WASHINGTON NATURAL HERITAGE PROGRAM

Developing an Absence Database for Observational Data

Prepared for
US Fish and Wildlife Service

Prepared by
Jake Kleinknecht and Walter Fertig
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WASHINGTON STATE DEPARTMENT OF
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Introduction

Since 1977, the Washington Natural Heritage Program (WNHP) has maintained a series of databases that record the location, abundance, habitat, management, and other information on the state's "elements" of biological diversity (rare plants and animals and plant communities). The current data system, Biotics, has been in place since the early 2000s and organizes species data based on biologically-defined populations or "element occurrences". Individual element occurrence records (EORs) in Biotics are based on populations that are currently extant or were historically present, and can be verified by a museum specimen, photograph, or observation. Such reports may be referred to as "presence" records because they confirm that the species or community element of interest is (or was) known to be present at a particular geographic location.

In contrast, absence data (also known as negative data) represent places where an element of interest is not known to occur. A species or community may be absent from a site despite the existence of potential habitat due to localized extirpation, poor dispersal, or bad luck (contingent absence, *sensu* Lobo et al. 2010). These locations may be of conservation significance as potential sites for (re)introduction of a species as a part of recovery efforts. More frequently, elements are absent due to a lack of suitable environmental conditions (environmental absence) or incomplete survey effort (methodological absence) (Lobo et al. 2010). Environmental absence data are useful in species distribution modeling to tease out relationships between environmental predictors (such as climate, substrate, and topography) and presence/absence of a species (Franklin 2009). Contingent or environmental absence data are also valuable to identify past survey efforts in order to more efficiently target new areas for survey.

Despite their potential utility, absence data are not routinely collected or archived. WNHP received Section 6 funding from the US Fish and Wildlife Service (USFWS) in 2019 to develop a GIS-based absence observation system to complement the existing Biotics database of presence locations. The following report describes the development of an absence database and some potential future applications. This work builds on the creation of observation databases for two federally listed plant species: Spalding's catchfly (*Silene spaldingii*) and golden paintbrush (*Castilleja levisecta*) funded by USFWS (Kleinknecht and Fertig 2020, Niggemann and Fertig 2018).

Methods

Updating existing observation databases

This project built upon the efforts of previous projects, including the creation of an observation database for *Silene spaldingii*, another observation database for *Castilleja levisecta*, and a habitat suitability model for *Pinus albicaulis*. All of these projects required the compilation and organization of data for these species into discrete observations of presence or absence at a specific place and time.

We combined the data from those three efforts into one file geodatabase that had all of the known presence and absence records for those species in Washington State. The schema of this WNHP observation database was modified to include a true/false field called PRESENT, which allows for a very simple delineation of presence records versus absence records. Previously, this

information would have been gathered from either the NUMBER_PLANTS field, which would have a value greater than zero for presences and equal to zero for absences, or from fields indicating minimum/maximum plant estimates. The addition of the PRESENT field reduces those fields down to the core of whether or not the element was present at that place and time, leaving the other count fields to provide further information when it is available. We also included two new comment fields, HABITAT_COMMENTS and ASSOCIATED_SPECIES_COMMENTS, to prevent overloading the existing OBSERVATION_COMMENTS field with comments that don't pertain to the observation itself.

Observation data template

One of the greatest challenges when creating the *Silene spaldingii* and *Castilleja levisecta* databases was organizing data from a multitude of data sources (Kleinknecht and Fertig 2020, Niggemann and Fertig 2018). Some of the data were inherently spatial, while others were tabular data with spatial fields (UTM coordinates, Latitude and Longitude, etc.). Different organizations collect similar information with different field names that need to be homogenized. Furthermore, different organizations use different terms to represent the same things, like a census, a count, and a survey all being used interchangeably. Some of the information was not stored in a database and instead needed to be extracted from reports and manually entered into the WNHP observation database.

To reduce these issues in the future, we developed an Observation Data Template for WNHP staff and our external partners, to use for recording observational data (Figure 1). This template captures the essential information for recording observations (species name, spatial information, date of observation, plant counts, comments, etc.). The template is color-coded to show users as to which fields are optional versus mandatory, and to help with the issue of using multiple terms
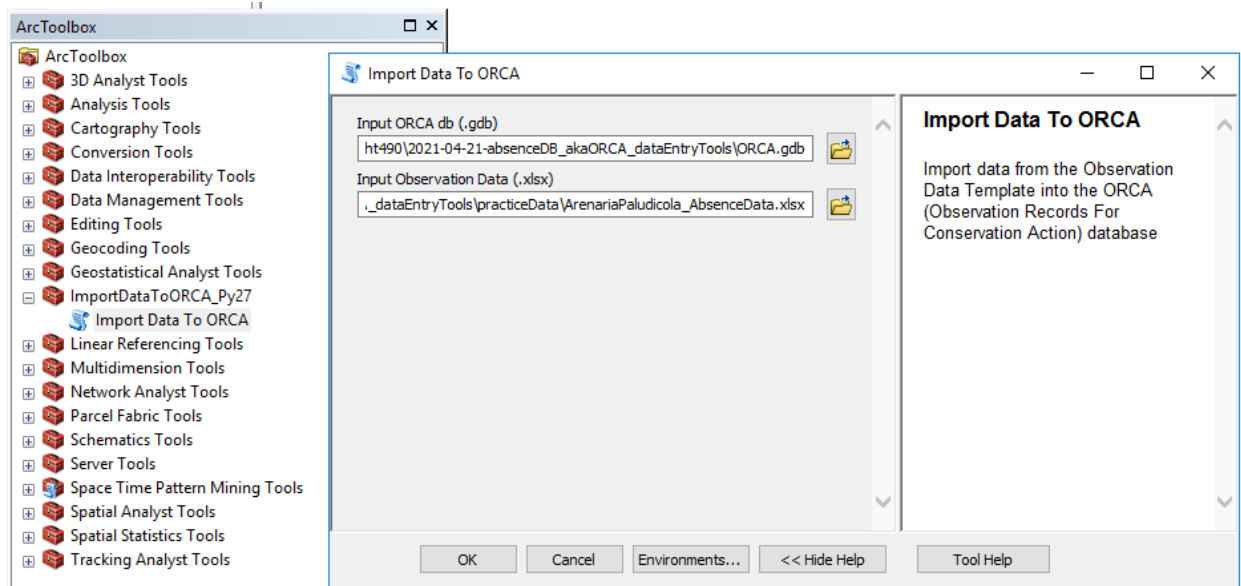

Figure 1: Importing data into the WNHP observation database.

to convey the same concept. It also has a tab in the spreadsheet to guide users as to which valid values to use. Use of this observational data template will greatly streamline future efforts to incorporate more information into the WNHP observation database. Data entry using the template is further explained in Appendix A.

