either packed or very loose soil with few herbaceous plants, or dominated by weedy grasses and sedges or by exotic species, such as *Alliaria petiolata* (garlic mustard).

RANK SPECS JUSTIFICATION
“A” rating threshold: Parker (1989) required that old-growth conditions for central hardwoods, including oak forests, was >150 years, but noted that distinctions between old forest (100-150 years) and old-growth forests have not been developed. Frelich (1995) used 120 years to define old growth oak-hickory forests in the Lake States of Michigan, Minnesota, and Wisconsin. Parker (1989) also restricted old growth to stands with >80 years with no livestock grazing. The role of fire in oak forests is not clear, but some type of ground fire with occasional catastrophic disturbances has been noted (Guntenspergen 1983, Parker 1989, Abrams 1992, Olson 1996). Ground-layer characteristics of fire-maintained oak forests are poorly understood, but *Quercus* spp. regeneration may be enhanced through fires.

“C”/”D” threshold: *Quercus* spp. regeneration is unlikely, and exotics will have altered the ground-layer, preventing re-establishment of native species. *Alliaria petiolata* is difficult to eradicate (Nuzzo 1991, Schwartz and Heim 1996).

EO RANK FACTOR *[2nd]*
Size

A SPECS
Very large (>=100 ha)

B SPECS
Large (40-99 ha).

C SPECS
Moderate (10-39 ha).

D SPECS
Small (<10 ha)

RANK SPECS JUSTIFICATION
"A" rating threshold: In a study of one township in southeastern Wisconsin, Guntenspergen (1983), reported that nineteenth century stands of forest rarely exceeded 200 ha, and averaged 40 ha. Currently few stands exceed 30 ha throughout the central hardwoods of the United States (Parker 1989).

"C"/"D" threshold: Guntenspergen (1983) found that below the 10 ha limit, edge effects became pronounced. Brothers (1992, 1993) reported that stands at or above 10 ha in size were fairly resistant to invasion by shade-intolerant exotics (*e.g., Taraxacum officinale* [dandelion], *Rosa multiflora* [multiflora rose], and *Chenopodium album* [goosefoot]). However shade-tolerant exotics (*e.g., Alliaria petiolata* [garlic mustard], *Lonicera japonica* and *L. tatarica* [honeysuckles]), may be able to spread into small fragments far more easily.

The minimum size, even for "D"-ranked occurrences, is not likely to fall below 2 ha. Stands below 2 ha become difficult to judge in terms of stand homogeneity, and become heavily influenced by edge effects, which can extend 50 m from the edge (Guntenspergen 1983, Brothers 1992).

EO RANK FACTOR *[3rd]*
Landscape context

A SPECS
Highly connected – area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities (>500 ha).

B SPECS
Moderately connected – area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities; landscape includes partially disturbed natural or semi-natural communities, some of it not high quality due to overgrazing or recent logging (>500 ha).

C SPECS
Moderately fragmented – area around the EO is largely a combination of cultural and natural vegetation, with barriers between species interactions and natural processes across natural communities; EO is surrounded by a mix of intensive agriculture and adjacent forest lots (total area no smaller than ten times the minimum "C"-rated size [>100 ha]).

D SPECS
Highly fragmented – area around the EO is entirely, or almost entirely, surrounded by agricultural or urban land use; EO is at best buffered on one side by natural communities.

RANK SPECS JUSTIFICATION
"A" rating threshold: Definitions for minimum dynamic area (*i.e.,* the area of land necessary so that the proportion of the landscape in early, middle and late successional stages will remain constant over time, given the occurrence of windstorms and fires) proposed by Shugart (1984) – fifty times the average disturbance size, or by Johnson and Van Wagner (1985) – two times the maximum disturbance size (see also Frelich 1995), can be used as a rough guide to landscape size. If disturbance regimes are virtually unknown, as they are for oak forests, the minimum "C"-rated size (10-39 ha) can be used as a starting point and multiplied by fifty. Thus, "A"-rated oak forest landscapes may need to be about 500-2000 ha in size.

"C"/"D" threshold: "C"-rated landscapes still provide a buffer against some edge effects on an EO and provide some connectivity to other natural communities.

GRANKSPECS AUTHORSHIP
Dunevitz, H. and D. Faber-Langendoen

GRANKSPECS DATE
1998-06-29

GRANKSPECS NOTES

D2.1.3 *Tsuga canadensis – (Betula alleghaniensis)* Mesic Forest,
eastern hemlock – (yellow birch) mesic forest

SPECS GROUP
Tsuga canadensis Forest Alliance Group

MINIMUM SIZE
2 ha

EO Separation

SEPARATION BARRIERS
Barriers that would separate patches of this community include a four-lane highway, urban development, and an open body of water.

SEPARATION DISTANCE – DIFFERENT NATURAL/SEMI-NATURAL COMMUNITIES
2 km

SEPARATION DISTANCE – CULTURAL VEGETATION
0.5 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
The separation distance for cultural vegetation is based on the suggested minimum value, since little is known about limitations on seed dispersal. The separation distance of 2 km for intervening natural or semi-natural communities seems to be a pragmatically useful distance.

FEATURE LABELS

GSPECS AUTHORSHIP
Faber-Langendoen, D.

GSPECS DATE
1998-06-29

GSPECS NOTES

RANKSPECS GROUP

RANK PROCEDURE
Size is the primary factor, landscape context is the secondary factor, and condition is the tertiary factor. The primary and secondary factors are weighted equally, and weighted more heavily than the tertiary factor. The rationale for the sequence is that this is a matrix type, less affected by condition than size and landscape context. Note however, that size can be naturally very variable in this type (Mladenoff et al. 1993).

EO RANK RACTOR *[1st]*
Condition

A SPECS

a) Overstory structure intact (*i.e.*, old-growth has not been cut), generally 150 years old or more;
b) understory vegetation composed of native species;
c) stands may have been thinned with minimal disruption of understory (>20 years ago), but little or no exotics are present.

B SPECS

a) Overstory structure intact, with perhaps some selective logging. Stand age may range from 80-150 years;

b) if thinning of small diameter trees has occurred, there is little evidence of disruption of understory vegetation;

c) some light grazing by livestock may have occurred;

d) exotic species may be present at low densities.

C SPECS

a) Heavily logged with only small diameter trees remaining and disturbance to understory vegetation (due to logging activities or grazing); stand age may range from 50-80 years;

b) heavy grazing by livestock or by deer has severely altered ground layer composition;

c) some exotic species present.

D SPECS

a) Heavily logged and thinned, perhaps to the point of a clear-cut; stand age less than 50 years;

b) ground very disturbed with major disruptions to vegetation;

c) large proportion of exotic species.

RANK SPECS JUSTIFICATION
"A" rating threshold: Hemlock forest systems begin to take on old-growth characteristics only after 150 years, and may even go through a series of old-growth changes between 180 and 400 years (Tyrrell and Crow 1994). Forest stands of this type experience relatively low disturbance rates, so under natural disturbance regimes most of the stands should be in old-growth.

"C"/"D" threshold: Native ground layer composition is severely altered and unlikely to replace exotics. Recovery of hemlock old-growth structure would take greater than 100 years. Overgrazing by deer could prevent hemlock regeneration (Mladenoff and Stearns 1993).

