Habitat Relationships Database Pilot: Supporting a Habitat-Based Approach to Conservation of At-risk Biodiversity on SFI Certified Lands

Final Report

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Introduction

Under Sustainable Forestry certification programs, such as the Sustainable Forestry Initiative (SFI), industry must take appropriate steps to protect at-risk biodiversity on fiber-producing lands (specifically, globally imperiled [G1-G2] species and communities). These private lands take a variety of forms, from concentrated industry-owned lands to multi-state areas where procurement from small private non-industrial landowners is the norm. The numbers of at-risk species and communities that could occur on these lands nationwide run into the thousands, but due to limited field inventories, precise locality data are lacking.

There is a critical need to describe habitat requirements for this at-risk biodiversity, develop tools to efficiently locate and evaluate these habitats, and document management guidelines for their conservation. This report describes part of a phased effort, in which habitat requirements for at-risk biodiversity likely to be encountered on procurement lands are documented and presented in a searchable database.

Our intent is to better understand the extent to which imperiled species and communities are consistently associated with generalized habitat types and attributes that may be more easily identified than directly searching for each species or community type. Some examples of these include broad habitat types (riparian zones, bogs/fens, cliffs, etc.); NatureServe terrestrial ecological systems (most of which have been mapped regionally and nationally); and Society of American Foresters (SAF) cover types (Eyre 1980). Habitat attributes include successional stages and/or structural condition of the vegetation. If these factors can be reliably discerned from existing maps and other remotely-derived

information, then that greatly enhances the ability of field foresters to evaluate the potential for targeted lands to support at-risk biodiversity.

In addition to this report, the principal deliverable of this project is a companion Microsoft Access 2007 database that contains the results. The database is called HabitatRelations_NCASI_Pilot.accdb.

This systematic approach will help ensure that SFI standards are met in a most effective and efficient manner. The core of this effort is the knowledge of habitat relationships for at-risk biodiversity produced and compiled by NatureServe and its member programs in all 50 United States and the Navajo Nation. Our systematic methods will clarify the at-risk biodiversity likely to occur in affected areas. This will help avoid and/or minimize negative impacts, minimize the costs associated with project- and species-specific field assessments, and ensure that conservation decisions are well supported in the course of fiber procurement. Our mutual aim is to ensure that all at-risk biodiversity is conserved on all lands providing SFI-certified forest products.

Methods

Project Objectives

1) Establish regional lists, for three pilot areas, of at-risk species and communities of conservation concern to the forest products industry;
2) Document habitat relationships for each at-risk species and community type in the three pilot areas;
3) Summarize known presence/absence as well as numbers of known extant occurrence of each species and community type by habitat category, for each pilot area

Habitat Relations Database

The steps in the creation of the database are summarized and grouped in relation to the main objectives of the project.

Establish regional lists, for three pilot areas, of at-risk species and communities of conservation concern to the forest products industry

In order to create a list of the species to be included in the database, we began with the shapefiles of the USDA Forest Service Sections of interest (Cleland 2007). These three geographic areas of interest are the Pacific Northwest (section M242; Cascades and Coast ranges of OR & WA), the Northern Great Lakes (section 212; northern forests of MN, WI & MI), and the Southeast Coastal Plain (section 232; portions of NC, SC & GA), (Figures 1-3).

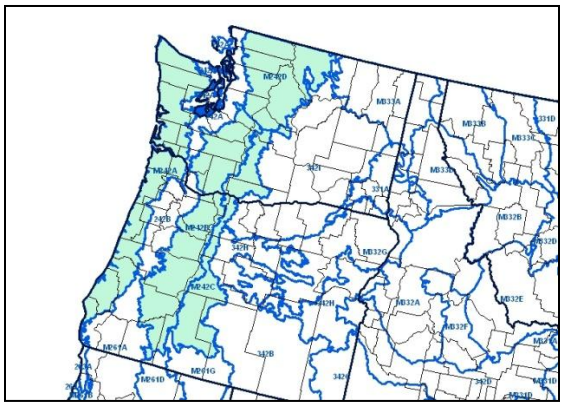

Figure 1 – Pacific Northwest Area

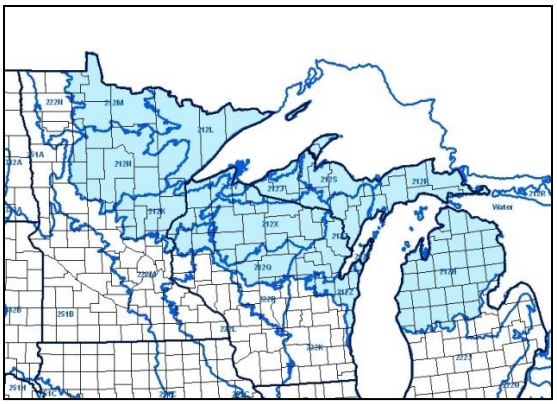

Figure 2 – Northern Great Lakes Area

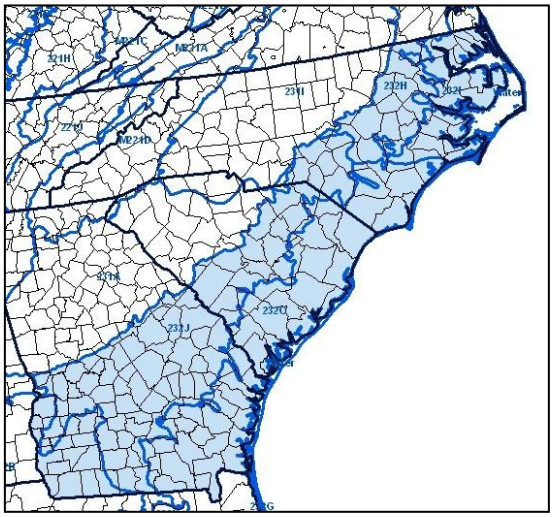

Figure 3 – Southeast Coastal Plain Area

The shapefile of the geographic areas of interest was intersected with a shapefile of United States counties to generate a list of counties of interest for the three regions of the project. This county list was used to query the NatureServe Multijurisdictional Dataset (MJD) for Element Occurrence Records (EORs or EOs).

