Process EPA Uses to Develop Core Maps for Draft Pesticide Use Limitation Areas for Species Listed by the U.S. Fish & Wildlife Service (FWS) and their Designated Critical Habitats

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1. Introduction

1.1. Purpose of PULAs and species core maps

When EPA registers a pesticide or reevaluates it in registration review, the Agency has a responsibility under the Endangered Species Act (ESA) to ensure that the pesticide registrations do not jeopardize the continued existence of federally threatened or endangered (listed) species or adversely modify their designated critical habitats. Where EPA determines that a pesticide in the registration or registration review process "may affect" a listed species, EPA must consult with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (the Services), as applicable. During consultation, the Services provide EPA with measures, where needed, to avoid jeopardy to listed species and adverse modification of critical habitats. If the Environmental Protection Agency (EPA) identifies a need for geographically specific mitigations to protect a federally listed endangered and threatened ("listed") species and/or designated critical habitat[1,2] from the use of pesticides, EPA may communicate those mitigations and where they apply using a web-based system called Bulletins Live! Two (BLT)[3]. The locations where those mitigations apply are called Pesticide Use Limitations Areas (PULAs). Thus, the purpose of a PULA is to identify areas where pesticide mitigation measures must be implemented to conserve a listed species and its critical habitat (if designated). These areas are where pesticide exposures are likely to impact the continued existence of listed species, resulting in a reduction in survival or recovery of the species. PULAs focus mitigation to where they are most needed to protect populations and include one or more species that share the same mitigation measures for a pesticide or group of pesticides. Using PULAs ensures species protection while minimizing impacts to pesticide users.

EPA and Fish and Wildlife Service (FWS) have developed a number of PULAs for pesticide registration activities. EPA anticipates developing many more PULAs as it implements protections for more listed species under its ESA strategies and through other registration or registration review activities under FIFRA.[4] Due to the need to develop a large number of PULAs in a clear and transparent manner, EPA developed a standardized approach described in this document that it plans to use to develop species maps (referred to as core maps as defined below) that serve as the basis for PULAs. Core maps are specific to a species while PULAs include pesticide considerations for one or more species that share the same mitigation measures. EPA intends to use this process for species that need a core map or when existing PULAs need refinement. There are over 1600 FWS listed species, and to date PULAs for about 65 species have been developed through pesticide consultations.[5] EPA plans to use the PULAs developed by

[1] Critical habitat is the specific areas within the geographic area, occupied by the species at the time it was listed, that contain the physical or biological features that are essential to the conservation of endangered and threatened species and that may need special management or protection. Critical habitat may also include areas that were not occupied by the species at the time of listing but are essential to its conservation. (https://www.fws.gov/sites/default/files/documents/critical-habitat-fact-sheet.pdf)

[2] Designation of critical habitat does not: affect land ownership, allow the government to take or manage private property, establish a refuge, reserve, preserve, or other conservation area or allow government or public access to private land.

[3] http://epa.gov/pesticides/bulletins

[4] https://www.epa.gov/endangered-species/implementing-epas-workplan-protect-endangered-and-threatened-species-pesticides

[5] Through recent pesticide specific consultations, National Marine Fisheries Service (NMFS) has provided PULAs for species under their purview that EPA anticipates needing in the foreseeable future. NMFS' PULA development was

FWS through the consultation process as species core maps if they are not specific to a single pesticide or use site.

Under the standardized approach described in this document, the development of a PULA is first informed by the geographic areas that need to be conserved for listed species and/or critical habitats. EPA refers to this area as the species core map. A core map can be considered the building block of a PULA. A species core map is drawn using the best available information for a species. Such information typically obtained from FWS can include species designated critical habitat, its range, or biological information (such as occurrence data, habitat information, or other biological information that can be mapped). A PULA is based on a species-specific core map then adds to adjacent areas to account for pesticide transport (via spray drift and runoff/erosion) and/or exposure to taxa the species depends on such as pollinators or prey, as applicable. PULAs are ultimately the mapped areas where mitigations measures must be implemented to minimize impacts to specific listed species. Thus, in the process of developing a PULA, there may be multiple types of maps:

- **Species range maps**: Developed by FWS, species range maps show where listed species live, are suspected to live, and areas that impact the species' survival in some way. These maps are stored in the Environmental Conservation Online System (ECOS) at ecos.fws.gov. Core maps and PULAs have a different purpose compared to range maps. Core maps and PULAs identify areas needing pesticide mitigation in order to protect species populations, which EPA expects in many cases, may be different than a species range map. Range maps may be different than core maps or PULAs (described below) because they may be created for different purposes. Therefore, developing a core map or PULA does not alter FWS' range map or critical habitat map.
- **Critical habitat maps**: Some threatened and endangered species have designated critical habitat by FWS, while other do not. Designated critical habitat contains the physical or biological features[6] essential to the conservation of the species or may need special management or protection. Critical habitat includes specific areas that may be occupied or unoccupied by the species. Examples of physical features include water characteristics, soil type, geological features. Examples of biological features include vegetation, prey, and symbiotic species.[7] When designating critical habitat, FWS develops a map of the included areas. For some species, the critical habitat may align well with the purpose of a core map.
- **Core maps**: Core maps are species specific and developed by EPA or non-governmental entities as part of the PULA process to identify areas that need to be conserved for a listed species and/or designated critical habitat that are relevant to pesticide mitigations. A core map may be the same or similar to a species range or critical habitat map but could also be a smaller area within a species range, particularly in cases where ranges are broad and include unoccupied areas.
- **PULA**: A PULA includes areas where geographic pesticide mitigations must be implemented. PULAs may take into account pesticide characteristics to account for potential pesticide movement from a treated area into a species habitat due to run-off or spray drift and/or

facilitated by the smaller number of species under their jurisdiction. Therefore, EPA is focusing this process on developing core maps for those species under FWS's authority.

[6] Physical or biological features are new terms from recent critical habitat regulation (50 CFR 424). Older critical habitat designations may use the term primary constituent element (PCE) or essentials features. This change in terminology does do not alter the analysis for critical habitat.

[7] https://www.fws.gov/sites/default/files/documents/critical-habitat-fact-sheet.pdf

impacts to prey, pollination, habitat and/or dispersal that reduce necessary elements for species survival/recovery. PULAs can be based on one or more species core maps. PULAs identify areas where pesticide use/exposures may impact the continued existence of one or more listed species due to a reduction in survival or recovery of the species. Thus, PULAs are intended to focus mitigations to where they are needed to protect populations from potential pesticide exposures.

This document describes a standardized approach EPA plans to use to develop core maps based on the available data from FWS for listed species, occurrence data from sources like NatureServe, iNaturalist, and Global Biodiversity Information Facility (GBIF), and additional GIS datasets used to map species biological information. This document also describes the accompanying documentation and QA/QC of the core map in light of that documentation. Through the QA/QC process, EPA will evaluate whether core maps are reasonable and sufficient for use in PULA development based on whether they represent areas needed for conservation or recovery of populations. EPA looks for the core maps to be 'reasonable' in acknowledgement that there are limitations to the accuracy and uncertainties with spatial data. Despite these limitations, the core map is intended to provide an appropriate and sensible map based on best available data that represents areas where mitigations are most needed to protect listed species and excludes areas where exposure is less likely to occur. The process described in this document does not alter a species critical habitat or range as defined by FWS.

Finally, this document provides information on the species EPA has prioritized for core map development and information on how entities with the necessary expertise can develop and send core maps to the Agency. EPA is making this platform available to developers to create core maps. If maps are developed by non-governmental entities, and EPA determines they are useful for developing PULAs, the Agency expects to review these maps and perform a QA/QC check before using them to develop PULAs.

1.2. Goals of this process

The primary goal of the process described in this document is to produce sustainable and scientifically sound core maps that EPA can use to develop PULAs that identify those areas where mitigations are needed to conserve a listed species and its critical habitat (if designated) while minimizing extraneous areas and impact to pesticide users. The primary goal of this document is to create and communicate a consistent and transparent framework for developing core maps that considers the different types of data available for a species to develop reasonable core maps that EPA can use to create PULAs.

For the Draft Vulnerable Species Pilot and Draft Herbicide Strategy,[8] EPA proposed using species range maps as PULAs for most of the species included in the pilot and strategy. EPA received comment that, for many listed species, the resulting PULAs were often too broad, covering areas where additional protection from pesticide exposure is not needed to conserve the species. EPA acknowledges that use of range maps may be overly broad for determining use restrictions in many cases.

The process described in this document is intended to produce more refined and reasonable core maps for listed species with varying types and amounts of available data. Available information varies widely from species to species. For example, only some of the following information may be available for some

[8] https://www.epa.gov/endangered-species/implementing-epas-workplan-protect-endangered-and-threatened-species-pesticides

species while for others all of it is available: designation of critical habitat, recent species status reviews, detailed knowledge of species ecology and life history, and knowledge of current locations. This process is not meant to cover every type of data that developers may encounter but provides a framework to integrate available information to develop a core map. EPA anticipates preparing many core maps, and also acknowledges that some outside parties may wish to develop core maps for EPA's consideration. For all core maps, EPA intends to conduct a quality assurance/quality control (QA/QC) review prior to use in PULAs. As part of that review, EPA will evaluate whether a particular core map is reasonable and meets EPA's needs as described in this document. Core maps with a completed QA/QC review will be considered interim until FWS has also reviewed the species core map. As a result, interim core maps and any associated PULAs may be revised in the future after receiving additional feedback from the FWS species experts. However, EPA intends to use interim core maps until FWS experts complete their reviews.

The process described in this document is not a regulation and, therefore, does not add, eliminate or change any existing regulatory requirements. This process is not binding on either EPA or any outside party, and the EPA may depart from this process on a case-by-case basis where circumstances warrant without prior notice.

1.3. Approach to develop core mapping process

EPA considered available methods, approaches, and examples to create this process for developing core maps. US Fish and Wildlife Service (FWS) and US Department of Agriculture (USDA) provided input on this process throughout its development. This process was also informed by technical support provided by the University of Georgia (UGA). As noted below, input from beta testers was also important to the development of this process.

The process described in this document incorporates elements of methods the FWS has used to establish species ranges and distributions (*e.g.*, FWS's SOP for refining ranges[9], Sofaer et. al 2019[10]) and PULAs developed through the section 7 Endangered Species Act consultation process, and the resulting biological opinions issued by FWS[11]. This process also incorporates public comments that stakeholders submitted during the Draft Vulnerable Species Pilot[12] and Draft Herbicide Strategy[13] comment periods and other public comment opportunities on pesticide registration activities.

EPA first developed a draft process, which it beta tested with a number of testers with relevant experience and expertise. These testers ranged in their familiarity and expertise of species biology, mapping, and pesticide mitigations and included registrants, registrant consultants, and Non-

[9] https://ecos.fws.gov/docs/SR_SOP/SDM_SOP_Final_14Nov2019.pdf

[10] Helen R Sofaer, Catherine S Jarnevich, Ian S Pearse, Regan L Smyth, Stephanie Auer, Gericke L Cook, Thomas C Edwards, Gerald F Guala, Timothy G Howard, Jeffrey T Morisette, Healy Hamilton, Development and Delivery of Species Distribution Models to Inform Decision-Making, *BioScience*, Volume 69, Issue 7, July 2019, Pages 544–557, https://doi.org/10.1093/biosci/biz045

[11] https://www.epa.gov/endangered-species/biological-opinions-available-public-comment-links-final-opinions-and-links

[12] https://www.epa.gov/endangered-species/implementing-epas-workplan-protect-endangered-and-threatened-species-pesticides#species

[13] https://www.epa.gov/endangered-species/implementing-epas-workplan-protect-endangered-and-threatened-species-pesticides#Strategy

Governmental Organizations (NGOs). Based on the feedback and lessons learned during the beta-test, EPA made a number of improvements to the draft, including:

- simplifying the process;
- adding a level of best professional judgment to account for the amount of data interpretation needed to produce a core map, which may inform the level of confidence in the core map;
- including a smoothing process to reduce (1) complexity[14], (2) occurrence of small random areas in core maps that are unlikely actual habitat, and (3) file size; and
- adding additional description of factors related to selecting and evaluating data for use in core map selection or development.

Species distribution modeling (SDM) is a technique EPA considered when creating this process for developing core maps. FWS, conservation organizations, and others have used SDMs for identifying potential species habitat and establishing ranges. SDMs are available for some but not all listed species. The process for developing core maps allows developers to use available SDMs for a species; however, it does not suggest creation of a SDM when one does not exist. SDMs may be time and data intensive and result in identifying potential areas inhabited by individuals of a species, not necessarily areas that may need pesticide use restrictions to protect the population.

1.4. Organization of this document

This document describes the types of core maps this approach produces, the process EPA plans to use to develop those core maps, and the type of data that should be used. The types of core maps this process will produce are described in **Section 2** of this document, and the primary steps to develop those core maps are described **Section 3**, which include:

(1) compiling and considering best available species information;
(2) selecting the type of core map that reflects the available species information;
(3) developing a species' core map; and
(4) documenting the development of the core map.

Section 4 of this document includes some data considerations that are relevant to developing core maps. **Section 5** discusses some of EPA's current thinking on the QA/QC review of core maps. Core map development can be a complicated process, and the amount and type of available information can vary greatly across the >1600 listed species. Therefore, the process described in this document is not a proscriptive step-by-step process but describes a systematic approach that is flexible enough to allow for such variability in data.

2. Types of core maps included in this process

There are many different types of data available for listed species that can be used to identify and map areas where pesticide exposures may be relevant to the conservation of a species. The type and amount of information available varies from species to species. For example, some species have FWS designated or proposed critical habitats while others do not. FWS species ranges may vary greatly, from narrow endemic species[15] that occur only in a very limited area to wide ranging species that occur throughout

[14] https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/dicing-godzillas-features-with-too-many-vertices/

[15] Endemic species generally have limited geographic distributions and are often found in specific, unique habitats.

multiple states. Species life history/biological information varies greatly from one species to another, especially for different types of species (*e.g.*, plant life history differs substantially from migratory birds). Also, information that is known about a species, including their locations and habitat needs, may vary based on how well studied a species may be and available resources and public interest in that species. These types of data considerations are included in the types of core maps that may be appropriate for a species. To support data collection for a species, developers should first check for available critical habitat as only some species have designated or proposed critical habitats. All species will have an available range and at least some biological information, though this may be limited for some species simply because little may be known about them. Developers should compile available information relevant to refining where species are located prior to making a core map type selection.

Mapping biological information is often time consuming, and developers should focus on specific information needed to create a reasonable core map. Developers should collect information on the critical habitat, range, and biological information prior to developing a map for a species and use this information to focus the mapping efforts for the core map. For the purposes of mapping, developers should identify the simplest core map type that is reasonable for identifying areas that need to be conserved for a listed species and/or any designated critical habitat that are relevant to pesticide mitigations, based on the collected information. The core map selection and mapping may be supported using one or more types of information.

Based on a synthesis of the data available for a species, core maps will be based either on already defined geographic areas or on other location, biological, or habitat information typically found in species recovery documents. This document describes three types of core maps that can be used to develop PULAs. Those types of core maps are:

1. Core maps based on FWS designated or proposed critical habitat;
2. Core maps based on FWS species ranges; and
3. Core maps based on biological information, which can include one or more of the following characteristics:
    - known locations of the species (*e.g.,* point occurrences; areas that can be described by polygons, such as parks, ponds, streams, or other named places);
    - areas within the species range that contain necessary habitats or landscape features (*e.g.,* elevation*,* slope, canopy cover, soil type) for conserving the species;
    - areas associated with critical life stages such as breeding areas; or
    - other important biological information that can be identified using available GIS datasets.

These types of core maps are described in greater detail in the following sections of this document. Although this document includes three basic types of core maps, the available data for some species may be such that a core map may utilize more than one of the types of information and all core maps should consider available known location/occurrences. For example, species range + critical habitat may

Types of Species Location Data

Occurrence data: Information detailing the specific locations where a particular species has been observed or is known to exist.

Known locations: Geographic locations where species have been observed or recorded as occurring.

Element occurrence: A mapped area of land or water where a species or ecological community is known to be present or was once present.

be appropriate to define a core map for some species, or a species critical habitat core map may be supplemented with biological information. Therefore, these three types of core maps may not be mutually exclusive to each other. Where feasible, the developer should use multiple lines of evidence to confirm the appropriateness of a core map to meet its intended purpose. For example, as described in more detail in **Section 4** of this document, known locations (also referred to as occurrences or element occurrences) may be particularly useful to help ground truth each type of core map when reliable data are available. However, for species with limited information it may not be possible to establish presence or absence of species based on occurrences and the developer will need to rely more heavily on mappable biological information such as habitats. In this context, 'reliable data' is meant to describe data that meets EPA's quality standards,[16] is as accurate and complete as possible, and can be counted on to consistently represent its intended purpose.

The following sections include more explanation of each of the three types of core maps. **Figure 1** depicts the decision framework for reviewing available data when selecting between or combining core map types. A selected core map type can be supplemented with information from other core map types to provided multiple lines of evidence to confirm the appropriateness and reasonableness for the core map.

[16] https://www.epa.gov/quality

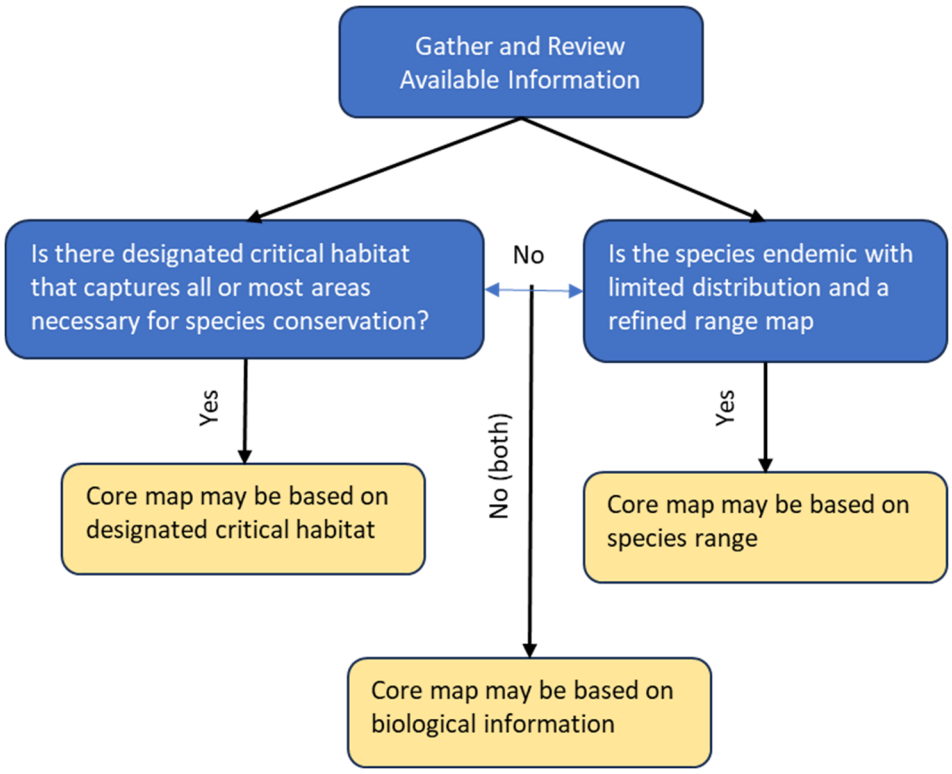


Figure 1. Overview of decision framework for reviewing available data when selecting the core map type.

Binning core maps into three categories helps to establish a clear and transparent framework for developing core maps and to inform the type and amount of data needed to develop them. The core map type should reflect information that is most consistent with the purpose of a PULA (to identify locations where pesticide mitigations are needed to conserve the species). **Section 4** describes some considerations relevant to the available information, which can help developers identify the most appropriate type of core map.

The process described in this document does not alter a species critical habitat or range as defined by FWS. This process is intended to better define and map areas that are more relevant for species conservation when considering pesticide exposures. In many cases, FWS species range will be appropriate for use as the core map, but in others, only a subset of the range may be necessary to establish a core map. More information on the different core map types is provided below.

Key FWS Documents

Critical Habitat Designation: Critical habitat is a tool that supports the continued conservation of imperiled species by guiding cooperation within the federal government. Designations affect only federal agency actions or federally funded or permitted activities.

5-year Reviews: A five-year review is a periodic review of the status of species listed under the Endangered Species Act of 1973, as amended (ESA), that is conducted at least once every five years. The purpose of a five-year review is to ensure that listed species have the appropriate level of protection under the ESA.

Recovery Plans: Recovery plans provide a road map with detailed site-specific management actions for private, Tribal, federal, and state cooperation in conserving listed species and their ecosystems. A recovery plan provides guidance on how best to help listed species achieve recovery, but it is not a regulatory document.

Species Status Assessment: The foundation supporting recovery plans is a Species Status Assessment (SSA). An SSA includes much of the information and analyses previously housed in the "background" section of a recovery plan, but it also assesses this information in a more explicit and deliberative manner. The SSA is structured around the conservation biology principles of the 3Rs – Resiliency, Representation and Redundancy.

2.1. Core map based on FWS designated critical habitat

Approximately half of listed species have designated or proposed critical habitat and developers should check for availability when starting a core map. According to FWS[17], "Critical habitat is the specific areas within the geographic area, occupied by the species at the time it was listed, that contain the physical or biological features that are essential to the conservation of endangered and threatened species and that may need special management or protection." Although critical habitat may include unoccupied areas that are also thought to be essential to its conservation.

Critical habitat core maps are appropriate in cases where the critical habitat includes all or nearly all of the species' current habitat or areas that are targeted by FWS for conservation of a species. Species reports from FWS, such as the critical habitat designations, 5-year reviews, recovery plans and species status assessment, will describe the area targeted for conservation and the habitats or populations included in the critical habitat when designated. However, a critical habitat core map may not be appropriate in cases where critical habitat designations include historically occupied areas, unoccupied areas, new occurrences/populations were identified outside of the critical habitat after its designation, or contains only a fraction of the habitat necessary to support recovery of the species. For example, this may be the case when older critical habitat is available and there are newly occupied areas identified after the critical habitat was designated. The core map developer can evaluate the appropriateness of the critical habitat by comparing current occurrence information to the critical habitat map. Developers should always consider available known location/occurrences and the available range information for a species when evaluating the appropriateness of a critical habitat core map.