EO RANK FACTOR *[2nd]*
Size

A SPECS
Very large (>=400 ha)

B SPECS
Large (40-399 ha)

C SPECS
Moderate (4-39 ha)

D SPECS
Small (<4 ha)

RANK SPECS JUSTIFICATION
"A" rating threshold: Stands this size would be able to support natural disturbance processes such as wind blowdowns, and would contain sufficient internal variability to be representative of the type. Studies of old-growth landscapes in the Great Lakes region show that stands can attain this size (Mladenoff *et al*. 1993).

"C"/"D" threshold: Studies by Mladenoff *et al*. (1993) found that in one old-growth landscape, patches of hemlock stands ranged in size from 2 ha to over 1,000 ha, and that the average stand was 21 ha. Stands much below this average (*i.e.*, less than 4 ha) will be dominated by edge effects throughout the stand.

The minimum size, even for "D"-ranked occurrences, will rarely fall below 2 ha. Stands below 2 ha become difficult to judge in terms of stand homogeneity, and become heavily influenced by edge effects. Note, however, that size can be naturally quite variable in this type (Mladenoff et al. 1993).

EO RANK FACTOR *[3rd]*
Landscape context

A SPECS
Highly connected – area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities (>5000 ha).

B SPECS
Moderately connected – area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities; landscape includes partially disturbed natural or semi-natural communities, some of it not high quality due to overgrazing or recent logging (>5000 ha).

C SPECS
Moderately fragmented – area around the EO is largely a combination of cultural and natural vegetation, with barriers between species interactions and natural processes across natural communities; EO is surrounded by a mix of intensive agriculture and adjacent forest lots.

D SPECS
Highly fragmented – area around the EO is entirely, or almost entirely, surrounded by agricultural or urban land use; EO is at best buffered on one side by natural communities.

RANK SPECS JUSTIFICATION
"A" rating threshold: Landscapes could sustain natural disturbance regimes. Definitions for minimum dynamic area (*i.e.*, the area of land necessary so that the proportion of the landscape in early, middle and late successional stages will remain constant over time, given the occurrence of windstorms and fires) proposed by Shugart (1984) – fifty times the average disturbance size, or Johnson and Van Wagner (1985) – two times the maximum disturbance size (see also Frelich 1995), can be used as a rough guide to landscape size. Frelich and Lorimer (1991) showed that the average disturbance size in these hemlock-hardwood forests was about 100 ha, so that landscapes of over 5,000 ha would be needed to sustain old-growth characteristics.

"C"/"D" threshold: Processes such as natural disturbances are essentially irretrievable.

GRANKSPECS AUTHORSHIP
Faber-Langendoen, D.

GRANKSPECS DATE
1998-06-29

GRANKSPECS NOTES

D2.2 Large Patch Communities

D2.2.1 *Artemisia tridentata* spp. *tridentata / Pseudoroegneria spicata* Shrub Herbaceous Vegetation,
basin big sagebrush / bluebunch wheatgrass shrub herbaceous vegetation

SPECS GROUP
Artemisia tridentata Shrub Herbaceous Alliance, zonal or loamy soil group

MINIMUM SIZE
0.4 ha

EO Separation

SEPARATION BARRIERS
Barriers that would separate patches of this community include a four-lane highway, urban development, and an open body of water.

SEPARATION DISTANCE – DIFFERENT NATURAL/SEMI-NATURAL COMMUNITIES
2 km

SEPARATION DISTANCE – CULTURAL VEGETATION
0.5 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
The separation distances for cultural vegetation are based primarily on the suggested minimum value, since little is known about limitations on sagebrush and herb seed dispersal. The separation distance for intervening natural or semi-natural communities seems to be a pragmatically useful distance. Primary criteria considered are the reaction of native species to disturbance, seed dispersal by dominant shrubs, and biology of shrub-steppe passerines.

FEATURE LABELS

GSPECS AUTHORSHIP
Chappell, C., D. Faber-Langendoen, and R. Crawford

GSPECS DATE
1997-07-02

GSPECS NOTES

RANKSPECS GROUP

RANK PROCEDURE
Condition is the primary factor, size is the secondary factor, and landscape context is the tertiary factor. The primary and secondary factors are weighted equally, and weighted more heavily than the tertiary factor.

EO RANK FACTOR *[1st]*
Condition

A SPECS

a) Cryptogamic crust intact, covering >80% of vascular plant interspace; high diversity of lichens and/or mosses in crust;

b) non-native species and native annual increasers (*e.g., Plantago patagonica*, annual fescues) absent or incidental;

c) fire-sensitive shrubs mature and recovered from past fires; shrubs well-spaced if present (generally <20-25% cover);

d) diverse forb layer within expected range for the type; native perennial increasers not particularly prominent. This is now very rare to non-existent and is meant to represent a community that is indistinguishable from a community that has never been grazed and has not burned for some time. Fire was probably part of the "natural" landscape, but fires have increased in frequency unnaturally such that unburned areas are of greater natural value than recently burned areas. Fire frequency has decreased in some parts of the range (*e.g.,* Pacific Northwest).

B SPECS

a) Cryptogamic crust well-developed**,** >60% cover of vascular plant interspace; cryptogamic crust little disturbed or may have recovered well from long-past grazing; cryptogamic crust diverse in species composition (at least 3-4 species prominent);

b) community dominated by natives; non-natives and native annual increasers <10% total cover and <20% relative cover in the herb layer; cheatgrass *not* thick under shrub crowns;

c) fire-sensitive shrubs prominent, but may not be mature or fully recovered from fire; shrubs well spaced if present; diverse forb layer within expected range for the type; native perennial increasers do not predominate. This is generally the best of what remains in the landscape.

C SPECS

a) Cryptogamic crust moderately degraded or recovering, >30% cover of vascular plant interspace (although monotypic early-successional moss may be more abundant); species diversity of crust may be relatively low; lichens likely to have low percent cover;

b) community clearly dominated by natives in the herb layer; non-natives and native annual increasers <20% total cover and <30% relative cover in the herb layer; bunchgrasses >50% relative cover in the herb layer; indicator bunchgrasses (*Pseudoroegneria spicata*, *Festuca idahoensis*) clearly more important than increasers or non-natives; forb diversity may be somewhat lower than expected for the type; native perennial increasers may be relatively prominent but do not dominate. Cheatgrass can often be dense under shrub crowns;

c) fire-sensitive shrubs may be present or absent; shrubs that increase (*e.g., Artemisia tridentata* spp. *tridentata*) may be somewhat more dense than pre-disturbance, but still <35% cover.

D SPECS

a) Cryptogamic crust degraded or absent, <30% cover of vascular plant interspace; crust often low diversity;

b) community may not be clearly dominated by natives; herb layer is a mix of natives and non-natives; native annual increasers or non-native invaders may be >20% cover and >30% relative cover in the herb layer; native indicator bunchgrasses (*Pseudoroegneria spicata*, *Festuca idahoensis* combined) >5-10% cover;

c) shrubs may be quite dense, with >40% cover.

RANK SPECS JUSTIFICATION
"A"-rating threshold: The "A" rated criteria are based on descriptions of relict communities and reactions of key plant species to anthropogenic disturbances.

"C"/"D" threshold: This threshold is intended to separate "C"-rated occurrences that will naturally improve in condition when released from livestock or other anthropogenic disturbance, from "D"-rated occurrences that will not improve and are prone to irreversible changes in composition.

