

Interim Core Map Documentation for the Hine's Emerald Dragonfly

Uploaded to EPA's Geoplatform: August 2025

Draft Interim Core Map Developer: Center for Biological Diversity

Species Summary

Hine's emerald dragonflies are terrestrial invertebrates that depend on groundwater fed wetlands near forest edge habitat. Adults and larvae are generalist predators of other small invertebrates and require water to complete their life cycle. Historically, the species has records in six midwestern states and Alabama. Due to habitat loss and fragmentation the species has severely declined. It has recently been confirmed to breed at 52 sites in Illinois, Michigan, Missouri, and Wisconsin. While habitat loss is the major factor in the species' decline, the U.S. Fish and Wildlife Service (FWS) notes that pesticides continue to pose a threat to the species. FWS noted that potential pesticide risks include cherry and apple orchards, other agricultural uses, plant nurseries, municipal use, golf course use, gypsy moth and mosquito control.¹ The core map for this species was based on designated critical habitat and known locations.

EPA Review Notes

The developers created this core map using the U.S. Environmental Protection Agency's (EPA) process available at: <https://www.epa.gov/endangered-species/process-epa-uses-develop-core-maps-pesticide-use-limitation-areas>. EPA reviewed the draft interim map and documentation and evaluated if: (1) the map and documentation are consistent with the agency's process; (2) areas included or excluded from the interim core map are consistent with the biology, habitat, and/or recovery needs of the species; (3) data sources are documented and appropriate; and (4) the GIS data and mapping process are consistent with the stated intention of the developer. EPA agrees that this map is a reasonable depiction of core areas for this species and was consistent with the agency's mapping process. This documentation was not prepared by EPA, and EPA may have edited this documentation for clarity, consistency, or other purposes. This documentation may include views not necessarily held by EPA or its staff.

The core map developed for this species is considered interim and can be used to develop pesticide use limitation areas (PULAs). 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 expert feedback from FWS.

This core map does not replace or revise any range or designated critical habitat developed by FWS.

¹ FWS 2001 pp. 20-21

Description of Core Map

The core map for the Hine's emerald dragonfly is biological information type, consisting of the occupied designated critical habitat and known locations (Figures 1 and 2). All critical habitat areas were included in the core map. All critical habitat areas were considered occupied at the time of designation.² In more recent documents, FWS only indicates that some portion of private land at the Long Run seep (Illinois Critical Habitat Unit 7) have been extirpated. For occupied sites outside of the designated critical habitat, no precise maps or coordinates of known occupied habitat are available, but general place descriptions are presented in the 2013 and 2025 5-year reviews. The list of places that are considered occupied in recent 5-year reviews is provided in Appendix 1. Using place names and other biological information, we produced a core map consisting of the critical habitat and 52 named sites across four states. Further information and assumptions about places designated in the core map are detailed in our approach to the core map and Appendix 1 and 2.

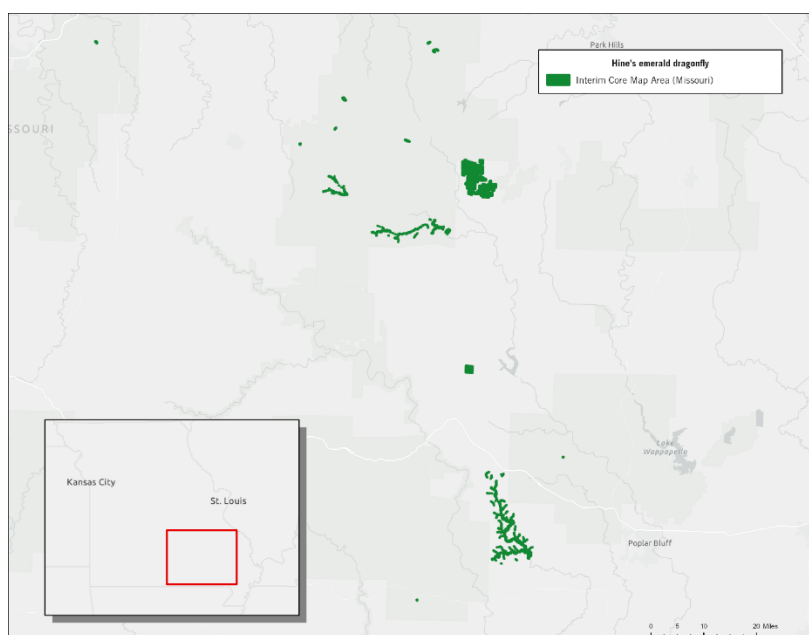


Figure 1. Hine's emerald dragonfly interim core map for Missouri.

² FWS. 2010. Endangered and Threatened Wildlife and Plants; Final Revised Critical Habitat for Hine's Emerald Dragonfly (*Somatochlora hineana*). 21405. Available at <https://www.govinfo.gov/link/fr/75/21394?link-type=pdf>.

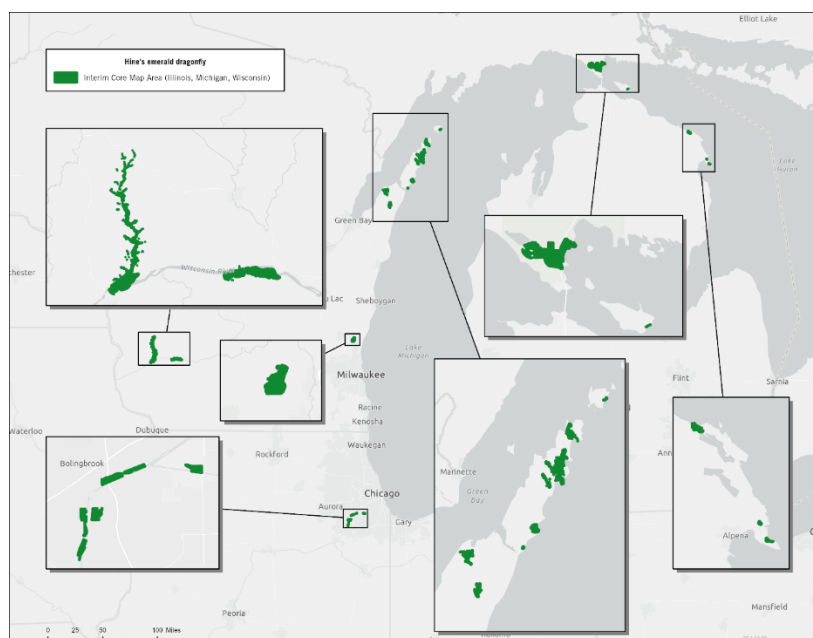


Figure 2. Hine's emerald dragonfly interim core map for Illinois, Michigan, and Wisconsin. The total acreage of all Core Map area is approximately 55,000 acres.