In the ranking system developed by NatureServe to describe the vulnerability of plants and animals to extinction, a number (1-5) is assigned through a process of evaluating a set of standard criteria (see NatureServe methods publications for background and details http://www.natureserve.org/publications/ConsStatusAssess_RankMethodology.jsp).

These ranks are assigned globally (a G-rank) - for the range-wide perspective of a given species or community type - or for a state, province or other "subnational" political subdivision (an S-rank). These ranks may be single values (e.g. G2 or S2) or may represent a "range rank" to express an uncertainty (e.g. G1G2). The designation "T" is used to indicate that the rank is applied to an "infrataxon" or entity recognized at a level below the species rank (such as a variety or subspecies). These are expressed as a

T-rank (e.g. T2), appended to the global or subnational rank (as, for example G2T1 where the infrataxon is more vulnerable than the full species).

We obtained the Element Occurrence records for G1-G2 and T1-T2 species for the selected counties of interest. The query was conducted in this way because EOs are routinely attributed with the county of occurrence. Because some counties include area both within and beyond the geographic area of interest, the initial list of EOs was generous in extent. In order to generate the final dataset of EOs, and from it a species list for the project area, a shapefile of the centroid locations of all EOs in the selected counties was then clipped to the USDA Forest Service Ecoregion boundaries.

This process, of necessity, did not capture rare species that, due to limited field inventory, had no EOs. Using information in the files of the NatureServe state member programs, additional species were brought in which were rare in the state (G1-G2 or S1-S2) but which had no EOs. These were later evaluated based on expert knowledge of range data to screen out "false positives"; that is, species that occur in the state but are unlikely to occur in the project area.

In a comprehensive taxonomic review, we identified and screened out aquatic and subterranean (cave) species. The aquatic species included Dragonflies and Damselflies (order Odonata) because they have an obligate aquatic life cycle stage.

Aquatic species (those found primarily in lakes, streams, and rivers) were not included in the project because of ongoing industry efforts to conserve aquatic-related G1/G2s by protecting these habitats through best management practices, adherence to state regulations, and the expectations of sustainable forestry certification programs. Best management practices include the use of Riparian Management Zones (RMZs), streamside management zones (SMZs), and other mechanisms which result in the protection of water quality in streams, ponds, lakes, and wetlands.

Despite our best efforts, there are some species whose habitat preferences are poorly known. These are included in the database, but are given an attribute of "data deficient" (DD) and are not shown in reports derived from the database. Most of these are fungi, lichens, and nonvascular plants (mosses and liverworts). A list of them is given in Appendix 3.

For purposes of compliance with the standard of the Sustainable Forestry Initiative (SFI) and this project, plant communities of concern (“community types”) are defined as the plant association level of the US National Vegetation Classification (USNVC; Grossman et al. 1998, FGDC 2008). In addition to rare species, critically imperiled and imperiled (G1-G2) plant associations in all three regions of interest were selected based on their ranges with respect to the ecoregions (for all 3 regions). This information on the range of each type is maintained by NatureServe. Associations were selected on the basis of their ranges, because there are limited element occurrence data on which to base a selection, as was done with plants. Below we provide a few examples of rare plant associations from each of the 3 project regions. These lists also were reviewed by experts to determine if any might not actually occur in one of the three project regions.

Some examples of Southeastern Coastal Plain critically imperiled and imperiled plant associations:

ELCODE	GLOBAL_NAME	TRANSLATED_NAME	COMMON_NAME
CEGL004155	*Aristida beyrichiana - Rhynchospora oligantha - Panicum nudicaule - (Eurybia eryngiifolia)* Herbaceous Vegetation	Southern Wiregrass - Feather-bristle Beaksedge - Gulf Bog Panicgrass - (Eryngo Aster) Herbaceous Vegetation	East Gulf Coastal Plain Seepage Bog (Upper Terrace Type)
CEGL004515	*Adiantum capillus-veneris / Conocephalum conicum* Herbaceous Vegetation	Southern Maidenhair / Snakeskin Liverwort Herbaceous Vegetation	Southeastern Coastal Plain Lake Shoreline Coquina Outcrop
CEGL004720	*Nyssa biflora / Ilex myrtifolia / Carex glaucescens - Eriocaulon compressum* Forest	Swamp Tupelo / Myrtle Dahoon / Southern Waxy Sedge - Soft-head Pipewort Forest	East Gulf Coastal Plain Blackgum Dome Swamp

Some examples of Northern Great Lakes critically imperiled and imperiled plant associations:

ELCODE	GLOBAL_NAME	TRANSLATED_NAME	COMMON_NAME
CEGL005236	*Juniperus horizontalis - Dasiphora fruticosa ssp. floribunda / Schizachyrium scoparium - Carex richardsonii* Dwarf-shrubland	Creeping Juniper - Shrubby-cinquefoil / Little Bluestem - Richardson's Sedge Dwarf-shrubland	Creeping Juniper - Shrubby-cinquefoil Alvar Pavement
CEGL005054	*Quercus alba - Quercus velutina - Quercus palustris / Carex pensylvanica* Woodland	White Oak - Black Oak - Pin Oak / Pennsylvania Sedge Woodland	Lakeplain Mesic Oak Woodland
CEGL005109	*Spartina pectinata - Carex spp. - Calamagrostis canadensis* Lakeplain Herbaceous Vegetation	Prairie Cordgrass - Sedge species - Bluejoint Lakeplain Herbaceous Vegetation	Lakeplain Wet Prairie