The available FWS documents include helpful information to determine when critical habitat includes all areas necessary to protect the species compared to historical or unoccupied area. Specifically, documents released after the critical habitat designation may identify parts of the critical habitat that are no longer occupied or areas where the species has recently been found that were unknown at the

[17] https://www.fws.gov/sites/default/files/documents/critical-habitat-fact-sheet.pdf

time of designation. For this reason, developers should start with the most recent documents and refer to old documents to fill in any missing information. Critical habitat maps are generally available for download and can offer a simple starting point when developing the core map.

When a critical habitat map is chosen as a core map, the developer should also consider the known location/occurrence information (described in **Section 4.2**) relative to the critical habitat to decide if the critical habitat represents the best available core map and meets the purpose of a core map and PULA. As described in **Section 4.2**, unreliable known locations/occurrences that do not signify an area that is important to a species for conservation should not be used to supplement a critical habitat core map (or any core map). However, if there are reliable known locations/occurrences of the species outside of the critical habitat, and those areas are needed to conserve the species (*e.g.*, based on the recovery goals or criteria[18]), the developer should consider whether the FWS species range or use of biological information would result in a more appropriate core map. The developer should consider these other core map types when the majority of the known locations, habitats, or other landscape feature critical for species conservation fall outside of the critical habitat. If the critical habitat includes the majority of areas needed for the conservation of the species, but there are a limited number of known locations outside of the critical habitat that are relevant to the species' conservation, the developer may use the critical habitat as a start of the core map and add the known locations/occurrences, if feasible and appropriate. The resulting core map would be a combination of the critical habitat and a few additional known locations, represented by polygons[19], and would still be considered a critical habitat core map type.

Combining FWS designated critical habitat and known locations outside of the critical habitat involves (1) consideration of FWS recovery goals for the particular species of interest, (2) robustness of the known locations based on the number, age, and quality of the occurrences, and (3) relevance of known locations to species conservation. **Section 4** includes additional consideration for assessing robustness in the known location data. The recovery goals of the species should first be examined before combining critical habitat with known locations. Recovery goals can be very specific and may provide more details explaining why FWS included or excluded certain areas from the critical habitat. Often, FWS identifies explicit reasons why certain areas, even with known species occurrence or locations, may be outside of designated critical habitat. In other situations, recovery goals may outline a specific number of populations needed to change the listing status from endangered to threatened and/or to reach recovery. If the number of populations inside of FWS critical habitat are less than the number needed for recovery, then expanding a core map to areas outside of the critical habitat using reliable known locations would be further supported.

[18] Recovery goals and criteria are thresholds that define when a species can be considered for removal from the endangered species list or downlisted. This information is generally provided in the Recovery Plan for the species.

[19] A polygon is a digital map feature that represents a place or thing with area. It's a closed shape on a map that's defined by a series of x,y coordinate pairs or endpoints. The first and last coordinate pairs are the same, and all other pairs are unique. Polygon boundaries are made up of line segments called sides that join at the endpoints called a vertex.

2.2. Core map based on FWS species range

In cases where FWS has not designated critical habitat for a species, or FWS critical habitat does not represent the most robust area for a core map because, for example, it represents a fraction of a species' occupied habitat, then the developer should consider the FWS species range as a potential choice on which to base a core map. Range core maps are most appropriate for narrow (small) range endemic species (a species that is native and restricted to a certain place) with maps that FWS has refined. A refined range map from FWS will typically follow landscape features rather than political boundaries (such as county or state boundaries) and will generally have a more limited total area; ranges with an area of 10,000 acres or less are likely refined. Ranges with larger areas may still be refined when FWS generated the range using species locations or landscape features such has habitats or watersheds, for example the Miami tiger beetle or the bull trout. The larger refined ranges, often include many (more than 10) disconnected polygons with boundaries[19] that do not have straight lines or right angles. Straight lines or right angles are indicative of non-natural features or geo-political boundaries. Both types of refined range maps likely reflect the known locations of the species or their specialized habitats, and further refinements for core map development would yield little benefit and introduces unnecessary uncertainty.

However, similar to the critical habitat core map, it may be appropriate to add areas to a range core map that represent reliable known locations found outside of the species range when relevant to the species' conservation and recovery goals, although EPA expects that core maps would rarely expand to areas outside of a species range.

All areas within a species range are not necessarily equally important or relevant for species conservation. Sometimes in order for a range to include all areas where a species may be found, the range may include large continuous areas of unoccupied or unsuitable habitat, even though a species may only reside in certain habitats within the range's boundary. In those cases, the range may not be an appropriate choice for a core map, and the developer should consider if additional analyses are needed to identify areas within a species range for core map development. In those cases, a biologically based core map may be more appropriate as described in the following section of this document. For example, a species range is refined if the developer is confident that the species occupies the whole area or a majority of it. However, if not, the developer should remove habitats where the species does not live from the total range. Developers should only pursue further refinements to develop a biologically based core map if there is substantial benefit to doing so (*e.g.*, a species range is based on counties or states or covers large, continuous areas that are not all likely suitable habitat for a species). If after pursuing the development of a biologically based core map, the resulting core map is similar to the range, the developer should consider selecting the range as the core map to reduce introducing uncertainty caused by using and interpreting multiple data sources. In this situation, the developer should still highlight how the biological information supported the selection of the range as the core map type in the documentation. However, the range can be used for the purposes of mapping.

2.3. Core map based on biological information

EPA recommends that core map developers base maps on FWS critical habitat and species ranges when appropriate, while still highlighting how available species biological information supported the selection of the core map type. This simplifies the process for map development because GIS datasets do not need to be identified to map the biological information, which reduces uncertainty associated with

creating a map from multiple data sources that require interpretation and judgment and simplifies future core map updates. However, EPA acknowledges range maps and designated critical habitat maps (if available) vary in specificity across the >1600 FWS species, and some range and critical habitat maps may include areas that are not relevant to pesticide exposure or not include other areas that are relevant. Therefore, in cases where FWS critical habitat and ranges are not appropriate for core map development and/or specific enough for pesticide exposure, then the core map can be based on a combination of (1) biological information as identified in FWS species reports such as reliable known locations/occurrences, (2) habitat descriptions or other GIS data, and/or (3) other species life history information like dispersal distance and timing of bloom periods. As noted previously in this document, all core maps should consider known locations/occurrences but for some species, a developer may create a core map based only on known locations/occurrences. Core maps based on biological information should reflect the spatial/mappable data that best represent the biological requirements of a species, and this may include one or more datasets. These biological requirements will vary by species, but examples include habitat type, soil requirements, foraging range, migratory area, or bloom periods. This type of core map should reflect the best available information but may have greater uncertainty in representing areas that are most important to species conservation. This type of core map requires a higher level of judgment from the developer when translating biological information to mappable elements. Mapping biological information can be difficult and time-consuming task, multiple data sources may need to be combined, and developing these maps requires a more advanced knowledge of GIS analyses. Available species distribution models (SDMs) may also be considered for this type of core map in cases where they already exist and if the process and data used to develop the SDM is clearly and thoroughly described. This process does not suggest creation of an SDM for this core map type if one doesn't not already exist.

These biologically based core maps should have a defined outer extent[20] for the species based on available information found in a FWS report. The outer extent may be FWS species range or some other spatial limit for the species (*e.g*. extant counties, species recovery units, or named areas). This outer extent does not represent the full extent for the core map, but it will serve as the outer boundary for which the core map will not extend beyond. For example, a core map for a species that uses grassland or prairie habitat and is only known to occur in three counties, may be grassland and prairie habitat found within those three counties. In this situation, the outer extent of the core map would be the three counties where the species is known to occur, even if the range included additional counties. The developer should include the information used to set the outer extent of the core map with the supporting information or citation from FWS in the species documentation.

This document includes additional discussion on the type of information most commonly used to develop biologically based core maps, and data considerations in **Section 4.3**. Determining the appropriateness and utility of information to use for a biologically based core map depends on multiple factors relevant to the species. Given the large number and variety of listed species, EPA cannot reasonably identify all types of reliable data that may be available to help develop a core map for a species. Therefore, developers will need to use scientific principles on data quality to identify reliable data that meets EPA's quality standards.[21] A reliable dataset is as accurate and complete as possible given availability of the species information and can be trusted to represent its intended purpose. Factors to consider when assessing how data can be used (or not) to define a core map includes amount of data, uncertainties and quality of the data source, age, precision/resolution, data type,

[20] The map extent is the geographic boundaries that define the area of a map that's displayed.
[21] https://www.epa.gov/quality

representativeness of the data to the biological information, and completeness which are discussed in more detail in **Section 4.3**.

Three types of information commonly available to help develop a biologically based core map include: (1) occurrence data; (2) habitat descriptions; and (3) other biological information (*e.g.* foraging area, slope or elevation limitations). Additional considerations for assessing robustness of known location/occurrence data and quality of GIS datasets are outlined in **Section 4.2** of this document. Under certain situations, the known location/occurrence information may be sufficiently robust to base the core map solely on these locations. For example, if the known location areas are mappable and capture all populations of the species that appear to be important for conservation based on available FWS reports.

At least some known location/occurrence data are available for a majority of listed species. If a reliable dataset exists for a species, known locations may serve as the primary data source for core maps. In cases where the available known location/occurrence information is not reliable, is only historical (more than 15 years old) or likely represents a small fraction of populations/occurrences of a species, the developer should combine GIS datasets that map biological and habitat requirements to develop a core map. The developer should identify available biological information such as habitat types used by a species (*e.g*., forest, prairies), dispersal distances for forging, canopy cover[22], elevation, slope, waterbody characteristics, or soil types from the FWS reports, then identify GIS datasets that can be used to map these elements. These biological requirements will vary species to species.

Even for species with reliable known location data, additional mappable information should still be used, when available, to confirm the appropriateness of a biological core map. For example, a starting point for a species with specific habitat requirements could be selecting those habitats within the species range from one of the available habitat GIS layers (*e.g.* NLCD, GAP, LandFire). Developers should be aware that identifying GIS dataset that are comparable to the species requirements can be a time-consuming process. Justification and criteria to select a GIS source, in addition to any filtering of the GIS data, should be included in the core map documentation. For some species, map development may be more efficient or more reliable by identifying areas where the species do not occur. For example, if a species does not occur on cultivated land, these areas may be removed from the core map. This workflow can be applied to any critical biological element and multiple elements can be combined to create the core map. Known location data can also be used to confirm or supplement core maps developed using habitat or other biological information.

2.4. Iterative process for selecting core map type

The process of selecting a core map type requires a developer to re-evaluate core maps as information is attained and processed. For example, a developer should not assume that a range core map is an inappropriate choice simply because a designated critical habitat exists. After obtaining known location/occurrence information, a developer may learn that a number of known locations exist outside of the critical habitat, leading to either a different type of core map, such as the range, or supplementing a critical habitat map with known locations. In other cases, a developer may produce a map based on biological information that ends up essentially reproducing a species range map. In those cases, the developer should simply use the species range map. The core map should represent the simplest map

[22] Area covered by tree crowns

that is reasonable. The developer may see critical habitat or range as most reasonable only after exploring options to generate a biologically based core map. The selection of a core map type should always be support based on available species information. The developer should select the simplest process taking the available species information and developing the core map.

This iterative process also involves consideration of the recovery goals for the species, as described in **Section 2.1**. The recovery goals for a species can outline important information such as what type of habitats are important for species conservation, the number of populations needed for recovery, and the quality of those habitats and populations needed for recovery. When choosing the type of core map, the developer should align the core map selection with any explicit recovery goals. For example, if a critical habitat is selected as the core map that includes four known distinct populations, and the recovery goals for the species outlines that four distinct populations are needed for the recovery of the species, then the critical habitat core map is consistent with that species' recovery. When describing recovery goals, FWS often includes descriptions of the number and distribution of populations that vary from species to species that can help developers compare populations within a core map to recovery goals. Similarly, the developer should consider the species distribution against areas with active recovery actions to inform the extent of a core map. Examples of recovery actions include but are not limited to land acquisitions, easements that protect land, and recovery sites found on federal land. If this information is not available from a FWS report for a species this type of evaluation should not be done, meaning developers should not try to glean this information from non-FWS sources.

Using a feedback loop to reassess and focus the analysis is an important step in the core map development process and encourages developers to consider all relevant data. Identifying species habitat and known locations can be a complicated and time-consuming process and can introduce additional uncertainty to the core map development. The developer should stop adding extra pieces of information to a core map when there is little benefit compared to level of effort. A developer may spend a great deal of time adding and removing aspects of a spatial dataset that end up in little change to the original range or designated critical habitat, adding unnecessary complexity to the core map.

Core maps based primarily on known location data and/or biological information should be used only when (1) the range or critical habitat maps are not consistent with the goals described earlier in this document or the recovery goals of the species or (2) the species range or critical habitat is determined to include significant areas where the species is unlikely to occur or be impacted by a pesticide.

3. Process for developing core maps

The process for developing core maps described in this document involves four major steps:

1. compile available information for a species from FWS reports, see outline **Section 3.1**;
2. identify the type of core map most appropriate to represent the areas necessary to conserve the species;
3. develop the core map for the species; and
4. create documentation that describes the core map selection and development.

Each of these steps are further described below. This document does not provide a comprehensive step-by-step process for developing maps, but instead describes elements and data to consider when developing core maps because the amount and type of information available for species will vary considerably, which requires a flexible process for developers. This document also assumes the reader

has knowledge of GIS processes. In particular, biologically based core maps may require more advanced GIS processing as well as knowledge of species biology and ecology and should only be carried out by developers with relevant expertise.

3.1. Step 1. Compile available information for a species

Step 1 involves compiling information to identify the most appropriate core map for a species. Reviewing the available species documentation is a time-consuming process. EPA recommends that developers start with the most recent available species information from FWS. Please see **Section 4.1** for various considerations when compiling best available data for a species for the purposes of developing a core map. Below is an outline that summarizes the types of information to gather during this step of the process. The developer should gather this information for all species and use the information to inform the selection of the core map type. The major steps described in this section include identifying, reviewing, and documenting FWS species reports, known location/occurrence data, and some of the key GIS data that is applicable across the types of core maps.

A. Identify recent FWS documentation available for species.
    a. Go to species profile on ECOS website (https://ecos.fws.gov/ecp/).
    b. Recent documents to consider include the following. When multiple reports are available EPA recommends starting with the most recent document:
        i. Recovery plan and Recovery Implementation Strategy,
        ii. Species status assessment (if there are multiple species status assessments, start with the most recent available),
        iii. 5-year review, and
        iv. Designation of Critical habitat documents (in federal register).

        Notes:
        - Available documentation varies by species.
        - An individual species may have some or all of these documents.
        - 5-year reviews, for example, are status checks and in some cases, older documents may contain more substantive information than more recent updates.
        - There may be other less common FWS documents available with useful information for Step 2 (*e.g.,* biological opinions, habitat conservation plans, safe harbor agreements).
        - There may also be species accounts or information available on other FWS websites.
B. Review recent FWS documentation available on FWS ECOS species webpage and compile key information on species as described below. Other sources may be considered if needed to supplement or fill in key missing information after reviewing FWS reports. **Section 4.1** provides some guidance on how to access the quality of non-FWS data sources. Developers should provide references for all data sources for QA/QC. Some key information to obtain and document from available FWS documents include:
    a. What are FWS's recovery goals, criteria and actions?
    b. Has FWS identified locations where the species is managed for recovery? If yes, compile any of these locations that apply:
        i. Recovery units

ii. Management units
iii. Other protected lands

c. What are the habitat or other biological requirements of the species?
    i. Document description(s) of these biological elements.
d. Document any other aspects of a species habitat or biology that can inform a core map.

Notes:

- Habitat and descriptions of biological requirements can vary in their level of detail. For example, the developer should consider if there are areas outside of these requirements that are important for the species such as dispersal, migration, prey, habitat and/or pollination. When available, the developer should document dispersal distance for prey and/or pollinators for use by EPA to consider when developing a PULA. Some species ranges, critical habitats, and occurrences include areas where its food, pollinators, or other biological requirements are located in addition to just where the species is located. This may be explicitly stated in the source data as a buffer or implicitly accounted for through the use of generalized areas such as HUC-12 watershed. In such cases, EPA recommends the developer provide this information in the documentation.
- Ideally, use the simplest description to convey the habitat or other requirements of the species.
- Consider using direct quotes from FWS documents when documenting these requirements and include a citation.

i. Does the FWS documentation identify a minimum habitat (or patch) size?
    1. If yes, what is it?
    2. Are there confidence limits noted for these areas?
ii. Does the FWS documentation identify a known outer extent of all know locations?
    1. If yes, what is it?
iii. Note and document any additional characteristics that define species habitat or other biological information that can be used for mapping (*e.g.*, elevation, slope, soil requirements, associated or symbiotic species, stream flow, foraging area, breeding seasons)
iv. Is there other information that is relevant to the species life history timing that may result in some periods when the species may or may not be exposed?
    1. Examples: some species of adult butterflies may visit certain habitat types during specific periods of the year, invertebrate may be above ground during specific months, birds migrate and only visit certain locations during specific periods of the year
    2. Which elements does FWS state are important for the conservation of the species or relevant to pesticide exposures?

e. Is a species distribution model (SDM) identified by FWS that is available for some or part of the range?

C. Compile known locations/occurrences from the FWS sources identified above.
    a. Include narrative descriptions of species location information (*e.g.*, western part of a county), including places (e.g., specific state parks).

b. Include any point locations. Consider applicability of points based on collection method and point accuracy.
c. Include any maps that identify locations (may be at different scales, such as points, county, and watershed).
d. Does FWS documentation identify the extent of species surveys completed and the relative robustness of such surveys?
e. Do species remain in the same place and expand slowly to other locations? Or is occupancy more ephemeral, with sites changing on a more frequent basis, for example salamanders.

Note: These maps may be helpful for visual comparisons of species ranges/critical habitats and occurrence information.

D. Compile known locations/occurrence data from other sources.
a. Data sources include published government data sources, academic/research literature, museum/species collections.
b. Publicly available databases to consider include: NatureServe[23], iNaturalist[24],GBIF[25], eBird[26], Berkeley Ecoinformatics[27], VertNet[28], iDigBio[29], OBIS[30].
c. Data from state natural heritage programs may also be included with appropriate permissions. These data may be available from the NatureServe database or from individual states.
d. Other reliable sources may be considered *as long as they are publicly accessible*.

Notes:
- EPA does not expect a developer to purchase any data and does not endorse any non-government data source.
- If a non-public data source is found, EPA recommends the developers include a citation in the document. EPA may determine that the raw data are needed to consider this information for a future action.
- Ideally, the developer should use known location data available at the finest spatial resolution (*e.g.*, coordinates, specific places) that is publicly available. Data available at a county level may be used qualitatively but may be less informative for the known location core map; however, they may be helpful for other types of core maps.
- The same occurrence data may be captured through multiple sources. It may be necessary to remove redundant records of the same data.
- FWS uses occurrence data reported within the last 50 year when species ranges are refined[31]. For some species, occurrence data may be historic and represent areas where the species are known to have been extirpated. Weighting of more recent data (*e.g.,* within 15 years) may be appropriate, especially with a high number of

[23] https://explorer.natureserve.org/
[24] https://www.inaturalist.org/
[25] https://www.gbif.us/
[26] https://ebird.org/home
[27] ecoengine.berkeley.edu
[28] vertnet.org
[29] www.idigbio.org
[30] obis.org
[31] https://ecos.fws.gov/docs/SR_SOP/SDM_SOP_Final_14Nov2019.pdf

occurrences or if landcover changes may have resulted in changes to species habitat since the occurrence was recorded.

- See **Section 4.2** for additional consideration regarding known locations/occurrences

E. Acquire spatial data for species range and critical habitat (if proposed or designated)
   a. From EPA's species and critical habitat data services[32], which are updated each week from the FWS Environmental Conservation Online System (ECOS) database.
      i. Range
         1. use the layer named Diced Endangered Species Range Areas
         2. website: https://services.arcgis.com/cJ9YHowT8TU7DUyn/arcgis/rest/services/Species_Ranges/FeatureServer

      ii. Critical Habitat
         1. use the layer named Endangered Species Critical Habitat Areas
         2. website: https://services.arcgis.com/cJ9YHowT8TU7DUyn/arcgis/rest/services/Critical_Habitat/FeatureServer

      iii. Note: The files can be downloaded directly from ECOS instead of using the data services; however, the files will not update after download. EPA recommends documenting the date of download/access.

      iv. Or download directly from the ECOS species profile page:
         1. https://ecos.fws.gov/ecp/

F. Conduct initial evaluation of range and critical habitat
   a. Using GIS software (*e.g.*, ArcGIS, QGIS, AGOL, R), generate a species-specific layer or file.
   b. Calculate the area (in acres) of the range.
   c. Calculate the area (in acres) of the critical habitat (if available).
   d. Does the species range follow geopolitical boundaries (*e.g.*, counties, states, townships)? This could indicate the need to use a biological information core map using occurrences, habitat or other species biological information because species do not typically follow man-made boundaries. After developing a biological information core map, EPA recommends comparing the core map area to the original area of the range and/or designated critical habitat and documenting the change. If the change is less than 5% the developer should consider if the critical habitat or range is reasonable enough for use as a core map.

Note that if it appears likely that a core map will be based on critical habitat or a species range after initial review of the species information, then the developer will not likely need to gather much additional GIS information beyond the available known location/occurrences. However, if a core map is likely based on biological information because, for example, there is no critical habitat designated and

[32] https://www.epa.gov/endangered-species/advancing-transparency-endangered-species-act-evaluations-through-publicly

the range appears to encompass multiple states or entire counties, then developers will likely need to gather additional GIS information/layers. Some examples of such additional layers are identified in **Section 4.3** and **Appendix 2** of this document; however, additional GIS information not listed in this document may also be suitable depending on the specific characteristics and recovery criteria for a species.

3.2. Step 2. Identify core map type

In Step 1, a developer identifies and obtains relevant species information to help them determine what type of core map is appropriate for a species. In Step 2, a developer will evaluate that information in the context of the data quality and conservation needs of the species to identify an appropriate type of core map (critical habitat, range, or biological information) for the purposes of mapping. This section describes some considerations that will help developers choose an appropriate core map for a species based on information gathered in Step 1. The core map selection should include a justification supported by the information collected in Step 1.