Table 1. Percentage of Interim Core Map Represented by NLCD¹ Land Covers and Associated Example Pesticide Use Sites/Types.

Example pesticide use sites/types	NLCD Landcover (Value)	% of core map represented by landcover	% of core map represented by example pesticide use
Forestry	Deciduous Forest (41)	17.5	21.2
Forestry	Evergreen Forest (42)	1.7	21.2
Forestry	Mixed Forest (43)	2	21.2
	Pasture/Hay (81)	2.3	2.4
Agriculture	Cultivated Crops (82)	.1	2.4
Mosquito adulticide, residential	Open space, developed (21)	1.1	2.1
Mosquito adulticide, residential	Developed, Low intensity (22)	.9	2.1
Mosquito adulticide, residential	Developed, Medium intensity (23)	.1	2.1
Mosquito adulticide, residential	Developed, High intensity (24)	0	2.1
Invasive species control	Woody Wetlands (90)	60.4	74
Invasive species control	Emergent Herbaceous Wetlands (95)	11.1	74
Invasive species control	Open water (11)	1.6	74
Invasive species control	Grassland/herbaceous (71)	.5	74
Invasive species control	Scrub/shrub (52)	0	74
Invasive species control	Barren land (rock/sand/clay; 31)	.4	74

Evaluation of Known Location Information

- 2013 and 2025 5-Year Reviews

The FWS's 2013 and 2025 5-year reviews are the most comprehensive sources of information for this species. No Species Status Assessment has been completed for the Hine's emerald dragonfly. Precise location information was not presented in either of these 5-year reviews, but general place names and a broad scale range map were provided (see Appendix 1). The combination of habitat information, place names, and ownership information was determined to be sufficient to identify occupied areas for the core map. Analysis and interpretation of site location is detailed in Appendix 2 and supplemental materials.

EPA acknowledges that the developers evaluated other publicly available data sources. EPA is not including those sources in this documentation because they were not used to identify mappable areas in the core map, but were useful for comparison purposes.

Approach Used to Create Core Map

The core map for the Hine's emerald dragonfly uses designated critical habitat as the primary source of location information. Additional habitat areas outside of the critical habitat areas were included based on supplemental biological information presented in the 2013 and 2025 5-year reviews.

FWS critical habitat is the primary source of location information because all critical habitat areas are presumed occupied in the 2010 revision.³ No unoccupied sites were designated. The designated critical habitat is comprised of 26,531 acres across 37 units in Illinois, Michigan, Missouri, and Wisconsin. All critical habitat units were included in the core map.

Additional potentially occupied habitat areas were included because there is uncertainty in the exact locations of many occurrences and new occupied areas have been discovered since the 2010 critical habitat revision. Areas outside but nearby the critical habitat were also included as additional potential habitat to accommodate dispersal and to increase the resilience, redundancy, and representation (3Rs) of the species. Habitat fragmentation and barriers to dispersal (including pesticides) have been highlighted as significant threats to the species.⁴ The 3Rs for the species are currently likely low. Hine's emerald dragonflies can disperse at least 3.4 miles (5.5 km) and potentially up to 30 miles (48.3 km).⁵ Including nearby conservation lands⁶ to protect habitat from pesticide exposure can increase connectivity and the 3Rs for the species.

³ FWS. 2010. Endangered and Threatened Wildlife and Plants; Final Revised Critical Habitat for Hine's Emerald Dragonfly (*Somatochlora hineana*). 21405. Available at <https://www.govinfo.gov/link/fr/75/21394?link-type=pdf>.

⁴ FWS 2001 pp. 19-20.

⁵ FWS 2013 p. 17.

⁶ We define conservation lands very broadly to include both publicly and privately held lands with at least some conservation objective. This can include but is not limited to: National Wildlife Refuges, State Wildlife Management Areas, National Forests, BLM lands, Land Trust properties, Nature Conservancy properties and other lands held by Non-governmental organizations. Conservation lands should be protected from pesticide exposure and have little or no justification for the use of pesticides.

There is no comprehensive, precise map of delineated and occupied wetland habitat available to the public. Critical habitat provides some delineated areas, but does not include more recently discovered sites and is often narrowly defined. Since the critical habitat was revised in 2010, FWS has published two 5-year reviews that provide additional descriptions of occupied areas. The 2013 5-year review includes a table of known or presumed sites (see Table A1-1) from which we extracted place names for the known locations. The 2025 5-year review also includes a broad-scale map of known locations (Figure A1-4).

The Hine's emerald dragonfly is a wide-ranging species with a lack of precise location information which has required the Center to make assumptions about the location and size of occupied areas. These assumptions introduced further uncertainty. The Center used our best professional judgement to map occupied areas based on named sites and other biological information. Given the uncertainty in our mapping, we score this core map as a 4 ("moderate") for the best professional judgement.

Our site selection was based on (in order of importance) 1) critical habitat areas, 2) biological information for the species, and 3) areas of public or conservation lands. Table 1 from the 2013 5-year review (Table A1-1) describes 69 sites, some of which may not be extant locations. We considered sites to be extant if breeding was confirmed in the "Number of Breeding Areas" column. Sites were not included if there is no confirmed breeding and there is no overlapping critical habitat area. Of the 69 named occupied sites identified in the 2013 5-year review, 52 were considered for inclusion in the core map because they had confirmed breeding and were considered viable sites.

For every named site, we searched for corresponding natural and anthropogenic features. Critical habitats were always included if they were in a named area. We cross-referenced the site names in Table A1-1 with critical habitat and found that there is a high degree of overlap between the critical habitat and the list of known sites from the 2013 5-year review. Of the named sites, 12 did not correspond at least partially to critical habitat areas. If a named site closely overlapped with a critical habitat area, the critical habitat was used solely to represent the location. When site names represented broad or vague areas, adjacent wetlands or conservation areas were included on a case-by-case basis. When bodies of water were named as occupied areas, wetlands within 1 mile of an occupied stream, lake, or water feature were included to likely capture the habitat and provide potential habitat for dispersal and to increase the 3Rs for the species.

A 1-mile wetland buffer was used for several reasons. A hypothetical large, occupied wetland adjacent to a named feature could be as large as 200 acres⁷ A circular 200 acres wetland that is directly adjacent to a water feature like a river would have a diameter of 3330 feet (0.63 miles) and would represent a lower bound value of a buffer. To capture dispersal or wetlands that are not directly adjacent to the feature, a buffer of 1.55 miles (2.5 km) would be necessary considering that mark-recapture studies indicate that adults could disperse at least 3.4 miles (5.5 km).⁸ In the 2001 Recovery Plan, FWS has depicted the size of a single occupied subpopulations as ~5 km (3.1 miles) based on mark-recapture studies (Figure 4). The radius of a circular area 5 km across is 2.5 km (~1.6 miles). A wetland buffer distance of ~1.6 miles represents an upper bound of a buffer distance that would capture wetlands for dispersal of the species. Therefore, a 1-mile wetland buffer distance was chosen as a conservative value that would capture a potentially large, occupied wetland, that may or may not be directly adjacent to the named water feature, but also potentially include some habitat for dispersal.