Some examples of Pacific Northwest critically imperiled and imperiled plant associations:

ELCODE	GLOBAL_NAME	TRANSLATED_NAME	COMMON_NAME
CEGL000551	*Quercus garryana / Festuca idahoensis* Woodland	Oregon White Oak / Idaho Fescue Woodland	Oregon White Oak / Fescue Sparse Woodland
CEGL001658	*Puccinellia lemmonii - Poa secunda* Seasonally Flooded Herbaceous Vegetation	Lemmon's Alkali Grass - Curly Bluegrass Seasonally Flooded Herbaceous Vegetation	Curly Bluegrass - Lemmon's Alkali Grass - Bottlebrush Squirreltail Grassland
CEGL000047	*Chamaecyparis lawsoniana / Rhododendron occidentale / Carex spp.* Temporarily Flooded Forest	Port Orford-cedar / Western Azalea / Sedge species Temporarily Flooded Forest	Port Orford-cedar Ultramafic Meadows

Document habitat relationships for each at-risk species and community type in the three pilot areas

These initial data were incorporated into a database designed for this project and populated with additional data from Biotics (NatureServe 2010a; Appendix 1 this document), and data entry windows were developed. Other databases used in this phase of the work include the Southern Appalachian Species Viability Database (Nordman and Pyne 2006), and the USGS Phenology database (NatureServe 2010b). In addition, crosswalks to other broad-scale vegetation classifications used by Federal agencies and other partners were integrated. One of these is the Society of American Foresters (SAF; Eyre 1980) classification of forest cover types. The crosswalks between these types and the terrestrial ecological systems were integrated into the database; western crosswalks were already developed, and eastern

ones were added. Similarly, a crosswalk to the Wildlife TRACS system of Broad Habitat Types was developed and added (USFWS 2010). The Wildlife TRACS types are very broad categories defined for a national database system developed by the U. S. Fish and Wildlife Service, and the inclusion of these units will increase the utility of the database for a variety of users and partners.

A list of habitat attributes (Appendix 2) was developed, and added to the database as a table. It was based originally on tables developed for the Southern Appalachian Species Viability Database (Nordman and Pyne 2006), with additional review and revision by experts. The Southern Appalachian Species Viability Database was developed for the USDA Forest Service's regional planning effort through their partnership with NatureServe. NatureServe developed the database and brought Southeastern Natural Heritage programs, academic partners, and other scientists onto the project. It includes rarity, habitat, threat, and conservation information for rare species and others of interest to the Forest Service.

The compilation and development of the species-terrestrial ecological system relationships began with the existing set of relationships reflecting expert knowledge during the initial writing of the descriptions of the systems (Comer et al. 2003). Additional species-terrestrial ecological system relationships were developed several years ago under a grant from the EPA for isolated wetlands across the conterminous U.S. These were uploaded from Biotics, NatureServe's central database.

The use of terrestrial ecological systems as the primary basis for establishing the relationships among species and communities includes a means of "rolling up" these relationships so that they may be expressed in terms of higher-level organizing units for associations, including Wildlife TRACS (USFWS 2010), the Macrogroup level of the US National Vegetation Classification (FGDC 2008), and Society of American Foresters (SAF) Cover Types (Eyre 1980).

The TRACS types and the Macrogroups of the US National Vegetation Classification were used to organize the Ecological Systems into higher-level units for reporting purposes. This is appropriate and useful because the Systems "nest cleanly" into these higher level units. The same cannot be said of the SAF units, which have a very complex relationship to Systems; they were not integrated into reports in the same way.

In this process, an expert review of the taxa and their distributions was conducted. This resulted in the identification of several rare species which were added to the database because they occurred in the state but had no EOs. Others were identified which did not actually occur in the geographic area of interest. These were flagged by the experts for removal. Several taxa were also identified that required an expert review of their global rank. Some of these were determined to not meet the criteria for rarity (G1-G2 or S1-S2) and were removed from the database. Subsequent expert review will determine an appropriate G- or S-rank for these species.

The relationships between the species and the habitat attributes were entered into the database. In the southeast this was done by Milo Pyne and Carl Nordman of NatureServe, and Bruce Sorrie and Stephen Hall of the North Carolina Natural Heritage Program. For the Northern Great Lakes, this was done by Jim Drake of NatureServe with assistance from NatureServe Zoology staff. In the Pacific Northwest, this was done by the ecologists from the Washington Natural Heritage Program.

Reports were created by Kristin Snow, and reviewed by the team. A list of these reports is provided in the results section of this report. The habitat attribute table was reviewed for its applicability to associations. Some attributes were simply not relevant or appropriate for use in the characterization of

associations. Appendix 2 in this report identifies what habitat attributes were used with the species, the associations, or with both.

County distribution data were obtained from Biotics for the rare species, based on the Element Occurrence records. These were loaded into the database, making it possible to derive reports based on what elements would be expected in a particular county. The following language has been inserted into the database to alert users to this and other issues.

> "The lack of data for any geographic area cannot be construed to mean that no significant features are present. In particular, the relationships between species and counties are only as good as the completeness of the Element Occurrence data for a given species. The data are generally stronger and more complete for vertebrate animals and vascular plants than for invertebrates and nonvascular plants. These county lists should be used more as a general guide to the habitats that are likely in the county than as a comprehensive list of the rare plants and animals that could be expected.
>
> "In addition, county-level distribution for a species may be incomplete in cases where the county-level record is associated with an infrataxon (e.g. variety or subspecies) of that species, rather than with the 'full' species; always look at the county distribution for related subspecies and varieties to ensure that the full distribution of the species is accounted for."