A. Considerations for developer to determine if the core map should be based on the critical habitat (Step 2A)

Evaluate the following information obtained in Step 1 in the context of a species' conservation and the goal of a core map as described in Section 1 of this document:

- Critical habitat maps and documentation
- Known locations/occurrence data and species range data relative to critical habitat
- FWS priority areas for species management
- Species life history and ecology
- Relevant FWS recovery criteria, actions and goals

Based on the above information, if all (or the vast majority of) known locations/occurrence data and/or FWS priority areas for species management are within the critical habitat and the species documentation from FWS (or other referenced sources) confirms that the important areas for a species are contained (e.g. preferred habitat) with a species' critical habitat, then a core map should likely be based on critical habitat.

In cases where the developer finds that most, but not all, of the areas that are critical to the conservation of the species are within its critical habitat, then the core map for that species may be based on critical habitat with some supplemental areas added as identified by the occurrence data or other information in FWS species documents that are important to a species' conservation.

If FWS has not designated critical habitat for a species, or if the available data suggest that critical habitat represents a fraction of the areas necessary for conservation of a species, then move to Step 2B because critical habitat may not be an appropriate core map for this purpose.

Notes:

- Older critical habitats (*e.g.,* >10 years old) may need additional scrutiny to determine if they still represent those areas that are necessary for the conservation of the species.

- There may be cases where there are occurrences outside of the critical habitat but the critical habitat is still an appropriate base core map. For example, migrating birds may be observed while stopping; however, those stop over locations may not be critical to the conservation of the species.
    - It may be appropriate for the developer to use the critical habitat as the core map when the critical habitat includes the majority of areas needed for the conservation of the species. If there are known locations outside of the critical habitat that are high quality and represent important conservation areas for the species, those locations could be added to the map. Reliable data meet EPA's quality standards[33] and are as accurate and complete as possible given the extent of the available data

B. Considerations for developer to determine if core map should be based on species range (Step 2B)

Evaluate the following information obtained in Step 1 in the context of a species' conservation and the goal of a core map as described in Section 1 of this document:

- FWS range map and documentation
- FWS critical habitat maps and documentation describing the basis for critical habitat
- Known locations/occurrence data
- FWS priority areas for species management
- Relevant FWS recovery criteria, actions, and goals

A core map should be based on FWS species range if a species is considered endemic with a narrow range. Although there is not a clear criterion for what constitutes a 'narrow range', refined ranges that are contained within a 10,000-acre area are likely to be assigned a range core map. Range core maps may still be appropriate for ranges of any size (>10,000 acres, >100,000 acres, or larger), especially for species that have the ability to disperse long distances such as some mammals, birds, reptiles, and fish. The utility of additional biological information to refine a core map becomes greater as the size of the range increases.

If there is critical habitat that is outside of the species range, those critical habitat areas should typically be combined with the species range and included in the core map unless there is scientific justification to exclude them such as the areas being unoccupied.

If known locations/occurrences and/or priority areas identified in the FWS documentation for a species are wholly contained within a species range, then additional areas would not need to be added to a core map based on the species' range. If not, then the developer would need to consider if these additional areas should be included in a core map given the stated purpose of the core map. Core maps should typically include FWS priority areas for a species. If a priority area is excluded from the core because it is unoccupied or for a similar reason, this should be justified and documented.

[33] https://www.epa.gov/quality

In cases where species range maps contain large areas of no occupancy or suitable habitat based on available information found in FWS documentation, then unmodified range maps may not be the most appropriate core map, and a biologically based core map may be more appropriate (see following section). Developers should consider if the data and justification for removing areas with little to no occupancy and no suitable habitat is sufficiently robust to move away from a range map as the selected core map. For example:

- Have these areas been surveyed? More confidence can be place in the lack of occurrences when the area has been surveyed and no species found.
- Does the available information suggest that there are substantial areas within the range where there is likely unsuitable habitat for a species? For examples, when considering habitat preferences, if a species is unlikely to occur on cultivated field, cultivated land should be removed from the core map.
- Are prey or pollinator species likely to occur on-field such that exposure would reduce necessary elements for species survival/recovery? If so, the developer should document dispersal distances noted in FWS reports for these pollinators or prey when available for use by EPA when adding buffers to a PULA, and if the core map accounts for these areas.
- Does a species range appear to follow a man-made or geo-political boundaries? Species do not typically follow man-made boundaries, and ranges based on these boundaries likely include unoccupied areas that could be removed.

Step 2C below describes additional considerations in cases where developers determine that it may be appropriate to further refine core maps by basing them on species occurrences, habitats, or other biologically based considerations based on information available in species recovery documents.

C. Considerations for developer to determine if core map should be based on known locations and/or biological information (Step 2C)

If a developer has determined that designated critical habitat and species ranges would result in core maps that either do not identify the full suite of areas needed for species conservation OR are overly broad such that they include large swaths of areas that are not likely suitable habitat for a species, then the developer should evaluate additional biological information to determine if a core map can be developed using other mappable information. In these cases, the developer should evaluate the following information obtained in Step 1 in the context of a species' conservation and the goal of a core map as described earlier in this document:

- Species range and or critical habitat for the purposes of defining the outer extent or limit for the core map
- Known locations/occurrence data
- FWS priority areas for species management as identified in recovery documents
- Species life history
- Relevant FWS recovery criteria, actions, and goals

If there is robust information on known locations (occurrence data, FWS priority locations for species management and conservation), a core map may be based primarily on known locations within a species range.

Robust known location/occurrence data includes recent occurrences (*e.g.,* within the last 15 years), and the lack of occurrence data does not indicate absence of the species. Additional information to help developers utilize occurrence data and assess robustness is included in **Section 4.** The choice to use occurrence data as the primary basis for a core map may become evident by considering the recovery criteria for the species. For example, if FWS recovery criteria identifies a number of populations needed for recovery and the occurrence data indicate that the developed core map meets or exceeds the criteria, then the core map can be considered sufficient to achieve recovery goals. If known location data are limited (*e.g.*, species was not monitored in the last 15 years) then occurrence data should not be the sole basis for a core map, and additional information, such as habitat descriptions or other mappable biological information collected in Step 1, should also be considered along with occurrence data. Core maps based on biological information are far more complicated than core maps based on critical habitat or range. Therefore, developers should only consider basing a core map on this type of information where the range or critical habitat is overly broad, outdated, and/or not comprehensive of species preferred habitat and occupancy. If a developer lacks the appropriate GIS or biological sciences expertise, and a critical habitat or range core map is not the most appropriate core map for a species, then they should not attempt to further develop a core map for that species. Additional considerations for developers are described in Step 3 below.

3.3. Step 3. Develop the core map for the species

Step 3 involves developing the core map. This step is informed by the previous two steps that involved collecting information and using that information to select the appropriate core map type (*i.e.,* critical habitat, range, biological information). The mapping procedure used here is influenced by the core map type that is identified in Step 2. This step involves using GIS software and spatial data. In this step, the core map is either downloaded (*i.e.,* critical habitat or range) or developed (*i.e.,* known locations or habitat locations) and used to create a core map. The procedure for developing the biologically based core map is the most complex of the three core map types. Developing the biologically based core map involves identifying habitat or locations or other mappable biological features within the range (and critical habitat if available) and evaluating those locations using the reliable known location information that may be available.

A. For critical habitat base core maps (Step 3A)

a. Use the current FWS critical habitat obtained from EPA hosted data services or directly from FWS' website as noted in Step 1.
b. If there are recent known locations from trusted sources like FWS or other areas to supplement the critical habitat that the developer identified as important for species conservation, these locations should be added to the map. In that case the map will be represented by the critical habitat plus a limited number of known locations.

B. For species range base core maps (Step 3B)

a. Use the current FWS species range obtained from EPA hosted data services or directly from FWS' website as noted in Step 1.
b. If there are a limited number of high-quality known locations outside of the range that the developer identified as also being needed, these locations can be added to the map. In that case the map will be represented by the range + a limited number of known locations. EPA recommends including supporting information and justifications for these locations to support review.

C. For the biologically base core maps (Step 3C)

a. Start with the species range obtained from FWS' website as described in Step 1.
    i. If the species has a designated critical habitat and there are any areas of the critical habitat that fall outside of the range, include those areas outside of the critical habitat. The starting point for these core maps should be species ranges + critical habitat.

b. Identify areas within the range (and possibly critical habitat) where a species is expected to occur based on its habitat[34] and biological characteristics as described in FWS recovery documents.
    i. Determine the outer extent for the core map. This may be the range or other defined areas such as extant counties, species recovery units, or occupied locations.
    ii. Select spatial data sets that represent the species habitat information, such as:
        1. Habitat/Landcover Types: NLCD, GAP, National Wetland Inventory, NHD+[35]
        2. Elevation/slope: Digital elevation models (DEMs)
        3. Soil type: SSURGO
    iii. Using GIS software, select specific habitat landcover classifications within the GIS data that represent the species habitat information. This will be different for each type of data being considered.
        1. Consider the degree to which the data accurately represents the species habitat information from FWS and landcover classifications (see "Data Considerations")
        2. Often, landcover types represented by spatial data include different terminology compared to data provided in species life history information
            a. Some spatial data sources may have multiple options to represent the species habitat. For example, the GAP data has multiple levels of resolution representing habitat types. EPA recommends starting with a medium level of resolution to minimize unnecessary complexity in the resulting core map. However, for species with highly specific habitats moving to a finer resolution is appropriate with justification.
            b. Make sure to document your assumptions and the basis for your judgment when selecting landcovers. It may also be helpful to consider different combinations of landcovers when evaluating how well the GIS datasets map the relevant species habitats. The landcover class descriptions are a valuable resource to determines how closely the mapping description matches the FWS description for the species habitat.

[34] Note that Critical Habitat and habitat differ in this document. Critical habitat represents specific geographic areas that contain the physical or biological features that are essential to the conservation of listed species. Habitat describes the types of environments that species need for survival (*e.g.*, prairie, forest).
[35] NLCD = National Land Cover Database, GAP = Gap Analysis Project, NHD = National Hydrography Dataset

Considering the landcover classes found on or near occurrence information is another useful option for landcover evaluation. More careful consideration can be invested in those landcovers that represent the greatest area to confirm it represent species habitat.

3. For aquatic habitats with flowing waters (*e.g.*, streams, rivers)
    a. crosswalk habitat types to NHD+
        i. relevant sources: McManamay et al 2018[36] and Sheldon et al. 2015[37] (**Table 1**).
    b. Determine flow direction within stream reaches of interest.
        i. Do not include stream reaches downstream of habitat (chemical contamination does not flow upstream)
    c. Use catchment data to identify the catchments flowing into habitat and locate catchments adjacent to the catchments encompassing habitat.
    d. Include reaches within adjacent catchments upstream of habitat

D. Table 1. Size classes of flowing waters as described by size and gradient classes. From McManamay et al 2018 and Sheldon *et al.* 2015.

Size class	Range (km^2)	Gradient Class	Range (rise/run)
Headwater	0-10	Very low	<0.001
Creek	10-100	Low	0.001-0.005
Small river	100-500	Moderate	0.005-0.02
Medium river	500-2,500	Moderate high	0.02-0.04
Mainstream	2,500-10,000	High	0.04-0.1
Large river	10,000-25,000	Steep	>0.1
Great river	>25,000	Not applicable	Not applicable

Notes:

- The above sources of spatial data sets are broadly available but are not intended to represent a comprehensive list. Additional national level data sets are discussed in the data consideration sections.
- Non-national sources of data may also be considered (*e.g.*, from states).
- Considering species patch sizes and the minimum mapping unit for the GIS layers is important to confirm habitats or other features are captured as expected. For examples, could small habitat patches be removed because they are not the dominant habitat. Or is a mosaic of such habitats still supportive or potentially supportive of an important population.

[36] McManamay RA, Troia MJ, DeRolph CR, Sheldon AO, Barnett AR, Kao S, Anderson MG (2018) A stream classification system to explore the physical habitat diversity and anthropogenic impacts in riverscapes of the eastern United States. PLOS ONE. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6010261/

[37] Sheldon AO, Barnett A, Anderson MG (2015) A stream classification for the Appalachian Region. The Nature Conservancy. https://easterndivision.s3.amazonaws.com/Freshwater/APP_LCC_STREAM/A_Stream_Classification_f or_the_Appalachian_Region.pdf

Key Mapping Definitions

Datum: Reference surface (e.g. sea level) used for map making.

Projection and Transformation: Flat representation of Earth's curved surface, often expressed as latitude and longitude.

- Developers should review the data considerations in Section 4 of this document when selecting other data sources and be aware of datum conflicts when using multiple GIS datasets found in different projections.
- Apply projection transformations when necessary.
- The data consideration section (Section 4) also addresses cases where there are uncertainties in the representativeness of the habitats or biological information described by FWS.

- If a species does not use any type of cultivated land as habitat, remove these areas from the core map using the modified cultivated land layer[38] developed by EPA and document the basis for removing cultivated lands with reference(s). Note that some of the removed areas may be added back by EPA when generating a PULA from the core map to account for pesticide movement from use sites into a habitat or to account for species that the listed species relies on such as prey and pollinators (if necessary).
- When considering a specific location, if other habitat layers, such as the NLCD, indicate significant presence of cultivated land after removal using EPA's modified cultivated land layer, the developer may choose to remover additional areas at their discretion. The developer should include the data source and rationale in the documentation in this situation. Please note the EPA's modified cultivated land layer focused on contiguous areas larger than 25 acres to align with the smoothing process described in **Appendix 3.** This may contribute to differences between datasets.
- When combining GIS data from multiple sources, processing tools may introduce artifacts in the core map knows as holes or slivers. Sliver polygons are small narrow polygon features that generally appear along the borders after overlaying two or more datasets. A hole is a small gap in an otherwise contiguous polygon that is an artifact/error of a processing tool. The smoothing process described in **Appendix 3** is intended to address these artifacts. The developer can also address these artifacts prior to sharing with EPA.

i. Clip GIS layer to all areas within the species range or other appropriate extent (and possibly critical habitat)

ii. Refine the species habitat information.
    1. If species have elevation, slope or soil type requirements, or other factors, identify the locations and remove areas that don't match the requirements.
    2. If species have a defined minimum patch set or a minimum of amount of viable area, filter out patches below that minimum habitat area requirement. EPA will use a 2-acre minimum during QA/QC unless species specific information is available. If a species value is identified

[38] https://epa.maps.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668

include this information in the documentation. If this is a point of uncertainty, FWS species experts may provide feedback on this value during review.

3. The developer should remove areas from a core map if they do not represent the habitat of a species (*e.g.*, impervious surfaces or cultivated land) and include justification for removal in the documentation to support review. If the species does not occur on agricultural fields buts relies on other species that could be found on agriculture field, such as prey or pollination, the developer should include available dispersal distances of prey and pollinators in the documentation if available. This distance may be considered by EPA when developing PULAs from the core maps when applicable. If species-specific dispersal distances are unavailable, EPA may make an assumption if the PULA would need to consider these resources for a species. [39,40] FWS species experts may provide feedback on how a map accounts for pollinators or prey during review.

4. For aquatic species in flowing waters
    a. Remove all water areas down stream of species habitat.
    b. Remove all water areas upstream of dams because these areas are assumed to be diluted by larger volumes of water and thus not need runoff mitigations.
    c. Add one catchment upstream of species habitat areas.

b. Evaluate/validate species core map locations using available known location data.
    i. Even if known location data is limited, there may be enough information to compare with habitat layers for any discrepancies (are there groups of occurrences in areas not identified as suitable habitat?)

    Note: The intent of this analysis is to evaluate whether the core map captures important conservation areas. Known location data may identify sources of error in layer selection or in the developer's assumptions as described below. EPA recommends the developer includes data used to evaluate the core map, and any intermediate files created when generating the core map when submitting files.

    ii. If all occurrence data overlap with identified core map areas, evaluation/validation is complete.
    iii. If any occurrence data occur in areas not identified as habitat,
        1. Is such occurrence data no longer representative of species habitat or biological feature?
            a. Has land been converted to unsuitable habitat?
            b. Are occurrences not recent (*e.g.,* within 15 years) such that they may not be representative of current conditions.

[39] https://www.federalregister.gov/documents/2013/04/23/2013-09404/endangered-and-threatened-wildlife-and-plants-designation-of-critical-habitat-for-eriogonum-codium

[40] https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/4236.pdf

c. Have the occurrences points been obscured by the data owner? In this case the points will not line up with habitat, rather a generalized area around the point should be considered such as a HUC-12 watershed.
d. Could the suitable habitat be the non-dominate habitat type in the area based on the resolution of the GIS data?
e. Are species moving into less suitable areas due to the lack of preferrable habitat?
f. The developer may need to consider potential inaccuracies with the chosen layers as they may not be appropriate for use in mapping.

2. If known location data may still be representative for species, consider whether additional habitat types incorporated in the spatial data should be added to represent potential species locations. This decision is best informed by FWS habitat descriptions of the species found within the species documentation.
3. If known locations are appropriate for combining with mapped habitat, follow the steps below:
    a. Develop polygons to represent priority management areas or places (*e.g.*, preserves, state parks) identified by FWS.
        i. It may be necessary to convert narrative information into geospatial data.
    b. Develop polygons to represent occurrence data.
        i. If occurrence data are available as coordinates, it may be possible to expand the area of those locations to represent a patch of relevant habitat.
4. Compare occurrence data and species habitat locations again from revised habitat mapping to see if any discrepancies are apparent (are groups of occurrences outside of the core map?).

Document Level of Best Professional Judgment/Certainty

The developer of the species core maps will need to use judgment when reviewing available species information, known location/occurrence datasets, and other GIS datasets. For this reason, the developer should assign a level of best professional judgment for each core map between 1 and 5 (with 1 being the lowest level of judgment/uncertainty and 5 being the highest level of judgment/uncertainty) based on the judgment used when interpreting available data sources and the level of confidence the developer has in the mapped location representing the species biological needs. The assigned judgment level should encompass both the choice of the appropriate map as well as the data used to define the map for a species.

The developer should assign the best professional judgment level based on the quality of the known location and GIS data, and any selection criteria used for a dataset. For example, FWS recovery goals/criteria may identify a minimum number of populations needed for delisting a species. In cases where a core map includes populations or occurrences that equals to or exceeds that minimum number of populations, meaning the core map captures the number populations needed for recovery, the core map has less uncertainty because the map is consistent with the species conservation criteria.

Alternatively, if public GIS data is unavailable for the known locations, and a map was digitized to develop the GIS layer, then the additional judgment should be reflected in best professional judgment level. For biological elements, GIS datasets with data elements comparable to the species habitats or recovery generally have less uncertainty and require lower judgment. For example, habitat definitions that are similar between the species description and GIS dataset (habitat is described as 'forest' and no interpretation or judgment was needed to identify the type of forest when selecting GIS layers), or slope requirements are within the measurements of the GIS dataset.

Judgment levels of 1 and 2 would indicate the core map choice was well supported and no or limited judgment was needed when selecting GIS layers to include in the species' core maps. These levels would mostly apply to critical habitat or range core maps that are not significantly supplemented with other data sets, such as occurrence/known location data. Judgment level 2 may also apply in cases where species habitat requirements are comparable to the spatial dataset's habitat classification, or when removing non-suitable habitat. For judgment level 3 and above, core maps are based largely on GIS layers mapping habitat, biological information, or occurrence data that may have additional uncertainties or requires substantial professional judgment to match the biological need to a dataset. Considerations and examples for these levels include:

- 1- none – critical habitat or range core map with no addition or subtractions; all supporting data sources consistently support the core map;
- 2- limited – critical habitat or range core map with limited additions or subtractions from robust occurrences data sources or removal of unsuitable habitat (see **Section 4** for additional detail on defining robustness); FWS documents include occurrence information but may not have been updated recently; occurrence data largely converge and predominantly support the boundaries of the core map;
- 3- average – biologically based core maps with clear and mappable descriptions of key biological requirements; GIS data are comparable to and consistent with the habitat needs of the species or other biological requirement; occurrence data may be robust, but highly fuzzed such that precision is low;
- 4- moderate – assumptions made when connecting species life history or biological needs, (*e.g.* habitat preferences, stream attributes, foraging needs) to a GIS dataset; uncertainty within the GIS dataset due to resolution, age, or element definitions; uncertainty regarding known locations/occurrences due to robustness and fuzzing;
- 5- significant or high – highly uncertain or limited species biological data; limited to no occurrence/known location data; high uncertainty expressed in FWS documentation; use of digitized GIS data; assumptions made regarding known locations due to summarized information from non-public data sources; uncertainty regarding GIS data accurately reflecting habitat descriptions or biological needs for the species; conflicting data such that the developer chooses to include/exclude large areas for core map development; need to deviate from the process described in this document in a manner that increases level of judgment and uncertainty.

EPA will apply the QA/QC process described further in **Section 5** to all core maps. The best professional judgment level may help EPA prioritize species core maps for review by FWS species experts and any additional external review beyond the standard QA/QC (described in **Section 5**). These interim core maps and any associated PULAs may be revised in the future after receiving additional feedback from the FWS species experts.

3.4. Step 4. Documentation

Documentation of the core map development is a critical part of ensuring transparency and for QA/QC review. While developers are not required to use it, EPA has developed a template (**Appendix 1**) that it plans to use when it develops core maps to describe the basis for a core map, including information relevant to the process described above (compile information, select the core map type, develop the core map). EPA has used this template to document its development of core maps for a number of species so developers may refer to those documents as a compliment to this process document available on the EPA website[41]. For non-EPA developers that elect not to use the template, EPA suggests they review it and the QA/QC process (**Appendix 3**) as another way to understand the types and level of documentation that would facilitate EPA's review. EPA recommends including a summary in the documentation that highlights the determinative information and rationales used to select a core map type and develop them. Developer can summarize details on the collected species information and GIS processing steps is respective appendices. Documentation for core maps based on critical habitat and species range can generally be shorter and simpler compared with biologically based core maps because fewer GIS datasets are considered. Duplicating the final steps used to create complicated biological information core map is often useful to support clear and concise documentation. This will often remove steps that ultimately did not impact the core map development.

