

Overview of Proposed Methodology for Developing Spatial Features

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OVERVIEW OF PROPOSED SPATIAL METHODOLOGY

The solution proposed by the Spatial Methodology team was developed to address the following goals:

1. **Integrate observation data**, mapped as-is (i.e., without incorporating any locational uncertainty in the mapped feature), into the existing spatial methodology.
 - **Note:** This does not address whether it is preferable, or even valid, to represent observations without including locational uncertainty in the mapped features. Mapping, managing, and/or providing Observation Features mapped without uncertainty is already being done in some programs to meet client needs, and is the norm for mapped observation data outside of NatureServe. Whether to map, manage, and/or provide such Observation Features is a programmatic decision, but providing the ability for programs to do so through integration of observations into the proposed spatial methodology was mandated.
 - Despite integration in the spatial model, mapping Observation Features as defined by the methodology is optional; this enables
 - programs to opt not to manage Observation Features mapped without locational uncertainty, and
 - programs that use the full spatial methodology to continue their work without adding another mapped feature type to the process or losing mapped features they already manage
 - Reasons for incorporating Observation Features mapped without locational uncertainty in the methodology, include:
 - many clients request raw, un-interpreted Observation Features
 - a number of analyses valuable for informing conservation require raw observations (e.g., predictive modeling)
 - many programs need, and already manage, raw observations datasets
 - in order to share like data and collaborate with partners and other conservations agencies/organizations, Observation Features mapped without uncertainty included are required
2. **Establish standard stages of implementation** within the proposed spatial methodology that allow all member programs – including those that have historically been challenged by limited resources and/or developing client-requested products from the features managed under the existing methodology – to find a stage that is both attainable and meets their needs. Stages in the proposed methodology, defined according to data output:

Figure 1. Feature development stages and data outputs in the proposed spatial methodology.

OPTIONAL?	SYSTEM USED	STAGE	OUTPUT FEATURE	CHARACTERISTICS OF OUTPUT FEATURE
<i>Optional</i>	Kestrel	1	Observation	<ul style="list-style-type: none"> • Locational uncertainty NOT included in mapped feature
	Biotics	2	Source Feature	<ul style="list-style-type: none"> • Locational uncertainty is ALWAYS included in mapped feature
	Biotics	3	Autogenerated EO	<ul style="list-style-type: none"> • Mapped feature represents the observed location of a practical conservation unit • Developed by applying Separation Distance to Source Features
<i>Optional</i>	Biotics	4	Refined EO	<ul style="list-style-type: none"> • Mapped feature represents only the suitable habitat portion of the observed location of a practical conservation unit • Results from: <ul style="list-style-type: none"> – clipping unsuitable habitat from Autogenerated EO OR – EO being composed entirely of Source Feature(s) that do not include unsuitable habitat

3. **Streamline the methodology**, accomplished through automation of several steps in the spatial feature development processes, subject to user acceptance. This automation will, in most cases, provide users with the ability to process the output data from a particular stage to the next higher stage in a consistent fashion with relatively small effort (e.g., the system, with user acceptance, can use Observation or Source Features to develop Autogenerated EOs which have already taken into account Separation Distance). Processes to have automation in the proposed spatial methodology include:

- Generation of Source Features from mapped Observation Features when Locational Uncertainty (LU) Type is Negligible or Areal – Estimated
- If user chooses the automated option, application of Separation Distance to add Source Feature to a new or existing Element Occurrence (EO) and display preview, which the user can choose to accept or not
- If previewed EO is accepted, the Autogenerated EO will be saved
- Clipping of Unsuitable Habitat Features (UHF[s]) from EO, if user opts to define UHF(s) for refining EO

Based on input from the Products Team and Observations and EOs Team, removing Source Features to streamline the methodology is not an option. Because Source Features include locational uncertainty in the mapped feature, they are useful in that the boundaries can be relied upon to include with high confidence the location where the observation was actually made. As such, in many cases they are the preferred dataset for developing data products.

4. **Provide recommendations for common set of biodiversity map surfaces** that could be managed in member programs. Not yet completed, work on achieving this goal will continue into FY11.

Implementation of the proposed spatial methodology will utilize two integrated NatureServe applications: Biotics and Kestrel.

- Kestrel is a web-based application used for mapping and tracking observations, which are either entered manually or bulk uploaded.
- In the proposed Spatial Methodology, Observations are created in Kestrel and exported to/imported into Biotics. Programs not using Kestrel to develop Observations can use Input Features – *now referred to as Pre-source Features*¹ – to create Source Features with Areal – Estimated LU.
- Kestrel has been developed for a broad set of users, including many external to NatureServe.
- The core set of attributes associated with Observations within Kestrel are: element observed, observation date, location, and primary observer. In addition to the core set of attributes, Kestrel supports an extensible observation data model through *user authored observation templates (still in development)*. This enables the user to define a template according to their needs, including the desired attributes, their data types, domains, help text and whether they're required and/or will allow comments.

¹ Based on feedback received to date, the label 'Input Feature' has renamed 'Pre-source Feature' as it better indicates the fact that it is digitized for the system to use in applying a LU Distance buffer to create Areal – Estimated Source Features in cases when the Observation Feature is not digitized. Use of the Pre-source Feature in these cases allows all Source Features, regardless of LU Type, to be consistent by always incorporating LU.

SPATIAL FEATURE DEVELOPMENT

CURRENT DEFINITIONS

OBSERVATION, SOURCE FEATURE, AND ELEMENT OCCURRENCE

OBSERVATION:

An **observation** is the presence or historical presence of a species or ecological element at a location indicated by the collection of information, or a location where a target species or ecological element was searched for but not detected. When an observation is mapped, the digitized **Observation Feature** does NOT include locational uncertainty in the mapped feature. Observations are not evaluated in terms of potential persistence according to standards, but encompass a broad range of different quantitative and qualitative information types useful for assessing locations, or potential locations, of elements, and may serve as the basis for creating Source Features that can be used to develop Element Occurrences.

SOURCE FEATURE:

A **Source Feature** is the mapped representation of one or more observations indicating the presence or historical presence of a species or ecological element. A Source Feature *always* incorporates locational uncertainty in the mapped feature; inclusion of additional area or length for uncertainty as needed within the Source Feature boundary ensures that the actual on-the-ground location of the underlying observation(s) is captured within the feature. Source Features are developed through interpretation of the amount and direction of uncertainty (e.g., along an axis; a specified distance extending from the boundary of the underlying observation) which is to be included in the feature representing the underlying observation(s). One or more Source Features can be used to create an Element Occurrence.

ELEMENT OCCURRENCE:

An **Element Occurrence (EO)** is an area of land and/or water in which a species or ecological element is, or was, present, and is developed using standards to define locations of the element that have the potential to persist if current conditions prevail. Mapped **EO Representations** are developed from one or more Source Features. Consistency in EOs throughout the range of an element is achieved through the application of standard minimum data criteria and rules of separation specific to that element or group of similar elements.

ATTRIBUTES RELATED TO UNCERTAINTY OF LOCATION

MINIMUM MAPPING UNIT (mmu):

The minimum mapping unit is the size of smallest feature that can be delineated with boundaries on a map. The mmu differs by map scale:

- 12.5 m (40 ft.) mmu on 1:25,000 scale map
- 25 m (80 ft.) mmu on a 1:50,000 scale map

Observation Attributes

ACCURACY:

Indicates how closely the actual on-the-ground location of an observation is represented by where the observation has been placed on the map. While optional under the revised spatial methodology, Observation Features are digitized 'as-is,' meaning that Observation Features do not include any

additional area or length to represent the difference between actual and mapped locations. The two Accuracy Types for Observation Features are:

- **Accuracy Type: Within MMU**
 - Applies when the difference between the actual on-the-ground location of the observation and its placement on a map is *within half* the mmu for the map scale
- **Accuracy Type: Outlying MMU**
 - Applies when the actual location of an observation differs from its mapped location by a distance to be specified by the user, which is greater than half the mmu for the map scale

ACCURACY DISTANCE:

Recorded for Observation Features with Accuracy Type: Outlying MMU, the distance that best represents the difference between the actual on-the-ground location of the observation and where the Observation Feature has been placed on the map.

Source Feature Attributes

LOCATIONAL UNCERTAINTY:

Indicates the uncertainty in location that is incorporated in a Source Feature, which represents one or more underlying observations.