The county-level distribution for an infrataxon is more likely to be incomplete or unreliable than for "full species" because of possible inconsistencies among states as to how they track these entities. For example, one state may conduct inventories for given species statewide, while in the adjacent state, where the species is more common, only certain subspecies of that same species are tracked and surveyed due to their local rarity.

Summarize known habitat relationships as well as numbers of known extant occurrences of each species and community type by habitat category, for each pilot area

The expert-knowledge-based habitat relationships of species and plant associations with each terrestrial ecological system and broader level classification unit (e.g. TRACS units) can now be derived from the database. In addition, other habitat attributes for the species have been populated, such as landscape characteristics or habitat inclusions. Plant associations are linked to terrestrial ecological system types, as well as to other habitat characteristics such as landforms, soil characteristics, and hydrologic regime.

For at-risk species, known habitat relationships between species and ecological system types are represented in the database by two differently-derived types of data: expert-derived knowledge of the species' occurrence in an ecological system, and the results of the overlay between the species EOs and a national map of terrestrial ecological systems and land cover (NatureServe 2009).

The EOs, which are represented spatially as "source polygon" features[1], were pre-processed and then intersected with the national map. Since each at-risk species location is represented in slightly different forms from state to state, we took original "source features" as georeferenced points, then applied a consistent buffer polygon around each point, depending on biological/ecological category. Table 1 summarizes the buffer polygon sizes applied to each category (also see Comer and Hak 2010).

[1] See http://www.natureserve.org/prodServices/eodata.jsp for detailed explanation of EO mapping methods.

Table 1. Polygon buffer sizes applied to at-risk species location data

Biological/Ecological Category	Hectare	Acres
Plants	1	2.5
Insects	1	2.5
Small amphibians, reptiles, & mammals	1	2.5
Medium-size amphibians, reptiles, & mammals	5	12.5
Birds	5	12.5
Large reptiles & bats	10	25

Note: there were no G1-G2 large mammals in the study areas

These buffers were primarily intended as a consistent reflection on the primary area occupied by a generic at-risk species within a given category. *They should not be construed to reflect assumptions about actual area required for their conservation. That determination is context specific, and well outside of the scope of this analysis.* Our intent here is to simply focus the area for map overlay to provide greatest insight into habitat relationships.

For each EO, the area overlapping each ecological system or land cover type was computed. An EO may intersect more than one system. The data were filtered to exclude unnecessary 'noise' using a 20% threshold: intersection polygons were excluded if the system covered less than 20% of an EO's total area. In the database, the filtered data are summarized *across* EOs for each system by species intersection as total area (m^2) of overlap and total count of species EOs. It should be apparent that where the buffer of a given EO overlaps >1 mapped type, the total percentages will exceed 100%.

Because of issues with the different data types and possible incompatibilities of scale, noise can be introduced into the derived information (i.e. the additional species-land cover relationships contained in the database). For example, while we excluded EOs known to be extirpated, other EOs could have been documented in the field prior to land conversions reflected in the land cover map (*circa* 2000).

The database contains habitat relationships on a basis of the Element (i.e. the species or community type) and its habitat (e.g., TRACS Broad habitat types, terrestrial ecological systems, etc.). The further analysis in a spatial context is a more complex way of looking at these relationships in terms of documented occurrences in relation to the representation of the national map (NatureServe 2009).

In cases where transitional and converted land cover types appear with intersected EO polygons, these will be included if they are relevant to forestry operations. For example, urban areas and water may be intersected, but those types of land cover are not applicable to the task of fiber procurement, so these are not included in the analysis. On the other hand, ruderal and tree plantation land cover would be germane, so these are included.

Results

To view the results of the analysis, open the accompanying Microsoft Access database, click the Reports button on the switchboard, select a region (and county if applicable), and select a report to run. The list

of reports is shown below in Table 2. Microsoft Access functionality can be used to export reports to pdf, Excel, and other formats, and to apply additional filters to the reports.

Table 2 - List of reports included in the Access database

All reports are filtered by NCASI pilot region.

Lists of At-Risk Species and Communities (Objective 1)

report	notes
Species list by GName	Project species sorted by taxonomic group and scientific name
Species list by Common Name	Project species sorted by taxonomic group and common name. Note that some species do not have common names.
Association list by GName	Project community types (associations) sorted by scientific name
Association list by Common Name	Project community types (associations) sorted by common name. Note that some associations do not have common names.

Habitat Categories

Report	Notes
Ecological Systems List	List of Ecological Systems sorted by land cover class, with physiognomy, spatial pattern and wetland information
Ecological Systems – SAF Cover Type Crosswalk	Crosswalk (correspondence table) showing relationships among Ecological Systems and SAF Cover Types
Habitat Attributes for Species	List of Habitat Attributes used to characterize species
Habitat Attributes for Associations	List of Habitat Attributes used to characterize associations

Habitat Relationships of At-Risk Species and Communities (Objective 2)

Report	Notes
Species by System and TRACS	species listed by Ecological System and TRACS type, with habitat attributes
Species by System and Macrogroup	species listed by Ecological System and Macrogroup, with habitat attributes
Species by Habitat Attribute	Species listed under their habitat attributes
Associations by System and Macrogroup	Associations listed by Ecological system and Macrogroup, with habitat attributes
Associations by System and TRACS	Associations listed by Ecological system and TRACS, with habitat attributes
Associations by Habitat Attribute	Associations listed under their habitat attributes

Presence/Absence of At-Risk Species and Communities by Habitat Category (Objective 3)

Report	Notes
Species by County	species listed by Ecological System and TRACS type, with habitat attribute, filtered by County
Species Presence/Absence x System	Crosstab version of Species by System and TRACS (without the habitat attributes)
Association Presence/Absence x System	Crosstab version of Associations by System and TRACS (without the habitat attributes)

Numbers of known extant occurrences of At-Risk Species by Habitat Category (Objective 3)

Report	Notes
Species EO Counts by System and TRACS	Counts of species Element Occurrences by Ecological System and TRACS

The final list of Habitat Attributes developed for the project are given in Table 3 below.