⁷ The 2013 5-year review indicates that occupied wetland habitats for the species range in size from 5-200 acres. A hypothetical, circular 200ac habitat would have a diameter of ~0.66mile.

⁸ FWS 2013 p. 17

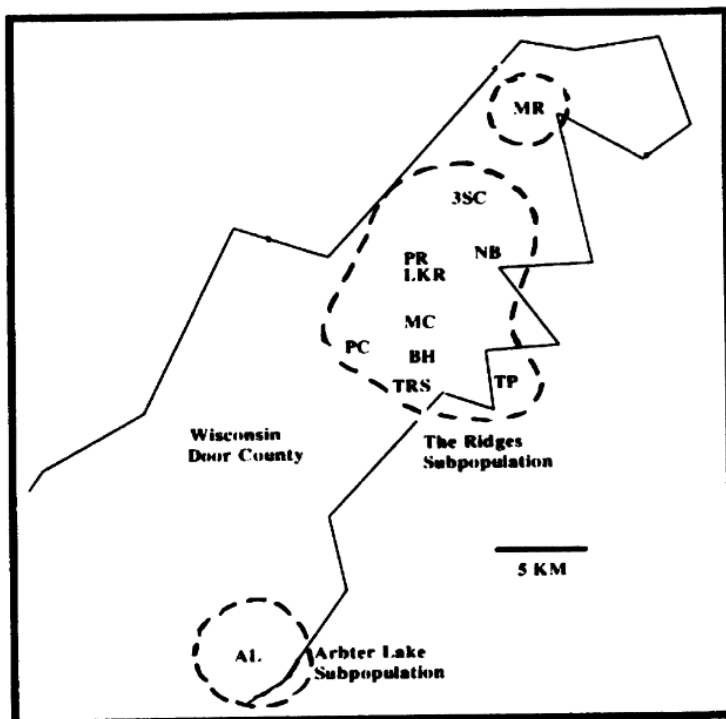


Figure 4. Subpopulation areas in Door County. Map from FWS 2001 Recovery Plan (p. 8).

Table 1 includes a list of the named occupied sites and the Center's mapping decision for each site. Further detail on the creation of each core map area is included in Appendix 2.

Table 1. Hine's emerald dragonfly sites described in the 2013 5-year review with notes on mapping.

State	Site Name	Breeding Site Confirmed?	Mapped Area
Illinois	Lockport Prairie NP	Yes	Illinois CH Unit 1
Illinois	River South and Middle Parcel	Yes	Illinois CH Unit 2
Illinois	Romeoville Prairie NP	No	Illinois CH Unit 3 No breeding has been confirmed, but the site was considered occupied at CH designation.
Illinois	Long Run Seep NP and ComED Parcel	Yes	Illinois CH Unit 7
Illinois	Keepataw FP	Yes	Illinois CH Unit 4
Illinois	Black Partridge FP	No	Not confirmed breeding area
Illinois	Waterfall Glen FP	Yes	Illinois CH Unit 5
Illinois	Cherry Hill Woods FP	No	Not confirmed breeding area
Illinois	McMahon Fen NP	Yes	Illinois CH Unit 6
Illinois	Palos Fen NP	No	Not confirmed breeding area
Michigan	I-75 West Mackinac County	No	Not confirmed breeding site
Michigan	Brevort Lake Road Mackinac County	Yes	Michigan CH Unit 1

State	Site Name	Breeding Site Confirmed?	Mapped Area
Michigan	Castle Rock Road Mackinac County	No	Not conformed breeding site
Michigan	Summerby Swamp Mackinac County	Yes	Michigan CH Unit 1
Michigan	Round Lake Mackinac County	Yes	Michigan CH Unit 1 + wetlands within 1 mile around NHD area for Round Lake
Michigan	Hay Lake Mackinac County	Yes	Michigan CH Unit 1 + wetlands within 1 mile around NHD area for Hay Lake
Michigan	Huebner Mackinac County	Yes	Michigan CH Unit 1
Michigan	I-75 East Mackinac County	Yes	Michigan CH Unit 2
Michigan	Acklund Road Mackinac County	Yes	Michigan CH Unit 2
Michigan	Foley Creek Mackinac County	Yes	Michigan CH Unit 2
Michigan	Martineau Creek Mackinac County	Yes	Michigan CH Unit 2
Michigan	Inglesbee Swamp Mackinac County	No	Not confirmed breeding site
Michigan	Horseshoe Bay Mackinac County	No	Not confirmed breeding site
Michigan	Bois Blanc Island Mackinac County	Yes	Michigan CH Unit 3
Michigan	Thompson's Harbor State Park Presque Isle County	Yes	Michigan CH Unit 4
Michigan	North Point Rd. Fen Alpena County	Yes	Michigan CH Unit 5
Michigan	Misery Bay Alpena County	Yes	Michigan CH Unit 6
Michigan	Negwogon State Park Alcona County	No	Not confirmed breeding site
Michigan	Hayward Lake Menominee County	No	Not confirmed breeding site
Michigan	Garden Island Beaver Island Archipelago Charlevoix County	No	Not confirmed breeding site
Missouri	Bates Hollow Dent County	Yes	Missouri CH Unit 2
Missouri	Fortune Hollow Dent County	Yes	Missouri CH Unit 4
Missouri	Barton Fen Iron County	Yes	Missouri CH Unit 5