Appendices in the documentation should include descriptions of species information available from FWS, biological information used to inform core maps, GIS sources, GIS procedures, and supporting information for the main decision points used to develop the core map. EPA recommends that developers provide intermediate GIS data and documentation of intermediate steps used to develop the core map to support the review process. For example, information necessary to understand the logic, procedures, tools, parameters, assumptions, and uncertainties for each step will help support review of developers' core maps. These include but are not limited to:

- Data sources (including date accessed when applicable)
- Software and version used,
- Projection for each of the datasets, and transformation parameters when appliable,
- Purpose/goal for each GIS step and a description of the output,
- Tools and parameters used for executing the analysis, and
- Information that would help connect the dots between steps and minimize the need to make assumptions about goals or parameters. For example, rather than only providing information on the selected habitat features describe how the selection was made (*e.g.*, used selected by attribute, extracted by mask, or raster calculator).

Including images of the resulting core map in the documentation is recommended as a reference for individuals without access to GIS software. Developers may also choose to include summary statistics of the core map such as core map area (acres) and overlap with different landcover types to summarize potential impacts to the core map. EPA recommends including an overlap analysis with the NLCD in the documentation, as this can help confirm the core map is found in the expected areas/habitats.

[41] https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas

4. Data considerations

The type of information available varies considerably across listed species depending on how well the species is studied, the specific species requirements, and locations of any given species. This document cannot feasibly describe all potential types of data that may be used to inform and prepare a core map. However, these data fall into three general categories, species life history/ecological information, species known location/occurrences, and GIS datasets. General considerations of the data found in these categories, and discussion of the commonly available datasets are discussed in this section. The developer should prioritize use of recent, highly quality data when available. Additional consideration on how to assess data age and quality are discussed in each of the following sections. Recognizing that new data will become available over time for all data type, data sources will be reviewed for updates when updating core maps.

4.1. Species information

FWS is the expert on species information related to listed species in their purview. Therefore, the core map developer should give deference to FWS documents (e.g., listing documents, recovery plans, 5-year reviews, species status assessments). Species information found in these reports will include species status, critical habitat designation, habitat preferences, life history/ecology, as well as known locations/occurrences and existing recovery goals, criteria and actions when available. The information on species life history or ecology found in the reports often includes habitats where the species occurs, soil, slope, cover requirements, elevations restrictions, diet, breeding seasons or timing, and foraging distances. As outlined in EPA's documentation template (**Appendix 1),** this information should be summarized to support the selection of the core map type. For core maps based on biological information, the developer will need to choose which biological information should or can be mapped for the core map development. When available, recovery plans often include recovery goals, criteria, and actions. The recovery goals for a species outline habitats that are important for species conservation, the quality of those habitats, ongoing or needed habitat conservation or restoration, and the number and distribution of populations needed for recovery. The distribution of populations needed for recovery are often referred to as recovery units or conservation units in the reports. When choosing the type of core map, the developer should align the core map selection with any explicit recovery goals based on identified population numbers, population distributions, or habitat conservation needs.

Availability and age of the FWS species reports will vary from species to species. The data found in the reports may also be more complete for some species compared to others. As the reports age, the relevance and accuracy of the information may decrease. For this reason, EPA recommends the developer start with the most recent report(s) from FWS, and then move to older reports to supplement or fill in missing information. The developer may need to review multiple reports to collect all current and relevant information for a species. For example, recently discovered populations may only be captured in the most recent report while information on stable populations may be found in older reports. As another example, new recovery units may be identified in an update recovery plan. As the species' experts, information from FWS reports will always be considered high quality information. However, the developer may note some uncertainty and adjust the best professional judgment category if the report identifies information as unknown, or if the age of the most recent report is over 15 years.

The core map developer may obtain information from other sources to supplement the FWS reports or to fill information gaps but should be cautious to ensure that the data are of high quality. When

assessing non-FWS species information for quality the developer should consider age, comparability, representativeness, and completeness. Similar to the species information collected from FWS reports, newer information is more likely to be representative of current research and needs for the species. Peer reviewed, academic data sources are more likely to be comparable in quality to FWS reports. However, these sources may focus on a single location, study site, or state and not the entirety of the species. The documentation should include an evaluation of non-FWS species data sources used in core map development based on the age, representativeness, completeness, and comparability consideration described here. The developer should prioritize high quality recent data that is representative of the full population over lower quality/older data. However, there may be species for which the only available data is older (greater than 15 years) or of low quality (*e.g.* incomplete, representative a sub-set of the populations, or focuses on a single life stage). In these situations, the developer should use the available data, and adjust the best professional judgment level of the core map based on the quality and/or uncertainty of the available data.

4.2. Species known location/occurrences

Reliable known locations should always be considered regardless of the selected core map type, as discussed throughout this document. Therefore, additional discussion regarding known location data is included here. In addition to the species life history/ecology, FWS reports will often summarize the known locations of existing populations or reintroduced populations, as of the report date. These known locations may include named locations or occurrences. Occurrences are often individual observations or surveys and generally come in the form of latitude/longitude points. Named locations may include parks, refuges, stream names, land formations, waterbody names, or other similar locations. When using named locations, the developer will need to identify an available GIS dataset that includes the named place to add the location to a map. In addition to the FWS reports, observational data points for a species may be available from various public data sources (*e.g.,* GBIF, iNaturalist, NatureServe, state heritage programs). These observational data may be in the form of occurrences (*i.e.* latitude/longitude) or element occurrences which is a summarized area of an observation or group of observations. Both occurrences and named locations may be available for some species.

Searching public databases for known location/occurrences can be time-consuming. For this reason, EPA recommends that the developer start with the available FWS reports. Generally, FWS indicates if their known location information includes all/most of the known locations/occurrences of the species at the time of the report. If FWS' known location information is complete for the species, then additional research of public databases is not needed. Specifically, when a species 5-year review is less than 5-years old, and includes a description of either known locations/occurrence data, then, in most cases, this data should suffice. In this situation, FWS recently completed a review of available known location/occurrence data and additional research is unlikely to add meaningful occurrences. However, if the most recent FWS document is greater than 5-years old, does not include a description of known location/occurrence information, or the data is not available publicly, the developer should consider incorporating non-FWS data sources. Common public sources of occurrence data include NatureServe Explorer Pro[42] iNaturalist[43], GBIF[44], or eBird[45] . These databases allow a user to search for specific species by name to identify occurrence information. State heritage programs also have information on species

[42] https://explorer.natureserve.org/pro/Welcome
[43] https://www.inaturalist.org/
[44] https://www.gbif.org/
[45] https://ebird.org/home

occurrences, but only some programs make the data available publicly. Additional data sources may be available from state or local resources. EPA recommends considering multiple sources because recent observations may be found in one source but not another, with the highest weight given to information from FWS reports. After identifying all available observations, the developer can narrow the results to include the most reliable and robust occurrences based on the consideration in the next paragraph. Occurrences may be unreliable when robust surveying necessary to establish presence or absence of a species does not exist, for example private land ownership precludes survey in a large percentage of the range). In these cases, the developer should rely on available other biological data, available species range and critical habitat maps to develop the core map.

When evaluating the robustness of known location/occurrences information, the developer should consider the number, reliability, age, resolution, and timing of the occurrences. The level of robustness influences how the data is used in the core map development. Description or categorization of the reliability and completeness of known location/occurrences from FWS are assumed accurate. Typically, FWS species documents indicate if all/most of the known locations/occurrences of a species are captured. When considering occurrence information, generally a species with 30 or more occurrences that cluster in one or more locations represent a high number of occurrences. However, the developer should compare the number and distribution of the available occurrences to the relative size of the species range. The number used to define "high" may be reduced for species with smaller ranges based on the judgment of the developer. Recent occurrences should be weighed more heavily. EPA recommends focusing on the last 15 years, for species with a high number of occurrences; however, the developer may expand this time-window up to 50 years[46] when only a few occurrences are available (<5). When this is done, older occurrence data should be evaluated carefully for relevance because populations may be historical or extirpated from those location. It also may be appropriate to target data from a specific time of year for certain species, based on available life history from FWS, such as breeding seasons. The public occurrence databases will often "fuzz" or obscure the exact locations of species, meaning the resolution has been purposely reduced for public release for species protection considerations (e.g., to avoid collection). EPA recommends weighing data points that include an indicator of positional accuracy over data without positional accuracy. The positional accuracy metric indicates the level of "fuzzing" and is often represented by a distance value. iNaturalist and NatureServe data often include positional accuracy, while GBIF and eBird only include positional accuracy for some observations. Occurrence data collected by state heritage program scientists (NatureServe) or verified by a photo, sound, or from another user of a platform (iNaturalist "research grade") should also be weighed higher. Verified occurrences should be given preference over unverified occurrences, and the developer should be careful to filter out occurrences from zoos or museums. For this reason, when supplementing FWS' occurrence data, EPA recommends starting with iNaturalist and NatureServe data, and then, if needed, supplementing occurrence information with other sources to increase robustness. Developers should include the data source or sources for any occurrence data with a justification for the search or filtering criteria and an assessment of robustness in the core map documentation.

A highly robust dataset may be used to change the extent of the core map, meaning areas may be added or subtracted from the core map. For example, a highly robust dataset including 30 or more research grade occurrences from the last 15 years, with a positional accuracy value, may be used to narrow the extent of the core map or add areas to the core map. In contrast, the use of occurrence information with low robustness should be limited to a general evaluation to confirm the occurrences are within or near the core map. When performing this comparison, developers should be aware that without a

[46] https://ecos.fws.gov/docs/SR_SOP/SDM_SOP_Final_14Nov2019.pdf

positional accuracy metric, occurrences found outside of the species map may actually be from an observation within the map. As an example, a species with 2 unverified occurrences that are older than 15 years and have been fuzzed without a positional accuracy metric would not be considered robust. Developers should not adjust the core map extent based on non-robust data but can adjust the best professional judgment level described in **section 3.4**, as appropriate, if occurrences do not align well to the core map or are unknown.

A lack of occurrence data does not imply a lack of species presence. Occurrence data may be limited to accessible lands (sampling bias) and frequently is the result of a lack of sufficient surveying for the species. Information may not be available for privately owned lands, and some species are difficult to find due to their size or behavior. When evaluating the number of populations captured by the occurrence data, the developer should keep in mind that sampling bias may also occur when occurrences follow public trails and roads. If a propriety occurrence dataset exists, EPA recommends the developer note the owner or data sources in the documentation even if the data source was not use for core map developement. EPA may evaluate the utility of datasets for future consideration.

If the developer cannot find public occurrences/known locations, but a static or paper map is available in a FWS report, the developer may choose to create a GIS file by digitizing[47] the static map or visually comparing the core map with the static map. However, these options increase the best professional judgment level.

4.3. GIS Datasets

For critical habitat and range core map, the developer should use the current FWS critical habitat or range map as the core map. As the species experts, additional review or assessment of quality is not needed for these GIS layers. However, for biological information core maps, the developer will need to select other GIS datasets to map the species biological requirements. As part of the selection process the developer will need to confirm that the dataset represents best available data that meets EPA's quality standards. When assessing GIS dataset for quality, the developer should consider the age, resolution and accuracy of the data, in addition to other applicable recommendations from the Federal Geographic Data Committee such as complete metadata[48,49] (FGDC). Ideally, data will be from publicly available sources or able to be made available to the public to ensure transparency; however, when essential to a species' core map, a subscription based or other non-public dataset may be used if a description regarding how such information can be made public is included.[50]

Table 2, found at the end of this section**,** provides some recommended national spatial datasets that meet EPA's quality standards that may support mapping of species biological information (e.g. habitat, soils, slope, elevations). Additional sources from state or local programs can be found in **Appendix 2**. These state or local datasets often map similar features as the national datasets, but may provide more precision or state specific considerations. Only a subset of these datasets will be applicable for any given

[47] The process of converting geographic information from a map or image into a digital format. This is done by tracing the spatial features of the map using a digitizing tablet or drawing commands. The x,y coordinates of the features are then recorded as spatial data.

[48] https://www.epa.gov/quality/guidance-geospatial-data-quality-assurance-project-plans-epa-qag-5g
[49] https://fgdc.gov/
[50] https://www.congress.gov/bill/113th-congress/senate-bill/9

species, and the developer will need to use judgments when selecting the best dataset for a species. **Table 2** also provides recommendations sources for mapping named known location such as parks or streams.

Developers may use data sources identified in **Table 2** of this document in core map development without additional review on quality. However, additional data sources may also be used if they are from publicly available sources that meet EPA's data quality standards. For example, states may provide geospatial data mapping of state specific habitats that are applicable for species found in a single or limited number of states. A state may also have GIS layers that would support the identification of named known locations. For all datasets, the developer should still include a rationale describing how well the GIS data matches the biological information available for a species. For datasets not captured in this document, the developer should also describe the quality, precision, and accuracy of the data.

There are strengths and limitations of the available spatial data to represent the habitat or other biological requirement of the species. When developing core maps, a developer may encounter different levels of resolution when selecting spatial data to represent a habitat type (*e.g.,* NLCD forest landcover may be used to represent a more specific species habitat description called "longleaf pine"). It may be helpful in these cases to consider whether the spatial data might over or underestimate the likely locations of a species habitat because of the assumptions made (*e.g.,* NLCD's forest landcover would likely overestimate the locations of longleaf pine because it would include other types of forest).

Other spatial data sets or information may be helpful in addressing and refining assumptions made with only one spatial data set (*e.g.,* LANDFIRE, GAP or state data may be helpful to refine a habitat class to be more focused on long leaf pine). Higher levels of spatial accuracy and more recent data are more likely to be representative of habitat locations. As datasets age (e.g., >10 years), it is more likely that landcovers have changed over time and represent lower quality data. Delineation of certain types of habitats may also be highly uncertain. Examples of habitats that tend to be more accurate include: grasslands/prairies, open aquatic habitat, forests[51]. Conversely there are several habitats that have shown to be quite difficult to accurately delineate, especially at a national level such as forested aquatic habitat, vernal pools, karst groundwater systems, scrub habitats, sinks holes, small waterbodies, springs, disappearing streams, and caves.

If available, the accuracy of the data used to define the core map should be considered and included in the best professional judgment level. The developer can consider the spatial extent of different uncertain landcover types within the species range and how these locations may or may not overlap with known location data. If the uncertain landcover types do not represent a substantial portion of the habitat locations within a species range, it may not be important to refine these uncertain landcover locations. However, if the uncertain landcover types do represent a substantial area within the species range, it may be helpful to consider other types of spatial data to represent this type of landcover. Developers are encouraged to consider the impact of uncertainties on the core map and refine assumptions if and when they have a major impact on the spatial extent of a core map (*e.g.* a decrease or increases of at least 10% in area), documenting the decision process, and incorporating these considerations when setting the best professional judgment level.

[51] Wickham, J., Stehman, S. V., Sorenson, D. G., Gass, L., & Dewitz, J. A. (2023). Thematic accuracy assessment of the NLCD 2019 land cover for the conterminous United States. *GIScience & Remote Sensing*, *60*(1). https://doi.org/10.1080/15481603.2023.2181143

The documentation should include the final rationale used when deciding which GIS data is best for mapping species biological information. The developer should also consider their assumptions and any uncertainty with the data when assigning the best professional judgment level. When datasets include multiple scales, a common occurrence for habitat layers, developers should start by using habitat type at an intermediate scale; unless the species has highly specific habitat needs. For the LandFire Existing Vegetation Type (EVT) layer, the vegetation group value would reflect a medium or intermediate resolution. Habitat types mapped at this intermediate scale include considerable heterogeneity[52]. When a species is highly localized, with specific habitat requirements, a finer scale habitat type would be appropriate. Finer scale elements will often require additional review to confirm the selection matches the species requirements and have higher uncertainty.

Appendix 2 provides additional suggestions for selecting and evaluating GIS datasets, including selecting between two similar datasets, and when to consider a state dataset over a national dataset. For a biologically based core map, high quality GIS data sources will be less than 10 years old and include data descriptions that are comparable to the species requirement. For example, habitat definitions are similar between the species and dataset, or species slope requirements are within the measurements of the GIS dataset. Older sources may still be used when recent data is unavailable or doesn't match the species requirement. The developer should include information on age, resolution and accuracy of the data when justifying the use of non-recommended GIS data sources in the documentation and adjust the level of best professional judgment accordingly.

Any biological data that can be mapped using GIS data sources can be included in the core map, and many data sources are available (e.g. habitat, soils, slope, elevations; see **Appendix 2** for examples). EPA recommends developers start with available national level GIS datasets[53] to support mapping. However, publicly available non-national data sources that meet EPA's data quality standards may also be used. For example, states may provide data that include additional information, elements, or categories not found in the national datasets when they are specific to the state. Similar to the known location data, the age and quality of the datasets should be considered when selecting data sources. Confirming that these datasets meet EPA quality standards can be a time-consuming process, especially when a species is found in multiple states. For this reason, starting with a routinely updated national level dataset then moving to state or local level datasets when they offer meaningful refinement (*e.g.* habitat categories not found in the national dataset) or fills in gaps (*e.g.* names of state parks/forest) may be more efficient in many cases rather than starting with state or local datasets. **Appendix 2** provides a list of available datasets, suggestions for selecting GIS datasets, suggestions on selecting the appropriate scale, and when to consider a state dataset over a national dataset. The list of datasets will be updated over time as sources are discovered and have been reviewed and included in a core map.

EPA does not expect that core maps developed under this approach contain any CBI information or create data ownership rights under 40 CFR Part 152 because EPA is not determining that this information is necessary to fulfill any data requirement under 40 CFR Part 158. Moreover, the underlying information for the core maps should be readily available and EPA plans to share the core maps publicly.

[52] https://www.landfire.gov/sites/default/files/documents/PCom_2003_Ecol_Systems_US.pdf

[53] Large GIS datasets that represent a multitude of data throughout the United States like census data, land use, and habitat. National level datasets generally apply a consistent process and standard across the country, or across the geographic extent that the data covers.

Table 2. Example national level GIS datasets to support core map development.

Data Source	Data Service (if available)[1]	Data Download
Species range and critical habitat from FWS	EPA species[1] and critical habitat[1]data services updated from ECOS each week, use the "Diced Species Range"	Species Profile on ECOS
National Land Cover Database (NLCD)	NLCD -data service from ESRI Living Atlas	NLCD- data downland MRLC
National Wetlands Inventory (NWI)	NWI – data Service from ESRI Living Atlas	NWI – data download from FWS
LandFire Existing Vegetation Type (EVT) layer or other LandFire layers	Existing Vegetation Type (EVT) – image service from USGS	LandFire Homepage
Gap Analysis Project (GAP) Landcover	Gap Analysis Project (GAP) Landcover – Data Services from USGS	Data Download from USGS
National Hydrology Dataset (NHD)	Data Services from ESRI Living Atlas: NHD high resolution[1] and version 2.1[1]	High resolution data download from USGS Version 2.1 data download from EPA's Office of Water
Protected Land Database - PAD-US	PAD-US: Data Service from ESRI Living Atlas[1]	Data download from USGS
Tax Parcels	N/A	May be available from states
USA Federal Land	USA Federal Land- Data service from ESRI Living Atlas	Data can be exported to FGGB
Digital Elevations Model (DEMs)	N/A	USGS- data download
Impervious (NLCD)	Impervious- Data service from ESRI living atlas	NLCD- data downland MRLC
Human footprint (NASA)	Human footprint -Data Service from NASA	NASA – data download
Tree canopy cover 2021 (NLCD)	Tree canopy cover- Data service from ESRI Living Atlas	NLCD products- data downland MRLC
State Geologic Map Compilation (USGS)	State Geologic Map Compilation - Data service from USGS	USGS: data download

Data Source	Data Service (if available)[1]	Data Download
Soils (SSURGO) – metrics include but not limited to • Soil types • Depth to bedrock • Soil moisture • Soil pH • Growing degree days • Evapotranspiration • Palmer's Drought Severity Index	USA Soils - Data service from ESRI Living Atlas	USDA SSURGO: Data download
NatureServe Explorer Pro – Species Occurrences	N/A	NatureServe Explorer Pro home page
GBIF – species occurrences	GBIF	GBIF home page
iNaturalist - species occurrences	iNaturalist Observations - data services from ESRI Living Atlas[1]	iNaturalist home page

[1] Included in the OCSPP - Available Data Options (PULA) group on the EPA GeoPlatform. Log-in may be required using your EPA GeoPlatform account.

5. Quality assurance/quality control

EPA is committed to assuring that the quality of the data EPA considers and relies on for its actions is appropriate. Incorporating a quality assurance/quality control step in this process improves EPA's policy-making and analysis and helps drive reliable and defensible decisions. The QA/QC process EPA intends to use to evaluate whether a core map is reasonable and sufficient for PULA development will include a documentation review of the:

- rationales for selecting the core map type with the expectation that they are clear, transparent and supported by FWS documents,
- species, known location/occurrence, and GIS data used to create core maps with a focus on data quality and applicability for use in PULAs, and
- steps used to create the core map with the expectation that they are transparent and repeatable.

Developers should provides sufficient documentation to:

- allow for an independent evaluation of the rationale used to select the core map,
- verify that the information representing the species is consistent with FWS documentation and other available sources,
- verify the rationales used when selecting GIS datasets,
- verify that the GIS steps used to develop the core map were carried out correctly; and
- confirm the core map includes complete metadata for the core map layer.

During QA/QC, EPA will verify that the data sources and selection criteria used by the developer align with the FWS reports and are of sufficient quality as described in **Section 4**. Biological information core maps will typically need the highest level of review. Similar to the other core map types, EPA will confirm that the rationale for selecting the biological information core map type is supported by the

current FWS reports, the selected biological requirements align the FWS reports, and confirm the selected GIS layers accurately represent the biological requirements used to develop the core map. EPA will also review the data sources and selection criteria the developer used to evaluate the available known location/occurrence data and other GIS datasets. During the QA/QC process, EPA will review the rationales for selecting a GIS dataset, confirm the selected dataset accurately represents the biological information and is of sufficient quality, as described in **Section 4**. In some situations, available GIS datasets may not exactly match the biological requirements for the species, and the developer will need to make assumptions. For example, vernal pools have proven difficult to map and the developer may need to select a surrogate habitat introducing additional judgment. EPA will review the rationales from the developer regarding assumptions when mapping the biological information as part of the QA/QC. In addition, FWS species experts will review core maps. Additional external review may also occur when needed, to address questions regarding specific datasets or other non-species related assumption that increase the uncertainties/judgment in the core map. EPA plans to prioritize external review of core maps that used higher levels of judgment and interpretation as appropriate. In addition to the rationales for selecting the core map type and data, EPA will review the GIS steps taken by the developer to create the core map to confirm transparency and repeatability. Core maps with a completed QA/QC review will be considered interim until FWS has also reviewed the species core map. As a result, interim core maps and any associated PULAs may be revised in the future after receiving additional feedback from the FWS species experts.

