Interim Core Map Documentation for the Star Cactus

Version 1

Review Completed: April 2026

Core Map Developer: EPA's Office of Pesticide Programs (OPP)

Species Summary

The star cactus (*Astrophytum asterias,* Entity ID 513) is an endangered terrestrial plant (dicot). The U.S. Fish and Wildlife Service (FWS) has not designated a critical habitat for the star cactus. This species is typically found growing on flats in shrublands and grasslands in Tamaulipan thornscrub and prefers to grow in the shade of plants or rocks. The star cactus is likely insect pollinated, but specific pollinators have not been observed. Currently, Star cactus is found in only Starr County, Texas, and the known locations in the U.S. are located within about a 125-km2 area (≈30,888 Acres) Amendment 1 - Star Cactus (2019). Additional information on the species is provided in **Appendix 1**.

Description of Core Map

The core map for the star cactus is based on biological information. The outer extent of this core map is defined by three HUC 12s which overlap with occurrences of the species. EPA further refined this area to cover the known distribution of Astrophytum asterias in Starr County, Texas, described in FWS Year Review (2013) and by including only shrub/grassland habitat. EPA's modified cultivated layer was also erased from the range to develop core map, as this species does not occur on cultivated lands.

Figure 1 depicts the resulting interim core map for the star cactus. The size of this core map is approximately 31,561 acres. Landcover categories within the core map area are included in **Table 1**. Landcover is predominantly shrub/scrub areas.

The core map developed for the star cactus is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the star cactus. This core map incorporates information developed by FWS and made available to the public; however, the core map has not been formally reviewed by FWS. This interim core map may be revised in the future to incorporate species expert feedback from FWS. This interim core map has an "average" (3) best professional judgment classification to describe major uncertainties/limitations. The map is based on known locations described by FWS, and EPA removed some additional areas based on biological needs of the species. This core map does not replace or revise any range or designated critical habitat developed by FWS for this species.