EO RANK FACTOR *[2nd]*
Size

A SPECS
Very Large (>=200 ha)

B SPECS
Large (80-199 ha)

C SPECS
Moderate: (20-79 ha)

D SPECS
Small (<20 ha)

RANK SPECS JUSTIFICATION
“A”-rating threshold: Stands this size would be able to support natural disturbance processes such as fire, and would contain sufficient internal variability to be representative of the type.

“C”/”D” threshold: Stands lack variability, and are prone to being eliminated by a single disturbance event.

The primary criteria considered are seed dispersal by dominant shrubs, biology of shrub steppe passerines, and the likelihood of an area completely burning in a single event.

EO RANK FACTOR *[3rd]*
Landscape context

A SPECS
Highly connected – landscape has been little altered, and the EO is completely surrounded by other high quality communities *and* extensive shrub-steppe (> 400 ha).

B SPECS
Moderately connected – EO is surrounded by moderate to extensive (>400 ha) low quality shrub-steppe, an extensive landscape that is used or has been extensively used for grazing or training.

C SPECS
Moderately fragmented – EO is surrounded by a mix of intensive agriculture and adjacent natural/semi-natural shrub-steppe, or by a relatively small area (total area smaller than twice the minimum EO size) of shrub-steppe in an agriculturally fragmented landscape.

D SPECS
Highly fragmented – area around the EO is entirely, or almost entirely, surrounded by agricultural or urban land use; EO is at best buffered on one side by natural communities. The surrounding landscape is primarily intensive agriculture or suburban development.

RANK SPECS JUSTIFICATION
“A” rating threshold: Natural disturbances, such as fire, can occur on a scale that permits maintenance of patches of the community in a variety of conditions.

“C”/”D” threshold: Processes such as natural disturbances are essentially irretrievable.

The primary criteria considered are seed dispersal by dominant shrubs, biology of shrub steppe passerines, and the likelihood of an area completely burning in a single event.

GRANKSPECS AUTHORSHIP
Chappell, C., D. Faber-Langendoen, and R. Crawford

GRANKSPECS DATE
1997-07-02

GRANKSPECS NOTES

D2.2.2 *Thuja occidentalis – (Picea mariana – Abies balsamea) / Alnus incana* Wetland Forest,

eastern white cedar – (black spruce – balsam fir) / speckled alder wetland forest

SPECS GROUP
Thuja occidentalis Saturated Forest Alliance Group

MINIMUM SIZE
0.4 ha

EO Separation

SEPARATION BARRIERS
A substantial barrier that would separate patches of this community is a two-lane highway or larger.

SEPARATION DISTANCE – DIFFERENT NATURAL/SEMI-NATURAL COMMUNITIES
1 km

SEPARATION DISTANCE – CULTURAL VEGETATION
0.5 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
Because white cedar swamps are dependent on saturated hydrological processes, the effects of even small roads may create substantial barriers between occurrences.

Boundaries can usually be determined from aerial photos. Difficulties in distinguishing this type from balsam fir, black spruce, or black ash swamps may require mapping as a complex.

FEATURE LABELS

GSPECS AUTHORSHIP
Aaseng, N. and D. Faber-Langendoen

GSPECS DATE
1997-07-02

GSPECS NOTES

RANKSPECS GROUP

RANK PROCEDURE
Condition is the primary factor, size is the secondary factor, and landscape context is the tertiary factor. The primary and secondary factors are weighted equally, and weighted more heavily than the tertiary factor.

EO RANK FACTOR *[1st]*
Condition

A SPECS

a) Site dominated by mature *Thuja occidentalis* generally >150 years old, with lesser cover of *Abies balsamea* and/or *Picea mariana;*

b) extensive areas (>5 ha) with sufficient tree cover (50-100%) to favor development of typical shade-tolerant flora; species diversity high (>65 species);

c) no obvious impact on vegetation from flooding or lowering of water table by activities such as road construction, ditching, or mining;

d) surface disturbance due to winter roads, selective logging, and utility corridors limited to small percentage (<5%) of swamp;

e) no exotic species present;

f) absence of overgrazing by deer, as inferred by presence of white cedar reproduction;

g) Downgrading of rank because of greater disturbance may be offset by significant presence of rare species such as *Cypripedium arietinum*, *Ranunculus lapponicus*, *Geocaulon lividum*, *Arethusa bulbosa*, *Polemonium occidentale*, or important concentrations of several species of orchid.

B SPECS

a) A stand with the above "A"-rated condition characteristics, but partially degraded by surface activities such as selective logging;

b) a stand with the above "A"-rated condition characteristics, but impacts due to water table alteration are present (although limited to a narrow band along ditch, road, *etc*.);

c) a stand with mature cedar and typical structure, but with depauperate ground flora due to alteration of groundwater by ditching.

C SPECS

a) Stand has structure and species composition significantly altered from its presettlement character by flooding, lowering of water table, or surface activities;

b) lowering of water table may result in reduction or near total loss of ground flora;

c) has more than occasional occurrence of exotic or non-typical cedar-spruce swamp species, but has enough structure and typical species so that the community is still recognizable.

D SPECS
A site where the hydrology has been severely altered or the surface drastically disturbed such that restoration is unlikely to occur.

RANK SPECS JUSTIFICATION
"A"-rating threshold: Maintenance of natural groundwater flow patterns is essential to the condition of this community. Use of rare species is suggested here because of their value as an indicator of natural processes.

"C"/"D" threshold: Groundwater flow has been severely altered such that the community is not likely to persist.

EO RANK FACTOR *[2nd]*
Size

A SPECS
Very Large (>=40 ha)

B SPECS
Large (20-39 ha)

C SPECS
Moderate (4-19 ha)

D SPECS
Small (<4 ha)

RANK SPECS JUSTIFICATION
"A"-rating threshold: In the United States, white cedar swamps can occur in stands of over 40 ha, and sometimes as large as 200 ha, but this is relatively unusual.

"C"/"D" threshold: White cedar swamps often occur in small, concentrated areas where minerotrophic flows occur. In the New England region, the average occurrence size is 19 ha, and the mode and median sizes are 8 ha. These averages are within the size range specified for "C"-rated occurrences. The minimum viable size of this community is set fairly low at 4 ha.

EO RANK FACTOR *[3rd]*
Landscape context

A SPECS
Highly connected – area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities (>1000 ha).

B SPECS
Moderately connected – area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities; landscape includes partially disturbed natural or semi-natural communities, some of it not high quality due to overgrazing or recent logging (>1000 ha).

C SPECS
Moderately fragmented – area around the EO is largely a combination of cultural and natural vegetation, with barriers between species interactions and natural processes across natural communities; EO is surrounded by a mix of intensive agriculture and adjacent forest lots.

D SPECS
Highly fragmented – area around the EO is entirely, or almost entirely, surrounded by agricultural or urban land use; EO is at best buffered on one side by natural communities.

RANK SPECS JUSTIFICATION
“A”-rating threshold: Landscape context meeting these criteria provides a buffer against hydrologic changes.

“C”/”D” threshold: EO is subject to direct hydrologic inputs from adjacent land use that will alter the water quality; maintenance of natural hydrologic dynamics will be very difficult.

The landscape context is somewhat small, and partially reflects the small to moderate scale of EO size requirements. Landscape requirements for white cedar swamps need investigation, particularly as they relate to groundwater flows.