In most cases, the locational uncertainty included in a Source Feature simply reflects the accuracy of the underlying observation – that is, the difference between the actual location of the observation and its mapped location – which is *not* included in the mapped Observation Feature. For example, if a digitized Observation Feature has Accuracy Type Within MMU, typically the Source Feature developed to represent that Observation Feature has Negligible LU; the Accuracy and Locational Uncertainty Types are consistent – the high accuracy value corresponds with the least amount of locational uncertainty associated with the spatial data. However, in cases when digitized Observation Features are represented differently as a Source Feature that includes uncertainty, the Accuracy and Locational Uncertainty Types may not be as comparable. For example, when multiple digitized Observation Feature Points, each with Accuracy Within MMU, are represented by a single Source Feature Polygon with Areal – Delimited LU, the Source Feature may incorporate more area for locational uncertainty within its boundary than would be included if every Observation Feature Point had been developed into a separate Source Feature, each with Negligible LU.

The four Locational Uncertainty (LU) Types that describe the uncertainty incorporated in Source Features are:

- **LU Type: Negligible**
 - Applies when the Source Feature is digitized with LU, the extent of which is *within half* the mmu for the map scale
 - If the underlying Observation has been digitized, the system will autogenerate the Source Feature from the digitized Observation
 - If the underlying Observation has not been digitized, user will need to digitize the Source Feature
- **LU Type: Areal – Estimated**
 - Applies when the Source Feature is digitized with LU that is based on the same estimated distance in all directions, and the extent of that LU is greater than half the mmu for the map scale
 - If the underlying Observation has been digitized, the system will autogenerate the Source Feature from the digitized Observation by applying a LU Distance buffer

- If the underlying Observation has not been digitized, user will need to digitize a Pre-source Feature and the system will autogenerate the Source Feature from the digitized Pre-source Feature by applying a LU Distance buffer
- **LU Type: Linear**
 - Applies when the Source Feature is digitized with LU that occurs along an axis, and the extent of that LU is greater than half the mm for the map scale
 - User will always need to digitize a Source Feature with Linear LU Type
 - The Source Feature may be digitized to represent one or more Observations
- **LU Type: Areal – Delimited**
 - Applies when the Source Feature is digitized with LU that is not restricted to an axis but can be circumscribed by a mappable boundary that is not based on the same estimated distance in all directions, and the extent of that LU is greater than half the mmu for the map scale
 - User will always need to digitize a Source Feature with Areal – Delimited LU Type
 - The Source Feature may be digitized to represent one or more Observations

LOCATIONAL UNCERTAINTY DISTANCE:

Recorded for Source Features with LU Type: Areal - Estimated, the distance that best represents the extent of uncertainty to be included in the Source Feature, which is digitized to represent the underlying observation(s).

FEATURE DEVELOPMENT PROCESS DESCRIPTION

The process for developing spatial features according to the proposed methodology is described below. Following is a decision tree that walks through the process of developing spatial features (Figure 3), and a summary diagram that shows every possible pathway for developing features (Figure 4). Note that while *all* the options for processing data implementing the methodology are shown in this diagram, some pathways and/or stages may be less utilized by programs than others, depending on factors such as 1) whether observations are digitized, 2) the data outputs that are most useful to the program, and 3) the resources available for managing spatial data.

STAGE 1 - OUTPUT: OBSERVATION

Optional

An Observation Feature is digitized in Kestrel (or another observations database), without including Locational Uncertainty (LU) in the mapped feature.

1. **USER** digitizes Observation Point, Line, or Polygon without including LU² in the mapped feature
2. **USER** specifies for Observation:
 - Accuracy Type
 - Accuracy Distance, if Accuracy Type: Outlying MMU
This Accuracy Distance will be used as the default LU Distance

² If digitized Observation will summarize multiple observations in a single feature that *cannot* be digitized without including LU, begin at Stage 2 in the process by digitizing a Source Feature (or a Pre-source Feature for Areal – Estimated LU Type) instead.

STAGE 2 - OUTPUT: SOURCE FEATURE

A Source Feature always includes LU in the mapped feature, and is created in Biotics using Observation Features imported from Kestrel (or another observations database), if available.

If Source Feature is LU Type Linear or Areal – Delimited:

- 3. **USER** digitizes Source Feature that includes LU in the mapped feature
- OR**

If Observation was not digitized AND Source Feature is LU Type Negligible:

- 3. **USER** digitizes Source Feature that includes LU in the mapped feature
- OR**

If Observation was not digitized AND Source Feature is LU Type Areal – Estimated:

- 3. **USER** digitizes Pre-source Feature that does *not* include LU in the mapped feature
- SYSTEM** autogenerates the Source Feature by applying the LU Distance buffer to the digitized Pre-source Feature after the distance has been specified

IN ALL OTHER CASES:

SYSTEM autogenerates the Source Feature from the digitized Observation.

Figure 2. Development pathways for digitizing Observations, Pre-source, and Source Features.

Observation Feature (no LU in mapped feature)	Opt to Digitize				Opt to Not Digitize			
	<i>Negligible</i>	<i>Areal – Estimated</i>	<i>Linear</i>	<i>Areal - Delimited</i>	<i>Negligible</i>	<i>Areal – Estimated</i>	<i>Linear</i>	<i>Areal - Delimited</i>
<i>LU Type</i>								
Pre-source Feature (no LU in mapped feature)	-	-	-	-	-	Digitize	-	-
Source Feature (all have LU in mapped feature)	Automatic generation by system	Automatic generation by system	Digitize	Digitize	Digitize	Automatic generation by system	Digitize	Digitize

4. **USER** specifies for Source Feature:

- LU Type
- LU Distance, if LU Type is Areal – Estimated
If an Observation Feature was digitized and an Accuracy Distance recorded, the system uses this value as the default for auto-populating the LU Distance, but user can edit
- Conceptual Feature Type
- Unsuitable Habitat (UH) Excluded indicator for specifying whether the mapped feature was digitized to exclude unsuitable habitat
- Create EO from Source Feature indicator to specify whether an EO should be generated from the Source Feature.

STAGE 3 - OUTPUT: AUTOGENERATED ELEMENT OCCURRENCE

An Autogenerated EO represents the observed location of a practical conservation unit, which is developed by applying Separation Distance to the Source Feature in Biotics.

SYSTEM provides user with the following choices, with the default being 'Apply Suitable Habitat Separation Distance' :

- Apply Suitable Habitat Separation Distance
- Apply Unsuitable Habitat Separation Distance
- Use Custom Separation Distance
- Manually Create EO

IF USER CHOOSES ONE OF THE THREE SEPARATION DISTANCE OPTIONS, the process for automatically applying the Separation Distance process is initiated:

SYSTEM automatically applies the Separation Distance selected or specified by the user to the Source Feature, comparing it with other existing Source Features to either create a new EO or add it to an existing EO.

SYSTEM automatically applies Procedural Buffer to the Source Feature if needed to bring it up to the size of a polygon that meets the mmu for the map scale.

SYSTEM displays the Autogenerated EO

5a. USER previews Autogenerated EO to decide whether to accept the EO or not

If user accepts previewed EO:

SYSTEM saves the Autogenerated EO and retains the Separation Distance that was used as metadata.

If user does NOT accept previewed EO

SYSTEM cancels the EO creation process

USER manually applies Separation Distance and uses 'Generate EO from Source Feature(s)' tool to produce an EO

OR

IF USER CHOOSES TO MANUALLY CREATE EO:

5b. USER manually applies Separation Distance to Source Feature, comparing it with other Source Features to create a new EO or add it to an existing EO

If a new EO is to be created:

USER selects the appropriate Source Feature(s) to create the new EO using the 'Generate EO from Source Feature(s)' tool

SYSTEM automatically applies Procedural Buffer to the Source Feature if needed to bring it up to the size of a polygon that meets the mmu for the map scale

SYSTEM creates a new EO or modifies an existing EO(s), as appropriate, using selected Source Feature(s)

OR

If Source Feature is to be added to an existing EO:

USER adds the Source Feature to the existing EO by editing the EO, clicking Add, and selecting the Source Feature(s).

STAGE 4 - OUTPUT: REFINED ELEMENT OCCURRENCE***Optional***

A Refined EO represents only the suitable habitat portion of the observed location of a practical conservation unit, and results from either defining an Unsuitable Habitat Feature which is automatically clipped from the EO, or from being composed entirely of Source Features that do not include unsuitable habitat.