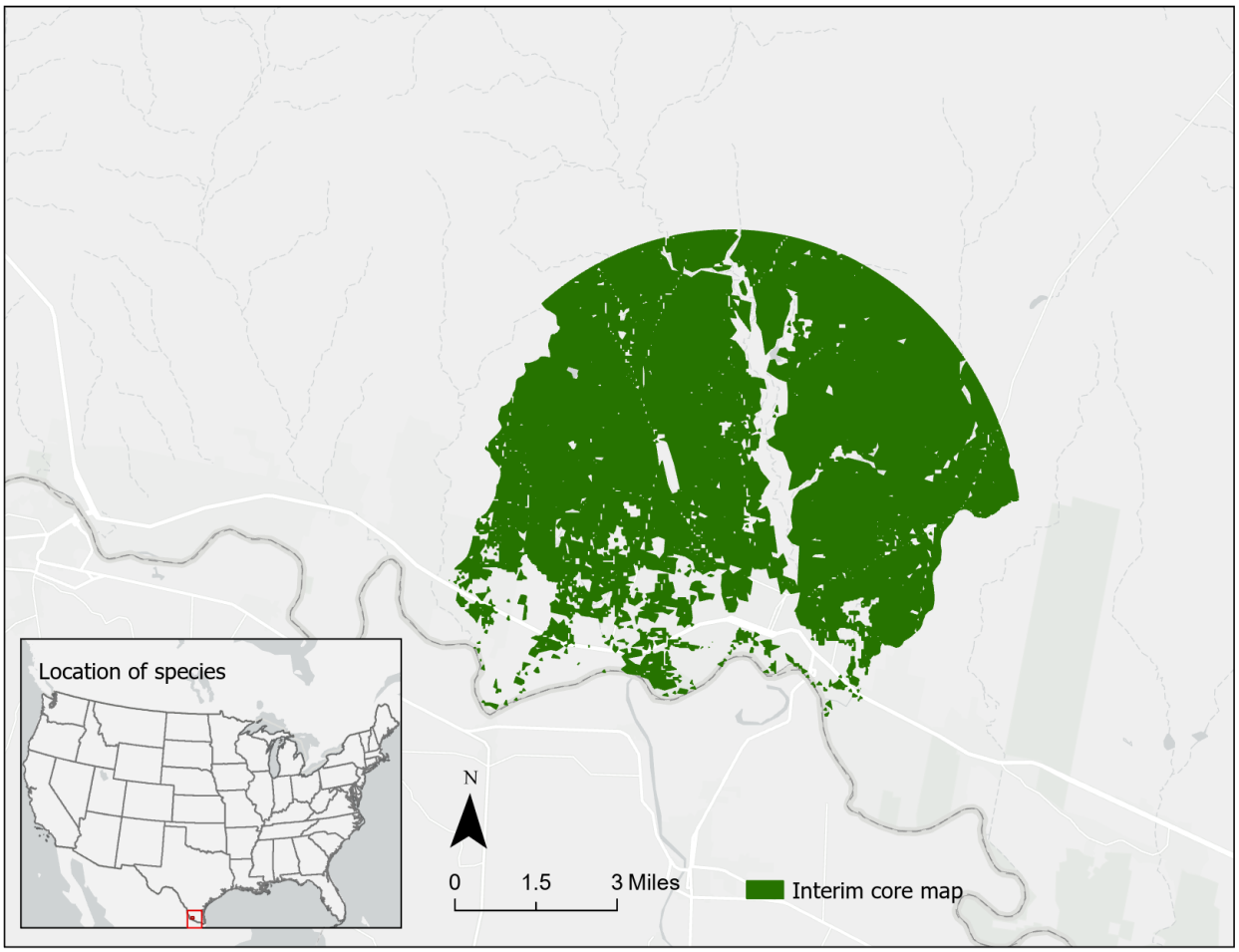


Figure 1. Interim core map for the star cactus.

Table 1. Percentage of Interim Core Map Represented by NLCD[1] Land Covers and Associated Example Pesticide Use Sites/Types.

Example pesticide use sites/types	NLCD Class/Value	% Area
Forestry	Deciduous Forest (41)	0%
Forestry	Evergreen Forest (42)	0%
Forestry	Mixed Forest (43)	0%
Agriculture	Pasture/Hay (81)	14%
Agriculture	Cultivated Crops (82)	0.5%
Mosquito adulticide, residential	Developed Open Space (21)	1%
Mosquito adulticide, residential	Developed Low Intensity (22)	1%
Mosquito adulticide, residential	Developed Medium Intensity (23)	0%
Mosquito adulticide, residential	Developed High Intensity (24)	0%
Invasive species control	Woody Wetlands (90)	1%
Invasive species control	Emergent Herbaceous Wetlands (95)	0%
Invasive species control	Open Water (11)	0%
Invasive species control	Grassland/Herbaceous (71)	6%
Invasive species control	Shrub/Scrub (52)	74%
Invasive species control	Barren Land (31)	2%
Total Acres	Interim Core Map Acres	~ **31,561**

Evaluation of Known Location Information

There are four datasets with known location information:

- Descriptions of locations provided by FWS
- Occurrence locations in iNaturalist
- Occurrence locations in NatureServe
- Occurrence locations in the Global Biodiversity Information Facility (GBIF)

EPA evaluated these four sets of data before selecting the type of and developing the core map. FWS appeared to have the finest resolution of the location information. Occurrences in iNaturalist, GBIF, and NatureServe supported species occurrences in the selected core map. **Appendix 1** includes more information on the available known location information.

Approach Used to Create Core Map

The core map was developed using the "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

[1] Dewitz, J., 2023, National Land Cover Database (NLCD) 2021 Products: U.S. Geological Survey data release, https://doi.org/10.5066/P9JZ7AO3

Habitats"[2] (referred to as "the process"). EPA developed the core map using the 4 steps described in the process document:

1. Compile available information for a species
2. Identify core map type
3. Develop the core map for the species
4. Document the core map

For step 1, EPA compiled available information for the star cactus from FWS, as well as observation information available from various publicly available sources (including iNaturalist, NatureServe, and GBIF). The information compiled for the star cactus is included in **Appendix 1**. Influential information that impacted the development of the core map included:

- Star cacti are only in Starr County, Texas.
- Astrophytum asterias occurs on flats in shrublands and grasslands in Tamaulipan thornscrub.
- All the known star cactus locations in the U.S. are located within only about a 125-km2 area in Starr County, Texas.

For step 2, EPA used the compiled information to identify the core map type including species range and known location information from the FWS documentations. The extant populations are in Starr County, Texas, within the species' range. The entire range of the species was not used as the core map because the range contains areas where the species does not occur.

For step 3, EPA used the best available data sources to generate the core map. Data sources are discussed in the process document. For this core map, EPA used the 2021 NLCD to identify shrublands and grasslands. **Appendix 2** provides more details on the GIS analysis and data used to generate the core map.