Benefits to Forest Products Industry

This collaborative application of NatureServe/Industry expertise, methods, and tools will help the forest products industry allocate scarce resources while ensuring the SFI standards for at-risk biodiversity are met.

The products can be used to provide benchmark inventory lists of at-risk biodiversity by region; provide input to industry planning staff, managers, consultants, and owners of procurement lands regarding the potential occurrence of at-risk biodiversity; and provide managers and procurement landowners a regional context for the relative importance of the biodiversity on their ownerships.

We are certain that this database and the products derived from it will greatly advance the availability and utility of biodiversity data for planners, managers, consultants and landowners. The increased availability of these data will help provide options for management actions that will avoid and/or minimize negative impacts, and ensure that the best conservation decisions as possible are made in the course of fiber procurement. Making the specific linkages between the habitat attributes linked to species preferences in the database, and the management actions needed to provide or enhance these attributes would be a desirable future step, but is beyond the scope of this phase.

The documentation of the relationships between at-risk species and communities with broad habitat types will better allow SFI participants to focus their conservation efforts on selected habitat types; more easily identify where at-risk biodiversity is most/least likely to occur on lands they manage; focus new survey effort more efficiently; and supply foresters and landowners with regionally appropriate information for field identification and compatible management practices.

We trust that the results of this project will help managers and researchers in these pilot regions identify the proportion of at-risk species / communities that would potentially be protected by a habitat-based approach; identify practices to avoid or minimize potential impacts from forestry operations; refine models (geographic and environmental) for species that are well-aligned with habitat type(s) and attributes; and prioritize and develop methods for field surveys targeting species and communities not closely aligned with one or more broad-scale habitat type.

This database will only be improved through its use and critical review by our partners and collaborators, and we look forward to these future opportunities and interactions.

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Appendix 1 - Field definitions for Biotics data

Field	Definition
CLASS_STAT	Classification Status - Indicates whether the concept has been formally recognized, described, and accepted by the standard classification as determined by NatureServe Central Sciences.
EGT_SEQUID	Element Global Sequential Unique ID - Unique identifier code assigned to the element.
ELCODE	Code - Unique record identifier for species and ecological communities (element code) used in Heritage methodology.
FAMILY	Appropriate taxonomic family for the species Element.
G_INT_ESA	Global Interpreted USESA Status - The current status of the taxon under the U.S. Endangered Species Act (USESA) as interpreted by NatureServe Central Sciences. This field does not contain the official status (if there is one) assigned by the regulating agency - that status is recorded in USESA Status. Interpreted status is determined from the taxonomic relationship of the Element to a taxon having USESA status, or its relationship to geopolitical or administratively defined members of a taxon having USESA status. The taxonomic relationships between species and their infraspecific taxa may determine whether a taxon has federal protection. Section 17.11(g) of the Endangered Species Act states, "the listing of a particular taxon includes all lower taxonomic units." Also, if an infraspecific taxon or population has federal status, then by default, some part of the species has federal protection. In cases where all infraspecific taxa of a species have status, the species also has status by default even if this status is not the same everywhere it occurs. Thus, an Element may have an interpreted USESA status value even though it may not be specifically named in the Federal Register.
G_RANK	Global Rank - The NatureServe Conservation Status of a species from a global (i.e., rangewide) perspective, characterizing the relative rarity or imperilment of the species or community. Definitions for specific ranks and more details about ranking can be found here: http://www.natureserve.org/explorer/ranking.htm
GCOMNAME	Global Common Name - Species: The common name of an element adopted for use by NatureServe. Associations: A colloquial name for the association. Note: Common names have not been tracked for all plants. Names for other groups may be incomplete. Many elements have several common names, often in different languages. Spellings of common names follow no standard conventions and are not systematically edited.
GENUS	Appropriate taxonomic genus for the species Element.
GNAME	Global Scientific Name - The standard global (i.e., rangewide) scientific name (genus and species) adopted for use by the NatureServe Central Databases based on selected standard taxonomic references.
INFO_TAX	Informal Taxonomy - The common name of the major taxonomic group of the species adopted for use by NatureServe.
INFO_TAX2	Informal Taxonomy 2 - The common name of the major taxonomic group of the species adopted for use by NatureServe; these are more finely divided groups that are used on NatureServe Explorer.
KINGDOM	Appropriate taxonomic kingdom for the species Element.