GRANKSPECS AUTHORSHIP
Aaseng, N. and D. Faber-Langendoen

GRANKSPECS DATE
1997-07-02

GRANKSPECS NOTES

D2.3 Small Patch Communities

D2.3.1 *Carex lasiocarpa – Carex buxbaumii – Scirpus cespitosus* Boreal Herbaceous Vegetation,

wiregrass sedge – Buxbaum's sedge – tufted club-rush boreal herbaceous vegetation

SPECS GROUP
Carex lasiocarpa Saturated Herbaceous Alliance Group

MINIMUM SIZE
0.05 ha

EO Separation

SEPARATION BARRIERS
A substantial barrier that would separate patches of this community is a two-lane highway or larger.

SEPARATION DISTANCE – DIFFERENT NATURAL/SEMI-NATURAL COMMUNITIES
1 km

SEPARATION DISTANCE – CULTURAL VEGETATION
0.5 km

ALTERNATE SEPARATION PROCEDURE

SEPARATION JUSTIFICATION
Because fens are dependent on hydrological processes, the effects of even small roads may create substantial barriers between occurrences.

Note that occurrences of this community may be difficult to distinguish from other communities. Possible difficulties include:

a) distinguishing between rich fen and wet meadow on aerial photographs (fens usually appear light blue in color on IR NAP [infra-red national aerial photography] photographs, while wet meadows appear white); and

b) defining boundaries between rich fen and poor fen. In the absence of field data, these types can often be distinguished on the basis of landform position and inferred surface chemistry and water flow. Poor fens are often distinguished by the abundance of ericaceous shrubs, which appear somewhat orange in color on NHAP (national high altitude photography) photographs.

FEATURE LABELS

GSPECS AUTHORSHIP
Aaseng, N. and D. Faber-Langendoen

GSPECS DATE
1997-07-02

GSPECS NOTES

RANKSPECS GROUP

RANK PROCEDURE
Condition is the primary factor, landscape context is the secondary factor, and size is the tertiary factor. The primary and secondary factors are weighted equally, and weighted more heavily than the tertiary factor.

EO RANK FACTOR *[1st]*
Condition

A SPECS

a) No obvious impact on vegetation (determined using aerial photos) resulting from alteration of groundwater by activities such as road construction, ditching, utility corridors, or mining activities. Some minor occurrence of abandoned winter vehicle trails is acceptable;

b) presence of *Drosera anglica*, and particularly *D. linearis*, is a good indicator of pristine condition. Other rare species may be present, such as *Drosera linearis*, *D. anglica*, *Xyris montana*, *Carex exilis*, *Cladium mariscoides*, and *Rhynchospora fusca* in the boreal section of its range, and *Scirpus cespitosus*, *Cladium maricoides*, *Carex viridula*, and *Eleocharis pauciflora* in the southern part of its range;

c) high flora diversity because of presence of mud-bottomed pools or flarks and moss-covered ridges (these features can be detected on aerial photos); moss layer is well-developed, consisting of genera such as *Campylium*, *Drepanocladus*, and *Calliergonella;*

d) no exotic species present.

B SPECS

a) Sites with “A”-rated condition characteristics, but where surface disturbance over a small to moderate percentage of fen has occurred due to winter roads or utility corridors;

b) small percentage of fen surface is impacted due to water table alteration (which may be indicated by invasion of *Asclepias incarnata*, *Alnus incana*, or *Cirsium arvense*, or an increase in *Chamaedaphne calyclata*, *Betula glandulifera*, *Larix laricina*, or *Calamagrostis canadensis*);

c) undisturbed site lacking floristic diversity, fairly monotypic, often with thick thatch; moss layer partially disturbed.

C SPECS

a) Overall ground water flow intact, but is extensively impacted by ditches and roads; significant portions of fen remain intact;

b) moss layer may be very patchy.

D SPECS

a) Hydrology has been severely altered or surface drastically disturbed (*e.g.*, by peat mining) such that restoration is unlikely to occur;

b) moss layer very sparse; composition may be very simplified.

RANK SPECS JUSTIFICATION
“A”-rating threshold: Maintenance of natural groundwater flow patterns is essential to the condition of this community.

“C”/”D” threshold: Groundwater flow has been severely altered, such that the community is not likely to persist.

Care should be taken not to inflate the rank based on the presence of rare species *per se*; rather, they serve to indicate high quality conditions. Their role as indicators needs further investigation.

EO RANK FACTOR *[2nd]*
Size

A SPECS
>=20 ha

B SPECS
10-19 ha

C SPECS
4-9 ha

D SPECS
<4 ha

RANK SPECS JUSTIFICATION
“A”-rating threshold: Fens of this size are more likely to have diverse composition.

“C”/”D” threshold: Fens below 4 ha in size are not likely to contain the full range of diversity, and will be easily affected by non-natural processes, should these be occurring nearby.

EO RANK FACTOR *[3rd]*
Landscape context

A SPECS
Highly connected – area around the EO is largely intact natural vegetation, with species interactions and natural processes occurring across communities (>1000 ha).

B SPECS
Highly connected – area around the EO is moderately intact natural vegetation, with species interactions and natural processes occurring across many communities; landscape includes partially disturbed natural or semi-natural communities, some of it not high quality due to overgrazing or recent logging (>1000 ha).

C SPECS
Moderately fragmented – area around the EO is largely a combination of cultural and natural vegetation, with barriers between species interactions and natural processes across natural communities; EO is surrounded by a mix of intensive agriculture and adjacent forest lots.

D SPECS
Highly fragmented – area around the EO is entirely, or almost entirely, surrounded by agricultural or urban land use; EO is at best buffered on one side by natural communities.

RANK SPECS JUSTIFICATION
“A”-rating threshold: This landscape context provides a buffer against hydrologic changes.

“C”/”D” threshold: EO is subject to direct hydrologic inputs from adjacent land use that will alter the water quality, and maintenance of natural hydrologic dynamics will be very difficult.

Landscape context is fairly small, and partially reflects the smaller scale of EO size requirements. Landscape requirements for fens need investigation.

GRANKSPECS AUTHORSHIP
Aaseng, N. and D. Faber-Langendoen

GRANKSPECS DATE
1997-07-02

GRANKSPECS NOTES

APPENDIX E: Element Lists and Ranking[53]

E1 Element Definition
E2 Element Lists
E3 Element Ranking

E1 Element Definition

An Element is a unit of natural biological diversity. Elements represent species (or infraspecific taxa), natural communities, or other nontaxonomic biological entities (*e.g.*, migratory species aggregation areas).[54]

To ensure that a broad, practical, and well-balanced representation of the biological diversity in a jurisdiction or ecoregion is protected, a "coarse filter/fine filter" approach to conservation site selection is utilized. Communities may be viewed as a coarse filter for natural diversity; identification and protection of the best examples of all types of communities (*i.e.*, terrestrial, subterranean, freshwater, marine) will ensure that most species and ecological processes are conserved. However, some species that are imperiled or vulnerable "fall through" the coarse filter; because of their rarity, they are not reliably found in habitats or communities where they might be expected, and their conservation cannot be assured without specific attention. Thus, a "fine filter" comprised of these species is needed. Targeting fine filter Elements for conservation along with communities ensures that a broad spectrum of biodiversity will be preserved.