State	Site Name	Breeding Site Confirmed?	Mapped Area
Missouri	Kaintuck Hollow Phelps County,	Yes	Missouri CH Unit 7
Missouri	Bee Fork East Reynolds County	No	Included with other Bee Fork sites.
Missouri	Bee Fork Center Reynolds County	Yes	Missouri CH Unit 8 + wetlands within 1 mile of NHD flowline for Bee Fork
Missouri	Bee Fork West Reynolds County	Yes	Missouri CH Unit 8 + wetlands within 1 mile of NHD flowline for Bee Fork
Missouri	Centerville Slough Reynolds County	Yes	Manually designated based on area description. See notes spreadsheet.
Missouri	Deckard Hollow Reynolds County	No	Not confirmed breeding site
Missouri	Grasshopper Hollow Reynolds County	Yes	Missouri CH Unit 11a + wetlands within 1 mile of NHD flowline for stream in USGS map that shows Grasshopper Hollow
Missouri	Johnson Shutin State Park Reynolds County	Yes	Entire Johnson Shut In State Park
Missouri	Johnson Shut in Walker Tract Reynolds County	Yes	Entire Johnson Shut In State Park
Missouri	Kay Branch Reynolds County	Yes	Wetlands within 1 mile of NHD flowline for Kay Branch
Missouri	Ruble Meadow Reynolds County	Yes	Manual designation based on Missouri Geographic Service wetland inventory data including PLSS township, Range, section
Missouri	Wisdom/Lanham Fen Reynolds County	Yes	Wetlands within 1 mile buffer of NHD flowline for Parker Branch identified from Walker et al. (2020)
Missouri	Cottonmouth Fen Ripley County	No	Not confirmed breeding area
Missouri	Emerald Fen Ripley County	Yes	Wetlands within 1 mile buffer of North Prong Little Black River identified from Walker et al. (2020)
Missouri	Glass Lizard Fen Ripley County	Yes	Wetlands within 1 mile buffer of South Prong Little Black RV identified from Walker et al. (2020)
Missouri	Montgomery Fen Ripley County	Yes	1.5 miles from Little Black Conservation Area. Wetlands within 1 mile buffer of South Prong Little Black RV identified from Walker et al. (2020)
Missouri	Overcup Fen Ripley County	No	Not confirmed breeding area
Wisconsin	Mink River Estuary Door County	Yes	Wisconsin CH Unit 2 + Mink River Preserve (Nature Conservancy)
Wisconsin	Three Springs Creek Door County	Yes	Wisconsin CH Unit 3 + Door County Land Trust Parcels
Wisconsin	North Bay Marsh Door County	Yes	Wisconsin CH Unit 4 + North Bay Preserve (Nature Conservancy)

State	Site Name	Breeding Site Confirmed?	Mapped Area
Wisconsin	Mud Lake North Complex Door County	Yes	Wisconsin CH Unit 5 + North Bay Preserve (Nature Conservancy)
Wisconsin	Mystery Creek Door County	Yes	Wisconsin CH Units 5 and 6 + Mud Lake Wildlife Area
Wisconsin	Piel Creek Door County	Yes	Wisconsin CH Unit 7 + wetlands within 1-mile buffer of NHD flowline of Piel Creek
Wisconsin	Bailey's Harbor Door County	Yes	Wisconsin CH Unit 5
Wisconsin	Ridges Sanctuary Door County	Yes	Wisconsin CH Unit 5
Wisconsin	Toft Point Door County	No	Wisconsin CH Unit 5
Wisconsin	Arbter Lake Door County	Yes	Wisconsin CH Unit 8 + wetlands within 1 mile buffer of NHD of Arbter Lake
Wisconsin	Big Marsh Washington Island Door County	Yes	Wisconsin CH Unit 1 + wetlands within 1 mile buffer of NHD of Big Marsh Lake
Wisconsin	Black Ash Swamp Door and Kewaunee County	Yes	Wetlands within NHD area for Black Ash Swamp
Wisconsin	Gardener Marsh Door County	Yes	Wisconsin CH Unit 3 + wetlands within NHD area for Gardener Marsh
Wisconsin	Ephraim Swamp Door County	Yes	Wetlands within NHD area for Ephraim Swamp
Wisconsin	Kellner Fen Door County	Yes	Wisconsin CH Unit 11
Wisconsin	Cedarsburg Bog Ozaukee County	Yes	Wisconsin CH Unit 10
Wisconsin	Lower Wisconsin State Riverway + Kendall Lake and Avoca Wildlife Area Iowa County	Yes	Wisconsin DNR State Natures Area called Avoca Prairie and Savannah clipped to Iowa County + wetlands within 1 mile of NHD area for Kendall Lake
Wisconsin	Lower Wisconsin State Riverway and Knapp Creek Iowa and Richland Counties	Yes	Wetlands within 1 mile buffer of NHD flowline for Knapp Creek clipped to Richland County + Wisconsin State Riverway clipped to Richland County

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

- Range Map Approach for Core Map

A core map based on the species range was rejected because the ECOS range map is county or grid scale and overly broad for a PULA. The ECOS range map is much larger than the current area of occupancy and includes a large proportion of non-habitat that is agricultural land where Hine's emerald dragonflies are not known to persist.

- Critical Habitat Approach for Core Map

A core map based on critical habitat only was rejected because there are many occupied areas outside of the critical habitat. All the current critical habitat was included in the core map, but critical habitat alone was insufficient as a core map.

- Habitat Modeling Approach for Core Map

A core map based on modeled habitat was considered but rejected. The 2025 5-year review indicates that the Illinois Nature History Survey (at the University of Illinois-Urbana Champaign) created a rangewide spatial habitat model for the species. We contacted the INHS, but access to use the model could not be granted without FWS permission. Access to the model had not been granted at the time of the creation of this core map.

- Other sources of information reviewed but not included

Location information available on the Global Biodiversity Information Facility (GBIF) did provide some recent observations of the species.⁹ However, nearly all the recent observations were from citizen science platforms such as iNaturalist. These observations could be considered, but are only available at low resolution with an uncertainty of ~28km and were considered practically unusable for designating a core map. Supplemental location information from GBIF was not considered in the core map. Walker et al. (2020)¹⁰ presented maps of surveyed areas within the species range. These maps are included for reference in Appendix 1. Maps and points were used to double check the locations derived from other methods.

⁹ GBIF.org (30 May 2024) GBIF Occurrence Download <https://doi.org/10.15468/dl.ap9rtz>

¹⁰ Walker, Jane, Meredith Mahoney, Alan R. Templeton, Paul McKenzie, Timothy E. Vogt, Everett D. Cashatt, Joseph Smentowski, et al. "Contrasting Ozark and Great Lakes Populations in the Endangered Hines Emerald Dragonfly (*Somatochlora hineana*) Using Ecological, Genetic, and Phylogeographic Analyses." *Conservation Science and Practice* 2, no. 3 (2020): e162. <https://doi.org/10.1111/csp2.162>.

Appendix 1. Information compiled for species during Step 1

1. Recent FWS documents

FWS. 2001. Hine's Emerald Dragonfly (*Somatochlora hineana* Williamson) Recovery Plan. Available from https://ecos.fws.gov/docs/recovery_plan/hedplan.pdf.

FWS. 2013. Hine's Emerald Dragonfly, *Somatochlora hineana* (Odonata: Corduliidae) 5-Year Review: Summary and Evaluation. Available from https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2152.pdf.