Observation data input tool

With a standardized data entry format, we were then able to focus our efforts on making data entry into the WNHP observation database an easier process. Formerly, inserts and updates to the database were handled by the NHP data manager, since it required knowledge and skill with using ESRI software and relational databases. But with the data entry template, a data import tool could be built around that format. Using Python 2.7 (ArcMap 10.1 and up) as well as Python 3 (ArcGIS Pro), we built custom toolboxes that can be added to the suite of toolboxes within a user's geospatial software. To use the data import tool, a user only needs to input the file path to the existing ORCA database, and the file path to the observation data template (Figure 1). The tool then creates a copy of the ORCA database with the date and time stamped into the name with the observation data appended to it. Creating a copy with the new data allows users to inspect the data to ensure everything is as expected before making this copy the new "most up-to-date and complete" version.

Metadata associated with the observation database are included in Appendix B.

Results and Discussion

Testing and New Data

We compiled sixty-six observations, fourteen presences and fifty-two absences, to enter into the WNHP observation database through our new data import tool, as a means of testing the error-handling of the tool. One observation was for a species already in the system (*Silene spaldingii*) and the remaining sixty-five observations were for nineteen species that were previously not represented in the database: those new species observations are for *Arenaria paludicola*, *Astragalus pulsiferae* var. *suksdorfii*, *Astragalus sinuatus*, *Carex capitata*, *Chaenactis thompsonii*, *Crepis bakeri*, *Erigeron disparipilus*, *Hackelia taylorii*, *Lomatium klickitatense*, *Lomatium knokei, Lomatium roneorum*, *Lomatium tuberosum*, *Oxytropis campestris* var. *wanapum*, *Penstemon hesperius*, *Penstemon pennellianus*, *Phacelia lenta*, *Phlox solivaga*, *Pyrrocoma liatriformis*, and *Sidalcea oregana* var. *calva*.