Across all core map types, the QA/QC reviewers may make minor adjustments based on information included in the submitted documentation from the developer, and their best professional judgement. For example, if the developer notes 8 counties where the species is known to occur based on a FWS report, but the core map included 9 counties EPA will check the data sources to determine if 8 or 9 counties is correct and will update the core map or documentation based on their findings. EPA will supplement the species documentation to account for any adjustments made as part of the QA/QC process.

EPA's QA/QC reviewers will use a checklist to facilitate their review (**Appendix 3)**. At the end of the QA/QC review, EPA will identify a core map with no major deficiencies as "sufficient" meaning it can be used in PULA development. Several reasons a core map would receive an "insufficient" classification include, missing data sources or citations, incomplete justifications for core map selection, missing data files, use of low-quality data sources when higher data is available, or insufficient information for the reviewers to repeat the GIS steps. EPA may reach out to the developer for additional information to support QA/QC review, particularly when its initial conclusion for a core map is insufficient. If EPA is unable to resolve the concerns through review or follow-up with the developer, the core map will be classified as insufficient, and EPA will not use the core map to develop PULAs. EPA will make species with insufficient maps available for development by EPA or non-government entities.

At the end of the QA/QC process, EPA's QA/QC documentation for sufficient core maps will include EPA's:

- Classification of the core map as either: sufficient-as is[54], sufficient- with revisions made during the QA/QC process[55], or sufficient- after receiving additional information from developer[56];
- Justification for the QA/QC classification;
- Completed QA/QC checklist outlining review steps; and
- Updates made to the core map as part of the QA/QC, if any

For the biological information core maps, at the end of the QA/QC process when needed, EPA will use a smoothing process to remove unnecessary complexity found in the core map. The purpose of this smoothing process is to eliminate anomalies found in modeled or remotely sensed GIS datasets used to create the core map, eliminate artifacts introduced by GIS processing tools, and to reduce file size and complexity. Including unnecessary complexity in the core map will impact the performance of the Bulletins Live! Two system[57]. These anomalies/artifacts may be introduced to a core map when converting remotely sense raster datasets to polygons, using modeled data such as NHD flowline data to represent stream locations, or using geo-processing tools to combine datasets into a single core map. EPA would apply the smoothing process to remotely sensed or modeled datasets, not defined or delineated areas like critical habitat or known locations.

A single set of criteria to identify anomalies, which are mapped locations that appear to be errors in the data, found in a core map does not exist. To support the identification and elimination of anomalies in core maps, EPA will use a minimum mapping unit of 2-acres for a species core maps. Patch size requirement for species can vary across species, quality of habitat, and landscape context. Use of a 2 -acre minimum mapping unit for a species core map is below the smallest patch size requirements for most taxa[58]. For this reason, the smoothing process will target and remove anomalies/artifacts and non-usable patches for a species. Therefore, the elimination of these anomalies will not impact the integrity of the core map or resulting PULA.

There are two parts to the smoothing process: (1) removing small patches that are disconnected from other areas identified as habitat in the core map (removing areas likely identified in error); and (2) filling in small patches or holes[59] that are surrounded by areas identified as suitable habitat (filling in small areas likely missed in error).

The smoothing process will identify polygons found in the core map that are disconnected and have a total area less than 2 acres. These polygons likely represent a location that is inconsequential for overall species conservation due to size and fragmentation and would not need mitigation for the purposes of protecting listed species or designated critical habitat. EPA will used 2-acres as the default minimum mapping unit. However, if available information from FWS supports a smaller minimum mapping unit for

[54] No concerns identified and no edits made to the map during review
[55] Edits made to the map during review based on cited information found in the documentation or during the smoothing process.
[56] Edits made to the map or map documentation during review based on additional information from the developer
[57] https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/dicing-godzillas-features-with-too-many-vertices/
[58] https://www.fs.usda.gov/nac/buffers/guidelines/2_biodiversity/2.html
[59] Holes: a small gap in an otherwise continuous polygon that is an artifact/error

a specific species, EPA recommends that the developer include this information in the documentation so that EPA can adjust the value accordingly. Generally speaking, larger animals require larger patches so smaller patch sizes may be appropriate for smaller animals such as invertebrates or small mammals.

The second part of the smoothing process will simplify the boundaries of the remaining polygons, by filling in gaps or "holes" that are found within an otherwise contiguous area. **Appendix 3** includes additional information on the smoothing process, including the specific tools and parameters that EPA plans to use. In addition to supporting the performance of the BLT system as described above, removing anomalies will also enhance the overall core map quality because the resulting core map will have fewer areas that were erroneously identified. After applying the smoothing process, the EPA reviewer will manually compare the smoothed core map to the source core map, other reference data, and available aerial photos/satellite imagery for logical consistency. During this comparison, the reviewer may flag areas of concern from the smoothing process for further review by subject matter experts. During this comparison, if the reviewer determines critical habitat or delineated known locations were unintentionally removed during the elimination step, the reviewer will add these areas back to the smoothed core map. For this reason, it is recommended the developer includes these non-remotely sensed data when sharing materials with EPA, especially when the total area is small. A summary of this comparison will be included in the QA/QC checklist.

After completing all review steps and applying the smoothing process when needed, EPA will make the species core map available publicly on the EPA GeoPlatform as a GIS layer[60]. EPA will use this core map layer when developing PULAs, described in **section 7.**

6. Information for core map developers on species selection and core map submission

EPA has identified species needing core maps to support PULA development related to the Strategies outlined in the ESA workplan and ongoing pesticide actions under FIFRA. EPA will post a table of species needing core maps on the EPA endangered species website[61] along with EPA's prioritization for development. The species core map table will be updated routinely to add species as needed, reflect changes in the status (available, checked out, under review, interim, final), and provide access to documentation for completed core maps. Individuals that want to develop core maps should use the website to share their name, affiliation, email, and the species entity ID number they wish to "check out" for core map development. EPA will send the requestor a confirmation email from the email address pula_core_maps@epa.gov confirming the identification of the species that the developer requested, and development can begin. EPA may also develop core maps for species as needed.

To start, EPA is asking that outside developers identify 1 species at a time, based on the individual's organization or affiliation. Exception may be made in cases for consistency purposes (*e.g.*, multiple species are all in the same location and habitat, so developing core maps separately could cause inconsistencies that would be confusing for such species). One species will not be available for multiple developers to prevent multiple individuals from working on the same species at the same time.

[60] https://epa.maps.arcgis.com/home/item.html?id=ccfd477229344b6a87bdf33f7007ed01

[61] https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas

EPA will also create an EPA GeoPlatform account for the developer to facilitate data transfer, and the developer will receive an email from geoservices@epa.gov with their username and password. As the developer completes a core map for a species, they should send the core map, the GIS data, documentation, and other supporting materials to EPA using the EPA GeoPlatform.[62] Additional details on how to upload materials to the GeoPlatform, including screenshots on how to log into the GeoPlatform and upload the materials, can be found in **Appendix 5**. The developer can expect an email two months after checking out a species to confirm core map development is in progress. Three months after checking-out a species, if EPA has not received the core map and associated documentation, it will assume the requestor is not developing a map and EPA will mark that species as available for development by others. After sending core maps and associated documentation for the checked-out species to EPA, the developer may request additional species. When QA/QC begins for core maps, EPA will download the materials from the GeoPlatform and remove them to avoid version control issues. At this point, submitted materials will no longer be viewable by the developer.

After review, EPA will make core maps it identifies as "sufficient" (see **Section 5**) available for PULA development and add them to the public core map GIS layer[63] via the EPA GeoPlatform.

7. Developing PULAs from core maps

The purpose of a PULA is to identify areas where pesticide mitigations are needed for a pesticide to conserve a population of listed species and its critical habitat (if designated). Previous sections of this document describe EPA's process for developing core maps, which will serve as the building blocks to develop PULAs. This section describes the basic process that EPA will use to develop a PULA from a core map.

EPA will develop PULAs from core maps that are created using the process described in this document. Core map developers other than EPA do not create PULAs, but a summary of the PULA development process is included here for context. EPA develops PULAs to identify locations where additional precautionary label directions apply to protect listed species or critical habitat. In other words, where the pesticide product labeling directs an applicator to visit BLT[64] and follow the instructions found there for their location, the applicator must follow those instructions to protect listed species for their particular location. BLT is a web-based mapping application that that houses the geographic-specific areas for these pesticides mitigations. A user interacts with BLT by identifying the location of their pesticide application, and the pesticide product they plan to apply to generate a PDF Bulletin. All mitigation instructions found on the Bulletin must be followed in additional to instructions found on the label. The Bulletin will include 1) a map of where the mitigations apply, 2) what pesticide products are associated with the mitigations 3) what additional label directions are applicable in the area (if any), and 4) the month for which the Bulletin is valid. These Bulletins allows EPA to reduce complexity on pesticide product labels and limit listed species protections only to areas where species are located.

The remaining step to develop a PULA from a core map is essentially to define a set distance away from the core map to create a potential pesticide exposure zone known as a 'buffer' that is adjacent to a core map and accounts for pesticide movement (*e.g.* via spray drift or run-off) into areas identified by the

[62] https://epa.maps.arcgis.com

[63] https://epa.maps.arcgis.com/home/item.html?id=ccfd477229344b6a87bdf33f7007ed01

[64] BLT (Bulletins Live!Two) and was defined in Section 1 of this document. It is a web-based system that allows pesticide users to determine if they are in an area where additional label directions apply to protect listed species.

core map. When applicable, these exposure areas will also account for a biological "buffer" to address potential impacts to pollinators and/or prey species that could result in reduced species survival/recovery. If a core map developer identifies species-specific dispersal distances when reviewing FWS reports, EPA recommends including this information in the documentation. Core map developers do not need to add areas or buffers to account for spray drift, run-off, or exposure to taxa the species depends on, such as pollinators. If applicable, EPA will add these areas to core maps when developing PULAs.

To create a PULA from a single species core map, EPA would add a buffer around the species core map to account for drift and surface water runoff from a pesticide treated field or use site as well as exposure to a taxa the species depends on such as pollinator or prey. Buffering from the core map to create a PULA classifies the area around the core map as relevant for exposure provides the opportunity to identify if any additional label directions that would be needed to reduce potential exposures.

EPA is still developing a process in cases where it may develop a PULA for multiple species that EPA identifies as needing the same mitigations for a particular pesticide or groups of pesticides with similar characteristics and will do so as EPA gains more experience implementing multi-chemical strategies such as the final Herbicide Strategy, which identifies groups of species with similar sensitivity to herbicides. EPA's current plan to develop PULAs based on species core maps that may involve multiple species is to first create an intermediate map based on species groups, such as the PULA groups from the Herbicide Strategy, for which the same set of mitigation apply for an exposure route (*e.g.* direct exposure, spray drift, or run-off erosion and spray drift) and level of mitigation (*e.g.* buffer distance or run-off points). Mitigation levels may vary between taxa for a pesticide and will likely differ across pesticides. All species found within a group will have the same mitigation level so that a PULA can be associated with the single set of mitigations. EPA would then buffer these combined core maps to account for pesticide movement from adjacent areas.

By including the entire exposure area associated with a mitigation in the PULA, the applicator can visualize if their applications will occur within areas necessary for species conservation. EPA is still developing a process for communicating the level of mitigation and describing mitigation options for these types of grouped PULAs. EPA expects the process to evolve as EPA gains experience incorporating grouped PULAs into actions that use them. If PULAs overlap, and have conflicting mitigations, EPA will determine how to display the PULA and associated instructions to ensure the necessary protection for all species and prevent confusion for the applicator. Describing how mitigations may be communicated for species within a PULA and access to the PULA GIS layers is beyond the scope of this document.

Appendix 1: Template EPA Uses to Document Core Map Development

Documentation of the core map development is a critical part of ensuring transparency and for QA/QC review. While developers are not required to use it, EPA has developed this template that it plans to use when it develops core maps.

The purpose of the documentation is to describe the basis for a core map, including information relevant to the process described above (compile information, select the core map type, develop the core map). At the beginning of the document, EPA recommends including a summary that highlights the determinative information and rationales used to select a core map type and develop them. Developers can summarize details on the collected species information and GIS processing steps is respective appendices. These appendices should include descriptions of species information available from FWS, biological information used to inform core maps, GIS sources, GIS procedures, and supporting information for the main decision points used to develop the core map. Often there will be two appendices, one for compiled species data, and the second that summarized the GIS data and core map development process. A separate GIS appendix may not be needed if all pertinent information is captured without it. Additional appendices specific to a species can be added to support the review of the core map.

Documentation for core maps based on critical habitat and species range can generally be shorter and simpler compared with biologically based core maps because fewer GIS datasets are considered. Duplicating the final steps used to create complicated biological information core map is often useful to support clear and concise documentation. This will often remove steps that ultimately did not impact the core map development. EPA recommends that developers provide intermediate GIS data and documentation of intermediate steps used to develop the core map to support the review process. For example, information necessary to understand the logic, procedures, tools, parameters, assumptions, and uncertainties for each step will help support review of developers' core maps.

Including images of the resulting core map in the documentation is recommended as a reference for individuals without access to GIS software. Developers may also choose to include summary statistics of the core map such as core map area (acres) and overlap with different landcover types to summarize potential impacts to the core map. EPA recommends including an overlap analysis with the NLCD in the documentation, as this can help confirm the core map is found in the expected areas/habitats.

Example Documentation Template

Note red highlighted text provides background information and descriptions of what to include in each section.

Species Summary

Provide a short summary of complied species information. Types of information to include:

- *Habitat preferences – include if species doesn't use agriculture as habitat*
- *Species specific minimum patch size for habitat*

- *Timing considerations that could impact exposure such as migration, breeding, bloom, time above ground*
- *Summary of diet information – include any prey specific dispersal distance if available*
- *Pollination consideration – including pollinator dispersal distance if available*
- *Critical habitat status*
- *Notable relevant pesticide use sites*

Description of Core Map

Identify the core map type selected for the species and provide the rational for why this core map is the best representation of areas where pesticide mitigations apply to conserve the species. Explaining why other core maps types were not select may be useful for some species.

- *Types of information to include*
    - *Major sources used to support selection*
    - *Outer extent for the core map*
    - *Total area of the core map*
    - *Image of core map*
    - *Summary statistics for the core map including overlap with common landcovers/habitats such as the NLCD*
    - *Include references when applicable*

Evaluation of Known Location Information

Summarize the available known location dataset for the species across available data sources. Include a list of data sources and the evaluation of the data quality and robustness. Types of information to include:

- *Number of extant population and number of extirpated population*
- *Number of locations*
- *Number of reintroduction sites when applicable*
- *Locations are within or side of the range and/or critical habitat*
- *Quality of the data, including year and type (e.g. research grade, FWS, not verified)*

Approach Used to Create Core Map

Summarize each step of the process including:

- *Available FWS reports used to support the core map selection and development*
- *Considerations that influenced the selection of the core map type*
- *Summarize the GIS data and steps used to generate the core map. This may include rational for selecting a specific dataset, setting the outer extent for the map and justification, identify supporting information used in the map develop and the GIS processing steps.*

Discussion of Approaches and Data that were Considered but not Included in Core Map

Summarize any approaches considered but not implemented during the core map development. Include the reason the approach was not implemented. Example reason could include, low data quality, limited impact in the core map, or lack of available data. If the developer identifies information that is currently unavailable but that could support future core map refinement, this can be included. Example of this type of information include non-public GIS datasets and species-specific information that would reduce uncertainty in the core map. EPA may consider options to acquire the information in the future.

Documentation Appendix 1. Information compiled for species during Step 1

The purpose of this appendix is to organize the complied species information relevant to creating a core map found in the available FWS reports. The format below captures the types of information commonly available for species. However, all information may not be available for all species, and additional information not captured in this template may be available for certain species. Documentation should focus on Information relevant to developing a core map.

1. Recent FWS documents

- *Include a list of the FWS reports reviewed to support core map selection and development. Example documents include 5-Year Reviews, Species Status Assessments, Recovery Plans, Species Listing Documents and Critical Habitat Designations. Other less common documents include Habitat Conservation Plans (HCPs), Safe Harbor Agreements (SHAs) and recent Biological Opinions (BiOps) pertinent for the species.*
- *Include citation and URLs for the documents when available.*
- *Other determinative data sources used to support the core map development may also be included as needed.*

To support the review of the materials, it is recommend to start with the most recent document and then move to older documents to fill in missing information.

2. Background information

Summarize the available species from the various FWS report. The outline below includes information that is generally available across species. Certain information may not be available for all species.

Status: *ESA listing status and year*

Resiliency, redundancy, and representation (the 3Rs)

The conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3Rs") are used as a lens to evaluate the current and future condition of the species. This information is typically found in FWS' species status assessments and characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings. However, other FWS report may include this information. Include report reference(s) used for summary.

- Resiliency – *describes the ability of a species to withstand stochastic disturbance. Resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations. Generally speaking, populations need abundant individuals within habitat*

patches of adequate area and quality to maintain survival and reproduction in spite of disturbance.

- Redundancy – *describes the ability of a species to adapt to changing environmental conditons over time. It is characterized by the breadth of genetic and environmental diversity within and among populations. The analysis identifies areas representing important geographic, genetic, or life history variation (i.e., the species' ecological settings).*
- Representation – *describes the ability of a species to withstand catastrophic events. Redundancy is characterized by having multiple, resilient populations distributed within the species' ecological settings and across the species' range. It can be measured by population number, resiliency, spatial extent, and degree of connectivity.*

Habitat, Life History, and Ecology

Habitat:

Summarize the habitat used by the species and include any species-specific information related patch sizes that was available in species reports. Include report reference(s) used for summary.

Diet:

For animal species summarize diet and include citation(s) used for summary. Note if dispersal distances for prey species were available in the species reports.

Pollination Type and Pollinator:

For plant species, summarize pollination mechanism(s) and pollinators when applicable. Note if the species has an obligate pollinator or species-species dispersal distances described in the FWS reports. Include a reference for the report(s) used to generate the summary.

Taxonomy:

Simple taxonomy description (e.g., terrestrial dicot plant)

Relevant Pesticide Use Sites

Describe any pesticide uses sites that are relevant for the species based on the information available in the FWS reports. Include a reference for the report(s) used to generate the summary.

Relevant Recovery Criteria and Actions

"Recovery actions" refer to the specific steps or activities taken to restore a system or population back to a healthy state after a disruption. These are often practical steps like habitat restoration, population augmentation, or invasive species removal., while recovery.

"Recovery criteria" are the measurable standards or thresholds that define when the species is considered to have reached a stable condition, allowing for potential removal from protected status or downlisting a species from endangered to threatened. There may be specific criteria for downlist a species and separate criteria for delisting a species. Example criteria include specific population numbers, habitat quality, or other measurable factors.

Information on recovery actions and criteria can typically be found in Species Status Assessment or Recovery Plans. Summarize the available information related to Relevant Recovery Criteria and Actions and include references to the reports used to generate the summary.

- Objective:
- Criteria**:**
- Recovery Actions**:**
- Recommendations for Future Actions/Actions Needed

3. Range

Summarize what is known about the species current and historical range. Include information on re-introduction sites when available. It is recommended to include the size of the current ranges, with a map, and the date of the last update. Include a reference for the report(s) used to generate the summary.

4. Critical Habitat

Summarize available information on the species critical habitat, including descriptions for the physical and biological features (PBFs) when available. It is recommended to include the size of critical habitat, with a map, and the date of the last update. Include a reference for the report(s) used to generate the summary. If critical habitat has not been designated for a species this can be noted.

- Essential Physical Biological Features (PBFs) for Designated Critical Habitat:

Summarize the PBF from the critical habitat designation when appliable/available
PBFs may include:

- *space for individual and population growth and for normal behavior;*
- *cover or shelter;*
- *food, water, air, light, minerals, or other nutritional or physiological requirements;*
- *sites for breeding and rearing offspring; and*
- *habitats that are protected from disturbances or are representative of the historical geographical and ecological distrubutions of a species.*

5. Known Locations

Summarize the available informaton on where species are known to occur. FWS reports often provide a summary of know location for the species, this may be specific survey locations or named areas such as parks, steams. Reports may include map or table that can be include in this section. This information can be found in any of the FWS reports but is often include in the species 5-Year Reviews. Include a reference for the report(s) used to generate the summary.

In addition to FWS reports, public databases may include addditional information, national databases include iNaturalist, GBIF, and the public information NatureServe Explorer Pro. States, including state heritage programs may also have publicly available databases. See Appendix 2 for additional data source suggestions. Section 4.2 includes specific consideration when review known location data.

It is recommended that developers check multiple sources for each species. For each source describe the data quality and how it was used to support core map development or validation. Including a map when available and the query used to identify the occurrences is helpful. If a subscription or other non-public data source is found please include this in the documentation for future consideration by EPA.

6. Additional Information *(Include when applicable)*

Additional information that may be applicable for certain species when appliable to the species

- *Species information that may affect types of available mitigation. For example, timing when the species is present such as breeding season, time above ground for invertebrates or other specific life-stage*
- *Existing conservation efforts for state or local government when noted in FWS documents*

Documentation Appendix 2. GIS Data Review and Method to Develop Core Map (Step 3)

The purpose of this appendix is to organize the GIS datasets and methodology used to generate the core map. This appendix can be skipped if all pertinent information is captured in the summary section at the beginning of the document.

1. References and Software

- *Include a list of the GIS data and software used to develop the core map. Please include citations and URLs for data when available. See **Appendix 2** for example datasets.*
- *Include citation and URLs when available*
- Software used: *Name of software with version number if applicable*

2. Datasets Used in Core Map Development

In this section describe each dataset used during core map development that includes a description of the data used. It is recommended to include the version or date accessed when applicable. For biological information core maps this should include the dataset used to set the outer extent of the core map.

2.1. Range

Recommended for all species, include the date accessed.

2.2. Critical Habitat

Recommended for all species when designated, include the date accessed.

2.3. Additional Dataset #1 -*replace with the name of the dataset*

If the dataset is included on the list found in Appendix 2, provide a description of the elements used and the reason it was chosen. Summarize information in tables or figures when applicable.

2.4. Additional Dataset #2 -*replace with the name of the dataset*

If the dataset is not included on the list found in Appendix 2, provide a description of the elements used, the reason it was chosen, and quality evaluation. Summarize information in tables or figures when applicable.