Decisions on which Element groups to target for conservation vary on the basis of several factors, including differences in the amount and availability of Element information, and whether the Elements represent coarse or fine filters for biodiversity conservation (see E2.2.1 through E2.2.9, below).

E2 Element Lists

E2.1 Global, National, and Subnational Element Lists

The first step in any heritage inventory is the compilation of Elements into **ELEMENT LISTS**. Although developing a comprehensive list of all the Elements that currently exist (or have existed historically) on earth is not feasible, the Element List should include as broad and well-balanced a representation of all biodiversity as possible. Whenever possible, to ensure consistency and comparability of data across jurisdictions, the taxonomy and nomenclature in the Element List should be based on standard name references or checklists (or, if no name sources are available, on names published in the scientific literature). The Central Zoological, Botanical, and Ecological

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[53] This Appendix summarizes Element listing and ranking as currently practiced. Some additional information on Element listing and ranking is contained in on-line documentation for the Element Tracking and Element Ranking files in the Biological and Conservation Data System (The Nature Conservancy 1996), and in the Natural Heritage Program Model Operations Manual (The Nature Conservancy 1988).

[54] Note that in regions where there is only limited information on Elements, surrogate targets may be used to model patterns of biodiversity for conservation planning and action. Surrogates that have been considered include higher taxonomic levels, image-derived cover types, land-use classifications, abiotic factors, and coarsely-mapped distributions of vulnerable species.

Databases of the Natural Heritage Network list standard names for many thousands of taxa (*e.g.*, vascular plants, vertebrates, community types, and many invertebrate and nonvascular taxa) occurring in North America for the benefit of network participants. The information in the Central Databases may thus be considered as a Global Element List. However, the Global Element List is currently not worldwide in scope; while the list includes global information about species and communities, it does not include all the species or communities in the world.

National and Subnational Element Lists may be developed that contain Elements found within particular nations or subnations, respectively. Such lists are a subset of the Global Element List.

E2.2 Developing an Element List

For some groups of Elements, decisions on what to include on an Element List are determined using a comprehensive approach in which all Elements within a group (typically phylum, class, order, or family for species) are listed[55]; this is termed **COMPREHENSIVE ELEMENT LISTING**. The comprehensive approach is often applied in situations where the taxonomy, status, and distribution (*e.g.*, by subnation) are reasonably well known for most species in each family or group (*e.g.*, amphibians, vascular plants, tiger beetles).

Comprehensive listing within a group of all the Elements known to occur or known to have occurred in a jurisdiction provides many benefits to a data center. Comprehensive Element listing facilitates the identification of taxa that are at risk (or, conversely, taxa that might pose risks [*e.g.*, invasive exotics]) in a particular jurisdiction and helps to ensure that vulnerable but unfamiliar species are not overlooked. Individual data centers benefit by receiving (*e.g.*, through data exchange) centrally recorded global information for all of the Elements in comprehensively listed groups in their jurisdiction. In addition, comprehensive Element listing helps to service a growing user community by providing basic, frequently requested information regarding which species in a particular group occur in a particular jurisdiction. Comprehensive Element listing also provides network-wide benefits by permitting all network data centers and a multi-jurisdictional user community to benefit from the collective work of many data centers and their collaborators. If all jurisdictions in a large region (*e.g.*, North America north of Mexico) comprehensively list and rank every Element in a particular group, rangewide information is then available for global and national conservation status assessments for most Elements in that group in the region.

For many Element groups, particularly within invertebrates and nonvascular plants, the taxonomy, distribution, and/or status of the component species are not sufficiently well known to develop a comprehensive Element List. In such cases, decisions on which Elements to list are made on the basis of a selective approach. In this situation, only some of the Elements within a group are included on an Element List without consideration of other Elements within the group, some of which could be of equal or greater conservation concern. This is termed ***AD HOC* ELEMENT LISTING**, and is usually applied to those species in poorly known groups of Elements that are believed to be imperiled and vulnerable, including species of official national or subnational concern.

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[55] The use of the verb "to list" in this Standard should not be confused with the placement of species on official lists (*e.g.*, national or subnational endangered species lists, CITES appendices).

E2.2.1 Vascular Plants

Vascular plants are relatively well known as a group in the United States and Canada. For this reason, all standard species in the network's central databases should be listed in each subnation (*i.e.*, state or province) where they occur. In Latin America, the status and distributions of most plant species are not as well known and *ad hoc* listing is necessary.

E2.2.2 Vertebrates

Vertebrate animals, except marine fishes, are relatively well known as a group in the United States and Canada. For this reason, all standard species in the network's central databases should be listed in each nation and subnation where they occur. In Latin America, the status and distribution of birds, mammals, reptiles and amphibians is relatively well known and these species should be comprehensively listed in each nation. Freshwater fishes, on the other hand, are not as well known in Latin America and *ad hoc* listing must be used. Marine fishes are generally not comprehensively listed nationally or subnationally in the United States, Canada, or Latin America, although in some cases *ad hoc* listing is used.

E2.2.3 Communities

In theory, communities should also be comprehensively listed, both for their intrinsic conservation value and as a coarse filter, assuring that many species that are not directly targeted for conservation (*e.g.*, most nonvascular plants and invertebrates, especially insects and bacteria) will still be protected. The listing of communities also helps to ensure the conservation of ecosystems and ecological processes.

In practice, however, comprehensive listing is only feasible for terrestrial vegetated communities (*i.e.*, at least at the global level) since only these community types have a standard classification system (Grossman *et al.* 1998). In contrast, global listing for subterranean (*e.g.*, caves, aquifers, lava tubes), freshwater, and marine communities is not possible until standard classification systems are developed for these community types.[56]

Lacking a global standard classification, nations and subnations may still list subterranean, freshwater, and marine communities based on locally developed classifications. In other words, each nation and subnation has the option to list (on an *ad hoc* basis) nonstandard community types, which can be beneficial for conservation in that jurisdiction. However, regional and global analyses, comparability of EOs, and identification of conservation priorities across jurisdictional lines are very difficult when each jurisdiction is listing different nonstandard Elements.

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[56] Standard classifications are currently under development for freshwater communities (Lammert *et al.* 1997) and marine communities (Sullivan Sealey and Bustamante 1999). A classification for subterranean communities is not yet under development.

E2.2.4 Nonvascular Plants[57]

In comparison with vascular plants, nonvascular plants (*e.g.*, mosses, liverworts, hornworts, lichens, other fungi, algae) are more poorly known in terms of taxonomy, distribution, rarity, and threats. Consequently, it is difficult to list nonvascular plants comprehensively. Where possible, selected groups (*e.g.*, mosses, liverworts, hornworts, and lichens) should be comprehensively listed at a national or subnational level, especially if the group is small and well known in a particular jurisdiction or region. *Ad hoc* listing of other imperiled or vulnerable species should also be considered.

Because of their more direct relationship with the substrate and their different biogeographic history, the distribution and habitats of nonvascular plants known to be at risk are often poorly correlated with those of vascular plants. Therefore, including at least selected nonvascular plants on an Element List usually provides an additional perspective on biodiversity, leading to conservation of sites that might not otherwise be chosen. Because other groups of "lower plants" (*e.g.*, various algal groups, fungi) and cyanobacteria cannot be feasibly listed in a comprehensive manner, conservation of these Elements is addressed through listing communities as a coarse filter for biodiversity.