TO INITIATE THE PROCESS FOR CREATING UHF(s):

6. **USER** defines UHF(s) for areas of unsuitable habitat that overlap or are contained within a particular EO by:
 - Manually digitizing polygons, or
 - Copying unsuitable habitat from a layer

SYSTEM records UHF(s) in a multi-user managed theme (i.e., an Unsuitable Habitat Feature layer)

SYSTEM associates the shape id of the Unsuitable Habitat Feature with the appropriate EO(s)

SYSTEM uses UHF(s) to automatically clip unsuitable habitat from the associated EO, both when initially created and every time thereafter that the EO is regenerated

Note that if unsuitable habitat was excluded from component Source Feature(s) – determined from UH Excluded indicator attribute of the Source Feature(s) – then the EO is considered to be a Refined EO regardless of whether Unsuitable Habitat Features are defined.

Advantages to using Unsuitable Habitat Features (UHFs) to edit EOs include:

- UHFs are associated with specific EOs such that every time the EO is regenerated due to a change in the component Source Feature(s), the system automatically clips the UHF(s) from the regenerated EO so that the original edits are not lost;
- UHFs are automatically maintained as a layer in Biotics, and can be updated as habitat changes.

FIGURE 3.

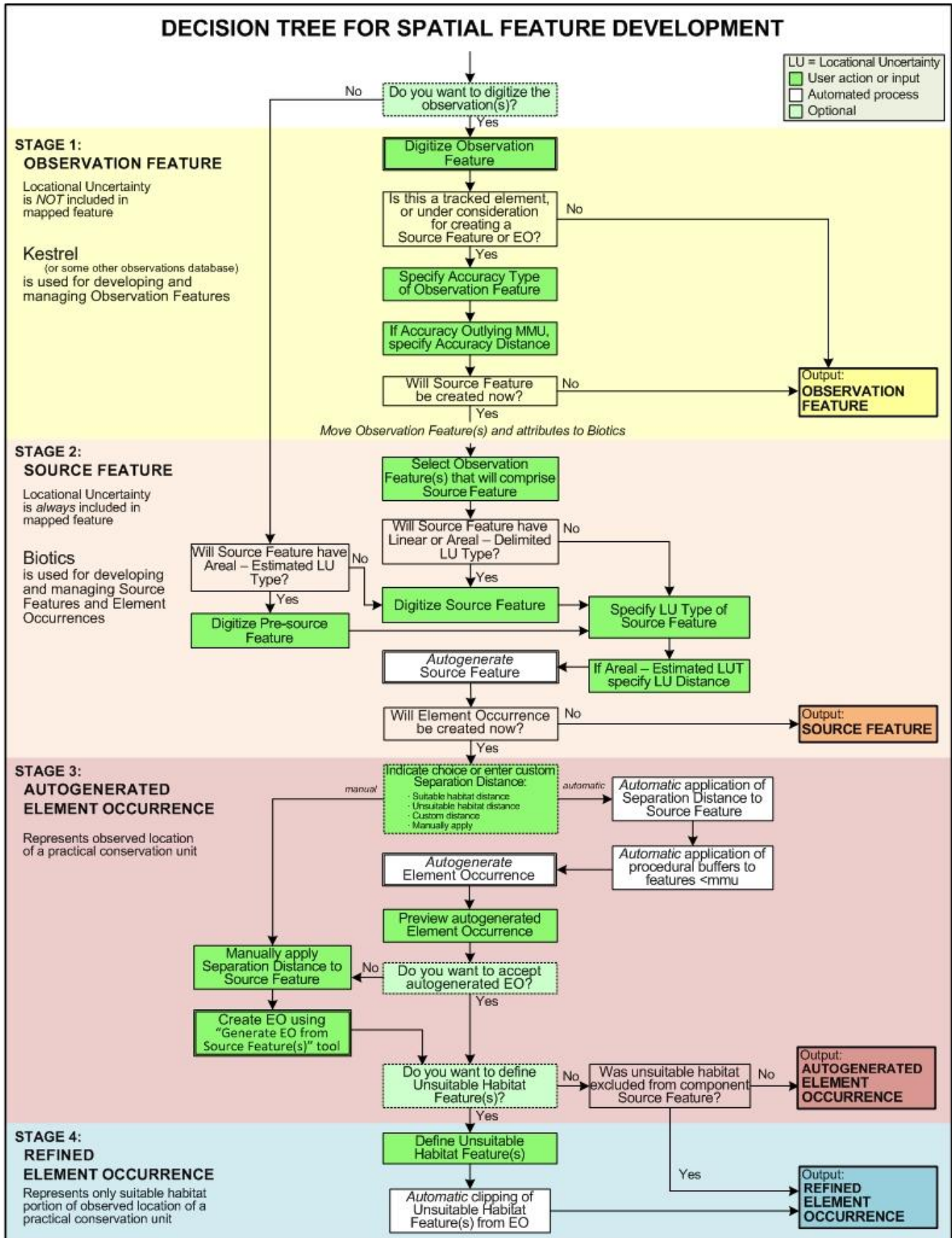
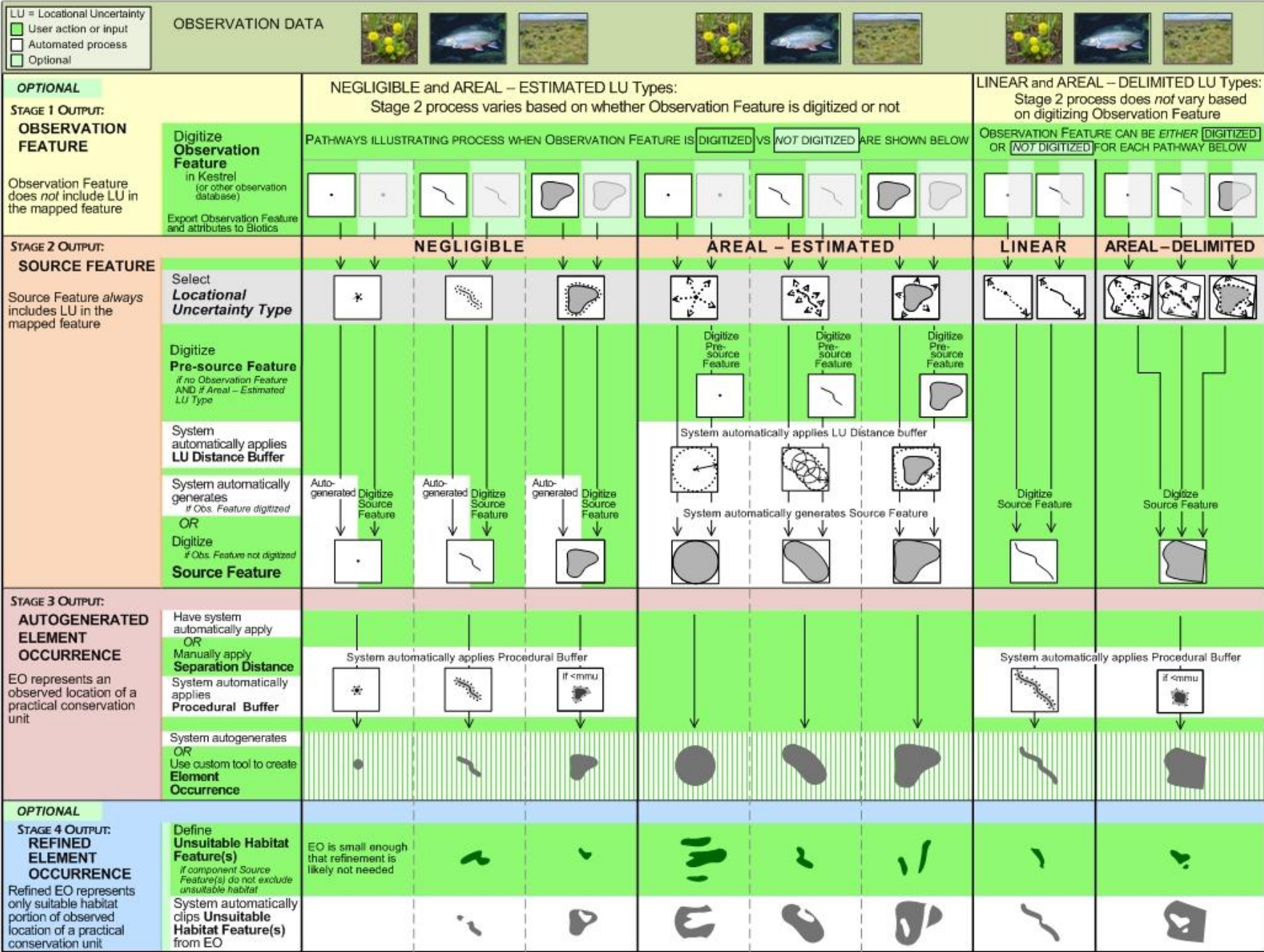


Figure 4.