2.5. Core Map Development - *Update section title as applicable*

In this section include a summary of the steps and tools used to develop the core map. Including tools and parameters that would support repeatability and review. Screenshot or tables that summarize tool parameters may be useful for certain species.

2.6. Data Reviewed but not Used in Development – *Section may not be applicable*

If a dataset was reviewed and not used, including a description of the data and rationale for excluding supports future considerations of the dataset.

EPA recommends the developer combines all materials into a single zip file before sharing with EPA. For organizational purposes, the developer can group files into folders based on type before zipping, for example, species information, original GIS data, processed GIS files, final GIS files (including the resulting core map) and supporting documentation.

Appendix 2: Additional suggestions when reviewing GIS datasets to include in the core map development

The core map developer has discretion when selecting which GIS datasets to use to represent any particular area or habitat within an area. Developers should include rationales for selecting a dataset, assessing quality, and criteria used when extracting specific data from a given source for inclusion or exclusion in the core map documentation to support review, QA/QC and transparency. This appendix includes some general principles for selecting and working with GIS datasets.

Consideration of State and Local Datasets

For most species and situations, EPA recommends using national level datasets as they will provide enough information to develop a reasonable core map. A list of potentially useful national dataset sources is provided at the end of this appendix.

After considering the national dataset sources, if additional refinements are needed to produce a reasonable core map, then state or local datasets may be used. Local datasets may be managed by counties or location specific groups such as conservation commissions. These state or local datasets may offer valuable refinement particularly for species (1) found in one state, (2) with highly specific localized habitat, or (3) that have specific landscape requirements within the state or locality. See **Table 2-1** for examples. EPA anticipates additional non-national datasets to be identified during the development of core maps and intends to update the data sources included in this table accordingly.

When considering new datasets that have not been identified in this document, developers should ensure that the data is reliable by reviewing available documentation, accuracy assessments, and/or by comparing the data to other data sources with known quality metrics (such as data from US government sources). The developer should include a summary of these considerations in their documentation. Valuable state and local datasets often map similar information as the recommended national datasets found in this document; however, state specific considerations may be included in more locally managed datasets. For example, both the NLCD and LandFire map habitat landcover, with the LandFire dataset having more specific habitat classes compared to the NLCD. However, a state dataset, like the Cooperative Land Cover Map in Florida, may offer state specific habitat classes that are more applicable for a species compared to these national datasets. State datasets may also include local terminology that capture names of land areas not captured in the national dataset. States may also have datasets that map features that are unavailable or difficult to map at the national level. For example, California has a GIS dataset that maps vernal pool complexes as areas of conservation emphasis. Additional habitats that may be available at a local level include sink holes and disappearing steams. EPA plans to maintain a list of state and local datasets that have been reviewed and included in core maps as these datasets may be a valuable resource for other species found these locations (**see Table 2-1)**.

EPA recommends starting with national layer(s) and moving to these state or local layer(s) to help fill in gaps or add refinement when needed. When making a final selection on the utility of datasets, the age and quality should be considered with preference towards recent higher quality data that are updated regularly. The developer should adjust the best professional judgment level described in Section 3 of this document accordingly based on the assessment of the dataset quality and applicability. For

example, using older dataset should increase the best professional judgement level assigned to the core map. Generally speaking, EPA recommends using datasets that are less than 10 years old. Older dataset may still represent best available data, especially when the data represents features that do not change such as geomorphic formations or land parcels. However, when comparing the habitats from the LandFire and GAP, the more recent LandFire dataset will likely be best unless there is a localize reason to focus on the older GAP dataset.

Complexity of Core Maps

The core map should represent a reasonable delineation of the areas needing protection based on best available species and GIS data. Combining multiple GIS data sources often increases the complexity of the resulting core map (e.g. number of vertices, boundaries with right angles and sharp edges). The resulting complexity of the core map should be considered when making dataset selections. As the complexity increases, the performance of the Bulletins Live! Two System may decrease. Therefore, additional data sources and additional complexity should only be added as a refinement to a core map when the improvement to the core map is significant enough to warrant its inclusion. The developer should consider if the additional data source/refinement reducing the uncertainty and judgement used in the core map. For example, comparing and combining multiple habitat datasets may reduce uncertainty allowing the developer to reduce the best professional judgment level for the core map. The smoothing process described in **section 4,** and in more detail in **Appendix 3**, will address some of the unnecessary complexities after the core map has been created.

Known or named locations:

Known locations can be valuable when developing a core map. Known locations may be available in the form of descriptions of places, which can be represented spatially using polygons. These descriptions may be names of waterbodies (*e.g.,* specific rivers and mile segments, ponds), protected lands or places (*e.g.,* state parks, preserves, wildlife refuges) or geographic features (*e.g.,* cliffs, ridges). FWS typically includes descriptions of known locations, including occurrence data and descriptions of places, in its species documents (*e.g.,* 5-year reviews, species status assessments). FWS may also identify priority management areas for species (*e.g.,* high priority zones, focus areas, special emphasis areas). Common national datasets for identifying these named locations include the USA Federal Lands Layers, US Protected Lands layers, and NHDPlus. Tax parcels, state/county or local datasets for management areas or streams may offer additional names/classification for areas that are difficult to identify or are state specific. In addition to these named locations, occurrence points may be available from public databases such as iNaturalist, Global Biodiversity Information Facility (GBIF), and NatureServe Explorer. Additional sources such as eBird may be specific to certain taxa, and states may also have information available on occurrences. As described in **Section 4** of this document, the developer should evaluate the robustness of the available known location/occurrence information but consider number, reliability, age, resolution, and timing of the occurrences. The level of robustness influences how the data is used in the core map development. Even limited high quality data may be useful in evaluating a core map as a line of evidence that occupied areas are captured in the core map. For species with more robust data, the known location/occurrences may be useful in refining the core map. As described in more detail in **Section 4** of this document**,** description or categorization of the reliability and completeness of known location/occurrences from FWS are assumed accurate, and no additional evaluation is needed. When evaluating point locations or points that have been generalized to a land area, generally a species with 30 or more occurrences that cluster in one or more locations represent a high number of occurrences.

However, the developer should compare the number and distribution of the available occurrences to the relative size of the species range. The number used to define "high" may be reduced for species with smaller ranges based on the judgment of the developer. Recent occurrences should be given more weight than historical occurrences.

EPA recommends focusing on occurrence data from the last 15 years for species with a high number of occurrences; however, the developer may expand this time-window up to 50 years when only a few occurrences are available (<5). In this situation, older occurrence data should be evaluated carefully for relevance because populations may be historical or extirpated from those location. EPA recommends weighing data points that include an indicator of positional accuracy over data without positional accuracy. iNaturalist and NatureServe data often include positional accuracy, while GBIF and eBird only include positional accuracy for some observations. Occurrence data collected by state heritage program scientists (NatureServe) or verified by a photo, sound, or from another user of a platform (iNaturalist - "research grade") should also be weighed higher than those that do not. Verified occurrences should be given preference over unverified occurrences, and the developer should be careful to filter out occurrences from zoos or museums. For these reasons, when supplementing FWS' occurrence data, EPA recommends starting with iNaturalist and NatureServe data, and then, if needed, supplementing occurrence information with other sources to increase robustness. Developers need to be aware that often points from iNaturalist are duplicated in GBIF, and these points should not be counted twice. Developers should include the data source or sources for any occurrence data with a justification for the search or filtering criteria and an assessment of robustness in the core map documentation. EPA also recommends reviewing multiple sources of data as occurrences may not be the same across all sources. Many public databases obscure point location to protect the exact location of the species. Therefore, it may be useful in some situations to generalize point locations to an area that is likely to capture the occurrence. For example, generalizing to a HUC-12 watershed may be appropriate in some cases; however, the developer can consider other generalization options. Specifically, when using public iNaturalist points that are often obscured to a ~ 30 km accuracy, HUC-12 may be a good choice because they represent an area of ~40-160 km^2. A justification for the generalization process should be included in the documentation and considered when evaluating best professional judgement.

If no public GIS datasets can be found to support mapping known locations, then the developer can digitize a PDF or paper map if available to create a GIS file. However, this option increases the level of judgement used when developing a core map. If a proprietary dataset is available, it is recommended to note the owner of the data in the documentation. If the data are not publicly available or accessible, then EPA may not be able to fully utilize it.

Datasets for mapping species biological information

A number of GIS datasets will be available to support the identification of areas that the meet species biological information or requirements. These specific characteristics include but are not limited to habitat, landcover, elevation, slope, soil, geomorphic features, human footprint, and canopy cover.

When datasets offer multiple scales of data, for example land cover or land use data, it is recommended to use a medium-level of resolution as a starting point to minimize unnecessary complexity in the resulting core map. In the LandFire land cover data, this would equate to using the "Group Level"

(EVT_GP_Name) from the attribute table when selecting vegetation classes[65]. For example, the LandFire data layer is based on the National Vegetation Classification, which uses the group name differently compared to the LandFire attributes. The finer scale data may be more applicable for species with highly specific habitat or biological requirements that are accurately captured in the GIS datasets. Generally speaking, when developing a core map involves selection of 30 or more attributes from a GIS layer, EPA recommends moving up a level in resolution when available. EPA believes this will apply mostly to habitat selections. For the NHDPlus, EPA recommends using version 2 medium resolution hydrography for aquatic species as a starting point. This will be sufficient for most species. However, in specific situations, it may be appropriate to use the high-resolution dataset. As stated above, documenting these considerations is recommended for the purpose of transparency and reproducibility especially when deviating from the recommendation found in this document.

In addition to using datasets to identify habitats or areas where species are more likely to be, developers should also consider datasets that remove areas from the core maps when a species unlikely to be found in a particular type of habitat within its range. For example, if available species information does not identify preferred or suitable habitat for a species but does identify unsuitable habitat that can be mapped, then those types of areas may be able to be removed from the core map. Developed and cultivated areas are two habitats commonly identified as unsuitable for listed species. In a situation where the species is unlikely to occur in developed areas, all habitats except the developed class can be extracted from the selected habitat layer. When species are unlikely to occur on cultivated land, these areas may be removed from the core map. In such cases, EPA recommends using the modified cultivated layer[66] developed for this purpose and available on EPA's GeoPlatform to remove cultivated land from a core map. As noted in **Appendix 3**, the core map smoothing process eliminates all interior holes in a core map that are less than 25 acres. Many of these relatively small interior holes will be covered during the PULA buffering process and eliminating them at the core map stage simplifies the core map and reduces areas that are mis-classified. EPA will apply this step of removing cultivated land from species not found on agriculture fields as part of the QA/QC review if appropriate and the developer does not perform this step. When working with these datasets, developers should consider if removing these areas would provide a significant enough refinement to warrant the additional complexity of the core map. Justifications for including or excluding data should be highlighted in the core map documentation, examples can be found in the species documentation released by EPA. During QA/QC review EPA may reach out to the developer if additional justification is need or with questions.

[65] https://www.landfire.gov/vegetation/evt

[66] https://epa.maps.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668

Example National and Global Level GIS Datasets

Table 2-1. Example national level GIS datasets to support core map development. This table will be updated as additional national sources are reviewed for use in core map development. EPA does not expect a developer to purchase any data and does not endorse any individual non-government data source. If a subscription-based dataset is identified by the developer, this should be included in the documentation for future consideration by EPA.

Data Source	Data Service (if available)[1]	Data Download
Species range and critical habitat from FWS	EPA species[1] and critical habitat[1]- Data services updated from ECOS each week, use the "Diced Species Range"	Species Profile on ECOS
National Land Cover Database (NLCD)	NLCD -Data service from ESRI Living Atlas[1]	NLCD- Data downland MRLC
Crop Data Layer (CDL)	USA Cropland- Data Service from ESRI Living Atlas[1]	USDA - National Agricultural Statistics Service- Research and Science - Cropland Data Layer Releases
EPA's Use Data Layer	EPA – Links to the Image Services	Available for download from the content item page for the UDL
EPA's Modified Cultivated layer	N/A	Data Download
National Wetlands Inventory (NWI)	NWI – Data service from ESRI Living Atlas[1]	NWI – Data download from FWS
LandFire Existing Vegetation Type (EVT) layer or other LandFire layers	Existing Vegetation Type (EVT) – Image service from USGS	LandFire Homepage
Gap Analysis Project (GAP) Landcover	Gap Analysis Project (GAP) Landcover – Data service from USGS	Data download from USGS
National Hydrology Dataset (NHD)	Data services from ESRI Living Atlas: NHD version 2.1[1] and high resolution[1]	Version 2.1 data download from EPA's Office of Water High resolution data download from USGS
Protected Land Database - PAD-US	PAD-US: Data service from ESRI Living Atlas[1]	Data download from USGS
EPA StreamCat metrics	N/A	StreamCat homepage
EPA LakeCat metrics	N/A	LakeCat homepage

Data Source	Data Service (if available)[1]	Data Download
USA Federal Land	USA Federal Land- Data service from ESRI Living Atlas[1]	Data can be exported to FGDB
USA Conservation Easement	USA Conservation Easement – Data Service from ESRI Living Atlas[1]	National Conservation Easement Database
Digital Elevations Model (DEMs)	N/A	USGS- Data download
Impervious (NLCD)	Impervious- Data service from ESRI Living Atlas[1]	NLCD- Data downland MRLC
Human footprint (NASA)	Human footprint -Data service from NASA	NASA – Data download
Tree canopy cover (NLCD)	Tree canopy cover- Data service from ESRI Living Atlas[1]	NLCD products- Data downland MRLC
EPA Ecoregions	N/A	EPA Ecoregion home page
State Geologic Map Compilation (USGS)	State Geologic Map Compilation - Data service from USGS	USGS: Data download
Soils (SSURGO) – metrics include but not limited to • Soil types • Depth to bedrock • Soil moisture • Soil pH • Growing degree days • Evapotranspiration • Palmer's Drought Severity Index	USA Soils - Data service from ESRI Living Atlas[1]	USDA SSURGO: Data download
NatureServe Explorer Pro – Species Occurrences	N/A	NatureServe Explorer Pro home page
GBIF – species occurrences	N/A	GBIF home page
iNaturalist - species occurrences	iNaturalist Observations - Data services from ESRI Living Atlas[1]	iNaturalist home page
eBird	N/A	eBird home page
Berkeley Ecoinformatics	N/A	Berkeley Ecoinformatics home page
VertNet	N/A	VertNet home page
iDigBio	N/A	iDigBio home page
OBIS	N/A	OBIS home page

Data Source	Data Service (if available)[1]	Data Download
Political Boundaries	Counties – Data service from ESRI Living Atlas[1] States – Data service from ESRI Living Atlas[1]	US Census Bureau - TIGER
Hydrologic Unit Code (HUC) Boundaries	HUC boundaries identified by unique 2- to 16-digit codes. Can be downloaded through ESRI Living Atlas – link for search • Data service[1] from ESRI Living atlas for HUC -12	Access National Hydrography Products | U.S. Geological Survey EPA also hosts a snapshot available for download
River mile, and upstream/ downstream search	WATERS GeoViewer | US EPA	WATERS GeoViewer | US EPA
Global Canopy Height	Global Canopy Height 2020[1]	ETH Global Sentinel-2 10m Canopy Height (2020) - awesome-gee-community-catalog
OpenStreetMap (OSM)	OSM- Data Service ESRI Living Atlas[1]	Data Download
United Nations Environment Programme (UNEP)	N/A	Data Download
NASA Earth Observations (NEO)	N/A	NASA: Data Download
Sentinel Satellite Data	N/A	Data Explorer
FAO GeoNetwork	N/A	Data Download
World Terrestrial Ecosystems (WTE)	World Terrestrial Ecosystems -Data Service from ESRI Living Atlas[1]	USGS: Data Download
WorldClim	N/A	Data Download

[1] Included in the OCSPP - Available Data Options (PULA) group on the EPA GeoPlatform. Log-in may be required using your EPA GeoPlatform account.

Table 2-2. Example state or local level GIS datasets that may be useful to support core map development. This table will be updated as additional non-national sources have been reviewed for use in core map development.

Data Source	Data Service (if available)[1]	Data Download
Tax Parcels	N/A	May be available from states • Wisconsin
Florida Geomorphology Provinces	Data service from Florida Department of Environmental Protection	Data download from Florida Department of Environmental Protection
Wildlife Management Areas Florida	Data service from Florida Fish and Wildlife Conservation Commission (FWC)	Data download from Florida Fish and Wildlife Conservation Commission (FWC)
Florida Cooperative Land Cover Map (CLC) Version 3.7	N/A	Data download from Florida Fish and Wildlife Conservation Commission (FWC)
Michigan DNR Parcels	Data service from Michigan department of natural resources	Data downland from Michigan department of natural resources
Vernal Pools -ACE	Data service from the California Department of Fish and Wildlife	Data download from the California Department of Fish and Wildlife

Appendix 3: QA/QC Checklist and Smoothing Process

EPA is committed to quality assurance for the data EPA considers and relies on for its actions. Incorporating quality assurance improves EPA's policy making and analysis and helps drive reliable and defensible decisions. The QA/QC process applied to the core maps will evaluate whether species core maps are reasonable and sufficient for PULA development by reviewing the following elements:

- rationales for selecting the core map type are clear, transparent, and supported by FWS documents;
- species information, known location/occurrence, and GIS data used to create core maps are of sufficient quality for use in PULAs; and
- steps used to create the core map are transparent and repeatable.

During QA/QC, EPA will review the data sources and selection criteria used by the developer to confirm alignment with the FWS reports and quality as describe in **Section 4** of this document. EPA will conduct two types of review. One focused on reviewing the species information from FWS reports, species known locations, and the selection of the core map type. The second focused on the GIS datasets and core map development. As a result, most species will have at least 2 EPA reviewers, allowing each reviewer to focus on areas that align with their expertise. In some situations, one reviewer may have the expertise to conduct both reviews. To facilitate QA/QC review, the core map developer should provide sufficient documentation to:

- allow for an independent evaluation of the rationale used to select the core map,
- verify that the information representing the species is consistent with FWS reports and other available sources,
- verify the rationales used when selecting GIS datasets and assessing them for quality,
- verify that the GIS steps used to develop the core map were carried out correctly; and
- confirm the core map includes complete metadata for the core map layer.

During QA/QC, the EPA reviewer will confirm the selected core map type aligns with the available species information from the FWS reports and the review of known locations/occurrences is complete, transparent, and repeatable. Each core map should be based on the best available information for the species, and EPA understands the quality of this data will vary from species to species. For species with many known location/occurrences the developer should focus the selection on highest quality data as described in **Section 4.** For some species, the developer may need to select and develop core maps based on limited information. The EPA reviewer will evaluate the selection criteria used by the developer for the available known location/occurrence. During the QA/QC process, EPA may reach out to the developer if they identify additional or newer data sources that could change the core map, or if they have question on the selection criteria.

For maps based on biological information, EPA will confirm the rationale for selecting the core map type is supported by the current FWS reports, the selected biological requirements for developing the core map align the FWS reports, and confirm the selected GIS layers accurately represent the species' biological requirements. During the QA/QC process, EPA will review the rationales for selecting a GIS dataset and confirm the selected datasets are of sufficient quality, as describe in **Section 4**. In some situations, available GIS datasets may not exactly match the biological requirements for the species, and the developer will need to make assumptions. For example, vernal pools have proven difficult to map and the developer may need to select a surrogate habitat introducing additional judgment. EPA will

review the rationales from the developer regarding assumptions when mapping the biological information to ensure sufficient quality and certainty for use in PULA development. Some species may only have limited or uncertain data related when mapping biological information. In this situation, the developer should include these considerations in the justification and assign a high level of judgment associated with more uncertainty. Core maps will be reviewed by FWS species experts, and EPA may prioritize review of maps with the highest-level of judgement and uncertainty. Additional external review may occur if needed to address outstanding questions for a map. In addition to the rationale and evaluation of the selected GIS datasets, EPA will review the GIS steps used by the developer to create the core map to confirm execution, transparency, and repeatability. Across all core map types, the QA/QC reviewers may make adjustments to the documentation based on information included in the submitted documentation from the developer. Additional detail and examples of the type of adjustments/edits EPA anticipated are included below in the descriptions of the QA/QC classifications.

EPA's QA/QC reviewers will use a checklist (**Table 3-1)** found in this appendix to facilitate their review and to document that the documentation provided by the developer is clear, represents species information found in available FWS documents, and that GIS steps are transparent, repeatable and align with the species information. At the end of the QA/QC each species and core map will receive one of the following classifications:

- Sufficient-as is
    - No adjustments made during the QA/QC process, and no major discrepancies identified by the QA/QC reviewers.
- Sufficient -with revisions made during the QA/QC process
    - Adjustments made by one of the EPA reviewers based on cited information found in the documentation or through the application of the smoothing process described in this appendix. EPA recommends the developer provide intermediate GIS data (*e.g*., results from various steps in the development process) with the draft core map to support review and potential adjustment. Any adjustments made by EPA's QA/QC reviewers will be included in the review documentation. Three example adjustments to the core maps include:
        - The smoothing process resolved anomalies found in the core map, and/or file size concerns. Details on the smoothing process are included later in this appendix.
        - Update of the core map outer extent to address possible human error based on the cited information in the documentation. For example, if a developer identified 8 counties where the species is known to occur based on a FWS report but included 10 counties in the core map. In this situation the EPA reviewer will update the core map by setting the outer extent to the 8 counties.
        - Removal of cultivated land from the core map when applicable for the species.
- Sufficient- after receiving additional information from developer
    - An element initially flagged as a discrepancy was addressed through follow-up with the developer. The information and any edits made to core map by the reviewer will be documented in the QA/QC review and included in the core map documentation. If EPA is unable to resolve concerns identified in the QA/QC review with the developers, then the core map will be noted as insufficient.
- Not reasonable/ insufficient documentation
    - The core map or documentation does not include enough information to confirm completeness, transparency, and repeatability, and EPA was unable to resolve these discrepancies with the developers. Examples of missing information that would result in

an insufficient classification include missing data sources or citations, incomplete justifications for core map selection, missing data files, and not having enough information to repeat GIS steps.

During the QA/QC process, EPA may reach out to the developer for additional information to support QA/QC review, particularly when it's initial conclusion for a core map is not reasonable/insufficient. If EPA is unable to resolve the concerns through review or follow-up with the developer, the core map will be classified as not reasonable/insufficient and EPA will not use the core map to develop PULAs.