E2.2.5 Invertebrates

Listing most invertebrates raises many of the same issues considered when listing nonvascular plants. However, in United States and Canada the status and distribution of species in some groups of invertebrates are sufficiently well known that these groups should be comprehensively listed at national and subnational levels. These groups currently include freshwater mussels, crayfishes, snails, and some insect groups, including butterflies and skippers, dragonflies and damselflies, tiger beetles, and several moth families. Additional groups may be added to this list as knowledge permits. As with nonvascular plants, although it may not be possible to assess the status and distribution of a particular invertebrate group globally, there may be sufficient information available in a given jurisdiction to do so. However, most species in most groups of invertebrates in the United States and Canada are less well known than species in the groups mentioned above, but should be individually listed on an *ad hoc* basis, especially when there is evidence that they are in need of conservation attention.

Similar to nonvascular plants, listing additional species or groups of invertebrates has led to the identification of sites that would not otherwise have been identified as priorities for conservation. Also, in some cases, such sites may be critically important on a global level to the survival of species in a particular group. For example, a high proportion of the world's known freshwater invertebrates, especially mussels, crayfishes, and aquatic insects, are endemic to the southeastern United States.

Because most invertebrate species cannot be comprehensively listed, it is anticipated that the conservation of communities, as well as the conservation of vascular plants, vertebrates, and relatively well known invertebrate species, will capture most invertebrate biodiversity. However,

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[57] As used in this document, "nonvascular plants" includes not only bryophytes, but also lichens (more accurately termed lichen-forming fungi), fungi, algae, and blue-green "algae" (cyanobacteria); these organisms have been traditionally treated as plants, although many are now classified in other kingdoms. When listed, these organisms are usually grouped with nonvascular plants on Element Lists.

inclusion of selected additional invertebrates on an Element List will help ensure that additional sites critical to the conservation of biodiversity are identified.

E2.2.6 Undescribed Species Elements

Estimates of the total number of living species span more than an order of magnitude, from around 3 million to more than 100 million, but fewer than 2 million of these species have been scientifically described and formally named. Even in relatively well known areas such as the United States, it is estimated that less than half of the species have been described and named. In most Element groups there are many "new" undescribed species that have been discovered, but these taxa may wait many years before being formally described. Rather than wait until they are formally described, it is desirable to include undescribed Elements of possible conservation concern on an Element List if there is a reasonable expectation that they are taxonomically distinct. Unpublished scientific names should not be used in Element Lists; instead, an informal designation (*e.g.*, *Carex* sp 7) should be used provisionally.

E2.2.7 Infraspecific Elements

Taxonomic practices and the degree to which infraspecific taxa are currently recognized vary tremendously among different Element groups. For vascular plants, subspecies and varieties are often recognized; for butterflies, subspecies are often recognized; for salmonid fish, informally named stocks are often recognized; however, for lichens, mussels, and many vertebrate groups, few subspecies are recognized in current taxonomic treatments. In most cases, the inclusion of infraspecific taxa on Element Lists should correspond to the degree to which such taxa are generally recognized by systematists working on that Element group.

E2.2.8 Questionably Distinct Elements

The taxonomic standing of many species and communities is questionable or unresolved. Uncertainty concerning the classification of a particular Element is discussed in the taxonomic comment or classification confidence fields (for species and communities, respectively) in the Element files (not necessarily by the assignment of a "Q" qualifier to the global rank[58]). In general, it is preferable to include an Element of possible conservation concern on an Element List if there is a reasonable expectation that it is taxonomically distinct.

E2.2.9 Nontaxonomic Elements

By definition, nontaxonomic Elements lack a standard global classification and, therefore, describe nonstandard types that may be listed at the discretion of each jurisdiction. Typically such Elements represent transient animal communities (*i.e.*, aggregations of migratory species). These transient animal communities include migratory shorebird concentrations; waterfowl concentrations; rookeries; bat hibernacula; alcid, tern, and gull colonies; and warm water, cold

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[58] Some species may have a "Q" qualifier assigned to their global rank indicating that the rank is uncertain due to questionable taxonomy. However, not all species with questionable taxonomy have a "Q" qualifier on their global rank since the assigned rank will not always be affected by a change in taxonomy. More comprehensive information on Element ranking is contained in on-line documentation for the Element Ranking files in the Biological and Conservation Data System (The Nature Conservancy 1996), and in the Natural Heritage Program Model Operations Manual (The Nature Conservancy 1988).

water, and anadromous fish concentrations. Treating these aggregations as Elements serves to group animals that are functionally related through shared seasonal behaviors. More importantly, because of the numbers of individuals of different species, such mixed species aggregations are often significant from a conservation perspective. For example, particular migratory shorebird aggregations may contain a large proportion of the hemispheric populations of several species.

Although geologic features are sometimes listed by Heritage Programs because of requirements of a parent agency, only the listing of biologically significant geologic features that are not yet classified as community Elements (*e.g.*, caves) can be readily justified. The use of caves (which may be subdivided into various categories [*e.g.*, solution and fissure, wet and dry]) as distinct Elements serves as a surrogate classification for subterranean communities, which currently lack a standard global classification system. Since the inclusion of caves on an Element List is analogous to listing subterranean communities, such listing should be considered in the same context as community Elements.

Various non-standard community types (*e.g.*, Coastal Plain pond shores zones, dune/swale complexes) may be useful where inventory is most feasibly accomplished by such units. Use of such types should not be seen as a means of creating an alternative classification to the natural community classification used by this document, but as a necessary means of characterizing parts of the landscape that are otherwise difficult to assess using the natural community classification. It is critical that the standard community types that comprise these units be identified, so that an understanding of what is being identified and potentially protected is made clear, and what the EO rank of the standard types might be. Since each occurrence of a nonstandard EO might contain a different mix of standard Elements, each nonstandard EO should list the standard Elements found within them.

E3 Element Ranking

Global, national, and subnational Element conservation ranks (GRANKs, NRANKs, and SRANKs) provide basic information on the relative imperilment or vulnerability of an Element within the specified geographic ranges based on a five-point hierarchical scale, ranging from critically imperiled to demonstrably widespread, abundant and secure. In addition, Element ranks provide, where appropriate, specific information reflecting an Element's historical or extinct status, taxonomic level, rank certainty (as a function of available information or taxonomic questions), and hybrid, captive/cultivated, exotic, accidental, potential, reported, and breeding/nonbreeding statuses. For species, Element ranks provide an approximation of the risk of extinction, and they serve as the single most important factor used to evaluate whether occurrences of an Element should be listed. Element ranks also serve as a critical factor (for both species and communities) in setting priorities for conservation action.

E3.1 Element Ranking Factors

Rare species and communities are particularly vulnerable to both human-induced and natural hazards. As a result, rarity is a key predictor of extinction potential. Although rarity may seem a straightforward concept, it is complex to characterize. For each Element, several distinct characteristics of rarity are evaluated in assessing its conservation status: the number of different populations or occurrences of the Element; the extent of its area of occupancy; the breadth of its geographic range; and, for species, the total population size or number of individuals of the species. Considerations other than rarity are also factored into conservation status determinations. Trends, both population trend for species (whether a species' numbers are increasing, stable, or declining) and trends in area of occupancy and total range for both species and communities, are key ranking factors. The viability of existing occurrences is also an important factor, especially for Elements whose occurrences are reduced in number or extent. Viability (see Section 5.3, EO Rank Factors) is a function of population or community size, condition (*e.g.*, reproductive output, intactness of ecological processes), and landscape context (*e.g.*, genetic connectivity). Threats to the Element, both human and natural, must also be considered since these are important predictors of future decline.