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

Based on the FWS Year Review (2013), the highest density of *A. asterias* was found on saline-sodic soils. For this soil characterization EPA used SSURGO data, and identified soil with sodium adsorption ratio >13, clay and loam soils texture, and subgroup Sodic Haplusterts attributes. However, this information is not available for all map units, and EPA did not rely on this information during the core map development process.

[2] Dated 2024, available online at: https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas

Appendix 1. Information Compiled for the Star cactus

1. **Recent FWS documents/links and other data sources**
   - Five Year Review (2013) (https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2038.pdf)
   - Star Cactus (Astrophytum asterias) Recovery Plan (2003)
   - Amendment 1 - Star Cactus (2019)

2. **Background information**
   - **Status**: Federally listed as endangered in 1993
   - **Resiliency, redundancy, and representation** (the 3Rs)

     Resiliency: "Species are assigned priority numbers ranging from 1 – 18 based upon degree of threats, recovery potential, and taxonomic distinctiveness. Astrophytum asterias received a priority of 2 indicating that the degree of threat is high, the recovery potential is high, and the listed entity is a species". The species remains highly vulnerable due to habitat destruction, herbivory, and limited protection on private lands. Its resiliency is moderate but requires continued conservation actions to ensure long-term survival (Five Year Review 2013)

     Redundancy: While redundancy has improved since the species' listing, it remains insufficient to fully safeguard the species against widespread threats. Continued efforts to establish and protect additional populations are critical to enhancing redundancy (Five Year Review 2013)

     Representation: The leading threat to A. asterias throughout its range currently, and at the time of listing, is habitat loss. All A. asterias populations in Starr County, Texas, are located on private property; the majority of which do not have signed conservation agreements (Five Year Review 2013). Species are assigned priority numbers ranging from 1 – 18 based upon degree of threats, recovery potential, and taxonomic distinctiveness. Astrophytum asterias received a priority of 2 indicating that the degree of threat is high, the recovery potential is high, and the listed entity is a species.

   - **Habitat**
     - Astrophytum asterias occurs on flats in shrublands and grasslands in Tamaulipan thornscrub and prefers to grow in the shade of plants or rocks.
     - The highest density of A. asterias was found on saline-sodic, followed by saline soils.

   - **Pollinator/reproduction**
     - Star cactus is likely insect-pollinated, but specific pollinators have not been observed.
     - Flowers usually bloom from March - May, opening in the morning and closing in the evening.
     - FWS Five Year Review (2023) shows that A. asterias is an obligate xenogamous species (fruits and seeds form only when pollen is transferred to a flower from a different plant). Seed set was significantly higher in hand-pollinated flowers

versus naturally-pollinated controls, suggesting that pollination vectors may be limiting.
    - Pollinator is not identified or described in FWS documentation

- **Taxonomy**
    - Terrestrial Plant
    - FWS Category: Flowering dicot plants with biotic pollination vectors with a high degree of homozygosity and low genetic diversity, suggesting inbreeding and/or genetic isolation at this site

- **Relevant Pesticide Use Sites**
  Pesticide or herbicide use is listed as one of the major threats. The potential for future road improvements and current right-of-way management practices using pesticides or herbicides may pose a threat to this population or others that have not yet been identified. (Recovery Plan, 2003)

- **Recovery Criteria/Objectives (2003 recovery plan)**
    - The primary objective for the Recovery Plan is to ensure survival and promote recovery of star cactus in its natural habitat such that the species can be reclassified to threatened status.
    - Maintain or establish ten fully protected, self-sustaining (i.e., a minimum of 2,000 individuals) populations of star cactus in the United States or Mexico on Federal lands (e.g., National Wildlife Refuge lands), voluntary State lands (e.g., State parks), voluntary private lands, or a combination, within the geographical and historical areas known to support the species. Full protection is considered management of the populations on Federal or State lands as part of an approved management plan, or a formal stewardship agreement with private landowners. Management should include monitoring the species' numbers and distribution, habitat, and threats. In addition, a formal conservation agreement between the United States and Mexico should be developed for the star cactus through the Canada/Mexico/United States Trilateral Committee for Wildlife and Ecosystem Conservation and Management (Trilateral Agreement).

- **Recovery Actions (from 2003 recovery plan)**
    - Protect and manage existing star cactus populations and habitat in the United States and Mexico
    - Gather information for management and monitoring programs for star cactus
    - Search for new populations of star cactus in the United States and Mexico
    - Establish and maintain a botanical garden population of star cactus
    - Establish new populations in natural habitat as necessary to meet reclassification criteria
    - Develop and implement a formal conservation agreement for star cactus between the United States and Mexico through the Trilateral Agreement
    - Develop a public education and awareness program for the species
    - Evaluate progress toward recovery, management direction, and status of information needed for development of delisting criteria within five years (2008-2009)

3. **Description of Species Range**
    - Figure A1-1 depicts the FWS range. The range was last updated on 1/27/2018. Total acreage of range is around 1,800,197 acres.