With these additions to the database, there are now a total of 21,460 observations in the database, of which 5,707 are presence and 15,753 are absence records (Figure 2). The majority of the observations (16,168 records) are for *Pinus albicaulis* of which approximately 94% are absences. The species with the second-most records in the WNHP observation database is *Silene spaldingii*, with 4724 records, followed by *Castilleja levisecta* with 503 records. The remaining records belong to the species listed in the above paragraph (Figure 3).
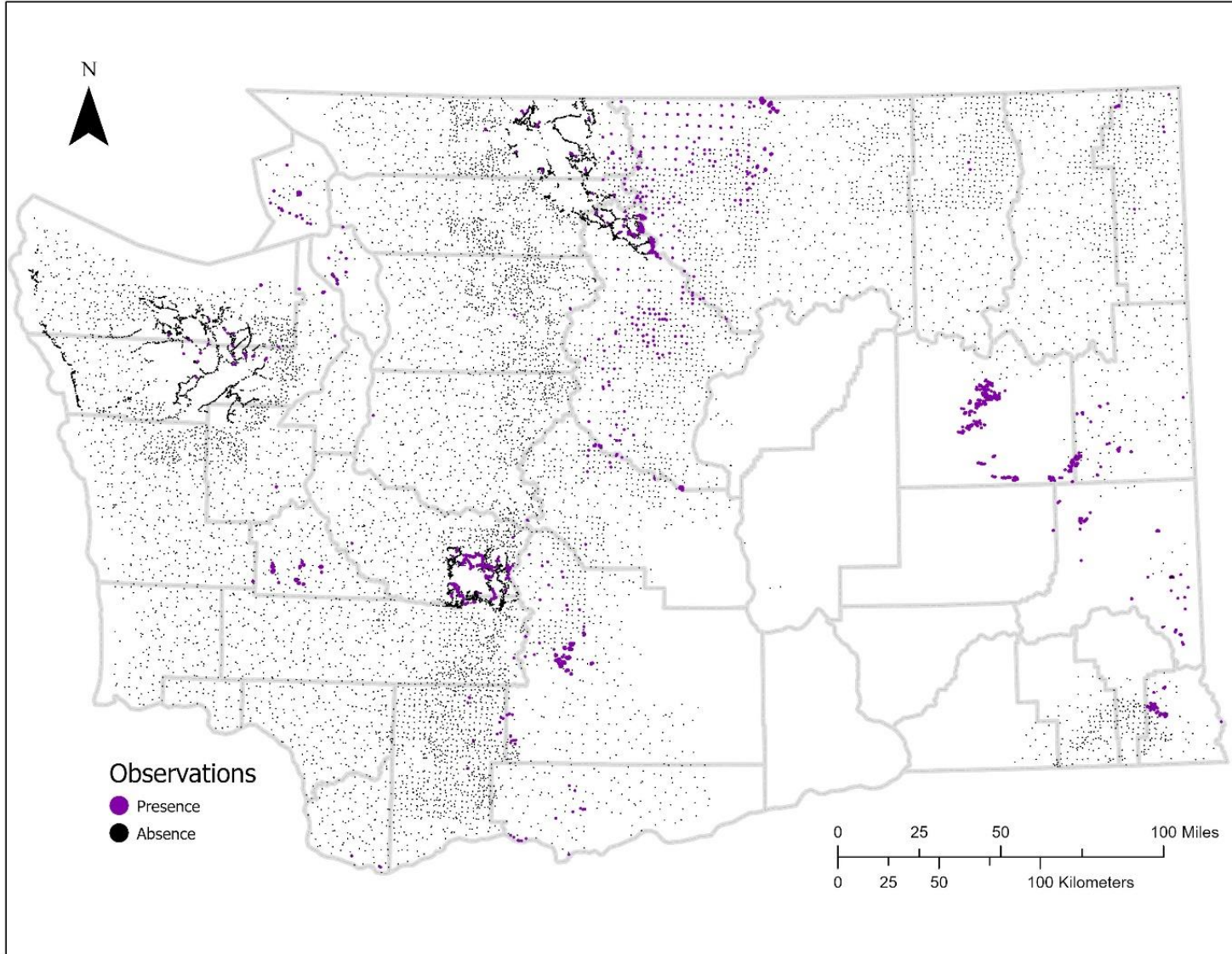
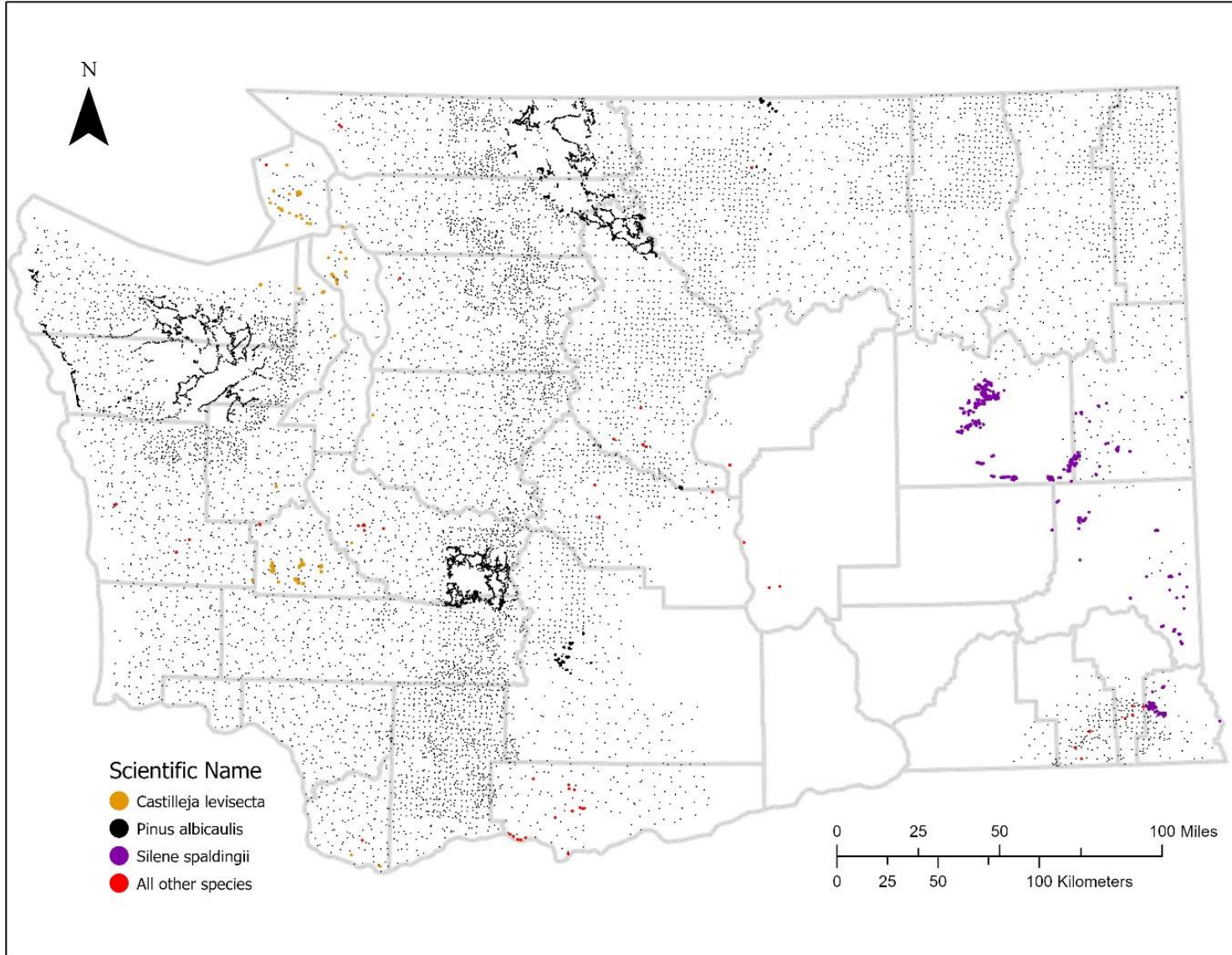Figure 2: All observations currently stored in the WNHP observation database, symbolized by presence or absence.

Figure 3: All observations currently stored in the WNHP observation database, symbolized by species

Application of Absence Data

Absence data for *Pinus albicaulis* locations in Washington have been used to build and validate a potential habitat model based on Classification Forest methods (Fertig and Kleinknecht 2021, in prep). In the future, other listed Endangered and Threatened or species of concern could be modeled using absence information maintained in our observation database. In some instances, absence locations formerly occupied by rare species could be used as future introduction sites to establish additional populations.

With the new changes to the WNHP observation database's schema, the fresh additions of data, the data entry tool, and the Observation Data Template, WNHP is now well-equipped to continue entering and maintaining observation level data into the future.

More Feature Classes in the Database

Although this project dealt only with the primary, observational data, there are other feature classes in this database that remain from the *Castilleja levisecta* and *Silene spaldingii* databases. This includes Introduced Source Features, which identify outplantings and include information on the time and methods used for planting, as well as Introduced Occurrences which provides an overarching spatial framework for linking together nearby plantings of the same element (Kleinknecht and Fertig, 2020). Another application of the absence database is recording the absence of an element within an area where it has been intentionally planted (through plugs or seeding) to establish new populations for conservation purposes. Sometimes outplantings are unsuccessful, so it is important to record whether the species is absent or present. For the golden paintbrush observation database, we created a feature to indicate absence or presence and have carried this over into this project. The database also has a "sites" feature class, which, for some species, provides a convenient area for grouping observations that have similar access points and managers, and "managed areas" feature class which identifies areas with a single ownership where conservation action is being taken for the benefit of a particular element (Niggeman and Fertig, 2018).