E3.2 Element Ranking Definitions

Global conservation status ranks are based on a one to five scale (see Table E1), ranging from critically imperiled (G1) to demonstrably widespread, abundant, and secure (G5). Species and communities known to be extinct (GX), or missing and possibly extinct (GH), also are recorded. A numeric range rank is used to denote the range of uncertainty about the exact status of a species or community (*e.g.*, G2G3); range ranks may be assigned in situations where an Element has a relatively equal probability of being either, or any, of the ranks included in the range specified. In addition, Element rank qualifiers may be used to provide information on uncertainty of a numeric rank ("?"), questionable taxonomy ("Q"), or the captive/cultivated status of an Element ("C").

The global conservation status of infraspecific taxa (subspecies or varieties) is indicated by using a "T" subrank as part of the global rank. Rules for assigning "T" subranks follow the same principles outlined above. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A "T" subrank cannot imply that the subspecies or variety is more abundant than the species' basic rank (*e.g.*, a G1T2 subrank should not occur).

Table E1 – Definitions of Global Conservation Status Ranks

Global Rank	Description
GX	Presumed Extinct not located despite intensive searches
GH	Possibly Extinct historical; still some hope of rediscovery
G1	Critically Imperiled Globally typically 5 or fewer occurrences, or 1000 or fewer individuals
G2	Imperiled Globally typically 6-20 occurrences, or 1000 to 3000 individuals
G3	Vulnerable rare; typically 21 to 100 occurrences, or 3000 to 10,000 individuals
G4	Apparently Secure uncommon but not rare; some cause for long-term concern; usually more than 100 occurrences and 10,000 individuals
G5	Secure common; widespread and abundant; usually with considerably more than 100 occurrences and 10,000 individuals

A similar numeric scale is also used for national (N1 through N5) and subnational (S1 through S5) Element ranks. For these ranks, the status of a species or community is evaluated within specific national or subnational jurisdictions rather than on a rangewide basis.

The global Element rank represents the rangewide conservation status of a species or community. If the Element is vulnerable or imperiled everywhere it occurs, it has a global rank of G1, G2, G3, or GH. Species and communities that are imperiled or vulnerable in a local area, but common elsewhere, have global ranks of G4 or G5 and local ranks of N1, N2, N3, or NH (or S1, S2, S3, or SH). These latter species and communities are components of biological diversity locally at risk, but common and unthreatened in at least some other portion(s) of their ranges. The three levels in the conservation status ranking system allow independent distinction of global, national, and more local (subnational) conservation status.

E3.3 Element Rank Rounding[59]

Rounded ranks simplify complex GRANK, NRANK, and SRANK values. They may be useful when performing tallies or analyses, or when summarizing complex Element status information for general purposes (*e.g.*, in products for external audiences). Rounded ranks serve as an approximate substitute only; they are not intended as a replacement for the detailed Element status information contained in the GRANK, NRANK, or SRANK fields when this detail is important. In general, the rounding algorithm eliminates range ranks, strips the qualifiers off the GRANK, and focuses on the "T" subrank for infraspecific taxa. Rounded ranks include GX, GH, G1, G2, G3, G4, G5, and the equivalent “T” subranks.

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[59] More comprehensive information on Element rank rounding is contained in the document titled Element Rank Rounding and Sequencing (The Nature Conservancy 1996).

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GLOSSARY

***AD HOC* ELEMENT LISTING**

A selective approach for determining what to include on an Element list. With *ad hoc* Element listing, only some of the Elements within a group are included without consideration of others in the group, some of which could be of equal or greater conservation concern. This approach is usually applied to those species in poorly-known groups of Elements that are believed to be imperiled and vulnerable, including species of official national or subnational concern.

AREAL DELIMITED UNCERTAINTY

Locational uncertainty greater than negligible that varies within a known extent in more than one dimension. The true location of an EO with areal delimited extent can be visualized as “floating” within some area for which boundaries cannot be specifically delimited.

AREAL ESTIMATED UNCERTAINTY

Locational uncertainty greater than half the minimum mapping unit and that varies an unknown extent in more than one dimension. The true location of an EO with areal estimated extent can be visualized as “floating” within a specified boundary that delimits the full extent of uncertainty associated with the occurrence.

BASIC FEATURE

A feature derived from a source feature that represents the occurrence including associated locational uncertainty without the addition of any procedural or programmatic buffers

CALCULATED REPRESENTATION ACCURACY

Ratio of the observed area to the procedural area of an EO representation, multiplied by 100, used to indicate the percentage of the procedural area of an occurrence that is actually occupied by the Element.

COMMUNITY

An ecological community (*i.e.*, a community Element Occurrence) is an assemblage of species populations that co-occur and potentially interact with one another (Begon *et al.* 1990, McPeek and Miller 1996).

COMMUNITY TYPE

A terrestrial vegetated community type (*i.e.*, a community Element) is defined by conceptually grouping “on the ground” communities into “associations” or taxonomically higher-level units (*i.e.*, “alliances” or “formations”) based on similarities in floristic composition, vegetation structure (physiognomy), and environmental characteristics (Grossman *et al.* 1998).

COMPOSITE EO

An occurrence comprised of different contiguous areas reflecting different categories of observed features (*e.g.*, an EO comprised of a stream [linear area] and a pond [large area]).

COMPOUND EO
An occurrence consisting of noncontiguous areas close enough to each other to be considered one EO, based on separation guidelines defined for the Element (*e.g.*, a pothole pond community comprised of two or more distinct ponds).

COMPREHENSIVE ELEMENT LISTING
An approach for determining what to include on an Element List in which all Elements within a group (typically phylum, class, order, or family for species) are listed. This approach is often applied in situations where the taxonomy, status, and distribution (*e.g.*, by subnation) are reasonably well-known for most species in each family or group**.**

CONCEPTUAL FEATURE
Conceptually characterization of an observed feature as a simplified cartographic unit (a point, line, or polygon).

CONDITION
EO rank factor that is an integrated measure of the quality of biotic and abiotic factors, structures, and processes within an occurrence, and the degree to which they affect the viability of the EO.

CULTURAL VEGETATION
Planted/cultivated areas defined by the Federal Geographic Data Committee (1996) as “Areas dominated with vegetation which has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation. The majority of vegetation in these areas is planted and/or maintained for the production of food, feed, fiber, or seed. This includes: vegetation planted in built-up settings, for recreation, erosion control, or aesthetic purposes; all areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, cotton, wheat, and rice; grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops; orchards, vineyards, and tree plantations planted for the production of fruit, nuts, fiber (wood), or ornamental. In cases where one cannot assess whether it was planted by humans (*e.g.*, some mature forests), the vegetation is considered ‘natural/semi-natural’”.

DETAILED FEATURE
A feature use to represent an observation at a scale larger than the standard map scale.

ELEMENT LIST
A register comprised of many species and communities that currently exist, or have existed historically. Element Lists are compiled at global, national, and subnational levels to provide a broad and well-balanced selection of the biodiversity present in the jurisdiction.