FWS. 2025. Hine's Emerald Dragonfly (*Somatochlora hineana*) Status Review: Summary and Evaluation. Available from https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/21792.pdf.

2. Background information

Status: ENDANGERED

Resiliency, redundancy, and representation (the 3Rs):

Resiliency – FWS has not formally assessed the resiliency of Hine's emerald dragonflies in any recent document.

Redundancy – FWS has not formally assessed the redundancy of Hine's emerald dragonflies in any recent document.

Representation – FWS has not formally assessed the representation of Hine's emerald dragonflies in any recent document.

Habitat, Life History, and Ecology

Habitat:

The Hine's emerald dragonfly relies on specific wetland habitat. The species occupies marshes and sedge-dominated meadows fed by groundwater on top of dolomite bedrock. Adjacent forest edge habitat also appears to be important to the species.¹¹

Diet:

The Hine's emerald dragonfly is a generalist predator of other insects and invertebrates. Both larvae and adults are predatory. Larvae are assumed to be lie-and-wait predators but also may actively hunt. The diet of adults and larvae includes larval mayflies, caddisflies, isopods, and larvae of other dragonfly species with prey size increasing as the individual grows and develops.¹²

Taxonomy:

The Hine's emerald dragonfly is an insect in the order Odonata (dragonflies and damselflies) in the emerald dragonfly family Corduliidae. Members of Corduliidae have metallic green eyes among distinguishing features. The Hine's emerald dragonfly, *Somatochlora hineana*, can be identified based on distinctive shapes of terminal appendages and ovipositors and separated from other *Somatochlora* species that also occur in the range including: *S. linearis*, *S. tenebrosa*, *S. ensigera*, *S. elongata*, and *S. williamsoni*.¹³ The species was first described in 1931 from adults collected near Indian Lake, Logan County, Ohio.¹⁴

¹¹ FWS 2001 p. iii

¹² FWS 2001 p. 13

¹³ FWS 2001 p. 1

¹⁴ FWS 2001 p. 6

Taxonomic Hierarchy	
Kingdom	Animalia – Animal, animaux, animals
Subkingdom	Bilateria – triploblasts
Infrakingdom	Protostomia
Superphylum	Ecdysozoa
Phylum	Arthropoda – Artrópode, arthropodes, arthropods
Subphylum	Hexapoda – hexapods
Class	Insecta – insects, hexapoda, insecto, insects
Subclass	Pterygota – insects ailés, winged insects
Infraclass	Palaeoptera – ancient winged insects
Order	Odonata Fabricius, 1793 – libélula, damselflies, dragonflies
Suborder	Anisoptera Selys, 1854 – dragonflies, libellules
Family	Zygoptera Selys, 1854 – green-eyed skimmers, Emeralds
Subfamily	Zygopterinae
Genus	Somatochlora Selys, 1871
Species	Somatochlora hineana Williamson, 1931 – Hine's Emerald

Figure A1-1. Taxonomy of Hine's emerald dragonfly as shows in the ITIS system.

Relevant Pesticide Use Sites:

Agricultural uses such as row crops and specialty crops
 Non-agricultural such as on rangeland and fencerow
 Urban and residential uses including golf courses
 Mosquito control
 Conservation uses to remove invasive species and other uses

Relevant Recover Criteria and Actions:

Objective:

From 2001 Recovery Plan Page 31

The objective of this recovery plan is to assure the long-term viability of the Hine's emerald dragonfly by arresting or reversing its decline and addressing threats to its survival. When this objective is achieved, the Hine's emerald dragonfly may be removed from the Federal list of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12).

Criteria:

From 2001 Recovery Plan Pages 31-32

CRITERIA FOR RECLASSIFICATION TO THREATENED

1. Each of the two Recovery Units contains a minimum of two populations, each composed of at least three subpopulations. Each subpopulation contains a minimum of 500 sexually mature adults for 10 consecutive years.
2. Within each subpopulation, there are at least two breeding habitat areas, each fed by separate seeps and/or springs.
3. For each population, the habitat supporting at least two subpopulations should be legally or formally protected and managed for Hine's emerald dragonfly, using long-term protection mechanisms such as watershed protection, deed restrictions, land acquisition, or nature preserve dedication. In addition, mechanisms protecting the up gradient ground watershed should also be in place.
4. A monitoring plan must be established for each population within 5 years to estimate population size on an annual basis for the purpose of determining whether recovery criteria have been achieved.

CRITERIA FOR DELISTING

1. Each of the two Recovery Units contains a minimum of three populations composed of at least three subpopulations. Each subpopulation contains a minimum of 500 reproductive adults for 10 consecutive years.
2. Within each subpopulation, there are at least two breeding habitat areas, each fed by separate seeps and/or springs.

3. For each population, the habitat supporting at least three subpopulations should be legally or formally protected and managed for Hine's emerald dragonfly, using long-term protection mechanisms such as watershed protection, deed restrictions, land acquisition, or nature preserve dedication. In addition, mechanisms protecting the up gradient ground watershed will also be in place within 5 years.

Recovery Actions:

FWS outlines their past and on-going conservation measures for Hine's emerald dragonflies in the 2025 5-year review and elsewhere. Broadly, the conservation actions include the following:

- Captive rearing
 - FWS is planning to conduct or is funding research into the most effective means to raise the dragonflies in captivity with the goal of releasing captive raised individuals into the Lower DesPlaines River Valley population
 - FWS and partners are also researching captive rearing techniques for the Great Plains mudbug (a crayfish) to release into dragonfly habitat. The mudbug is an important prey species that also provides burrows that are used by larval dragonflies.
- Environmental DNA Sampling
 - FWS is exploring the potential of using EDNA collection techniques to survey for the presence of Hine's emerald dragonflies.
- Species Distribution Models
 - The Illinois Natural History Survey has produced a species distribution model to identify potential areas where the species can occur.
- Education and Training
 - FWS has worked with biologists to train more people to survey for the dragonfly.
- Habitat Conservation Plan
 - Hanson Material Service has completed a habitat conservation plan.

Recommendations for Future Actions:

From 2025 5-Year Review Page 14

1. Continue to implement Hine's emerald dragonfly captive rearing and augmentation in the Lower DesPlaines River Valley population.
2. Implement the rangewide distribution model to identify and survey potential larval habitat for species presence.
3. Protect habitat in new locations.
4. Implement eDNA survey protocols with partners across the species historic range.
5. Monitor and estimate the size of Hine's emerald dragonfly populations.
6. Coordinate efforts with partners to restore and manage larval and adult (including recharge areas) habitat in existing, historic, and new sites as they are verified.
7. Assist in groundwater and habitat protection, enhancement, and management efforts

3. Description of Species Range:

The Hine's emerald dragonfly historically ranged across the upper Midwestern states with additional historic records in Alabama. The species currently can be found in Illinois, Michigan, Missouri, and Wisconsin.