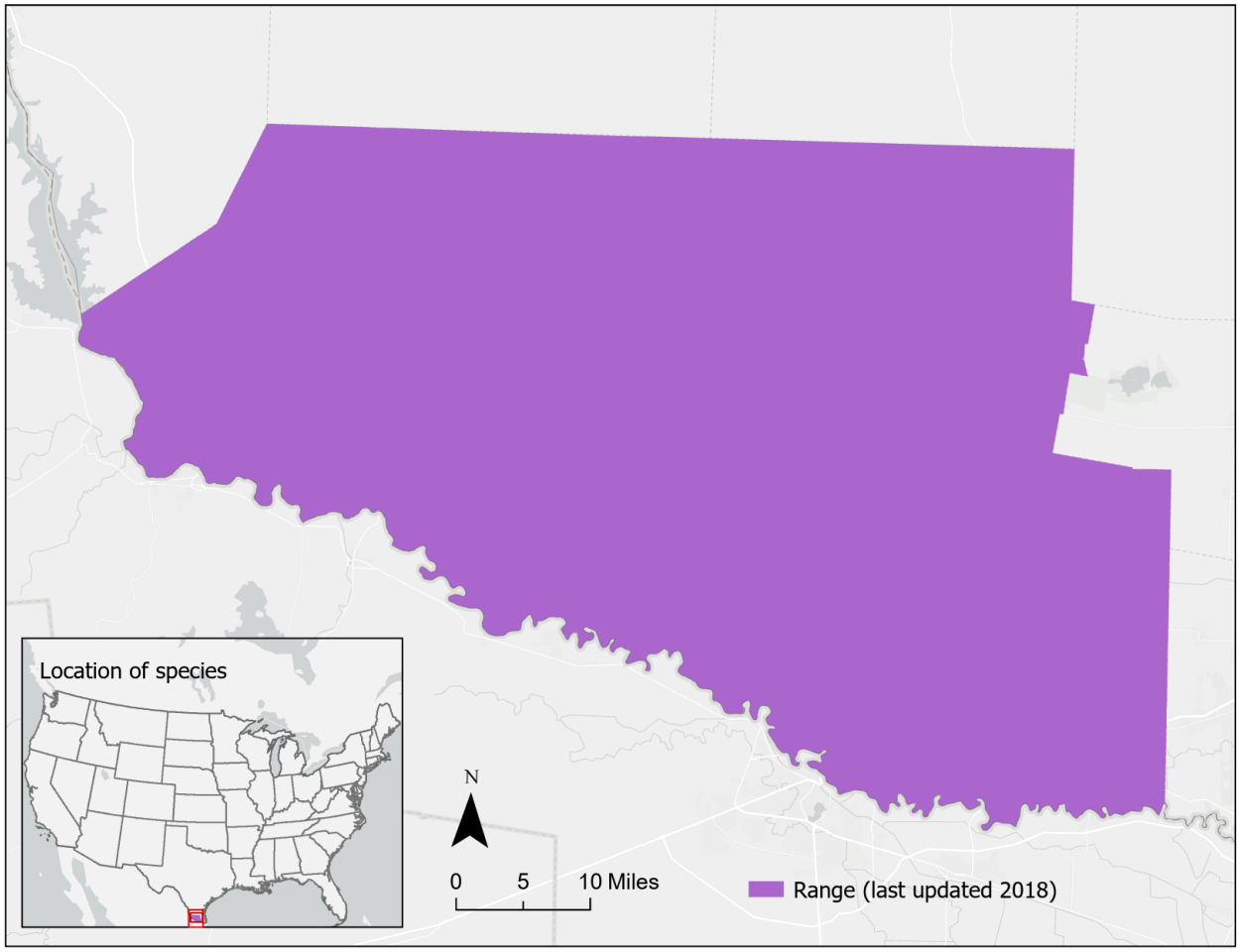


Figure A1-1. FWS range for the star cactus. The total acreage of the range is around 1,800,197 acres.