Table 3-1. QA/QC checklist EPA intends to use for reviewing species core maps

	Data Element	Type of information (if applicable)	Comments
PULA Submission Information	Species Name		
	ECOS Listed Species ID		
	Submitted by		
	Date Received		
	Reviewed by		
	Date Review Completed		
	Best Professional Judgement Category	1-None, 2-Limited, 3-Average, 4-Moderate, 5-Significant	EPA will review decision points related to data interpretation and uncertainties. EPA may seek input from experts as needed.
Files provided	Documentation File Name		
	Core Map File Format	Shapefile, fgdb etc	
	Support Images (in documentation?)	Present/Not Present	
	Core Map Filename		
	Core Map Type	Critical Habitat/Range/Biological Information	
	Core Map Justification	General description based on documentation	
	GIS Source Range	FWS/Other with source name	
	GIS Source Critical habitat	NA/FWS/Other with source name	

	GIS Sources - Known Location	List of data sources	
	GIS Sources - Biological Information used in core map	List of data sources	
	Supporting GIS data provided	List of data sources	
	Citations for GIS Data	All/All-Used in Development of Core Map/None	
	Other GIS data reviewed or provided but not used in core map development	List of data sources and summary	List of reviewed data sources and description on why it wasn't uses. For example, after reviewing biological information and complementary GIS data the developer decided the range was the best option for a core map.
	Recommendation for additional non-public data?	No/Yes - name of source	The developer may identify a non-public data source to support future refinement or address uncertainty.
Documentation and process steps	Background Information for Core Map Selection	Present/Not Present	
	Core Map metadata (how acquired)	General description based on documentation	
	Core Map Outer Extent	Range/Critical Habitat/Other (with description)	Examples may include occupied counties, recovery units, named waterbodies, known location.
	Species found on agriculture land?	Yes/No	
	General Process steps documented?	Adequate, insufficient, none	Adequate: there is enough information to understand the why each step was executed and to duplicate the process. EPA may for the additional information as needed.

	Supporting information for processing steps	NA, Type of information, insufficient, none	Examples could include tables used to select specific attributes such as habitat class, tables used to reclassify GIS data, or example code used in development. If information needed to duplicate a processing step is unavailable in the documentation EPA may for the additional information as a follow-up.
	Citations and bibliography complete?	Full Citations, URLs, General Reference, missing citation for GIS dataset, missing citation for supporting information, none	Missing citation for either FWS documents, GIS datasets or other supporting information may need follow-up before the core map is used.
GIS Files Review	Metadata	Present/Not Present	
	Lineage in Metadata?	Yes/No	
	Consistent with documentation?	Yes/No	
	Flagged concerns on process? (Qualitative)	Description or none	
	File Sizes issues?	No/Yes	
	Resolution issues?	No/Yes with description e.g. holes, silvers, raster to polygon, over precision	
	If multiple layers in one feature class, are appropriate attributes available to extract the Core Map?		
GIS Data QA	Check Extent of Core Map	Confirmed/Correctable/Not Correctable (with description)	This may be corrected during the QA/QC process if the outer extent is noted in the documentation and includes a citation.
	Spot checks of the data	General description	Additional scrutiny may be needed for core maps with a higher level of BPJ.
	Review of process steps	Description of the review	
	Digitized Files?	No/Yes	

	Digitized File description	Looks good/ Not good with description	If the reviewer is unable to match the digitized files with the original document, the classification will be set to "Not good"
	Holes or Slivers?	No/Yes	
	Other concerns?	Description or none	
	Agreement with BPJ category?	Yes/No	
	General assessment of quality?	Sufficient-as is/ sufficient - with revisions made during the QA/QC process/ sufficient after receiving additional information from developer, insufficient	EPA may reach out to the developer for additional information if clarification is needed. Example includes missing citations, clarifying selection criteria, or other processing steps for repeatability
Edits, Smoothing, and Buffering	Were any polygons or areas of polygons erased using cultivated layer?	Yes/Done by the developer/NA	
	Smoothing applied?	Yes/No/NA	
	Were any polygons eliminated based on minimum mapping unit considerations?	Yes/No	Note if a species-specific value is available in documentation
	Did the smoothing process address the concerns related to file size, resolution, holes, etc)	NA/Yes/No	
	Description of other changes (if any)		Other changes made during QA/QC
	Added to the GeoPlatform Layer?	Yes/No	
	Final core map name		

Smoothing of Complex Core Maps

At the end of the QA/QC process, when a "sufficient" classification has been reached, EPA will apply a smoothing process to core maps with the purpose of eliminating anomalies found in GIS datasets and reducing overall file size when needed. EPA believes the smoothing process will be applied mostly to biological information core maps that rely on modeled GIS dataset such as landcover and hydrography to develop the core map. Anomalies may also be introduced when converting remotely sensed raster

dataset to polygons or using geo-processing tools to combine datasets into a single core map. Removing these anomalies will reduce the overall file size of the core maps. unnecessary complexity in the core map will reduce the performance of the Bulletins Live! Two system[67]. Remotely sensed or modeled datasets are the primary targets of this process, not delineated areas like critical habitat or known locations. Development of delineated GIS datasets does not introduce these anomalies like modeled GIS datasets do.

There are three parts to the smoothing process: (1) removing small patches that GIS data sources identified as habitat that are disconnected from other areas of the core map that were likely identified in error; and (2) filling in small patches or holes not identified as habitat that are surrounded by areas identified as habitat for a species (filling in small areas likely missed due to error). EPA will also remove cultivated land from a core map in cases where the map developer has not done when appropriate for a species. This step is executed prior to the smoothing process when needed.

A single set of criteria to remove anomalies, which are mapped locations that appear to be errors in the data, found in a core map does not exist. To support identification and elimination of anomalies in core maps, EPA will use a minimum mapping unit of 2 acres for species core maps. Patch size requirement for species can vary across species, quality of habitat, and landscape context. Use of a 2 acre minimum mapping unit for species core map is below the smallest patch size requirements for most taxa[68,69,70,71]. For this reason, the smoothing process will target and remove anomalies/artifacts and non-usable patches for a species. As a result, the elimination of these anomalies will not impact the integrity of the core map or resulting PULA. The smoothing process is meant to target remotely sensed or modeled datasets that include these anomalies, not defined or delineated areas like critical habitat or known locations. For this reason, if a delineated area like critical habitat is inadvertently removed during the smoothing process, EPA plans to add these areas back to the core map before finalizing.

The EPA review team may execute several steps to refine the core map boundaries. For species with biological information core maps, that are not found on agricultural fields EPA will confirm cultivated land has been removed using the modified cultivated land layer available for download on the EPA GeoPlatform[72]. Based on the 2023 cultivated land from USDA[73], EPA generated this layer to support core map development, by converting cultivated land to a polygons and eliminating areas below 25 acres, see **Appendix 5** for additional details. The 25 acres area was selected for this step because this is the area that will be filled in when addressing interior holes during smoothing as noted below in the following steps. The purpose of this layer is not to identify all agriculture fields rather to identify large continuous areas of agriculture that would not serve as species habitat. This step should only be applied for species with biological information core maps not found on any type of agriculture field unless there is strong

[67] https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/dicing-godzillas-features-with-too-many-vertices/

[68] https://www.fs.usda.gov/nac/buffers/guidelines/2_biodiversity/2.html

[69] https://www.fws.gov/sites/default/files/documents/Section%207%20guidance%20for%20rusty%20patched%20bumble%20bee%20%28Bombus%20affinis%29.pdf

[70] https://www.federalregister.gov/documents/2024/02/15/2024-03042/endangered-and-threatened-wildlife-and-plants-threatened-species-status-with-section-4d-rule-for-the

[71] https://www.makingnaturescity.org/urban-biodiversity-framework/patch-size/

[72] https://epa.maps.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668

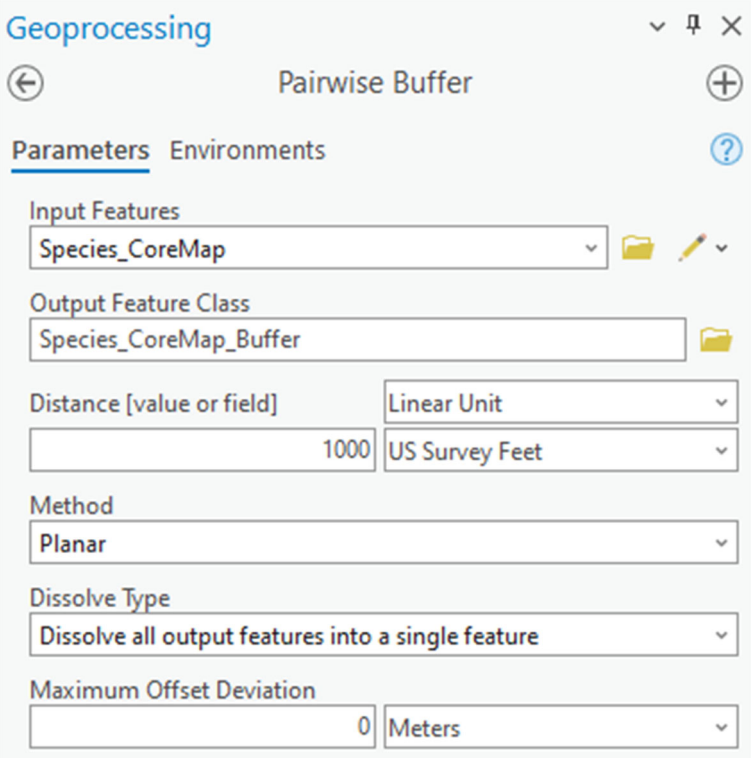
[73] Based on the 2023 cultivated land layer from UDSA NASS converted to a polygon, layer found on https://www.nass.usda.gov/Research_and_Science/Cropland/Release/

support in FWS species reports to focus on specific crops. These areas should be removed from the core map using ESRI's Pairwise Erase Tool[74] using the following parameters.

For biological information core maps, if the developer has not removed cultivated areas using this layer and it is appropriate to do so for the species, then this may be done by EPA during QA/QC. If a species is likely to be found on one or more types of crop fields this step would not be appropriate and would not be performed.

EPA also plans to eliminate polygons from remotely sensed data sets (not range or critical habitats) that are less than 2 acres and are disconnected from all other areas of the core map by more than 1,000 feet. These polygons likely represent locations that are either erroneously identified as suitable habitat or that are inconsequential for overall species conservation due to size and fragmentation. Polygons with a total area below 2-acres add unnecessary complexity to the GIS file. As a default, EPA will use 2-acres as a minimum mapping unit; however, if available information from FWS supports a smaller minimum mapping unit for a specific species, EPA recommends that the developer include this information in the documentation so that EPA can adjust the value accordingly. To support the identification of these small, disconnected polygons, EPA will first apply a temporary 1,000-foot buffer using ESRI Pairwise Buffer tool[75] using the following parameters. The buffer is not permanently added to the core map, rather it is used as a tool to support the identification of the disconnected polygons.

[74] https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/pairwise-erase.htm
[75] https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/pairwise-buffer.htm



Note: the input feature may be the core map or the core map with cultivated land removed depending on the species

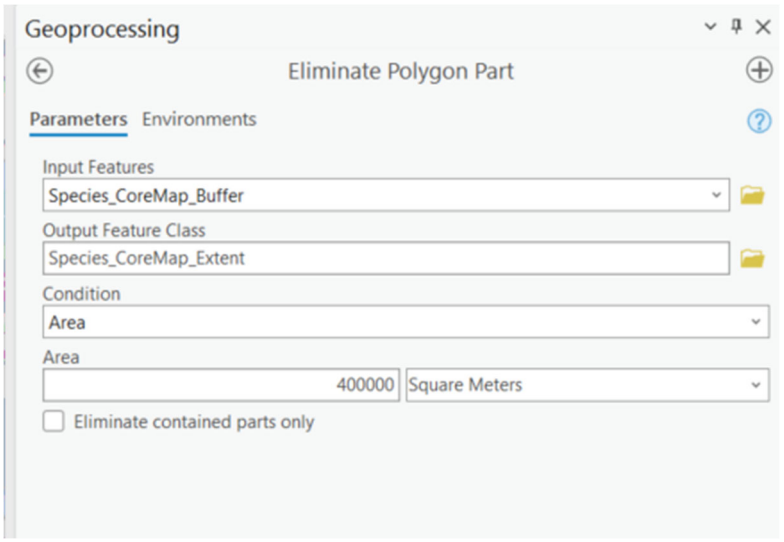
After adding the temporary buffer, EPA will eliminate polygons below the minimum mapping unit of 2 acres, which is 400,000 square meters after a 2-acre area has been buffered by 1000 ft (see calculations below). This value will be used as a default for all species and approximately equals a 2 acres polygon buffered by 1,000 feet ***that is disconnected from all other polygons in the core map***, see calculation below.

2 acres = 8093.71 square meters
Area for a 2 acre circular polygon: 8093.71 square meters= pi r^2
Radius for a 2 acre circular polygon: r = sqrt(8093.71/pi)
r= 50.757 meters

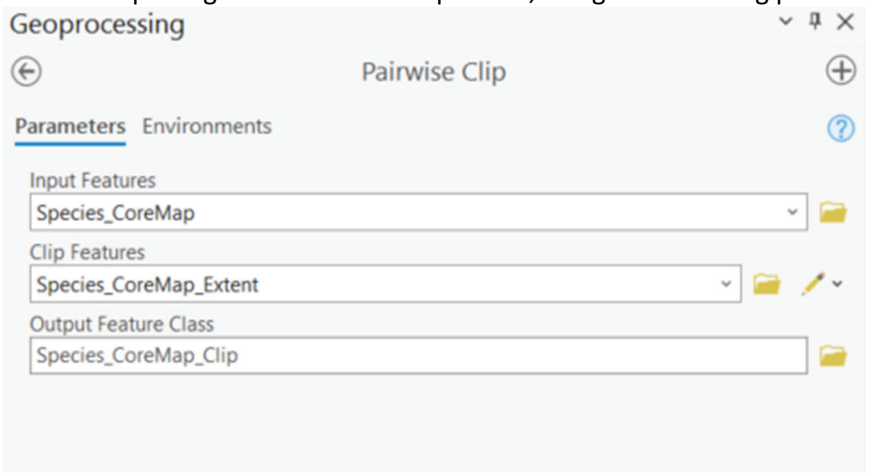
Distance to be added to radius for buffer area: 1,000 feet = 304.8 meters
total radius: 50.757 meters + 304.8 meters = 355.55 meters
Total area with buffer: pi (355.55m)2
A= = 397,163 square meters rounded up to 4000,000 square meters

After buffering, the EPA review team will eliminate all polygon parts from the buffered layers below 400,000 square meters in area (this includes both standalone polygons and internal holes) using ESRI Eliminate Polygon Part tool[76], using the following parameters.

[76] https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/eliminate-polygon-part.htm



EPA will use the file generated from the elimination tool to remove the disconnected 2-acre or less polygons from the core map using ESRI's Pairwise Clip Tool[77], using the following parameters.



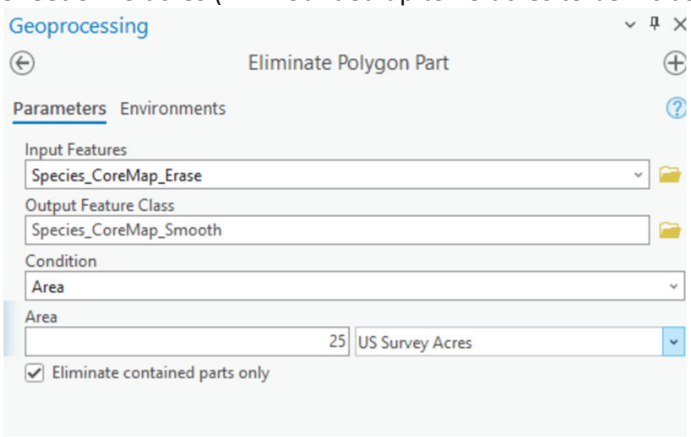
The third part of the smoothing process will simplify the boundaries of the remaining polygons, by filling in gaps or "holes[78]" that are found within an otherwise continuous area of the core map. **Figure 3-1** is an image of "holes" found in a polygon generated following the execution of a GIS processing tool. Put a different way, these small patches are holes that are surrounded by areas identified as suitable habitat for the species. These artifacts are often the result of using one or more geo-processing tool when creating a core map. Similar to the elimination of small, disconnected polygons, filling in these holes does not impact the final PULA because these areas would likely be added anyway when buffering a PULA to account for exposure from adjacent areas to the core map due to run-off or drift. Filling in these holes in the core map also reduces the complexity and size of the GIS layer. EPA will fill in these holes using the ESRI Eliminate Polygon Part tool, with the parameters set to only "eliminate contained parts". EPA will fill in interior areas of 25 acres or less because areas of this size would routinely be filled in

[77] https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/pairwise-clip.htm
[78] Holes: a small gap in an otherwise continuous polygon that is an artifact/error

during the PULA development process anyway (see calculation and tool parameterization below assuming a 1000-ft adjacent area (buffer) is added to a core map when developing a PULA.

Figure 3-1. Examples of the "hole" artifact that may be generated during core map development. Holes less than 25 acres that are surrounded by areas in a core map would be added to the core map.

Assuming a gap that is 1,000-feet across that will be completely enclosed after buffering 1,000-foot
Area of a square = length x width or 1,000 feet *1,000 feet
A= 1,000,000 square feet or 23 acres (EPA rounded up to 25 acres to be inclusive and protective)



After applying the smoothing process, the EPA reviewer will manually compare the smoothed core map to the source core map and other reference data for logical consistency. During this comparison the reviewer may flag areas of concern from the smoothing process for further review by subject matter experts. During this comparison, if the reviewer determines critical habitat or delineated known locations below 2 acres were unintentionally removed, the reviewer will add these areas back to the

smoothed core map. For this reason, the developer should include non-remotely sensed data when sharing materials used to develop core maps with EPA, especially when the total area is small.

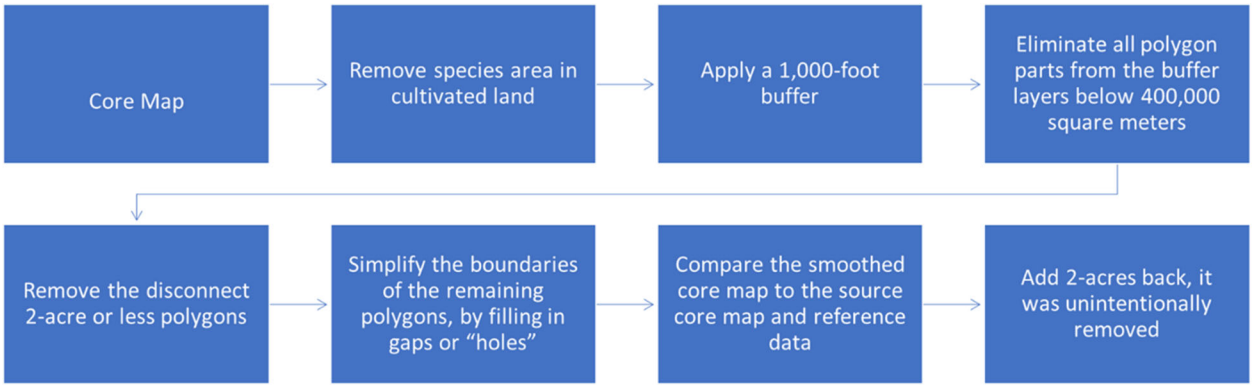


Figure 3-2. Removal of cultivated land and major smoothing steps (when applicable).

After completing all review steps and applying any necessary smoothing processes, EPA will make the species core map available publicly on the EPA GeoPlatform as a GIS layer. EPA will use this core map layer when developing PULAs, described in **Section 7** of this document.

Appendix 4. Description of modified cultivated land spatial layer for use in core map development

When creating biological information core maps, developers should consider whether a species uses agricultural fields as habitat. When a species does not use agricultural fields as habitat, these areas can be removed from the core map. For consistency across core maps, EPA created a modified cultivated layer based on USDA's 2023 cultivated layer[79] that it will use to remove agricultural fields from core maps. USDA's cultivated layer is based on the 5 most recent years of the Cropland Data Layer (CDL). The layer includes all cultivated areas found in at least two of the first 4 years and all cultivated areas from the most recent CDL. Cultivated land includes orchards, vineyards, Christmas trees, row crops, specialty crops, and flooded crops. Including multiple years helps identify fields that may rotate between crops across years. This layer includes fallow or idle cropland but does not include rangeland, non-alfalfa hay or pasture area, which aligns well with the recommended species considerations. The paragraph below explains how and why EPA modified this cultivated layer for use in core map development.

The purpose of this layer is to identify large continuous areas of agriculture that would not serve as species habitat, not to map all agriculture in the United States. Landcover data, like the CDL, is generated by applying a classification process to images taken using remote sensing software (e.g., satellite or drones) to identify specific landcover classes. This classification process often results in many isolated small areas of data that are misclassified or have limited relevance to an analysis[80]. For this reason, EPA took several steps to simplify USDA's cultivated land layer to include large contiguous areas of agriculture.

1) First, EPA removed all cultivated areas that are 2 acres or less using the Majority Filter tool[81]. Two acres was chosen because most fields in the United States are larger than 2 acres, with the median field-size increasing over time[82]. Removing these small areas first allows for easier processing during the remaining steps.
2) Next EPA used the Boundary Clean Tool[83], to smooth boundaries. This tool expands and shrinks the boundaries to allow larger continuous areas to include smaller non-continuous areas, supporting the removal of small, isolated areas.
    a. As noted in **Appendix 3,** the core map smoothing process eliminates all interior holes in a core map that are less than 25 acres. These relatively small interior holes will be covered during the PULA buffering process and eliminating at the core map stage simplifies the core map.
    b. As a result, if a cultivated area of 25 acres or less is removed from the interior of a core map, this area will be added back during the core map smoothing.