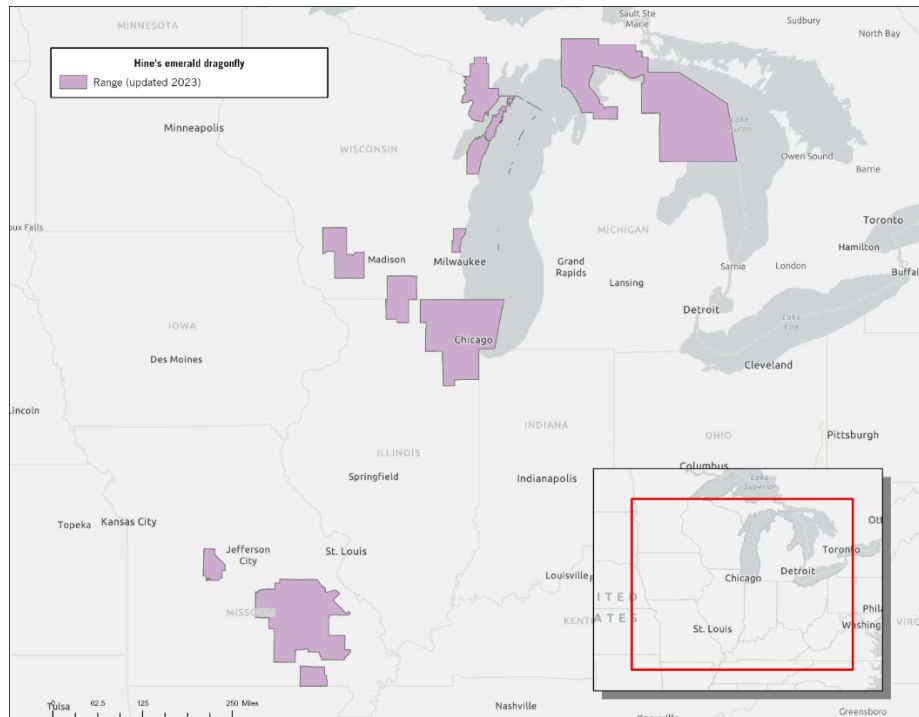


Figure A1-2. ECOS range map of the Hine's emerald dragonfly (updated 1-25-2023).

4. Critical Habitat:

The critical habitat for the Hine's emerald dragonfly was designated in 2010.

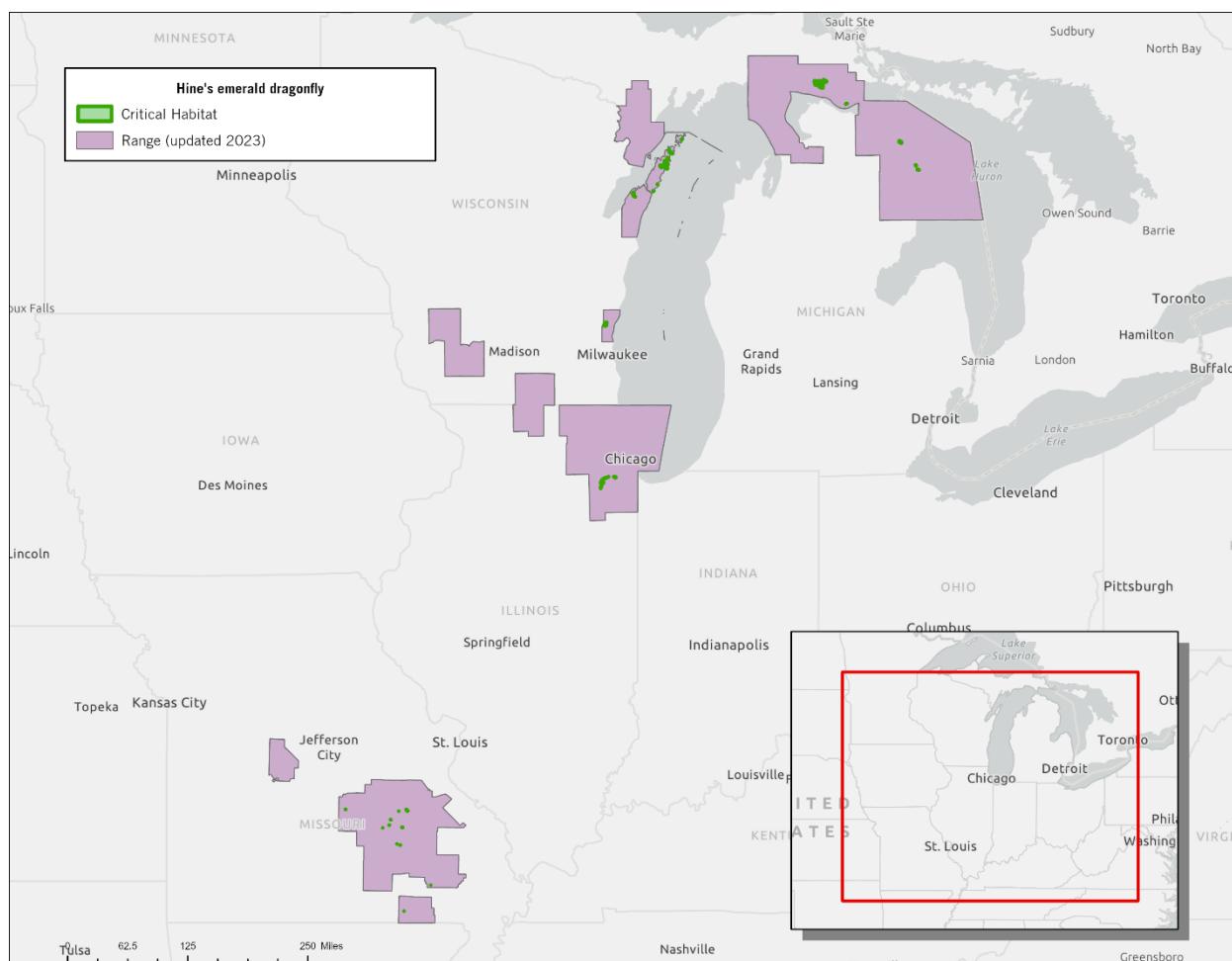


Figure A1-3. ECOS Critical Habitat for Hine’s emerald dragonfly. The total acreage of critical habitat is approximately 26,531 acres.

5. Known Locations

The 2013 5-year review provides the most comprehensive assessment of the distribution of the Hine’s emerald dragonfly. Location information in Table 1 from the 2013 5-year review (p. 4-10) is reproduced, in part, below to identify the named sites that are considered occupied. There are 69 named sites in total with 52 sites that have verified breeding (Table A1-1).