Field	Definition
LASTOBS_YR	Last Observation Year - The year that the Element Occurrence (EO) was last observed to be extant in the county. Note that the last observation date is not necessarily the date the site was last visited (i.e., the survey date) or the date on which the occurrence was assigned an EO rank (i.e., the EO rank date). However, for E-ranked (extant) EOs, the last observation date should be the same as the date on which the occurrence was ranked. (NOTE: Because this is a summarized field, the maximum year is reported. However, it is important to note that because Last Observed Date is not comprehensively filled out, there could other records for the species in the county that had a blank date in addition to the record with the year reported. For example, if there were 3 records for "Species A" in a county, and two had a blank last observed year, and one had a year of 1935, then 1935 would be reported in this field. However, it would be important to note in this case that there may be other records that were observed more recently that didn't have a date filled out, so the presence of the species isn't necessarily based on historic data. The "CountOfEOID" field indicates the number of EO records that presence of a species in a county is based on, so that can be useful information to consider along with LASTOBS_YR, as well as the "X_H_FLAG" field, which indicates if all EOs for a species in a county are ranked as Historic and/or Extirpated.)
MIMNWI_F	MI-MN-WI Flag - field that indicates with a "Y" that the species occurs within the select group of counties for MI, MN, and WI. (NOTE: for any full species that occur in this group of counties, any related infrataxa related to those full species that occur anywhere in the U.S. or Canada were also provided as part of the dataset, even if those infrataxa don't have representation in the counties in MI/MN/WI.)
NCSCGAFL_F	NC-SC-GA-FL Flag - field that indicates with a "Y" that the species occurs within the select group of counties for NC, SC, GA, and FL. (NOTE: for any full species that occur in this group of counties, any related infrataxa related to those full species that occur anywhere in the U.S. or Canada were also provided as part of the dataset, even if those infrataxa don't have representation in the counties in NC/SC/GA/FL.)
ORWA_F	OR-WA Flag - field that indicates with a "Y" that the species occurs within the select group of counties for OR and WA. (NOTE: for any full species that occur in this group of counties, any related infrataxa related to those full species that occur anywhere in the U.S. or Canada were also provided as part of the dataset, even if those infrataxa don't have representation in the counties in OR/WA.)
FEDTRUST_F	Federal Trust Flag - field that indicates with a "Y" that the species is on the list of Federal Trust species.
PHYLUM	Appropriate taxonomic phylum for the species Element.
PS_EGT_ID	Parent Species Element Global ID – For subspecies, the EGT_ID assigned to the related parent species; for full species records this field will be null or zero. This can be useful to “roll up” subspecies to the parent level.
RND_G_RANK	Global Rounded Rank - The Global conservation status rank (GRANK) rounded to a single character. This value is calculated from the GRANK field using a rounding algorithm to systematically produce conservation status values that are easier to interpret and summarize.
RND_S_RANK	Subnational Rounded Rank - The subnational conservation status rank (SRANK) rounded to a single character. This value is calculated from the SRANK field using a rounding algorithm to systematically produce conservation status values that are easier to interpret and summarize.
S_PROT	Subnational Protection Status - Code used by individual subnational jurisdictions for the level of legal protection afforded to the element by that jurisdiction. Values are typically similar to the U.S. ESA status values, but will vary by state or subnation.
S_RANK	Subnational Conservation Rank - The conservation status of a species from the subnational jurisdiction perspective, characterizing the relative rarity or imperilment of the species. Together these values provide national distribution data.
SCOMNAME	Subnational Common Name - The standard subnational common name of species adopted for use by the program based on selected standard taxonomic reference(s) for the jurisdiction.
SNAME	Subnational Scientific Name - The standard subnational scientific name (genus and species) adopted for use by the program based on selected standard taxonomic reference(s) for the jurisdiction.
SUBNATION	Abbreviation for the subnational jurisdiction (state or province) where the Source Feature is located.
TAXCLASS	Taxonomic Class - Appropriate taxonomic class for the species Element.
TAXORDER	Taxonomic Order - Appropriate taxonomic order for the species Element.

Field	Definition
USESA_CD	U.S. Endangered Species Act Status - Value that indicates the current status of the taxon as designated or proposed by the U.S. Fish and Wildlife Service (USFWS) or the U.S. National Marine Fisheries Service, and as reported in the U.S. Federal Register in accordance with the U.S. Endangered Species Act of 1973, as amended. Statuses include candidates for listing as reported by either of these agencies in the U.S. Federal Register. Definitions for specific status codes and more details can be found here: http://www.natureserve.org/explorer/statusus.htm
USESA_DATE	U.S. Endangered Species Act Status Date - Publication date of the Federal Register notice containing the status of the taxon designated under the U.S. Endangered Species Act (USESA) (entered in the associated USESA Status field). Dates are entered only for taxa and populations that are specifically named in the Federal Register. When a taxon has multiple statuses (see the USESA Status field for details), the date that corresponds to the first status that appears (not necessarily the most recent action) is entered. The USESA Comments field is used to provide a detailed explanation of multiple statuses and to list the dates associated with the other portions of the multiple statuses.

Appendix 2 - Habitat Attributes, grouped by Habitat Type

Habitat type	HabitatAttribute	species	associations
Disturbance			
	flood scour	X	
	soil disturbance	X	
Food			
	hard mast production	X	
	soft mast production	X	
	browse production	X	
	seed production	X	
	obligate food plant	X	
Geographic attribute			
	south Florida	X	
Habitat inclusion			
	Prairies	X	
	Seeps	X	
	hillside seeps	X	
	spray cliffs and wet rock	X	
	Caves	X	
	Mines	X	
	dense understory or early successional stages in riparian areas	X	
	dry cliffs	X	X
	shrub balds	X	X
	ravines	X	
	glades and flatrocks	X	X
	domes and rock outcrops	X	X
	sandhills	X	X
	coastal plain scrub	X	X