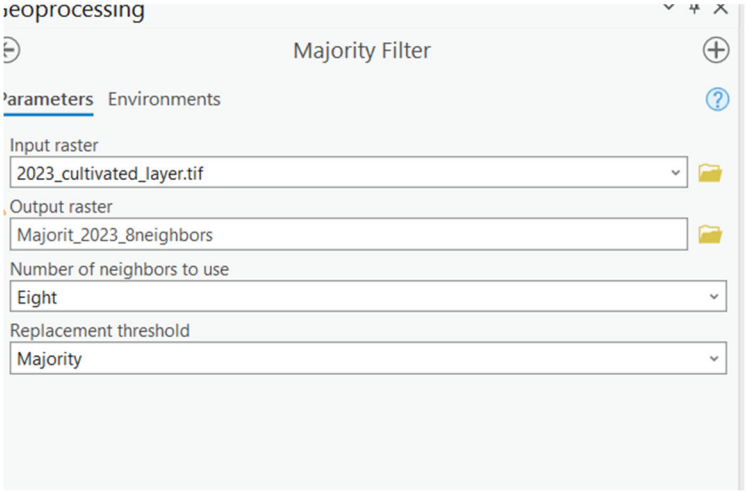
[79] A full list of crops found in the UDSA cultivated layer is included in the metadata:
[80] Generalization of classified raster imagery—ArcGIS Pro | Documentation
[81] https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/majority-filter.htm
[82] E.V. White, D.P. Roy. A contemporary decennial examination of changing agricultural field sizes using Landsat time series data. Geo Geogr. Environ., 2 (2015), pp. 33-54, 10.1002/GEO2.4
[83] https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/boundary-clean.htm

c. For this reason, EPA decided to focus on continuous cultivated areas greater than 25 acres to further simplify the layer (see 3).

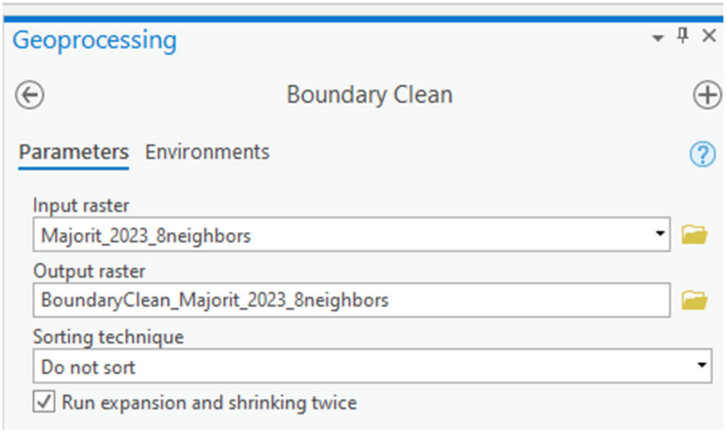
3) EPA identified clusters of cultivated areas using the Region Group tool[84] and then extracted all regions with an area over 25 acres using the Extract by Attribute tool[85].
4) Finally, EPA converted the raster to polygons using the Raster to Polygon tool[86], to support removal of the cultivated area from the core maps.

The resulting layer has a total area that represents ~86% of the ~390 million acres of cultivated cropland found in the United States. For use in core map development, this modified cultivated layer[87] is available for download from the EPA GeoPlatform. All tools and parameters used to develop the layer are provided as screenshots in the next section for reference.

1. Majority Filter

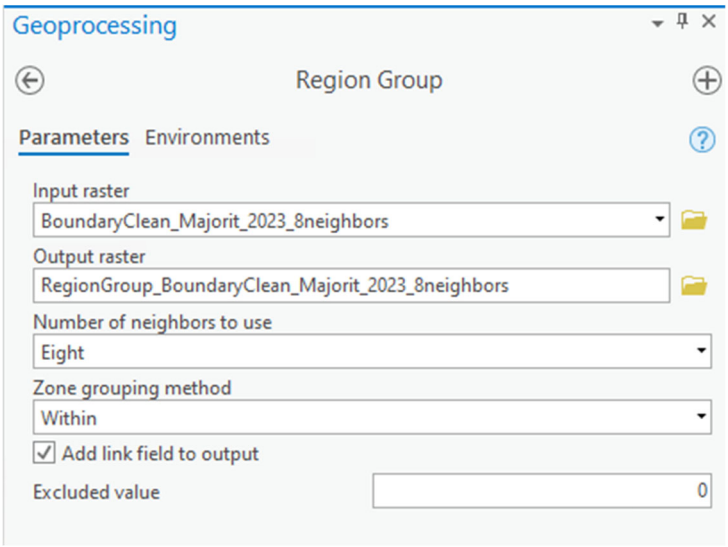


2. Boundary Clean

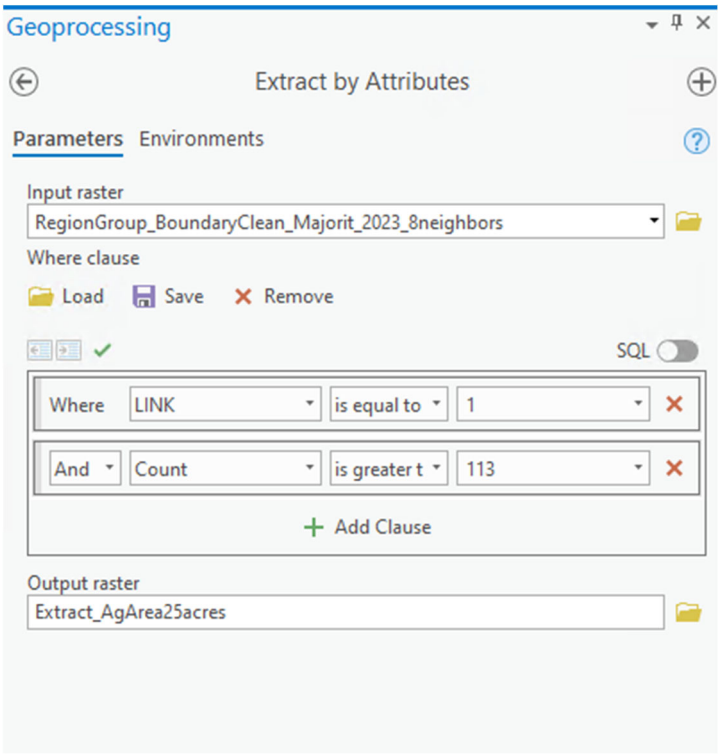


[84] https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/region-group.htm
[85] https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/extract-by-attributes.htm
[86] https://pro.arcgis.com/en/pro-app/latest/tool-reference/conversion/raster-to-polygon.htm
[87] https://epa.maps.arcgis.com/home/item.html?id=159e70ce4c284f5b972c687037f8a668

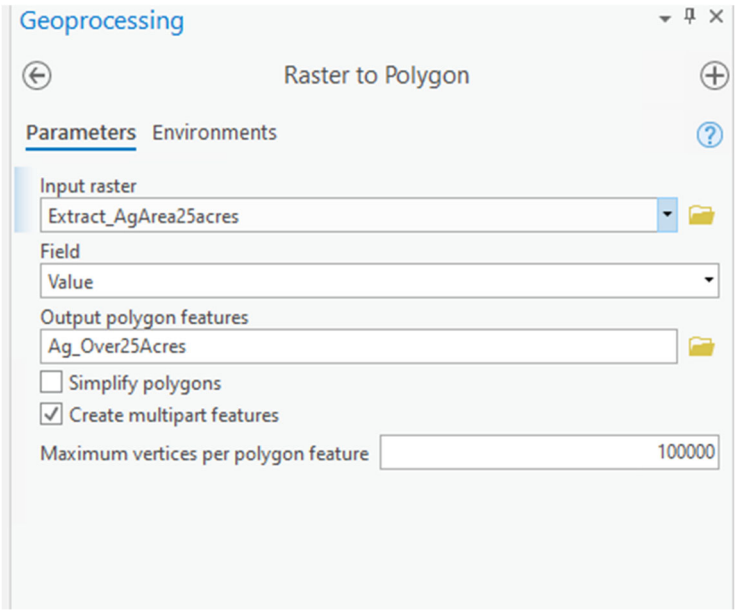
3. Region Group



4. Extract by Attribute – note cultivated areas is set to 1 in the 'link' field



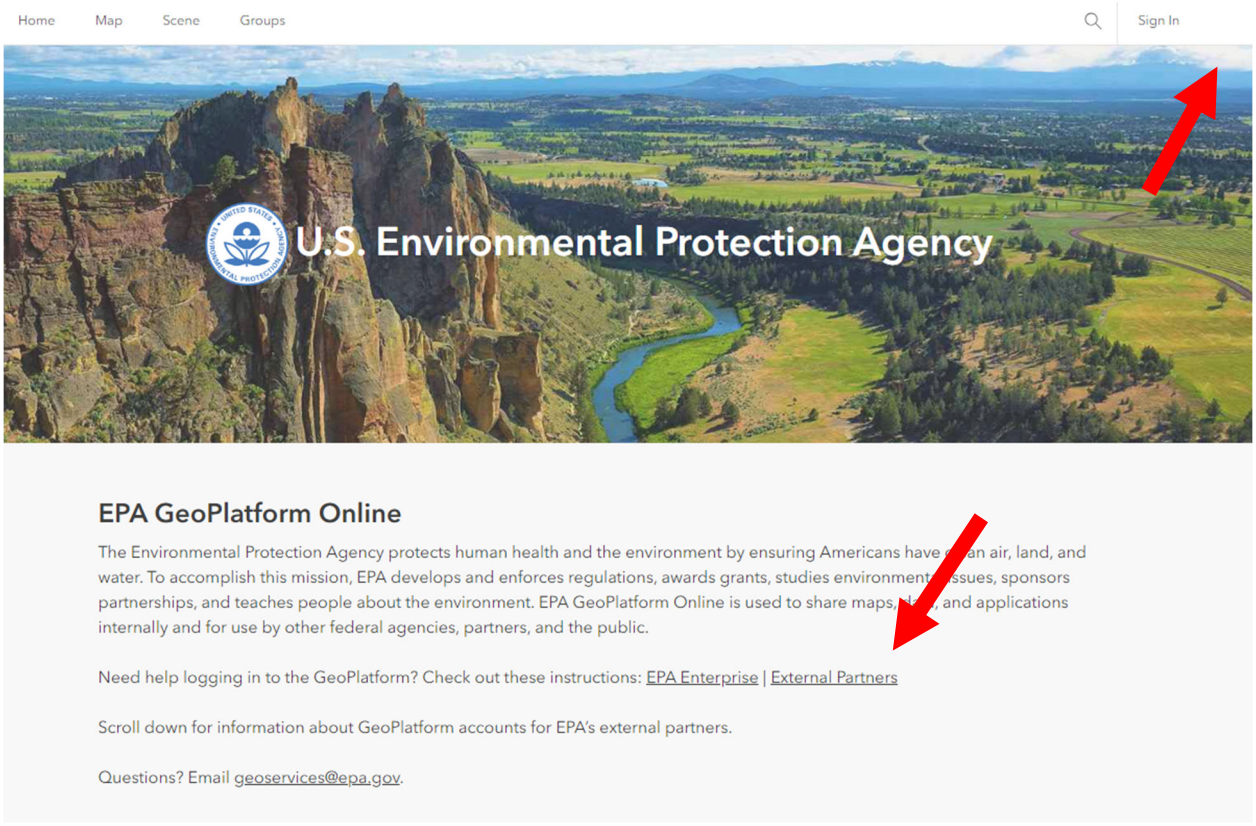
5. Raster to Polygon



Appendix 5. Logging into the EPA GeoPlatform and uploading species core maps

Logging into EPA GeoPlatform

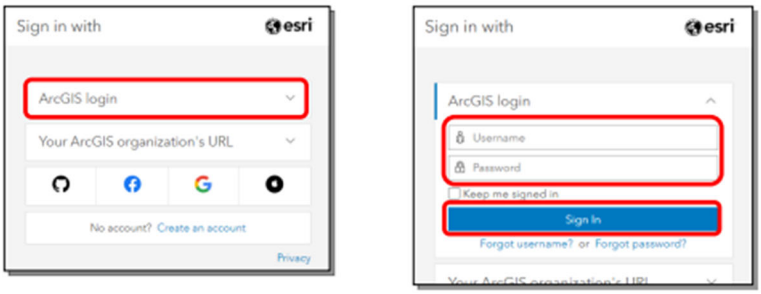
The first time a developer checks out a species for core map development an EPA will create an EPA GeoPlatform account on behalf of the development. The developer will receive a username and password from geoservices@epa.gov. The username format will be last name_first name_EPAEXT. The developer will log into the EPA GeoPlatform[88]use the "ArcGIS Login" option from the sign-in page, accessed using the button in the top right corner of the GeoPlatform homepage. The first screen shot shows the EPA GeoPlatform homepage and the second screen shot shows the sign-in page. The developer will not need to use login.gov or an organizational login to access your account. The developer can reference the "External partners" document found on the EPA GeoPlatform home page for additional guidance regarding login.



[88] https://epa.maps.arcgis.com/

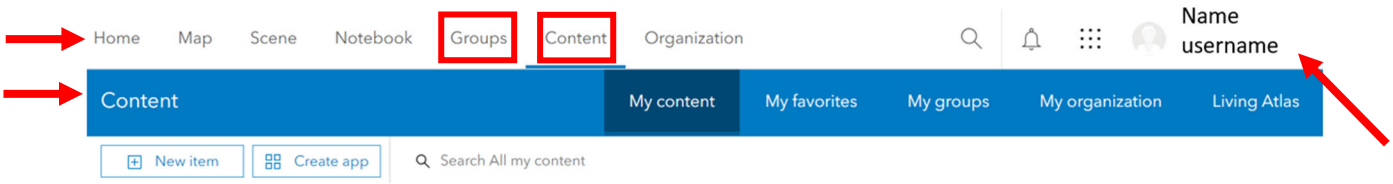
ArcGIS LOGIN INSTRUCTIONS

In your browser or ArcGIS mobile app, click **Sign in** or **Sign in with ArcGIS Online**. Under **ArcGIS login**, enter your assigned EPA GeoPlatform Online **Username** and the **Password** you chose when your account was created and click **Sign In**.



The EPA GeoPlatform is the EPA instance of ArcGIS online and shares a similar interface. Core map developer will interact with the "my content" space and two groups found on the GeoPlatform. EPA will add developers to these groups when your user account is created.

- My Content: Developer loads completed core maps and documentation.
- OCSPP- PULA Project group: Developers shares completed core maps and documentation in order to provide access to EPA.
- OCSPP- Available Data Options (PULA) group: GIS data sources identified in this document with ArcGIS online content items created in the ESRI living atlas or by the data owner. The developer may find these data sources useful when developing core maps. Please note, not all data sources are available as an online content item, and developers may use data not found in this group. Developers can find the recommended layer for removing agriculture fields from core in this group.



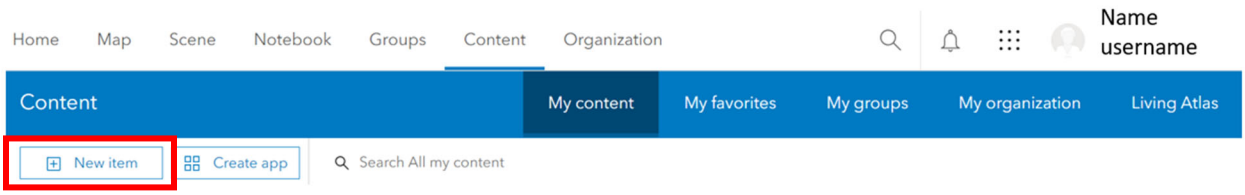
Loading core map and documentation to the EPA GeoPlatform

EPA recommends the developer combines all materials into a single zip file before loading. For organizational purposes, the developer can group files into folders based on type before zipping, for example, species information, original GIS data, processed GIS files, final GIS files (including the resulting core map) and supporting documentation.

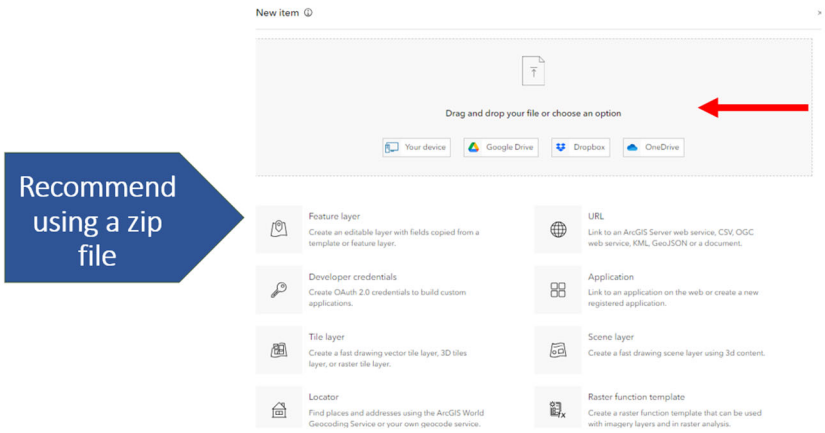
To share core maps and supporting materials with EPA the developer will first load the zip file to the "my content" space using the (1) "New item" button" to opens a window that allows the developer to (2) drag and drop or navigate to the files ready for sharing. Next the next window prompts the developer to (3) select a file type; EPA recommended using the "Geoprocessing sample file type and selecting the .zip

only option. The final window prompts the developer to (4) complete the item description. The following screenshots outline these steps.

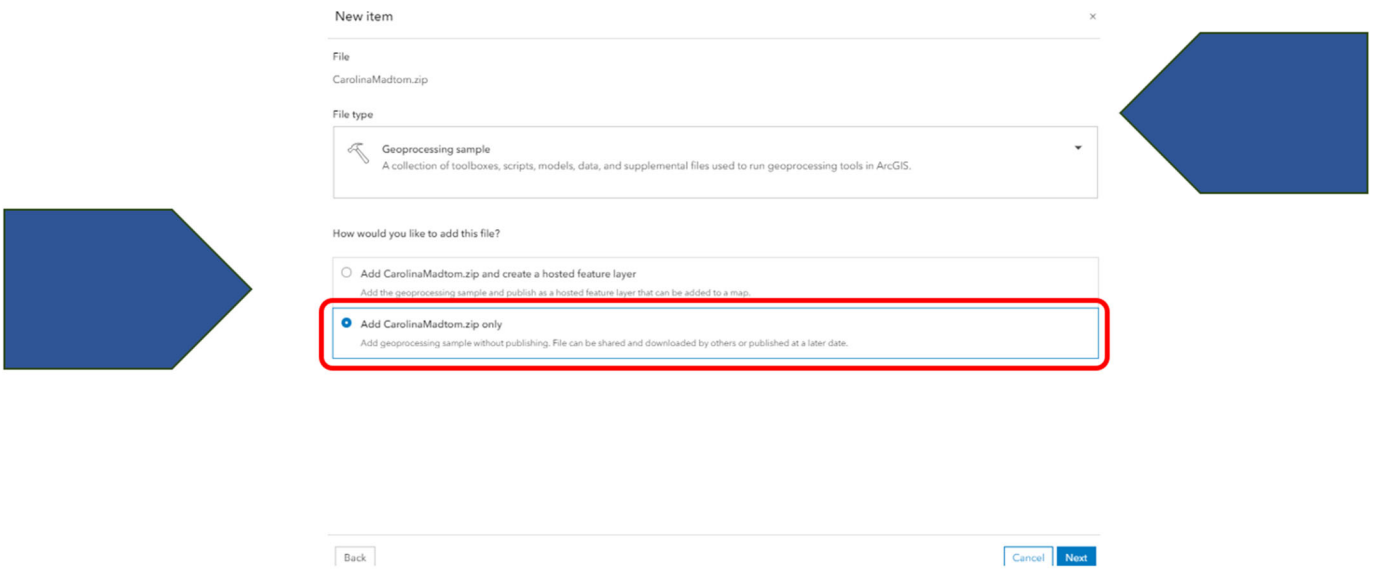
1. *Add a new item*



2. *Drag and drop or navigate to your file*



3. *Select the file type: Recommendation use "Geoprocessing sample and select add .zip only*



4. *Complete item description*

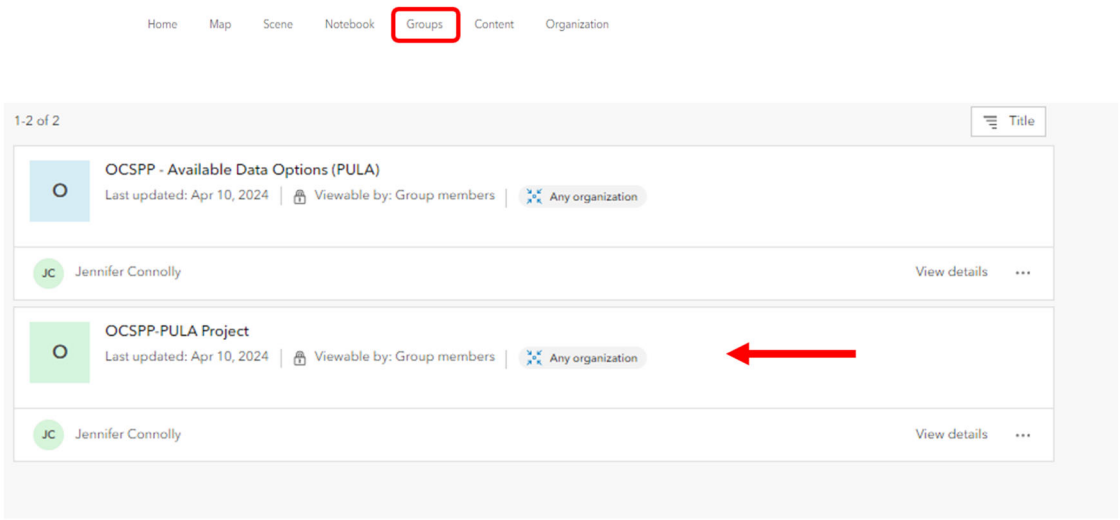
Providing EPA access to files

To provide EPA access the developer will share the file with the with the "OCSPP- PULA Project" group. This process is similar to loading the file to the "my content" space. Navigate to the (1) "Groups" space of the GeoPlatform, which provides a list of available groups, and select the "OCSPP-PULA Project".

Under group content (2) select the “Add items to group” button, then (3) navigate to the content ready for sharing and select “add item”. EPA will download and remove the file from the GeoPlatform after initiating the QA/QC process, to prevent versioning conflicts. The following screenshots outline these steps.

The “OCSPP- Available Data Options (PULA)” group includes GIS data sources the developer may find useful when developing core maps.

1. Navigate to the “Groups” section of the EPA GeoPlatform and select the “OCSPP-PULA Project”



2. Select the “Add items to group” under group content

3. Navigate to the content you want to share with EPA and select "add item"