SPATIAL FEATURE DEVELOPMENT



EXAMPLES ILLUSTRATING USE OF PROPOSED SPATIAL METHODOLOGY

In each of the examples in this section, there are two or more process paths for developing spatial features described, depending on 1) whether the user opts to digitize the observation, and 2) the type of uncertainty to be included in the Source Feature representing the underlying observation(s). Key to the proposed spatial methodology is providing the flexibility for users to map observations and develop additional features using different pathways – each of which includes options for automation – while at the same time providing a structure within which these pathways can be implemented consistently.

Examples 4 and 5 describe situations when the observation consists of multiple points, which may or may not be digitized as individual Observation Points in Stage 1 of the feature development process. Further, these two examples illustrate pathways in Stage 2 for creating a single Source Feature Polygon to represent these multiple points. The use of a single Source Feature to represent a number of underlying Observation Points may be, depending on various factors (e.g., rarity and importance of the element, available resources), a better option for managing the data than developing every individual Observation Point into a separate Source Feature, which would likely be grouped into a single EO based on Separation Distance at the next stage in the feature development process.

Following each of the examples in this section is a diagram illustrating the different pathways and options for developing spatial features.

EXAMPLE 1

OBSERVATION DATA: Ovenbird (*Seiurus aurocapillus*) nest recorded using a GPS with 12 m accuracy

In this example, the Accuracy and LU Type will differ depending on the map scale being used – in this example 1:24,000 or 1:50,000 map scale. As a result, the Source Feature and EO will also differ based on the map scale.

If 1:24,000 Map Scale is used:

STAGE 1 (Optional):

If digitized, the nest observation is mapped as a Point in Kestrel (or some other observation database) based on its size, which is less than the mmu for the map scale, regardless of whether the map scale is 1:24,000 or 1:50,000.

Mapped on a 1:24,000 scale map, the uncertainty associated with the observation data (12 m) is greater than half mmu for map scale, so Accuracy Type: Outlying MMU. An Accuracy Distance of 12 m, which indicates the difference between the actual location of the observation and where it has been placed on a map, is specified when the Accuracy is Outlying MMU.

Stage 1 steps for digitizing Observation (optional) on 1:24,000 scale map:

1. Digitize Observation Point (without including locational uncertainty)
2. Select Accuracy Type: Outlying MMU
3. Specify Accuracy Distance: 12 m

Export Observation Feature and specific associated attributes to Biotics to create Source Feature and EO.

STAGE 2:

Uncertainty associated with the nest is *not* restricted to an axis. The uncertainty to be included in the mapped Source Feature representing the observation based on the accuracy of the underlying observation is Areal – Estimated LU Type using a 1:24,000 scale map.

In this stage, if an Observation Feature was digitized, the system automatically creates the Source Feature, with the system automatically applying an uncertainty buffer using the LU Distance (which defaulted to the Accuracy Distance and was accepted in this example) for the 1:24,000 map scale.

If the Observation was *not* digitized, a Pre-source Feature needs to be digitized so that the system can generate the Source Feature to include uncertainty, accomplished by automatic buffering of the digitized Pre-source Feature with the LU Distance.

The Conceptual Feature Type is a Point, based on the size of the nest observation.

Stage 2 steps for creating the Source Feature on 1:24,000 scale map:

If the Observation was digitized in Stage 1:

1. Select LU Type: Areal – Estimated
2. Accept default LU Distance of 12 m (based on specified Accuracy Distance)
3. System autogenerates Source Feature Polygon from Observation, applying LU Distance as a buffer
4. Specify Conceptual Feature Type: Point

If the Observation was *NOT* digitized:

1. Select LU Type: Areal – Estimated
2. Specify LU Distance: 12 m
3. Digitize Pre-source Feature Point
4. System autogenerates Source Feature Polygon from Pre-source Feature, applying LU Distance as a buffer
5. Specify Conceptual Feature Type: Point

If 1:50,000 Map Scale is Used:

STAGE 1 (Optional):

As described above, the nest observation is optionally mapped as a Point in Kestrel (or some other observation database) based on its size, which is less than the mmu for the map scale, regardless of whether the map scale is 1:24,000 or 1:50,000.

On a 1:50,000 scale map, the uncertainty associated with the underlying observation is less than half the mmu in this case and Accuracy Type is Within MMU.

Stage 1 steps for digitizing Observation (optional) on 1:50,000 scale map:

1. Digitize Observation Point (without including locational uncertainty)
2. Select Accuracy Type: Within MMU
3. Accuracy Distance is not applicable

Export Observation Feature and specific associated attributes to Biotics to create Source Feature and EO.

STAGE 2:

Uncertainty associated with the nest is *not* restricted to an axis. The uncertainty to be included in the mapped Source Feature representing the observation is Negligible LU Type for a 1:50,000 map scale.

In this stage, if an Observation Feature was digitized, the system automatically creates the Source Feature. If the observation was not digitized, then the Source Feature is digitized as the first step in the spatial feature development process.

The Conceptual Feature Type is a Point, based on the size of the nest observation.

Stage 2 steps for creating the Source Feature on 1:50,000 scale map:

If the Observation was digitized in Stage 1:

1. Select LU Type: Negligible
2. LU Distance is not applicable
3. System autogenerates Source Feature Point from Observation (which includes LU although it is too small to be visible at the map scale)
4. Specify Conceptual Feature Type: Point

If the Observation was *NOT* digitized:

1. Select LU Type: Negligible
2. LU Distance is not applicable
3. Digitize Source Feature Point (which includes LU although it is too small to be visible at the map scale)
4. Specify Conceptual Feature Type: Point

For Both 1:24,000 and 1:50,000 Scale Maps:**STAGE 3:**

In this example, no other Source Features for the element are found within the applied Separation Distance.

Note that if the LU Type is Negligible, when generating an EO the system will apply a Procedural Buffer to the Source Feature. This buffer is half the mmu for the map scale, and is applied to the feature to make it visible on a map of this scale.

Stage 3 steps:

- If user opts for automated process, system automatically applies Separation Distance to Source Feature and either creates a new EO or adds the Source Feature to an existing EO(s), as appropriate.
- System displays a preview of the resulting EO
- If user accepts the previewed EO, system will save the Autogenerated EO.
- If user rejects the previewed EO, the EO creation process is cancelled. The user manually applies Separation Distance to Source Feature and uses the 'Generate EO from Source Feature(s)' tool to create an EO.

STAGE 4 (Optional):