4. **Critical Habitat**
    - FWS has not designated a critical habitat for this species (https://ecos.fws.gov/ecp/species/7913)

5. **Known Locations**
    - Known Locations Described in FWS Year Review (2013) and Amendment 1 - Star Cactus
        - Currently, the star cactus is found in only Starr County, Texas, and the known locations in the U.S. are located within only about a 125-km2 area (≈30,888.2 Acres).
        - Figure A1-2 depicts the currently known locations from FWS.

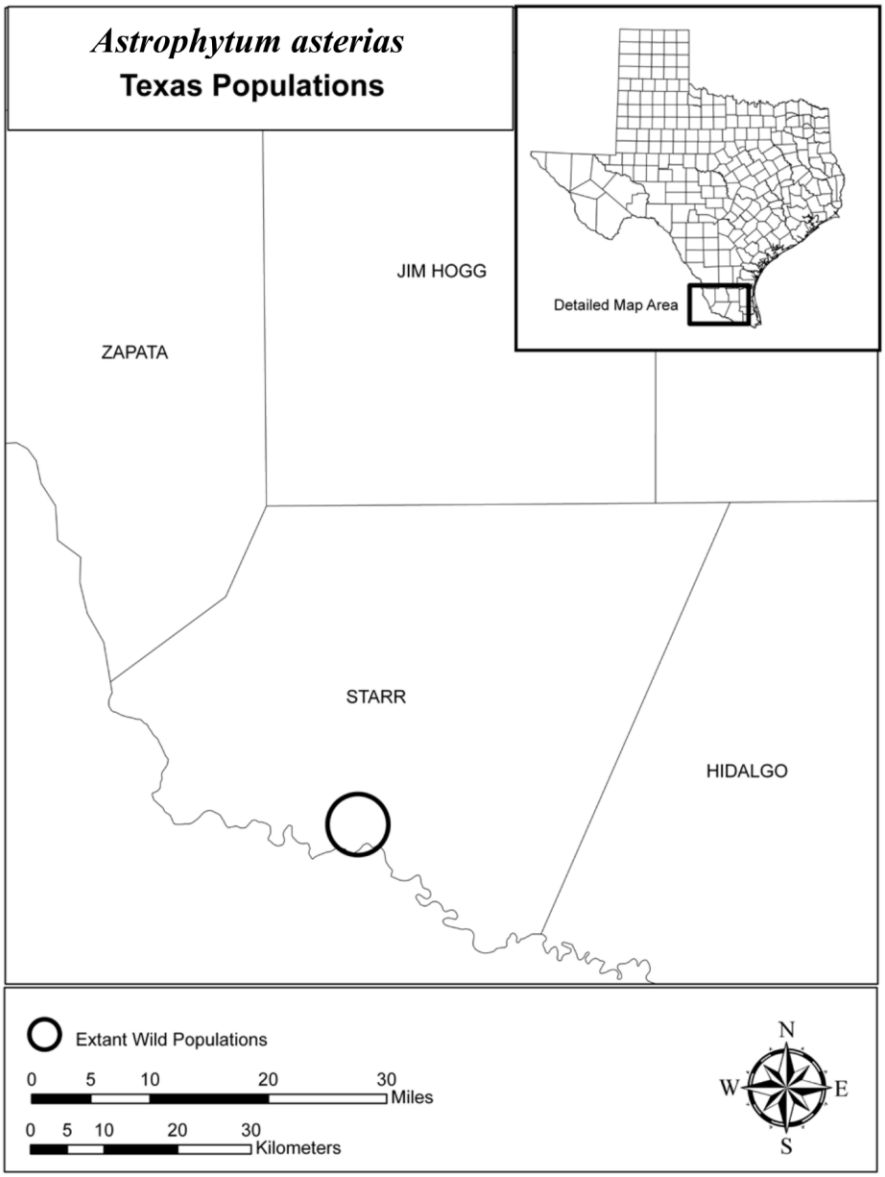
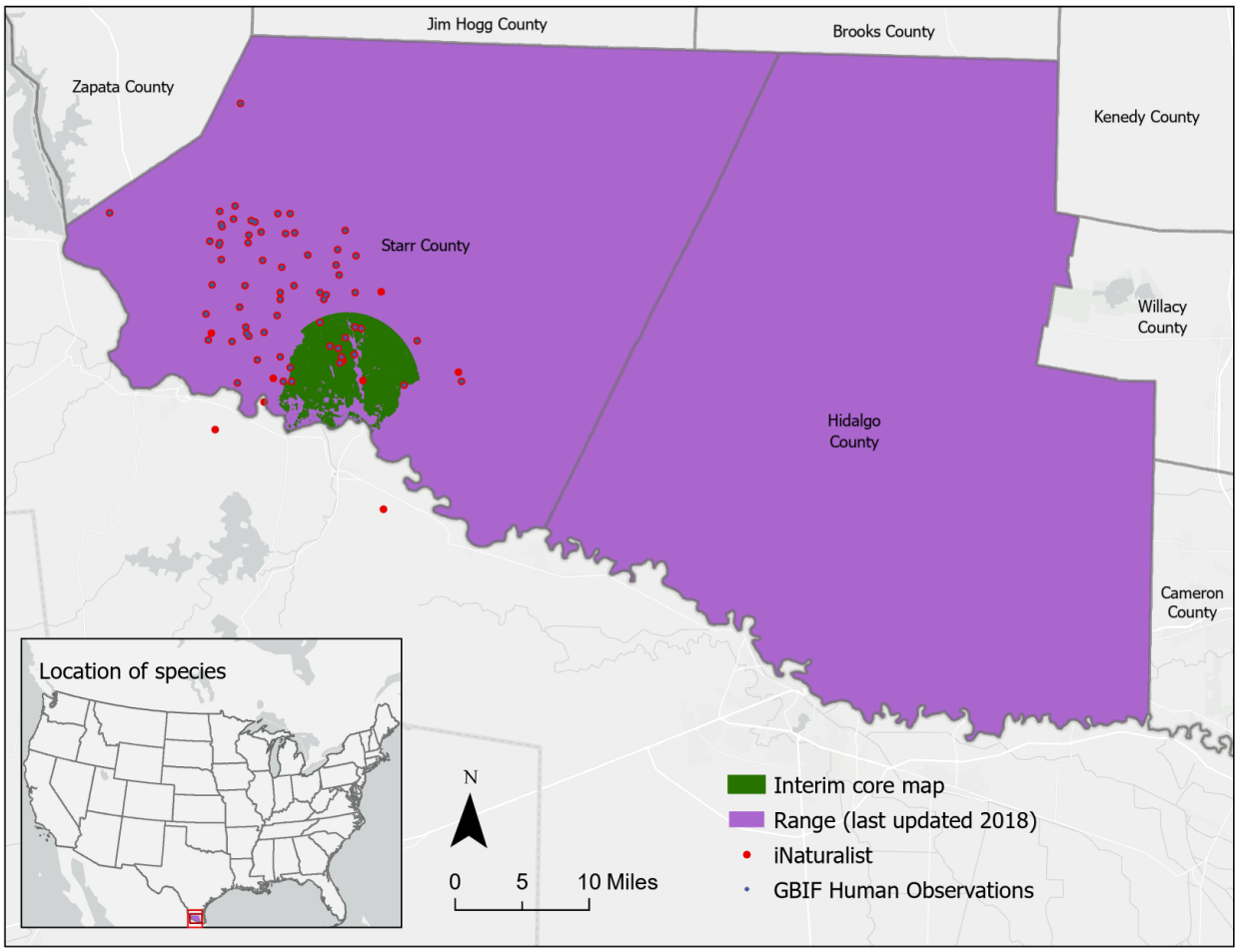