Only sites with verified breeding areas are considered occupied and are included in the core map. Further detail regarding the delineation of these sites is provided in Appendix 2.

Table A1-1. Sites with verified breeding areas as identified in the 2013 5-year review.

State	Site Name	Breeding Site Confirmed?
Illinois	Lockport Prairie NP	Yes
Illinois	River South and Middle Parcel	Yes
Illinois	Romeoville Prairie NP	No
Illinois	Long Run Seep NP	Yes
Illinois	Long Run/ComED Parcel	Yes

State	Site Name	Breeding Site Confirmed?
Illinois	Keepataw FP	Yes
Illinois	Black Partridge FP	No
Illinois	Waterfall Glen FP	Yes
Illinois	Cherry Hill Woods FP	No
Illinois	McMahon Fen NP	Yes
Illinois	Palos Fen NP	No
Michigan	I-75 West Mackinac County	No
Michigan	Brevort Lake Road Mackinac County	Yes
Michigan	Castle Rock Road Mackinac County	No
Michigan	Summerby Swamp Mackinac County	Yes
Michigan	Round Lake Mackinac County	Yes
Michigan	Hay Lake Mackinac County	Yes
Michigan	Huebner Mackinac County	Yes
Michigan	I-75 East Mackinac County	Yes
Michigan	Acklund Road Mackinac County	Yes
Michigan	Foley Creek Mackinac County	Yes
Michigan	Martineau Creek Mackinac County	Yes
Michigan	Inglesbee Swamp Mackinac County	No
Michigan	Horseshoe Bay Mackinac County	No
Michigan	Bois Blanc Island Mackinac County	Yes
Michigan	Thompson's Harbor State Park Presque Isle County	Yes
Michigan	North Point Rd. Fen Alpena County	Yes
Michigan	Misery Bay Alpena County	Yes
Michigan	Negwegon State Park Alcona County	No
Michigan	Hayward Lake Menominee County	No

State	Site Name	Breeding Site Confirmed?
Michigan	Garden Island Beaver Island Archipelago Charlevoix County	No
Missouri	Bates Hollow Dent County	Yes
Missouri	Fortune Hollow Dent County	Yes
Missouri	Barton Fen Iron County	Yes
Missouri	Kaintuck Hollow Phelps County	Yes
Missouri	Bee Fork East Reynolds County	No
Missouri	Bee Fork Center Reynolds County	Yes
Missouri	Bee Fork West Reynolds County	Yes
Missouri	Centerville Slough Reynolds County	Yes
Missouri	Deckard Hollow Reynolds County	No
Missouri	Grasshopper Hollow Reynolds County	Yes
Missouri	Johnson Shutin State Park Reynolds County	Yes
Missouri	Johnson Shut in Walker Tract Reynolds County	Yes
Missouri	Kay Branch Reynolds County	Yes
Missouri	Ruble Meadow Reynolds County	Yes
Missouri	Wisdom/Lanham Fen Reynolds County,	Yes
Missouri	Cottonmouth Fen Ripley County	No
Missouri	Emerald Fen Ripley County	Yes
Missouri	Glass Lizard Fen Ripley County	Yes
Missouri	Montgomery Fen Ripley County	Yes
Missouri	Overcup Fen Ripley County	No
Wisconsin	Mink River Estuary Door County	Yes
Wisconsin	Three Springs Creek Door County	Yes
Wisconsin	North Bay Marsh	Yes

State	Site Name	Breeding Site Confirmed?
	Door County	
Wisconsin	Mud Lake North Complex Door County	Yes
Wisconsin	Mystery Creek Door County	Yes
Wisconsin	Piel Creek Door County	Yes
Wisconsin	Bailey's Harbor Door County	Yes
Wisconsin	Ridges Sanctuary Door County	Yes
Wisconsin	Toft Point Door County	No
Wisconsin	Arbter Lake Door County	Yes
Wisconsin	Big Marsh Washington Island Door County	Yes
Wisconsin	Black Ash Swamp Door and Kewaunee County	Yes
Wisconsin	Gardener Marsh Door County?	Yes
Wisconsin	Ephraim Swamp Door County	Yes
Wisconsin	Kellner Fen Door County	Yes
Wisconsin	Cedarsburg Bog Ozaukee County	Yes
Wisconsin	Lower Wisconsin State Riverway + Kendall Lake and Avoca Wildlife Area Iowa County	Yes
Wisconsin	Lower Wisconsin State Riverway and Knapp Creek Iowa and Richland Counties	Yes

The 2025 5-Year Review additionally provides a map of Hine's emerald dragonfly sites. This map is included here as Figure A1-4.



Figure A1-4. Hine's emerald dragonfly sites per population. Map from FWS 2025 p. 35.

Additional survey results for the species are described in Walker et al (2020)¹⁵ and a map from this paper is included below.

¹⁵ Walker, Jane, Meredith Mahoney, Alan R. Templeton, Paul McKenzie, Timothy E. Vogt, Everett D. Cashatt, Joseph Smentowski, et al. "Contrasting Ozark and Great Lakes Populations in the Endangered Hines Emerald Dragonfly (*Somatochlora hineana*) Using Ecological, Genetic, and Phylogeographic Analyses." *Conservation Science and Practice* 2, no. 3 (2020): e162. <https://doi.org/10.1111/csp2.162>.

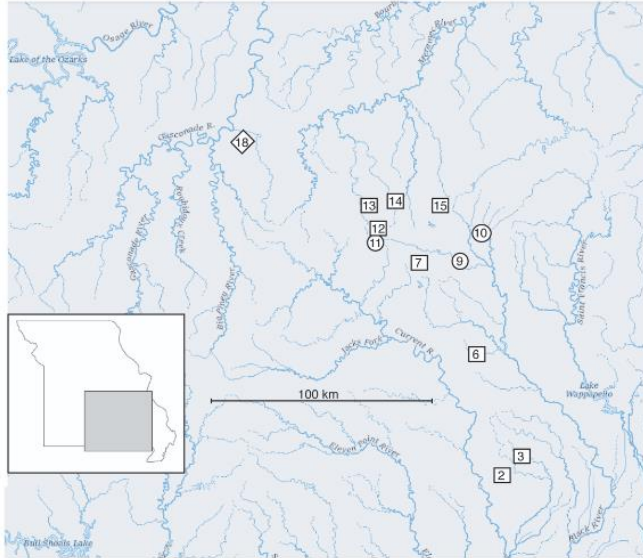


Figure A1-5. Hine's emerald dragonfly survey locations in Missouri. Map from Walker et al. 2020.