Habitat type	HabitatAttribute	species	associations
	coastal hammocks	X	
	Great Lakes dune	X	X
	Great Lakes freshwater estuary	X	X
	Great Lakes coastal marsh	X	X
	rocky outcrop	X	
	moist cliff	X	X
	talus slope	X	X
	bluffs	X	
	sinkhole	X	
	bridges	X	
	abandoned and unoccupied buildings	X	
	canopy of old-growth forest	X	
	vernal pools	X	
Hydrologic Regime			
	Nontidal - 1) Permanently flooded		X
	Nontidal - 2) Intermittently exposed		X
	Nontidal - 3) Semipermanently flooded	X	X
	Nontidal - 4) Seasonally flooded		X
	Nontidal - 5) Saturated		X
	Nontidal - 6) Temporarily flooded		X
	Nontidal - 7) Intermittently flooded		X
	Tidal - 1) Subtidal		X
	Tidal - 2) Irregularly exposed		X
	Tidal - 3) Regularly flooded		X
	Tidal - 4) Irregularly flooded	X	X
Landform			
	alluvial fan	X	X
	alluvial terrace	X	X
	backwater		X
	canyon	X	X
	depositional levee		X
	depositional stream terrace		X
	depression	X	X
	draw		X
	earth hummock		X
	esker		X
	flood plain	X	X
	foredune	X	X
	hummock		X

Habitat type	HabitatAttribute	species	associations
	kame		X
	kettle		X
	lagoon		X
	lava flow (undifferentiated)	X	X
	loess deposit (undifferentiated)		X
	mima mound	X	X
	outwash fan		X
	outwash terrace		X
	oxbow		X
	patterned ground (undifferentiated)	X	X
	plateau	X	X
	playa		X
	pothole	X	X
	ravine	X	X
	ridge	X	X
	sandhills		X
	scour		X
	seep	X	X
	slide	X	X
	slough		X
	spit		X
	swale	X	X
	talus	X	X
	tidal flat		X
	till plain	X	X
	toe slope	X	X
	transverse dune		X
	valley floor	X	X
	coastal plain		X
Landscape			
	interspersion of grasslands, pastures, old fields	X	
	interspersion of cropland	X	
	interspersion of forest openings	X	
	interspersion of permanent water	X	
	remoteness; low open road density	X	
	area sensitive; large patch size	X	
	forest interior	X	
	forest edge	X	
	riparian areas	X	

Habitat type	HabitatAttribute	species	associations
	dry savanna	X	
	barrens	X	
	sandplain/lakeplain	X	
	dune and swale	X	
Soil Chemistry			
	Ultramafic (Serpentine)		X
	Eutrophic Soil		X
	Mesotrophic Soil		X
	Oligotrophic Soil		X
	Alkaline Soil		X
	Circumneutral Soil		X
	Acidic Soil		X
	Saline Soil		X
Soil Depth			
	Very Shallow Soil	X	X
	Shallow Soil	X	X
	Deep Soil	X	X
Soil drainage			
	rapidly drained	X	X
	well drained	X	X
	moderately well drained	X	X
	somewhat poorly drained	X	X
	poorly drained	X	X
	very poorly drained	X	X
	Caliche Layer		X
	Impermeable Layer		X
Soil texture			
	sand	X	X
	sandy loam	X	X
	loam	X	X
	silt loam	X	X
	clay loam	X	X
	clay	X	X
	fibric peat	X	X
	sapric peat (muck)	X	X
	gravelly soil	X	X
	hemic peat	X	X
Special element			
	large hollow trees	X	

Habitat type	HabitatAttribute	species	associations
	cavities in live or dead trees	X	
	snags	X	
	burrows and stumpholes	X	
	exfoliating bark on standing trees	X	
	downed logs	X	
	thick leaf litter / duff	X	
	shaded moist soil	X	
	exposed rock/boulders	X	
	seepages and springs	X	
Structural			
	open canopy	X	X
	closed canopy	X	X
	open forest structure (midstory)	X	X
	dense forest structure (midstory)	X	X
	grassy ground layer	X	X
	dense shrub layer	X	X
	moderate shrub layer	X	X
	sparse shrub layer	X	X
	tall shrub layer (2-5 m)	X	X
	medium tall shrub layer (1-2 m)	X	X
	short shrub layer (< 1m)	X	X
	canopy gaps	X	X
Substrate affinity			
	calciphile	X	
Surficial Geology			
	Colluvial		X
	Eolian sand flats		X
	Glacial-fluvial deposits	X	X
	Marine deposits		X
	Solifluction, landslide		X
	Talus and scree slopes	X	X
	Lacustrine and fluvial deposits		X
Topographic Position			
	Backslope		X
	Basin floor		X
	Channel bed		X
	Channel wall		X
	High level		X
	High slope		X

Habitat type	HabitatAttribute	species	associations
	Interfluve/Summit		X
	Low level		X
	Lowslope		X
	Midslope		X
	Step in slope		X
	Toeslope		X
Wetlands			
	springs	X	X
	wetlands	X	X
	bogs	X	
	fens	X	
	river channels	X	
	canebrakes	X	X
	pond shore	X	X
	river bars	X	X
	lakeshores	X	X
	open wetlands, marshes, beaver ponds	X	
	wet savannas	X	X
	flatwoods	X	X
	Carolina bays	X	
	depression ponds	X	X
	fresh tidal river marshes	X	X
	hardwood floodplains	X	X
	limestone sinkhole ponds	X	
	streamheads	X	X
	swamp forests	X	X
	ditches and borrow pits	X	
	large reservoirs	X	
	Wet prairie	X	X
	Marsh	X	X
	peatland	X	X
	kettleholes	X	X
	sedge meadow	X	