Literature Cited

Fertig, W. and J. Kleinknecht. 2021, in prep. Conservation status of whitebark pine in Washington. Natural Heritage Report 2021-06. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA.

Franklin, J. 2009. Mapping Species Distributions: Spatial Inference and Prediction. Cambridge University Press, New York. 320 pp.

Kleinknecht, J. and W. Fertig. 2020. Developing an observational database for golden paintbrush (*Castilleja levisecta*). Natural Heritage Report 2020-03. Washington Natural Heritage Program. WA Department of Natural Resources, Olympia, WA. 19 pp.

Lobo, J.M, A.Jiménez-Valverde, and J. Hortal. 2010. The uncertain nature of absences and their importance in species distribution modelling. Ecography 33(1): 103-114.

Niggemann, R. and W. Fertig. 2018. Developing an observational database for Spalding's catchfly (*Silene spaldingii*). Natural Heritage Report 2018-11. Washington Natural Heritage Program, WA Department of Natural Resources, Olympia, WA. 13 pp.

Appendix A. Instructions for Adding Presence or Absence data to the WNHP Observation Database

The following are step-by-step instructions for adding new observation records (presence or absence) to the Washington Natural Heritage Program Observation Database. The working name for the database was "ORCA" (for Observation Records for Conservation Action) but the program decided to change this name to avoid confusion with organizations studying orcas or killer whales. The ORCA name remains, for now, since it was used in developing the tool and will be modified at a future date.