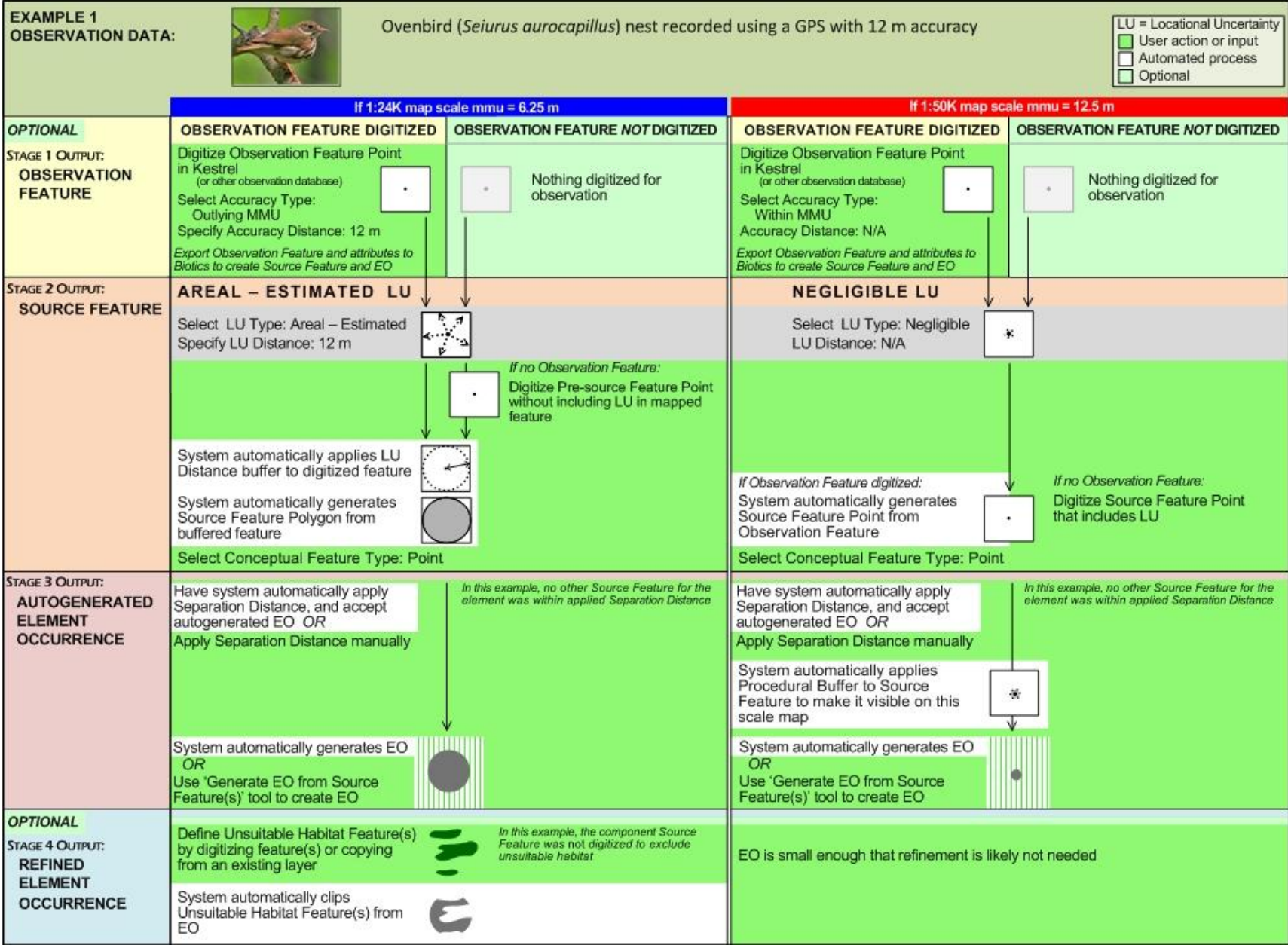
In this example, the component Source Feature of the EO was *not* digitized to exclude unsuitable habitat (which would have effectively made the EO refined without further action).

To refine the EO to include only those portions that can be occupied by the element, Unsuitable Habitat Features (UHF) are defined, either by digitizing the feature(s) or by copying the feature(s) from an existing layer. Once UHF(s) are defined, they are automatically clipped from the EO and stored in a UHF layer for reuse whenever the EO is regenerated.

Stage 4 steps if EO is to be refined (optional):

- User defines Unsuitable Habitat Feature(s)
- System automatically clips Unsuitable Habitat Feature(s) from the EO to create the refined EO

Figure 5. EXAMPLE 1 FEATURE DEVELOPMENT PROCESS ---- AREAL – ESTIMATED and NEGLIGIBLE LU TYPES



EXAMPLE 2

OBSERVATION DATA: Eastern Pondmussel (*Ligumia nasuta*) observed somewhere within Little Pee Dee River

STAGE 1 (Optional):

If digitized, the mussel observation is mapped as a Point in Kestrel (or some other observation database) based on its size, which is less than the mmu for the map scale. Data indicates uncertainty is likely greater than half mmu for map scale, so Accuracy Type is Outlying MMU. For this Accuracy Type, Accuracy Distance must be specified. In the example, 20 m is arbitrarily used. Accuracy Distance indicates the difference between the actual location of the observation and where it has been placed on a map.

Stage 1 steps for digitizing Observation (optional):

1. Digitize Observation Point (without including locational uncertainty)
2. Select Accuracy Type: Outlying MMU
3. Specify Accuracy Distance: 20 m

Export Observation Feature and specific associated attributes to Biotics to create Source Feature and EO.

STAGE 2:

Uncertainty associated with the mussel observation is along a river. The uncertainty to be included in the mapped Source Feature representing the observation is either Linear LU Type, or if the river is wider than the mmu for the map scale, Areal – Delimited LU Type.

Whether the Observation is digitized as the first step in the spatial feature development process or not, whenever the LU Type is Linear or Areal – Delimited, the steps that follow are identical. In Stage 2, a Source Feature needs to be digitized. Because Source Features with these LU Types include additional length or area for uncertainty, the boundaries cannot be automatically generated from a digitized Observation, but must be manually defined.

The Conceptual Feature Type is a Point, based on the size of the mussel observation (not the size of the Source Feature, which includes uncertainty length or area).

Stage 2 steps for digitizing Source Feature:

If Linear locational uncertainty will be included in the Source Feature representing the Observation

1. Specify LU Type: Linear
2. LU Distance is not applicable
3. Digitize Source Feature Line
4. Specify Conceptual Feature Type: Point

If Areal – Delimited locational uncertainty will be included in the Source Feature representing the Observation

1. Specify LU Type: Areal – Delimited
2. LU Distance is not applicable
3. Digitize Source Feature Polygon
4. Specify Conceptual Feature Type: Point

STAGE 3:

In this example, no other Source Features for the element are found within the applied Separation Distance.

Note that if the LU Type is Linear, when generating an EO the system will apply a Procedural Buffer to the Source Feature. This buffer is half the mmu for the map scale, and is applied to the feature to make it visible on a map of this scale.

If the LU Type is Areal – Delimited, the system automatically generates an EO from the Polygon Source Feature, with no change to the feature boundary.

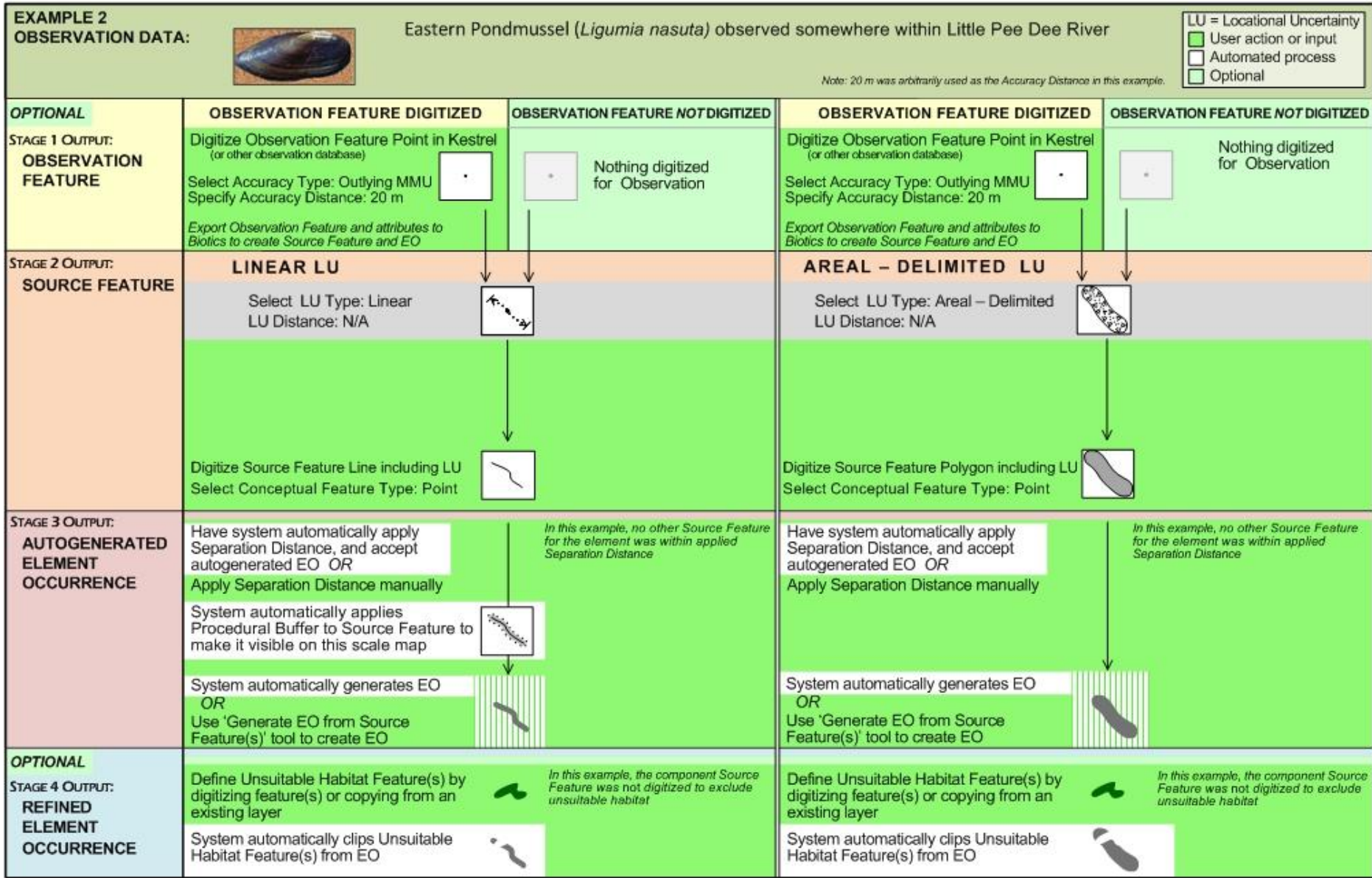
Stage 3 steps for developing an EO are the same as those in Example 1, above

STAGE 4 (Optional):

In this example, the component Source Feature of the EO was *not* digitized to exclude unsuitable habitat (which would have effectively made the EO refined without further action).