Appendix 3 - "Data Deficient" species not included in the analysis

Region	informalTax2	elcode_bcd	GNAME	GCOMNAME	notes
MW	Terrestrial Snails	IMGAS66200	*Catinella protracta*	No common name	Taxonomic status of species uncertain. Insufficient habitat data.
MW	Lichens	NLLEC5N210	*Umbilicaria polyrhiza*	No common name	Little information
MW	Lichens	NLTES10190	*Xanthoparmelia dierythra*	No common name	Only one location known and no habitat information.
MW	Flowering Plants	PDROS1K800	*Rubus vagus*	Rambling Dewberry	Very limited information and collection sites are outside of Great Lakes region.
MW	Flowering Plants	PDROS1K810	*Rubus variispinus*	Vicksburg Blackberry	Very limited information. Collection sites out of or right on edge of Great Lakes region.
MW	Mosses	NBMUS2X0A0	*Fontinalis macmillanii*	No common name	Habitat not known.
MW	Mosses	NBMUS8D010	*Oxystegus spiralis*	No common name	Insufficient information on habitat.
MW	Mosses	NBMUS79060	*Tayloria splachnoides*	No common name	
NW	Terrestrial Snails	IMGASA703A	*Monadenia fidelis spp. 2*	Umpqua Sideband	Very few locations, very limited habitat information.
NW	Fungi (non-lichenized)	NFSM000007	*Alpova olivaceotinctus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00008	*Amanita armillariiformis*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00012	*Arrhenia lobata*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00013	*Balsamia alba*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00017	*Cazia flexiascus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00020	*Conocybe subnuda*	Fungus	G rank review is needed
NW	Fungi (non-lichenized)	NFSM000053	*Dermocybe humboldtensis*	Fungus	
NW	Fungi (non-lichenized)	NFFUN86010	*Destuntzia rubra*	No common name	
NW	Fungi (non-lichenized)	NFNHP00022	*Elaphomyces decipiens*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00024	*Galerina fuscobrunnea*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00026	*Genea compacta*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00027	*Glomus pubescens*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00029	*Hebeloma occidentale*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00030	*Hebeloma oregonense*	Fungus	

Region	informalTax2	elcode_bcd	GNAME	GCOMNAME	notes
NW	Fungi (non-lichenized)	NFNHP00031	*Hebeloma parcivelum*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00032	*Hebeloma pungens*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00034	*Hemimycena pseudocrispula*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00036	*Hygrophorus albicarneus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00037	*Hygrophorus albiflavus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00041	*Leptonia subeuchroa*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00042	*Leptonia violaceonigra*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00043	*Leucogaster odoratus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00048	*Lyophyllum gracile*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00053	*Martellia medlockii*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00054	*Mycena gaultheri*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00056	*Nolanea verna var. isodiametrica*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00057	*Omphalina isabellina*	Fungus	
NW	Fungi (non-lichenized)	NFSM000150	*Phaeocollybia rufotubulina*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00066	*Radiigera bushnellii*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00068	*Rhizopogon bacillisporus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00069	*Rhizopogon brunneifibrillosus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00070	*Rhizopogon clavitisporus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00072	*Rhizopogon oswaldii*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00073	*Rhizopogon quercicola*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00074	*Rhizopogon rogersii*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00075	*Rhizopogon semireticulatus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00076	*Rhizopogon semitectus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00077	*Rhizopogon subcinnamomeus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00078	*Rhizopogon subclavitisporus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00079	*Rhizopogon subpurpurascens*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00080	*Rhizopogon subradicatus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00081	*Rhizopogon variabilisporus*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00083	*Sclerotinia veratri*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00084	*Squamanita paradoxa*	Fungus	
NW	Fungi (non-lichenized)	NFNHP00085	*Stephensia bynumii*	Fungus	
NW	Lichens	NLSPH52300	*Dermatocarpon lorenzianum*	No common name	

Region	informalTax2	elcode_bcd	GNAME	GCOMNAME	notes
NW	Lichens	NLLEC84190	*Hypogymnia oceanica*	No common name	Conflicting data regarding distribution and abundance
NW	Lichens	NLTESOR001	*Hypotrachyna riparia*	Lichen	
NW	Lichens	NLT0027190	*Rinodina stictica*	No common name	
NW	Lichens	NLLEC5N210	*Umbilicaria polyrhiza*	No common name	Little information
NW	Lichens	NLLEC5N220	*Umbilicaria rigida*	No common name	
NW	Lichens	NLLEC5N230	*Umbilicaria scholanderi*	No common name	
NW	Flowering Plants; Dicots	PDFAB0F4N0	*Astragalus lemmonii*	Lemmon's Milkvetch	may not be within region
NW	Flowering Plants; Dicots	PDPLM02080	*Collomia rawsoniana*	Flaming Trumpet	
NW	Flowering Plants; Dicots	PDRAN0B2G0	*Delphinium basalticum*	Basaltic Larkspur	
NW	Flowering Plants; Dicots	PDFAB2B090	*Lupinus amphibius*	Amphibious Lupine	
NW	Flowering Plants; Dicots	PDFAB2B192	*Lupinus cusickii ssp. brachypodus*	Cusick's Lupine	
NW	Flowering Plants; Dicots	PDFAB2B1K0	*Lupinus fissicalyx*	Grants Pass Lupine	
NW	Flowering Plants; Dicots	PDFAB2B1Q0	*Lupinus gormanii*	Gorman's Lupine	
NW	Flowering Plants; Dicots	PDBOR0V0X0	*Plagiobothrys salsus*	Desert Allocarya	Older record from Oregon barely within project boundary.
NW	Flowering Plants; Monocots	PMCYP03LJ0	*Carex constanceana*	Constance's Sedge	
NW	Flowering Plants; Monocots	PMIRI09120	*Iris thompsonii*	Thompson's Iris	
NW	Mosses	NBMUS3S0L0	*Hygrohypnum norvegicum*	No common name	