1. Locate the most current version of the WNHP Observation database in the Botany\ORCA folder.

2. To use the "Input data to ORCA" tool, add the toolbox to ArcMap. Open up arctoolbox, and right click on the "ArcToolbox" up top and then click Add Toolbox like in the picture below:
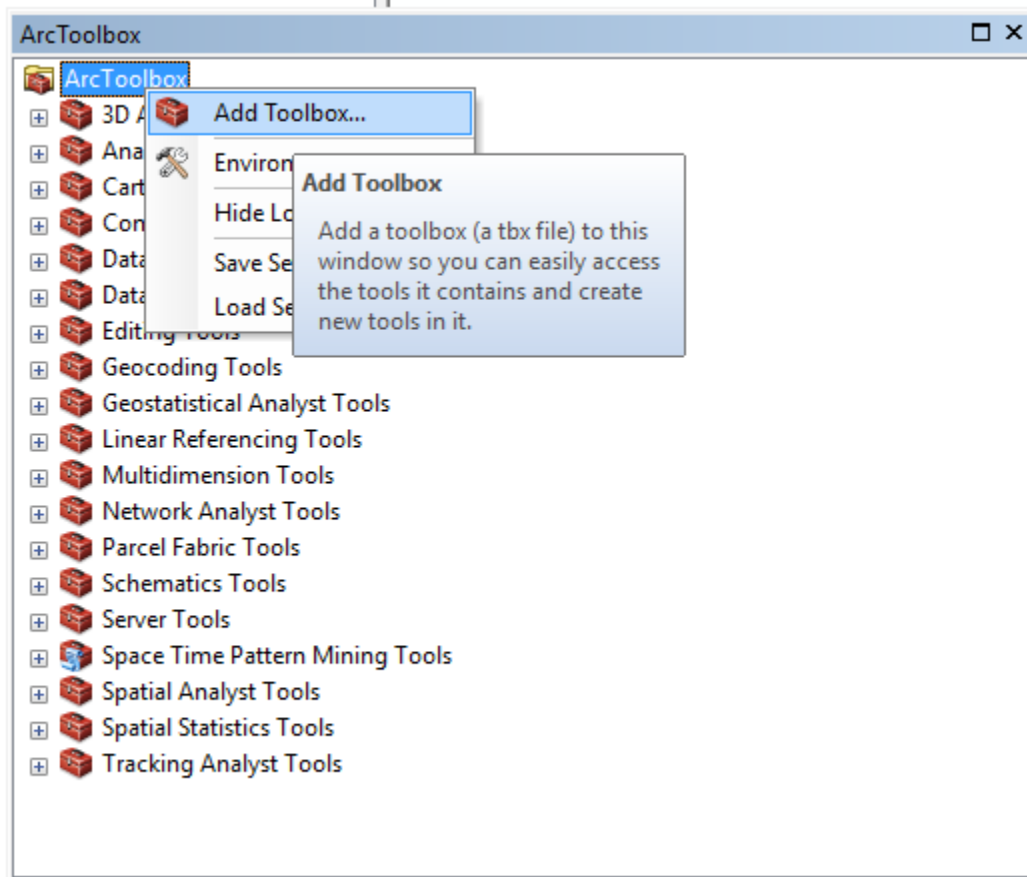
3. Navigate to the botany\ORCA\toolboxes folder. Use the toolbox with "Py27" in the name. This is the version that works with ArcMap and thus Python 2.7 (there is another version in there for Python 3). Once you have clicked on the InputDataToORCA_Py27.tbx, you should see this in your ArcToolbox:
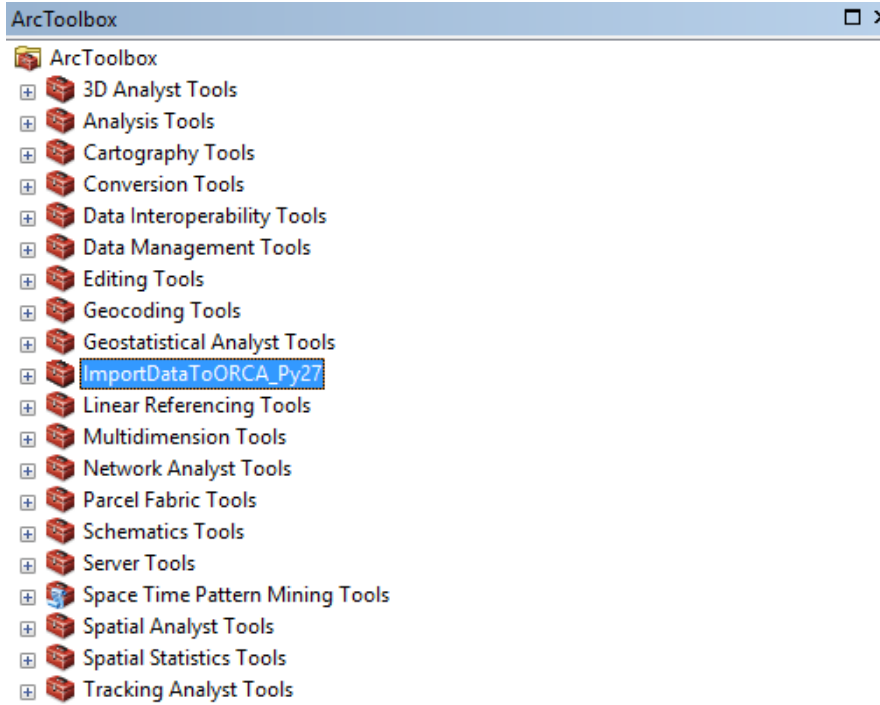
4. Expand the toolbox to see the tool itself:
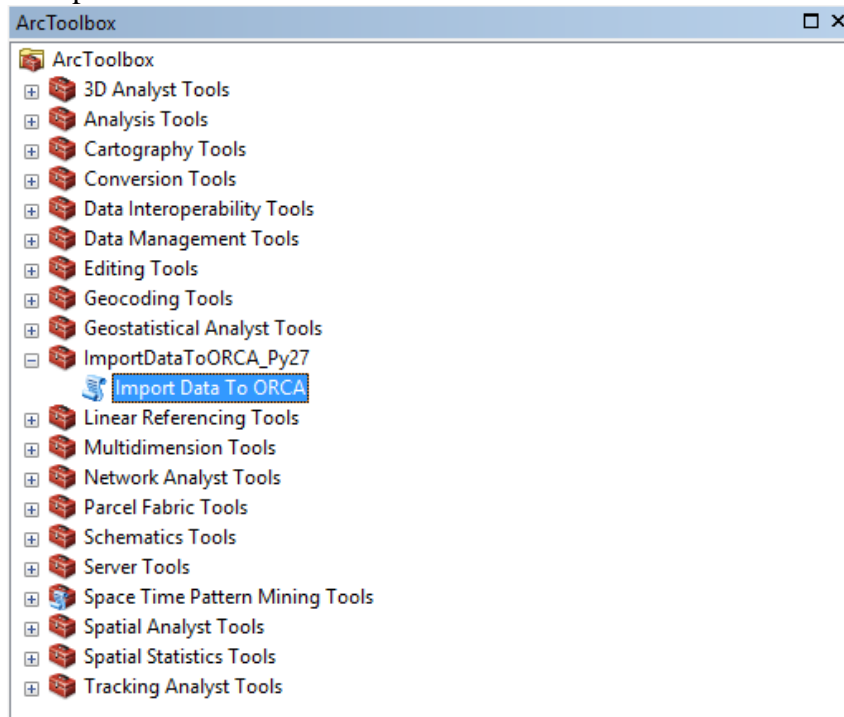
5. Double click on the "Import Data to ORCA" tool to open the tool. It will look like this:
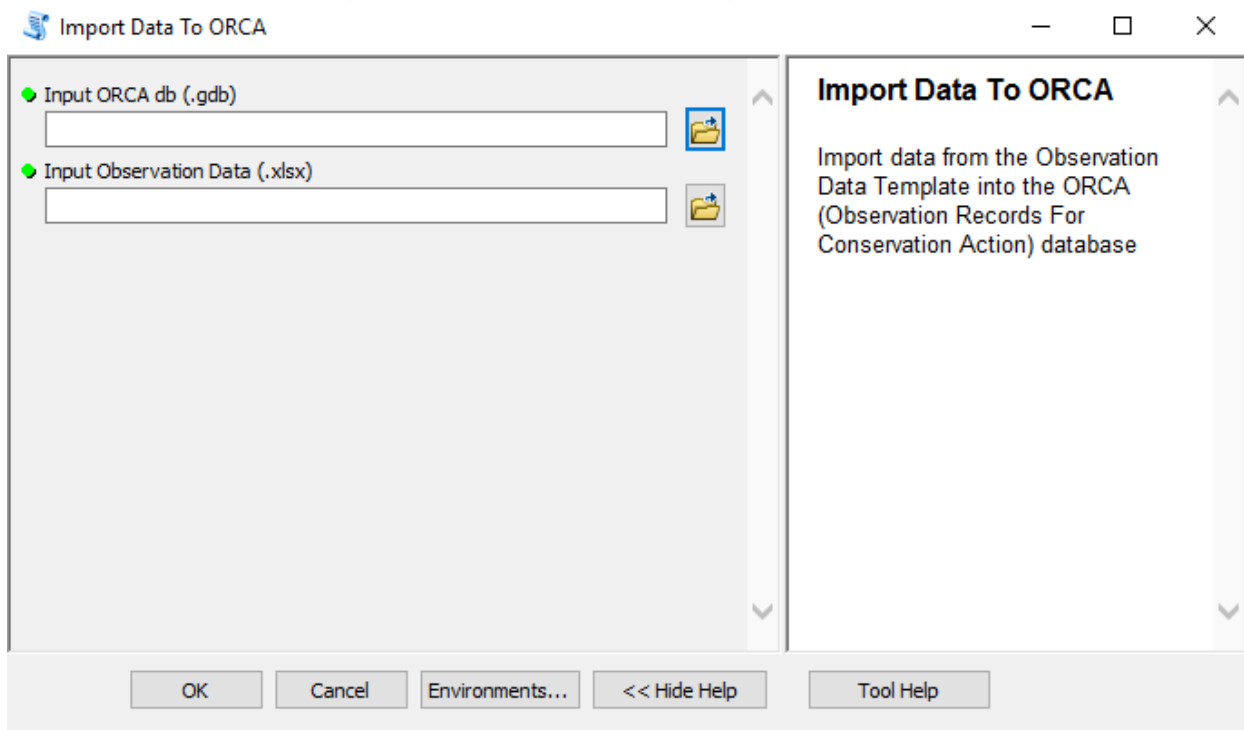
6, There are only two inputs: the ORCA database you want to input data to, and the observation data (contained in the correct observation data template) that you want to import.