Stage 4 steps for refining the EO (optional) are the same as those in Example 1, above

Figure 6. EXAMPLE 2 FEATURE DEVELOPMENT PROCESS ---- LINEAR and AREAL – DELIMITED LU TYPES



EXAMPLE 3

OBSERVATION DATA: Black spruce-tamarack bog (*Picea mariana-Larix laricina / Ledum groenlandicum / Sphagnum* spp. Forest) located east of Ludington Lake, on the west side of Depot Hill Road across from the intersection of Rt. 931 Grape Hollow Road

In this example, the observation can be digitized as either a Point which would essentially serve as a reference for the location of the bog, or as a Polygon, which may better represent its area.

If the Observation is a Point:**STAGE 1 (Optional):**

The bog can be digitized as a Point in Kestrel (or some other observation database) with no uncertainty included. For this pathway, uncertainty associated with the observation is deemed to be greater than half mmu for map scale, so Accuracy Type: Outlying MMU. For this Accuracy Type, Accuracy Distance must be specified. In the example, 50 m is arbitrarily used. Accuracy Distance indicates the difference between the actual location of the observation and where it has been placed on the map.

Stage 1 steps for digitizing Observation (optional):

1. Digitize Observation Point (without including locational uncertainty)
2. Select Accuracy Type: Outlying MMU
3. Specify Accuracy Distance: 50 m

Export Observation Feature and specific associated attributes to Biotics to create Source Feature and EO.

STAGE 2:

The uncertainty associated with the observed bog is not restricted to an axis.

If the bog was digitized as an Observation Point, the uncertainty to be included in the mapped Source Feature representing the observation is either Areal – Estimated LU Type if a buffer will be used to add uncertainty to the observation, or if a boundary can be delineated to capture the observation with uncertainty, LU Type is Areal – Delimited.

The Conceptual Feature Type is a Polygon, based on the size of the bog observed.

Stage 2 steps for creating the Source Feature that includes Areal – Estimated LU:

If Observation Point was digitized in Stage 1:

1. Assign LU Type: Areal – Estimated
2. Accept default LU Distance of 50 m (based on specified Accuracy Distance)
3. System autogenerates Source Feature Polygon from Observation, applying LU Distance as a buffer
4. Specify Conceptual Feature Type: Polygon

If Observation was *NOT* digitized:

1. Assign LU Type: Areal – Estimated
2. Specify LU Distance: 50 m
3. Digitize Pre-source Feature Point that does *not* include LU
4. System autogenerates Source Feature Polygon from Pre-source Feature, applying LU Distance as a buffer
5. Specify Conceptual Feature Type: Polygon

Stage 2 steps for creating the Source Feature that includes Areal – Delimited LU:*Regardless of whether Observation Point was digitized or not:*

1. Assign LU Type: Areal – Delimited
2. LU Distance not applicable
3. Digitize Source Feature Polygon to include LU
4. Specify Conceptual Feature Type: Polygon

If the Observation is a Polygon:**STAGE 1 (Optional):**

The bog can also be digitized as a Polygon in Kestrel, without including uncertainty in the mapped feature. As this example does not provide information on the uncertainty associated with the location of the observation, pathways that utilize both Accuracy Types – Outlying MMU and Within MMU – will be illustrated.

For the Accuracy Type Outlying MMU, Accuracy Distance must be specified. As mentioned above, 50 m is arbitrarily used in this example. Accuracy Distance indicates the difference between the actual location of the observation and where it has been placed on the map.

In order to meet the criteria for Accuracy Type Within MMU, the bog would need to have been circumnavigated using a GPS that resulted in accuracy within the mmu for the map scale.

Stage 1 steps for digitizing Observation Polygon (optional):

1. Digitize Observation Polygon (without including locational uncertainty)
2. Select Accuracy Type: Outlying MMU or Within MMU, depending on accuracy of the data
3. If Accuracy Type: Outlying MMU, specify Accuracy Distance: 50 m

Export Observation Feature and specific associated attributes to Biotics to create Source Feature and EO.

STAGE 2:

As stated earlier for this example, the uncertainty associated with the observed bog is not restricted to an axis. If the Accuracy Type of the observation is Outlying MMU and the uncertainty to be included in the mapped Source Feature will be applied as a buffer, the LU Type is Areal – Estimated. Alternatively, if the Accuracy Type of the underlying observation is Within MMU, then the Source Feature will have Negligible LU.

The Conceptual Feature Type is a Polygon, based on the size of the bog observed.

Stage 2 steps for creating the Source Feature that includes Areal – Estimated LU:

If Observation Polygon was digitized in Stage 1:

1. Select LU Type: Areal – Estimated
2. Accept default LU Distance = 50 m (based on specified Accuracy Distance)
3. System autogenerates Source Feature Polygon from Observation, applying LU Distance as a buffer
4. Specify Conceptual Feature Type: Polygon

If Observation was *NOT* digitized:

1. Select LU Type: Areal – Estimated
2. Specify LU Distance: 50 m
3. Digitize Pre-source Feature Polygon that does *not* include LU
4. System autogenerates Source Feature Polygon from Pre-source Feature, applying LU Distance as a buffer

5. Specify Conceptual Feature Type: Polygon

Stage 2 steps for creating the Source Feature that includes Negligible LU:

If Observation Polygon was digitized in Stage 1:

1. Select LU Type: Negligible
2. LU Distance is not applicable
3. System autogenerates Source Feature Polygon from Observation (which includes LU although it is too small to be visible at the map scale)
4. Specify Conceptual Feature Type: Polygon

If Observation was *NOT* digitized in Stage 1:

1. Select LU Type: Negligible
2. LU Distance is not applicable
3. Digitize Source Feature Polygon (which includes LU although it is too small to be visible at the map scale)
4. Specify Conceptual Feature Type: Polygon

For Both Observation Points and Polygons:

STAGE 3:

In this example, no other Source Features for the element are found within the applied Separation Distance.

Regardless of the LU Type in this example, the system automatically generates an EO from the Polygon Source Feature, with no change to the feature boundary.