ELEMENT
An Element is a unit of natural biological diversity. Elements represent species (or infraspecific taxa), natural communities, or other nontaxonomic biological entities (*e.g.*, migratory species aggregation areas).

ESTIMATED REPRESENTATION ACCURACY
Scale that indicates the accuracy of a feature. EOs with negligible uncertainty are the most accurate, with all other features categorized according to the biologist's estimate of the percentage of an EO representation that is attributable to the area of the original field observation (*i.e.*, before added locational uncertainty).

EO RANK
An EO rank represents the relative value of an EO with respect to others for that Element, defined according to criteria derived from specific EO rank factors. An EO rank provides an assessment of the estimated viability or probability of persistence of the occurrence.

EO RANK FACTOR
A factor that reflects the present status, or quality, of an occurrence, used as the basis for estimating the viability of the EO, *i.e.*, its EO rank. There are three EO rank factors, each reflecting what is currently known about an EO: size, condition, and landscape context.

EO RANK FACTOR SPECIFICATIONS
For communities, guidelines developed in a global context that establish rank criteria for each of the EO rank factors individually. EO rank factor specifications are based on knowledge of historical evidence and current status of occurrences of the Element.

EO RANK SPECIFICATIONS
For species, guidelines developed in a global context that establish criteria for an EO rank based on EO rank factors. EO rank specifications are based on knowledge of historical evidence and current status of occurrences of the Element.

EO REPRESENTATION
Mapped feature delineating the boundaries of an EO, including locational uncertainty associated with the underlying data.

EO SPECIFICATIONS
Guidelines developed in a global context that establish minimum criteria for what constitutes a valid EO.

EO TRACKING LIST
A subset of an Element List, compiled at national and subnational levels to define the set of Elements that are of sufficient conservation concern to warrant the accumulation and maintenance of detailed locational and status data (*i.e.*, EO records) on some or all occurrences. (Also known as an Element Inventory List.)

EO
Element Occurrence - an area of land and/or water in which an Element is, or was, present.

ESTIMATED VIABILITY
The likelihood that if current conditions prevail, an occurrence will persist for a defined period of time (typically 20-100 years). The estimated viability of an occurrence is essentially represented by its EO rank.

FEATURE LABEL
An optional descriptive label indicating what the data is (*e.g.*, deme, nest, den, watershed). In practice, feature labels are most useful for sub-EOs.

GENERALIZED REPRESENTATION
A representation of an EO with blurred boundaries and/or an offset position, used to protect the location of a sensitive Element on a map to be used for public distribution.

LANDSCAPE CONTEXT
EO rank factor that is an integrated measure of the quality of biotic and abiotic factors, structures, and processes surrounding an occurrence, and the degree to which they affect the viability of the EO.

LINEAR UNCERTAINTY
Locational uncertainty greater than negligible that varies in one dimension (*i.e.*, along an axis). The true location of an EO with linear uncertainty may be visualized as effectively "sliding" within a linear span that delineates the uncertainty.

LOCATIONAL UNCERTAINTY
The recorded location of the occurrence may vary from its true location due to many factors, including the level of expertise of the data collector, differences in survey techniques and equipment used, and the amount and type of information obtained. This inaccuracy is characterized as locational uncertainty, and should be incorporated in the representation of an EO.

LOCATION USE CLASS
A descriptive name that should be assigned to all observed areas of migratory species that utilize geographically and seasonally disjunct locations, used to group EOs by their season of occurrence.

METAPOPULATION
In a broad sense, a metapopulation is a spatially structured group of subpopulations where at least one of the subpopulations has a non-trivial probability of natural extirpation. More narrowly defined, a metapopulation is a population that has demographically significant exchange among subpopulations (*e.g.*, demes) such that the persistence of the metapopulation depends on the combined dynamics of extirpation from given patches and recolonization among patches by dispersal. If habitats are so far apart that dispersal between them virtually never occurs, the system will behave as a set of completely separate populations.

MINIMUM DIGITIZING UNIT
The size of the smallest feature that is larger than the minimum mapping unit for which boundaries will be digitized. Features that are larger than the minimum mapping unit but below the threshold of the minimum digitizing unit may be more practically digitized using a circle buffered to the appropriate size.

MINIMUM MAPPING UNIT
The size of the smallest feature for which boundaries will be delineated on a map of a particular scale.

NEGLIGIBLE UNCERTAINTY
Locational uncertainty that is less than or equal to half the minimum mapping unit in any dimension. EOs with negligible uncertainty are based on a comprehensive field survey with high quality mapping has a high degree of associated certainty.

OBSERVED FEATURE
Feature based on an observed area from a field survey or historical account that serves as the foundation from which an EO representation may be developed.

OCCUPIED HABITAT
For species Elements, the area that encompasses the full extent (or full seasonal extent for aerial, marine, or anadromous migratory species) of all behaviors and life history functions, except long-distance dispersal, for that local population.

POINT REPRESENTATION
A point used to represent an EO at any map scale small enough that the boundary of the occurrence is not apparent.

PRACTICAL CONSERVATION VALUE
Idea that an instance of an Element at a particular location should potentially contribute to the survival or persistence of the Element at that location in order to qualify as an EO. Because a primary purpose for delineating EOs is to guide conservation action, it is critical that occurrences have practical conservation value for the Elements they represent; this is evidenced by potential continued (or historical) presence and/or regular recurrence at that location.

PRINCIPAL EO
For species, a conceptual representation of the full occupied habitat (or previously occupied habitat) that contributes, or potentially contributes, to the persistence of the species at that location. Principal EOs are typically separated from each other by barriers to movement or dispersal, or by specific distances defined for each Element across either unsuitable habitat, or suitable but apparently unoccupied habitat.

For community types, a representation of a defined area that contains (or contained) a characteristic species composition and structure. Principal EOs are separated from each other by barriers to species interactions, or by specific distances defined for each Element across adjacent areas occupied by other natural or semi-natural community types, or by cultural vegetation.

PROBABILITY OF PERSISTENCE
The likelihood that that if current conditions prevail, an occurrence will continue to exist for a defined period of time (typically 20-100 years).

PROCEDURAL AREA
The area of the procedural feature derived through the process of developing an EO representation.

PROCEDURAL BUFFER
Buffer added to any basic feature that is smaller than the minimum mapping unit in any dimension during translation to a procedural feature to produce a polygon on a standard scale map.

PROCEDURAL FEATURE
Feature that results from translation of a basic feature to a shape that represents the occurrence and its locational uncertainty as a polygon on a standard scale map. One or more procedural features comprise an EO.

SEPARATION DISTANCE
For species, distances defined in EO specifications for intervening unsuitable habitat and suitable but apparently unoccupied habitat, used to separate principal occurrences of the Element. For communities, distances defined in EO specifications for intervening different communities and cultural vegetation, used to separate principal occurrences of the Element.

SIZE
EO rank factor that is a quantitative measure of the area and/or abundance of an occurrence.

SOURCE FEATURE
Feature derived from the translation of a conceptual feature to a tangible form. A source feature serves as the initial digitized or manuscripted spatial component in an EO record.

SUB-EO
Smaller geographically distinct areas nested within another occurrence of the same Element.

WATCH LIST
A register comprised of Elements of some current or potential conservation concern for which occurrences are not currently tracked. Watch List status is commonly assigned to Elements of lesser conservation concern than those that are EO tracked.