7. The tool does not insert the data into the database specified above. Instead, it copies the database and appends the data into the observations table of that database. This new database will be stored in the same folder as the Input Db, and will have the same name as the Input Db plus the current date.

8. Once copying is completed, there will be a message like that below in Arc Messages. Note the new filename is ORCA_todaysDate.gdb instead of just ORCA.gdb. It also indicates how many records were inserted and how many might have been skipped and why.


```
Import Data To ORCA                                              [ x ]

Completed                                              [ Close ]

                                                       [ << Details ]

□ Close this dialog when completed successfully

Running script ImportDataToORCA...
Tue Jul 27 12:52:29 2021 - Output database will be located here:
  J:\nat_hrtg_cons\nat_hrtg\botany\ORCA\ORCA_2021-07-27-125220.gdb
Tue Jul 27 12:53:13 2021 - SUCCESS: 15 Lomatium klickitatense
records successfully input to the ORCA db!
Tue Jul 27 12:53:13 2021 - Recalculating spatial indices...
Executing: AddSpatialIndex J:\nat_hrtg_cons\nat_hrtg\botany\ORCA
\ORCA_2021-07-27-125220.gdb\observations 0 0 0
Start Time: Tue Jul 27 12:53:16 2021
Succeeded at Tue Jul 27 12:53:23 2021 (Elapsed Time: 6.86 seconds)
Tue Jul 27 12:53:23 2021 - 4 Lomatium klickitatense records skipped
due to the lack of dates or years
Completed script ImportDataToORCA...
Succeeded at Tue Jul 27 12:53:25 2021 (Elapsed Time: 1 minutes 4
seconds)
```
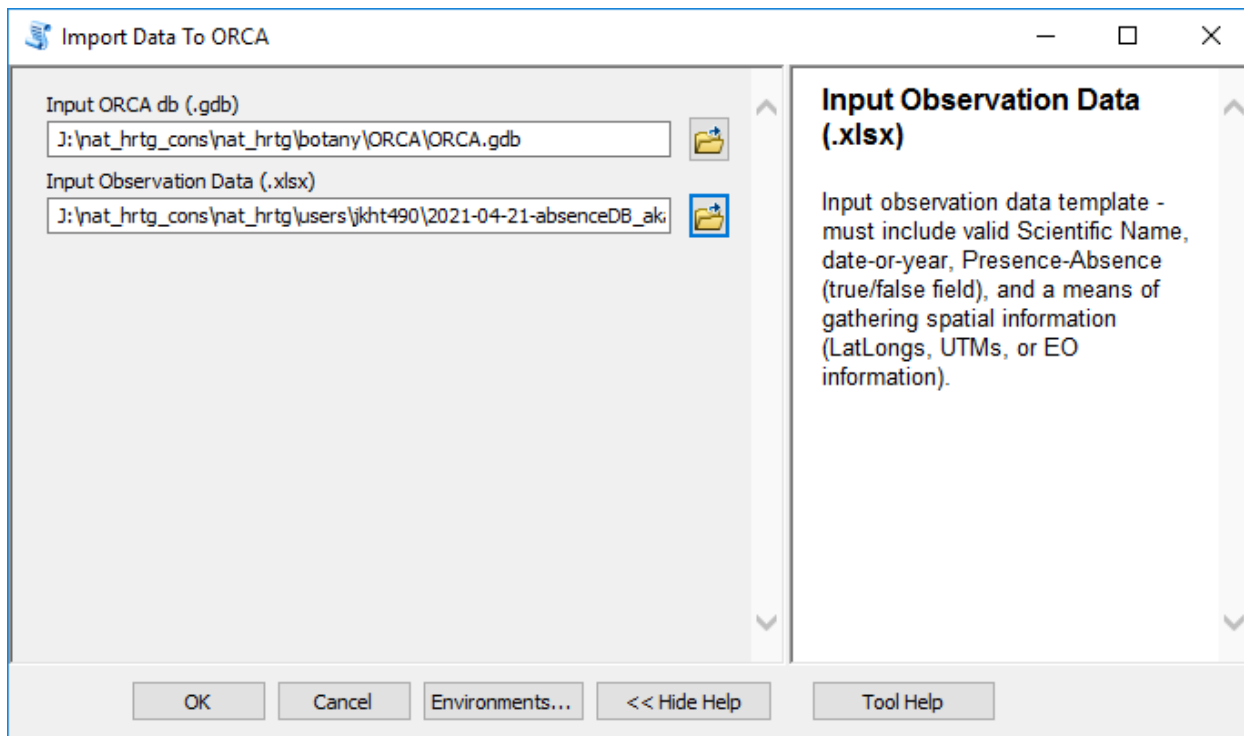
9. If you do not have background geoprocessing disabled, then to see this messages you may have to click up top on Geoprocessing→Results, then expand "Current Session", then expand "Import Data to ORCA", then expand messages. This will show the same info in a different format, like this:

Results

- Current Session
  - ⚠ Import Data To ORCA [125325_07272021]
    - ⊞ ◇ Inputs
    - ⊞ 🗁 Environments
    - ⊟ 💬 Messages
      - 💬 Executing: ImportDataToORCA J:\nat_hrtg_cons\nat_hrtg\botany\ORCA\ORCA.gdb "J:\nat_hrtg_cons\nat_hrtg\users\jkht◄
      - 🕓 Start Time: Tue Jul 27 12:52:20 2021
      - 💬 Running script ImportDataToORCA...
      - 💬 Tue Jul 27 12:52:29 2021 - Output database will be located here:
      - 💬 J:\nat_hrtg_cons\nat_hrtg\botany\ORCA\ORCA_2021-07-27-125220.gdb
      - 💬 Tue Jul 27 12:53:13 2021 - SUCCESS: 15 Lomatium klickitatense records successfully input to the ORCA db!
      - 💬 Tue Jul 27 12:53:13 2021 - Recalculating spatial indices...
      - 💬 Executing: AddSpatialIndex J:\nat_hrtg_cons\nat_hrtg\botany\ORCA\ORCA_2021-07-27-125220.gdb\observations 0 0 0
      - 💬 Start Time: Tue Jul 27 12:53:16 2021
      - 💬 Succeeded at Tue Jul 27 12:53:23 2021 (Elapsed Time: 6.86 seconds)
      - ⚠ Tue Jul 27 12:53:23 2021 - 4 Lomatium klickitatense records skipped due to the lack of dates or years
      - 💬 Completed script ImportDataToORCA...
      - 🕓 Succeeded at Tue Jul 27 12:53:25 2021 (Elapsed Time: 1 minutes 4 seconds)
  - 🗁 Shared

10. Inspect the newly-added observations in the new version of the database to find any errors. Once the quality control phase is completed, delete the former version, and rename the newest version to take the date out of the gdb name. Renaming the gdb is best done from ArcMap or ArcCatalog, and will also work best in a new GIS session that has not yet "touched" any of the layers inside ORCA.

Appendix B. Metadata for WNHP's Observation Database

This ESRI file geodatabase contains observation-level information about rare plants in Washington.

The file geodatabase is native to ArcGIS 10.6.1.

The Observation feature class has overlapping polygons, one for each observation event. The Managed Area feature class represents administrative units that contain observations.

Null values in tables denote unknown/no information available.

Contacts

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360.902.1710

Feature Class Field Descriptions

OBSERVATIONS FEATURE CLASS:

OBSERVATION_ID: Unique identifier for each observation event. Required.

SITE_ID: Identifier for each site. M:1 relationship with SITE_ID from the Site feature class.

INTRO_SOURCE_FEATURE_ID: This field links observations of an outplanting effort to a source feature in the introduced_source_features feature class via its INTRO_SOURCE_FEATURE_ID.

> If the value in this field is -1, and IS_POP_INTRODUCED is False, then this is not an introduced population. If the value in this field is -1 and IS_POP_INTRODUCED is True, then this is a survey of an introduced population, not an observation of the outplanting effort. If this field has a value, then the record represents an observation of the planting effort.

SCI_NAME: Scientific name of the element being observed. Required.

PRESENT: True-or-false field indicating if the element was present at this location and time. Required.

MONITOR_DATE: Date of the observation

MONITOR_YEAR: Year the element was observed

NUMBER_PLANTS: Number of plants observed or estimated at the time of the observation event. The number zero indicates no plants were found whereas null values indicate no information was available.

PLANT_COUNT_UNITS: Units of the plant count. Not constrained to the values listed below.

13

PLANTS

STEMS

GENETS

RAMETS

FLOWERS

FRUITS

PLANT_EST_MAX: The estimated maximum number of plants in the observation at the time of observation.

PLANT_EST_MIN: The estimated minimum number of plants in the observation at the time of observation.

PLANT_COUNT_METHOD: Method of the plant count. Not constrained to the values listed below.

CENSUS

ESTIMATE

MONITOR PLOT

SEEDLING_COUNT: Count of non-mature plants

VEGETATIVE_MATURE_COUNT: Count of mature but not reproducing plants

REPRO_COUNT: Count of reproductive plants

DEAD_COUNT: Count of dead plants

IS_POP_INTRODUCED: A True/False field that indicates whether the observed population is an introduced population (True) or a wild population (False)

SURVEYOR: People conducting the observation

HABITAT_COMMENTS: Comments on the element's habitat at this location.

ASSOCIATED_SPECIES_COMMENTS: Comments on the element's associated species.

OBSERVATION_COMMENTS: Comments relevant to that observation

OBSERVATION_PHOTO_PATH: Path to the folder of photos that were taken during the time of observation. Use UNC paths.

ID_DOCUMENTATION: Any documentation used to ID the plant

SPP_CODE: USDA species code.

CONC_FEAT_TYPE: Conceptual feature type (polygon, buffered point, buffered line, etc.)

MAPPED_BY: Name of the person that added the observation to table. Required.

MAPPED_DATE: Date the observation was added to table. Required.

DATA_SOURCE: Data source of the original observation. Include dataset name and date in a YYYYMMDD format.

FEDERAL_ID: Unique ID in original data source for the observation. BLM's GeoBOB: FLSITE_CN; USFS's NRIS: SPATIAL_ID.

SITES FEATURE CLASS: *Note, only populated for species for which these sites are biologically relevant. The skeleton of this feature class remains in place for extensibility with former and future observational databases.

SITE_ID: Unique identifier for each area containing at least one observation. Required.

SITE_NM: Name of a site. Not necessarily unique.

SITE_MANAGER_CONTACT: Contact person for the site

SITE_MANAGER_PHONE: Contact person's phone number. Format: 1234567890

SITE_MANAGER_ADDRESS: Contact person's mailing or physical address.

SITE_PROTECTION_LEVEL: Description of the site's level of protection.

PLANT_RECOVERY_ZN: Any recovery units associated with that population of the species.

SITE_COMMENTS: Comments about the site.

SITE_ACRES: GIS acres of the site polygon.

SITE_CONTACT_INFO_UPDATED: Date of the last time the contact information was updated.

MAPPED_BY: Name of the person that added the site to table. Required.

MAPPED_DATE: Date the site was added to table. Required.

SITE_PHOTO_PATH: Path to the folder of photos that were taken during the time of observation. Use UNC paths.

SITE_NAME_SYNONYM: Site names can change over time and old names can be stored here. If a site has more than one name, others can be stored here.

MANAGED_AREA_ID: Unique identifier for a managed area, defined by the site polgyon's centroid since a site can cross managed areas. M:1 relationship with the managed areas feature class. Whitman County records without managed areas have a MANAGED_AREA_ID = -1.