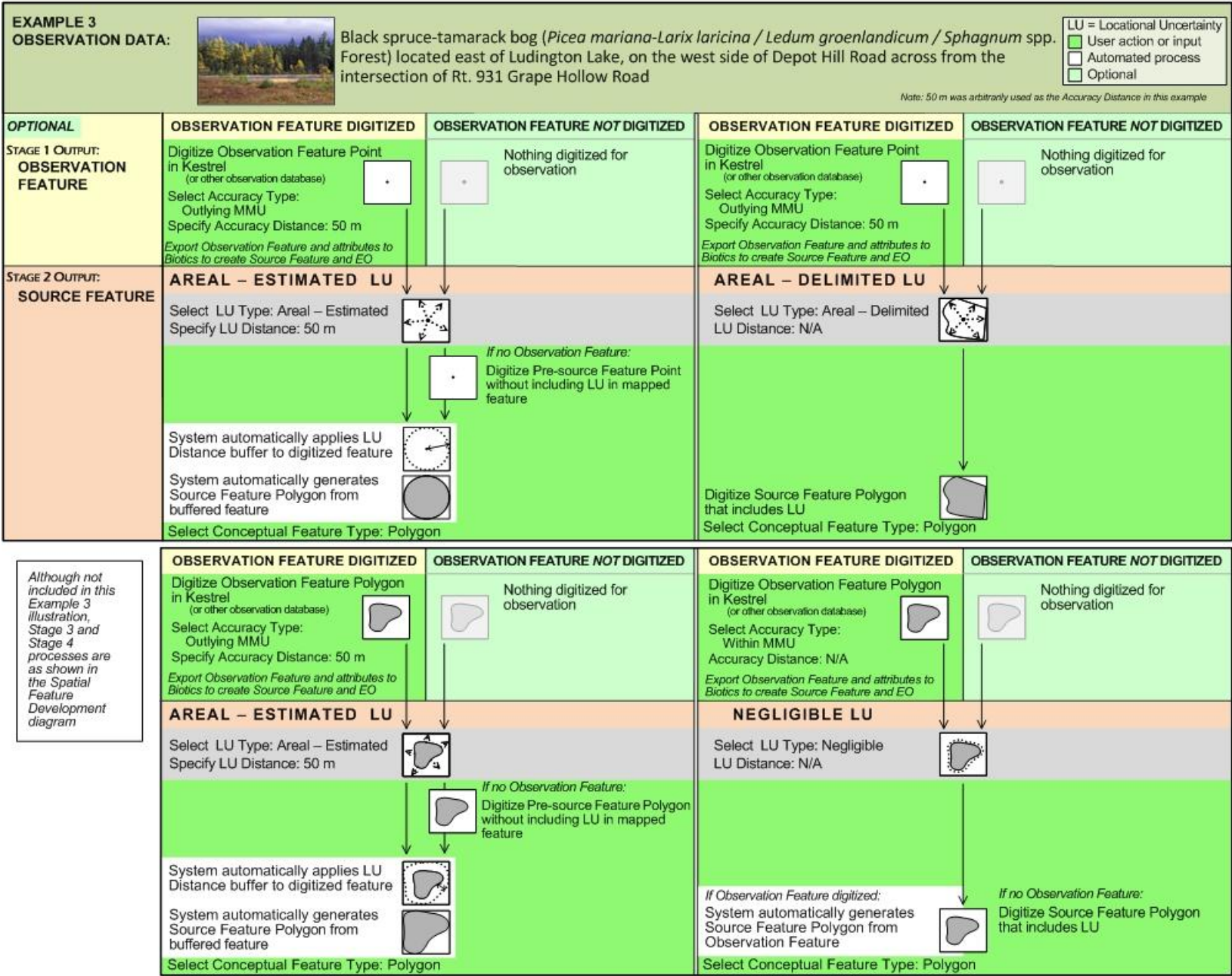
Stage 3 steps for developing an EO are the same as those in Example 1, above

STAGE 4 (Optional):

In this example, the component Source Feature of the EO was *not* digitized to exclude unsuitable habitat (which would have effectively made the EO refined without further action).

Stage 4 steps for refining the EO (optional) are the same as those in Example 1, above

EXAMPLE 3 FEATURE DEVELOPMENT PROCESS ---- AREAL – ESTIMATED, AREAL – DELIMITED, and NEGLIGIBLE LU TYPES



EXAMPLE 4 – MULTIPLE OBSERVATIONS

OBSERVATION DATA: Hundreds of Piping Plover (*Charadrius melodus*) nest observations along a shoreline.

In this example, the observations can be digitized as multiple Observation Points if it is practical and useful to record and maintain each individual Observation Point.

STAGE 1 (Optional):

Every nest observation in this example can be mapped as a separate Observation Point. Maintaining the individual points may be especially useful, for example, when the element is rare, has a designated legal status, or is the subject of a study or monitoring project. The accuracy distance associated with the observation data in this example is 15 m. Although in reality not all GPS points will have the same accuracy, a single distance is being used for the sake of simplicity in this example. Accuracy Distance indicates the difference between the actual location of the observation and where it has been placed on the map.

Stage 1 steps for digitizing individual Observation Points (optional):

1. Digitize Observation Points (without including locational uncertainty)
2. Select Accuracy Type: Outlying MMU for each
3. Specify Accuracy Distance: 15 m for each

Export Observation Features and specific associated attributes to Biotics to create Source Feature(s) and EO(s).

STAGE 2:

At this stage, the individual Observation Points will be represented as a single Source Feature for the beach, digitized to include locational uncertainty, with LU Type: Areal – Delimited. There is the option, if useful and practical, to create a Source Feature with LU Type Areal – Estimated from every individual digitized Observation Point, however this pathway is not illustrated in this example.

The Conceptual Feature Type is a Point, based on the underlying nest observations.

Stage 2 steps for creating the Source Feature from multiple Observation Points:

Regardless of whether Observation Point was digitized or not:

1. Assign LU Type: Areal – Delimited
2. LU Distance is not applicable
3. Digitize Source Feature Polygon to include LU
4. Specify Conceptual Feature Type: Point

For Both Observation Points or a Polygon:**STAGE 3:**

In this example, no other Source Features for the element are found within the applied Separation Distance.

Regardless of the LU Type in this example, the system automatically generates an EO from the Source Feature Polygon, with no change to the feature boundary.

Stage 3 steps for developing an EO are the same as those in Example 1, above

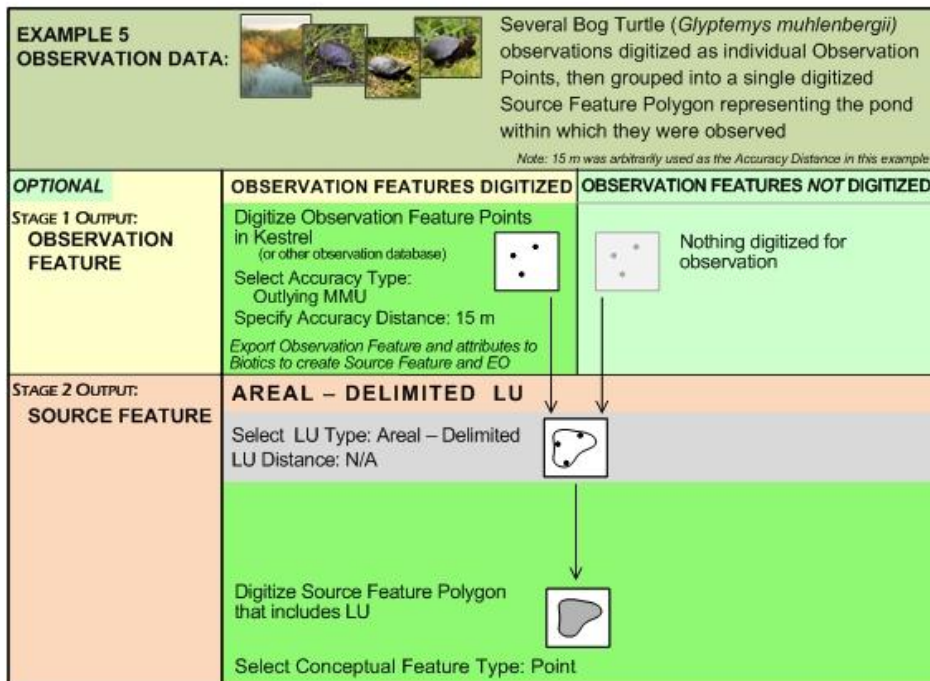
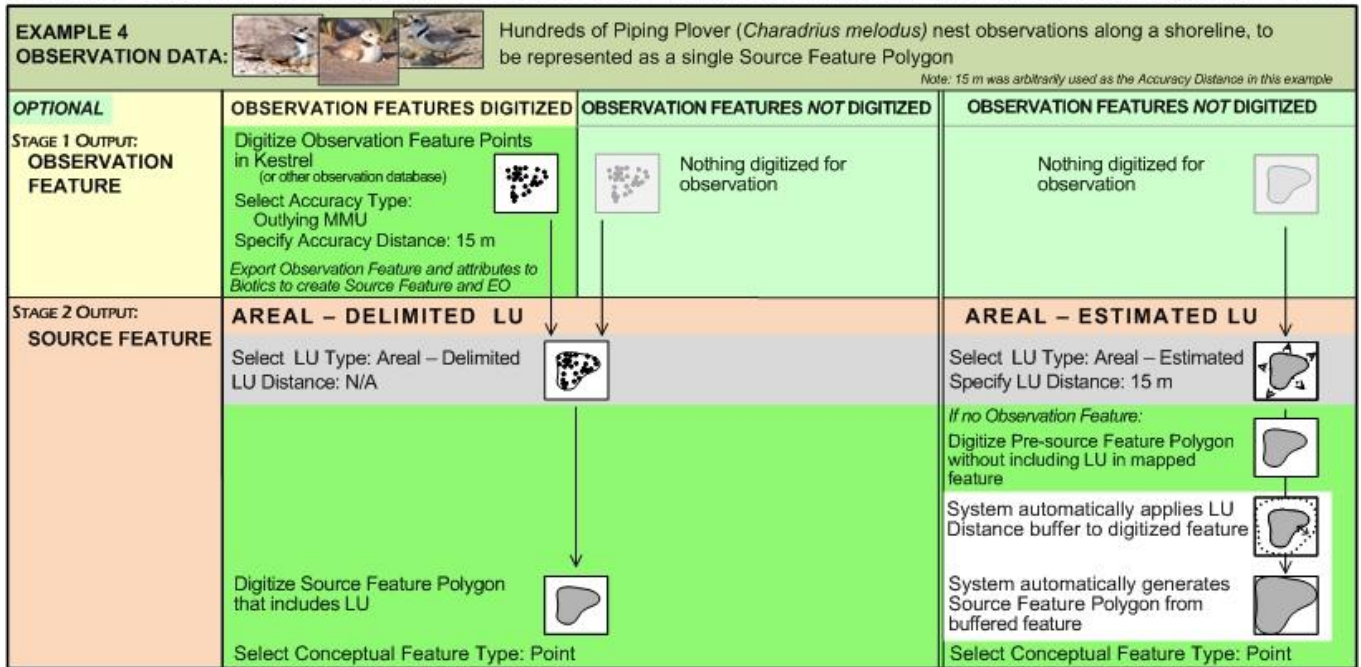
STAGE 4 (Optional):