Figure A1-2. Known location information from FWS. Map reproduced from most recent FWS 5-year review (2013).

- **Occurrences Included in Public Databases**
  EPA queried iNaturalist, GBIF, and NatureServe. Occurrences in NatureServe were also consistent with other occurrence data (linked here).

  iNaturalist (available here) had 73 research grade observations for this species, 2 of which appear to fall outside of the species range.

  GBIF (available here) included 41 occurrences and human observations (from 2004-2024). All but 2 of these observations are also included in iNaturalist or NatureServe. GBIF points largely coincide with the 3 occupied watersheds but those that fall outside of the core map can also be accounted for by the resolution of the location data.


Jim Hogg County
Brooks County
Zapata County
Kenedy County
Starr County
Willacy County
Hidalgo County
Cameron County
Location of species
N
0 5 10 Miles
Interim core map
Range (last updated 2018)
iNaturalist
GBIF Human Observations

Appendix 2. GIS Data Review and Method to Develop Core Map

This core map was created based on biological information, including occupied location and species habitat.

1. **Dataset References and Software**

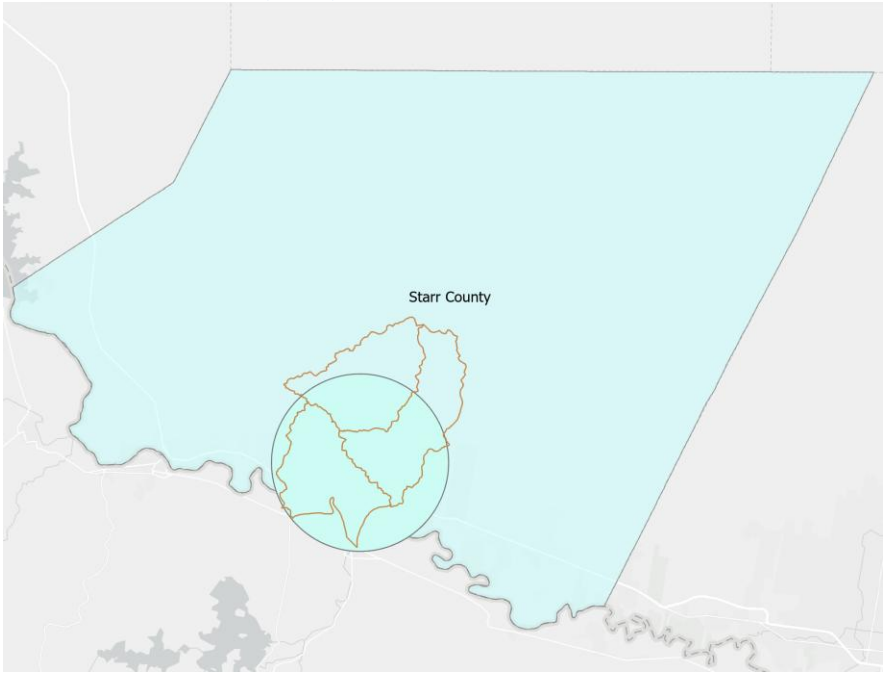
- NLCD 2021 - 30 m raster dataset comprised of 20 land cover classes. Classes include vegetation type, development intensity, and agricultural use. https://landscape10.arcgis.com/arcgis/services/USA_NLCD_Land_Cover/ImageServer
- Software used: ArcGIS Pro 3.2
- FWS Species Range – last updated on 1/27/2018
- Watershed Boundary Dataset HUC12s (Esri Online): https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/Watershed_Boundary_Dataset_HUC_12s/FeatureServer

2. **Datasets Used in Core Map Development**

All datasets used in core map development are described in EPA's process document.

3. **Core Map Development**

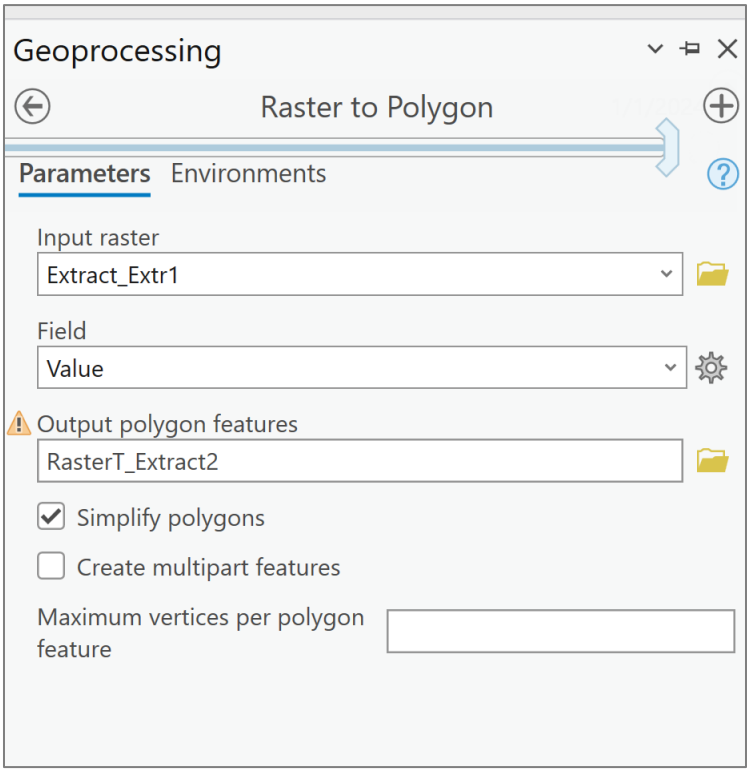
- A circle buffer area was created to approximately define the known distribution presented in the FWS Year Review (2013).