SITE HABITAT TABLE:

M:1 relationship with the site feature class.

SITE_ID: Unique identifier for each area containing at least one observation. Required.

HABITAT_DATE: Date the habitat was observed

HABITAT_YEAR: Year the habitat was observed

WOODY_COVER_PCT: Woody cover percent

NATIVE_COVER_PCT: Native cover percent

EXOTIC_COVER_PCT: Exotic cover percent

EXOTIC_SPP_CONCERN: Exotic species of concern

NATIVE_FORB_PCT: Native forbs percent

NATIVE_GRASS_PCT: Native grass percent

OTHER_TESP_PRESENCE: Other TESP species present

SURVEYOR: Surveyor name

SURVEY_TYPE: Habitat survey type

HABITAT_COMMENTS: Habitat comments

HABITAT_PHOTO_PATH: Path to the folder of photos that were taken at the time of observation. Use UNC paths.

SOILS: Soil types

GEOLOGY: Geology of the area

TOPOGRAPHIC_POSITION_DESC: Topographic position description

MANAGED AREA FEATURE CLASS:

MANAGED_AREA_ID: Unique identifier for a managed area

MANAGED_AREA_NM: Managed area name. Not necessarily unique.

MANAGED_AREA_OWNER: Land owner of the managed area

MANAGED_AREA_OWNER_CONTACT: Contact person for the managed area

MANAGED_AREA_OWNER_PHONE: Contact person's phone number. Format: 1234567890

MANAGED_AREA_OWNER_ADDRESS: Contact person's mailing or physical address.

MANAGED_AREA_PROTECTION_LEVEL: Description of the managed area's level of protection.

MANAGED_AREA_COMMENTS: Comments about the managed area

MANAGED_AREA_ACRES: GIS acres of the managed area polygon.

MANAGED_AREA_CONTACT_INFO_UPDATED: Date of the last time the contact information was updated.

MANAGED_AREA_NAME_SYNONYM: Managed area names can change over time and old names can be stored here. If a managed area has more than one name, others can be stored here.

MAPPED_BY: Name of the person that added the site to table. Required.

MAPPED_DATE: Date the site was added to table. Required.

INTRODUCED OCCURRENCES FEATURE CLASS:

IO_ID: Unique identifier for each introduction occurrence

IO_NUM: Number that identifies this particular occurrence of the introduced element. Not unique within the table, unique only within a single species.

SCI_NAME: Scientific name of the introduced element.

COM_NAME: Common name of the introduced element as defined by the Washington Natural Heritage Program.

IO_COMMENTS: Comments about the introduced occurrence.

INTRODUCTION_TYPE: Records if this is an augmentation of a naturally-established population or a brand new introduction. If an IO has an introduction_type of "AUGMENTATION", then its IO_ID will correspond to the natural population's EO_ID in the IOID_TO_EOID table

AUGMENTATION: augmentation of a naturally-established population.

OUTPLANTING: introduction where there were no recorded occurrences or the occurrence was

INTRODUCED SOURCE FEATURES FEATURE CLASS:

The Introduced Source Features feature class are primarily single part polygons, with some multipart polygons. The Introduced Occurrences may be multipart polygons containing/overlapping the Introduced Source Features. The Introduced Occurrences and Introduced Source Features are meant to be used in conjunction with the Element Occurrences from WNHP, which can be found here: https://data-wadnr.opendata.arcgis.com/datasets?group_ids=266f0b3bdc014f5ab2a96ad4ea358a28 . The WNHP Source Features are available upon request. The Introduced Occurrences are new occurrences established by humans through the outplanting of seeds or plugs and designed to expand the number of populations of a species to improve its conservation status. Introduced occurrences are not currently included in the WNHP Biotics database.

INTRO_SOURCE_FEATURE_ID: A unique identifier for each introduced source feature

IO_ID: Unique identifier for each introduction occurrence. This is not unique in this table as there can be multiple introduced source features within one introduced occurrence.

SCI_NAME: Scientific name of the introduced element.

COM_NAME: Common name of the introduced element as defined by the Washington Natural Heritage Program.

PROVENANCE: Where the seed or plugs of the introduced occurrence originated.

INTRODUCED_DATE: Date on which the introduction occurred

INTRODUCED_YEAR: Year in which the introduction occurred

INTRODUCTION_LAYOUT: Describe how the introduction was laid out. (i.e. were seeds dispersed in a grid or along a transect, were plugs planted according to a grid scheme or randomly, etc.)

INTRODUCED_QUANTITY: How many plugs or seeds were introduced

INTRODUCED_QUANTITY_UNIT: Units of how many seeds or what size plugs were introduced. Not constrained to the values listed below.

> POUNDS
>
> OUNCES
>
> GRAMS
>
> SEEDS
>
> 4 INCH

INTRODUCED_QUANTITY_TYPE: Type of introduction:

> SEED
>
> PLUG

INTRODUCTION_COMMENTS: Comments about the introduction

INTRODUCTION_TYPE: Records if this is an augmentation of a naturally-established population or a brand new introduction

> AUGMENTATION: augmentation of a naturally-established population
>
> OUTPLANTING: introduction where there were no recorded occurrences or the occurrence was extirpated

INTRO_SOURCE_PHOTO_PATH: Path to the folder of photos of the introduction area. Use UNC paths.

IOID_TO_EOID Table:

This table related Introduced Occurrences (IOs) that represented augmentations of natural populations with the Element Occurrences (EOs) being augmented. This relationship is being represented as a table because, for record-management reasons, some of the EOs are split up further than the "Habitat-based Element Occurrences Delimination Guidance" would suggest. Since the IOs are less finely-delineated, this creates a One:Many relationship between IOs and EOs. However, since Biotics cannot be altered to include IO_IDs in the EO, this relationship must be delineated via this linking table.

> IO_ID: The Introduced Occurrence ID that represents an introduction augmenting a natural population
>
> EO_ID: The Element Occurrence ID of the natural population being augmented

Data Diagram