In this example, the component Source Feature of the EO was *not* digitized to exclude unsuitable habitat (which would have effectively made the EO refined without further action).

Stage 4 steps for refining the EO (optional) are the same as those in Example 1, above

Figure 8.

EXAMPLES 4 AND 5 ILLUSTRATING MULTIPLE OBSERVATIONS IN THE FEATURE DEVELOPMENT PROCESS



LU = Locational Uncertainty
 User action or input
 Automated process
 Optional

Although not included in these Example 4 and 5 illustrations, Stage 3 and Stage 4 processes are as shown in the Spatial Feature Development diagram

EXAMPLE 5 – MULTIPLE OBSERVATIONS

OBSERVATION DATA: Several Bog Turtle (*Glyptemys muhlenbergii*) observations digitized as individual Observation Points, then grouped into a single digitized Source Feature Polygon representing the pond within which they were observed.

STAGE 1 (Optional):

In this example, the observations can be digitized as multiple Points – the element is of interest to track with detailed spatial information, and having only three observations would not require many resources to digitize individually. The uncertainty associated with the observations used in this example is 15 m, as other information is not provided. Although in reality not all GPS points will have the same accuracy, a single distance is being used for the sake of simplicity in this example. Accuracy Distance indicates the difference between the actual location of the observation and where it has been placed on the map.

Stage 1 steps for digitizing Observation Points (optional):

1. Digitize Observation Points (without including locational uncertainty)
2. Select Accuracy Type: Outlying MMU for each
3. Specify Accuracy Distance: 15 m for each

Export Observation Features and specific associated attributes to Biotics to create a Source Feature and EO.

STAGE 2:

The individual Observation Points will be represented as a single Source Feature (including locational uncertainty) for the pond within which the turtles were observed, with LU Type of Areal – Delimited. As in the previous Example 4, there is also the option, if useful and practical, to create a Source Feature with LU Type Areal – Estimated from every individual digitized Observation Point, however this pathway is not illustrated in this example.

The Conceptual Feature Type is a Point, based on the underlying turtle observations.

Stage 2 steps for creating the Source Feature from multiple Observation Points:

Regardless of whether Observation Point was digitized or not:

1. Assign LU Type: Areal – Delimited
2. LU Distance is not applicable
3. Digitize Source Feature Polygon to include LU
4. Specify Conceptual Feature Type: Point

STAGE 3:

In this example, no other Source Features for the element are found within the applied Separation Distance.

For LU Type Areal – Delimited, the system automatically generates an EO from the Source Feature Polygon, with no change to the feature boundary.

Stage 3 steps for developing an EO are the same as those in Example 1, above

STAGE 4 (Optional):

In this example, the component Source Feature of the EO was *not* digitized to exclude unsuitable habitat (which would have effectively made the EO refined without further action).

Stage 4 steps for refining the EO (optional) are the same as those in Example 1, above

IMPLEMENTATION QUESTIONS

1. Conceptual Feature Type is defined as the cartographic feature that would result from mapping an observation without the addition of LU, based on the size of the observation compared with the mmu for the scale map being used. So, if an observation consists of a nest, the Conceptual Feature Type is a Point. If an observation is a bog, the Conceptual Feature Type is a Polygon. In cases when the observation consists of multiple points (e.g., hundreds of Piping Plover nest observations along a shoreline) which are digitized individually as Observation Points and then represented as a single Source Feature Polygon, is the Conceptual Feature Type assigned to the Source Feature a Point or a Polygon?
2. If an Element Occurrence has an associated Unsuitable Habitat Feature(s) it will be considered a Refined Element Occurrence. Another instance that can be considered a Refined Element Occurrence would be when the underlying Source Feature has been digitized to eliminate the unsuitable habitat, so that a separate Unsuitable Habitat Feature need not be defined. However, if an Element Occurrence contains multiple Source Features, some of which have eliminated unsuitable habitat and others that have not, and no Unsuitable Habitat Feature has been refined, should the EO be considered as a Refined Element Occurrence?

CHARACTERISTICS OF PROPOSED SPATIAL METHODOLOGY

SOURCE FEATURE SIMPLIFICATION

- All Source Features now include LU, making them completely consistent in their representation
 - For LU Type Negligible:
Because Negligible LU is smaller than half the mmu for the map scale, the extent of uncertainty is too small to be visible on the map; as a result, the Source Feature that includes LU in the mapped feature will *look* the same as the digitized Observation Feature which does *not* include LU in the mapped feature
 - Only LU will be included in Source Features at Stage 2; Procedural Buffers are added automatically by the system at a later stage
- Consistent Source Features allow for automatic application of Separation Distance to identify Source Feature groupings for Autogenerated EOs, which user can choose to accept or not
- Basic Feature was removed from the methodology as it is no longer necessary for buffering Source Features with LU Type: Areal – Estimated

NEW OPTIONS WITH IMPLEMENTATION

- Option to digitize Observations
- Option to have Separation Distance automatically applied
- Option to save EOs autogenerated by system through automated application of Separation Distance

- Option to refine EOs by defining Unsuitable Habitat Features

CHANGES IN SPATIAL FEATURE DEVELOPMENT PROCESS

- User has the option to digitize Observation Points, Lines, and Polygons, which do not include LU in the mapped feature.
- If an Observation is digitized, user selects Accuracy Type and if appropriate, specifies Accuracy Distance for the Observation.
- If user chooses not to digitize an Observation, user must digitize either a Source Feature, or if LU Type is Areal – Estimated, a Pre-source Feature.
- User has the ability to represent multiple Observations as a single Source Feature.
- SYSTEM autogenerates a Source Features from digitized Observations or Pre-source Features, as appropriate.
- User has the option whether to allow the system to automatically apply Separation Distance and to accept Autogenerated EOs, or to manually generate EOs

If user chooses to have system automatically apply Separation Distance:

- SYSTEM utilizes distance selected or specified by the user
- SYSTEM creates an Autogenerated EO, either
 - from one or more Source Features or
 - by adding the Source Feature to an existing EO
- SYSTEM displays Autogenerated EO, which includes a Procedural Buffer if needed
- User previews Autogenerated EO and has the option to:
 - Accept the Autogenerated EO, in which case the system saves the EO, or
 - Reject the Autogenerated EO, in which case the user:
 - manually applies Separation Distance
 - identifies one or more Source Features for EO, and either
 - > uses ‘Generate EO from Source Feature(s)’ tool to produce an EO
 - OR
 - > adds Source Feature(s) to an existing EO

If user chooses NOT to automatically apply Separation Distance:

- User identifies one or more Source Features for EO, and uses ‘Generate EO from Source Feature(s)’ tool to produce an EO or adds the Source Feature(s) to an existing EO.
- User has the option to digitize Unsuitable Habitat Feature(s) which the system will exclude (clip) from the EO, resulting in a Refined EO
- If unsuitable habitat was excluded from the component Source Feature(s) of an EO, then the occurrence is considered a Refined EO