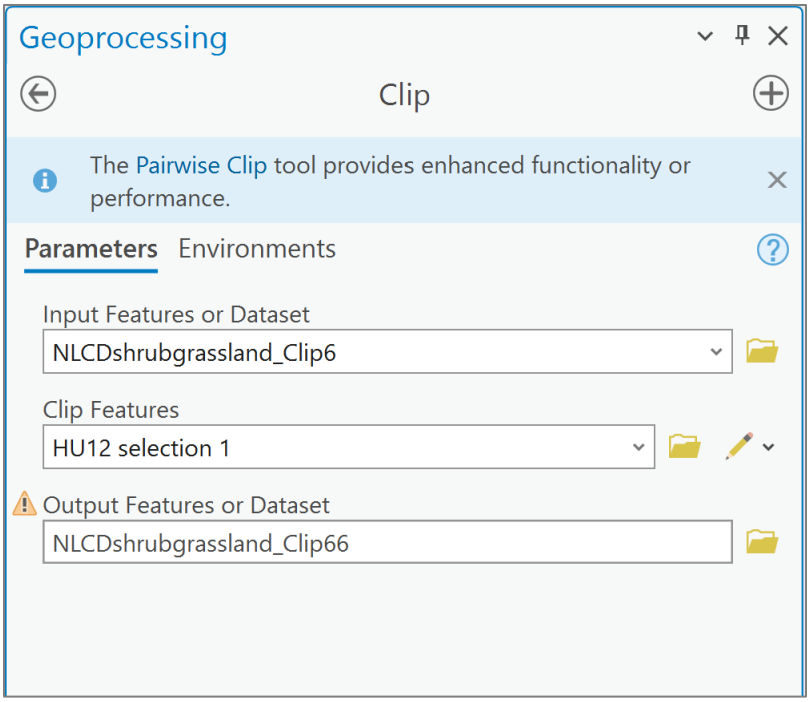
- EPA further refined this area to cover only shrub/ grasslands by selecting barren land, shrub, grassland/herbaceous and pasture/hay attributes from the 2021NLCD layer.

Value	Count	ClassName	Red	Green	Blue	UlcPopupTe	Popup Text
31	1735	Barren Land	240	233	235	Barren Land	barren land
52	203297	Shrub/Scrub	242	219	192	Shrub/Scrub	Shrub or scrub
71	40078	Grassland/Herbaceous	252	242	205	Grassland or Herbaceous	grassland or herbaceous
81	29330	Pasture/Hay	240	237	169	Pasture or Hay	pasture or hay

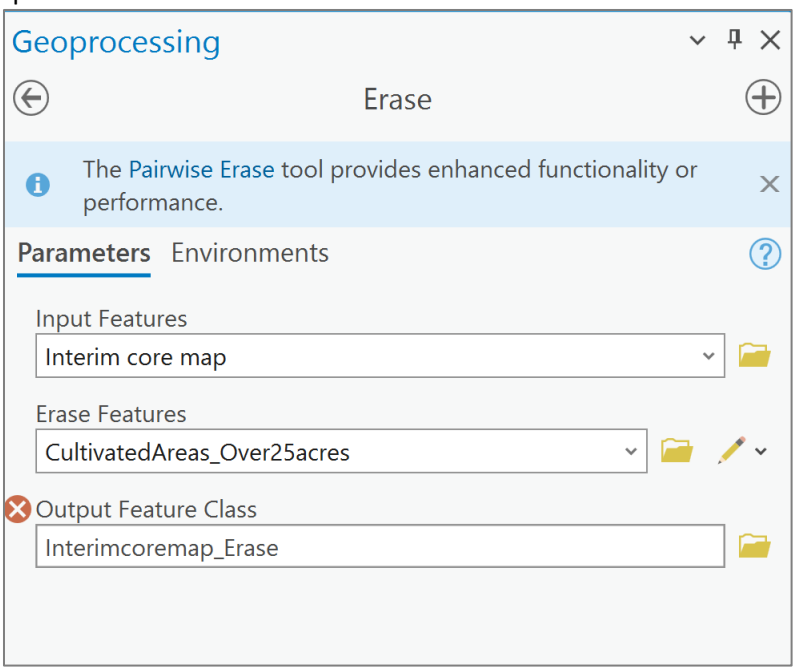
- Selected NLCD raster areas were changed into polygon using raster to polygon geoprocessing tool) [Raster to Polygon (Conversion)—ArcGIS Pro | Documentation]



- Resulted shrub/ grasslands polygon area was clipped using the HUC12s to keep the outer extent of the core map defined by HUC12s.



- EPA's modified cultivated layer was also erased from the range to develop core map, as this species does not occur on cultivated lands.



- This whole process resulted a core map are approximately 31,561 acres contained in the file "star_cactus_core_map.shp".