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

The core map type for this species is biological information type, based on FWS 2013 5YR table 1 known locations and GIS 2010 FWS critical habitat shapefile for Hine's emerald dragonfly.

The Center for Biological Diversity developed the interim core map by reviewing all critical habitats units and known locations in FWS 2013 5YR table. These two sources sometimes overlapped. As FWS critical habitat is the primary source, if an overlap existed but there was not much difference between the two, the critical habitat was used solely to represent the location. Criteria considered while reviewing locations in the FWS 2013 5YR table 1 are in the column with the heading of "Number of Breeding Areas". If a known location is categorized as "Not Confirmed" under "Number of Breeding Areas" column and there is not an overlapping FWS 2010 critical habitat area, then these were not included. This section details the data and steps used to create the core map for the Hine's emerald dragonfly based on this known location information

3. References and Software

- World UTM Grid:
https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/World_UTM_Grid/FeatureServer
- FWS Species critical habitat:
https://ecos.fws.gov/docs/crithab/zip/FCH_Somatochlora_hineana_20100423.zip
- FWS Species range:
https://ecos.fws.gov/docs/species/shapefiles/usfws_I06P_I01_Somatochlora_hineana_current_range.zip
- Wisconsin State Cartographer's Office Statewide parcels (downloaded):
<https://www.sco.wisc.edu/parcels/data/>
- North Bay Preserve Trails and Boundaries
https://www.nature.org/content/dam/tnc/nature/en/graphics/maps/web_maps_NorthBay.pdf
- USGS (Protected Areas Database US) PAD-US file Version 4.0
<https://www.usgs.gov/programs/gap-analysis-project/science/pad-us-data-download>
- National Hydrography Dataset Plus Version 2.0 file geodatabase with flowline, waterbodies and sinks feature classes
<https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/NHDPlusV21/FeatureServer>
- USA county/parish boundaries of United States in the 50 states and the District of Columbia
https://services.arcgis.com/P3ePLMYs2RVChkJx/arcgis/rest/services/USA_Census_Counties/FeatureServer
- 1990 Missouri DNR Wetlands Technical Committee "An evaluation of potential assimilation of Missouri Wetland Inventories
<https://share.mo.gov/nr/mgs/MGSDData/Open%20File%20Reports/An%20Evaluation%20and%20Potential%20Assimilation%20of%20Missouri%20Wetlands%20Inventories/OFR-90-81-WR.pdf>
- Public Lands Survey System (PLSS)
https://services2.arcgis.com/FiaPA4ga0iQKduv3/arcgis/rest/services/Public_Land_Survey_System_view/FeatureServer
- FWS National Wetlands Inventory GIS download by States (Michigan, Wisconsin, Missouri)
<https://www.fws.gov/program/national-wetlands-inventory/download-state-wetlands-data>

- Walker J, Mahoney M, Templeton AR, et al. Contrasting Ozark and Great Lakes populations in the endangered Hines emerald dragonfly (*Somatochlora hineana*) using ecological, genetic, and phylogeographic analyses. *Conservation Science and Practice*. 2020; 2:e162
<https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.162>
- Software used: ArcGIS Pro version 3.2

2. Datasets and Procedures Used in Core Map Development

2.1. Extract data from table 1 (Distribution and status of Hine’s Emerald Dragonfly Based on Recovery Criteria) from 2013 FWS 5YR report in excel table.

1. Highlight column headings from table 1 à right click à Open table in spreadsheet. (**Figure A2-1**)

Table 1. Distribution and Status of Hine’s Emerald Dragonfly Based on Recovery Criteria

Recovery Unit	Population	Subpopulation ¹	Adult Subpop. Size	Site ² * = site found since issuance of recovery plan	Adult # per site	Number of Breeding Areas ³	Legally Protected and Managed ⁴	GW Area Delineated	Mntrng.
		Mink River Estuary, Door County, WI	TBD	Mink River	TBD	Yes, 1 verified	Partially protected		

Figure A2-1. Screenshot of highlighted adobe text to be opened in csv

2. Highlight first row à right click à select “Copy as Table” and paste under column headings. Continue this until you have all the data from the table in excel format. Go to file à Save as à browse to location and save as an excel table named, “HED_EPA_2013_5yr_Table1” (**Figure A2-2**)

Subpopulation ¹	Adult Subpop. Size	Site ² * = site found since issuance of recovery plan	Adult # per site	Number of Breeding Areas ³	Legally Protected and Managed ⁴	GW Area Delineated	Mntrng.
Mink River				Yes, 1 verified	Partially protected	Delineated partially protected	No
Es...				Yes, 1 verified#	Partially protected	Delineated partially protected	No#

Figure A2-2. Screenshot of highlighted adobe text to be copied and pasted in csv

3. Insert five columns on the left-hand side and name them, “Note”, “Buffer 1 mile, NWI state wetland intersecting, remove other known areas”, “Geographic Source found to delineate area”, “Not Included because both not in CH AND not confirmed as a "Number of Breeding Areas"", and “Data Source(s) Used.” This is used to track the decisions and processes used to create the GIS records.
 - a. Note - Information about source, review process and decision
 - b. Buffer 1 mile, NWI state wetland intersecting, remove other known areas – If process to buffer NHD record one mile and clip any NWI state wetland by the buffer was used, “Yes” is added.
 - c. Geographic Source found to delineate area – If a source was found to define and delineate the location of known location, then “Yes” is added.
 - d. Not Included because both not in CH AND “Not confirmed” in "Number of Breeding Areas" – If there is not a critical habitat polygon around the known location **and** the “Number of Breeding Areas” is categorized as “Not confirmed” no GIS polygon record is created.
 - e. Data Source(s) Used – the primary GIS source used to create the polygon. “Null” indicates either column C is “No” or column D is “Yes.

1.2. Review and compare critical habitat polygons and known locations from table 1. Add critical habitat polygons to core map shapefile.

1. Find the location and geographic boundaries of the known locations in table 1 using GIS data sources, Google searches, and Google map searches for as many as possible. Upon determining the boundary, determine if a critical habitat polygon exists in the same area and if the critical habitat polygon will sufficiently represent the area. There were 31 instances where critical habitats overlap the known locations. Most often the critical habitat polygon sufficiently represents the known location area or areas. For those areas that do not, another polygon will be created for the areas with the critical habitat area removed. During the review, it was determined that critical habitat "Illinois UNIT 03" will not be used, because in FWS 2025 5YR Review under the heading "Environmental Contaminants" on page 13 regarding the Romeoville Prairie Nature Preserve site the extracted text below says the site was permanently destroyed. As well as table 1 indicates this site is "Not confirmed."
"Two oil pipeline leaks occurred outside of Hine's emerald dragonfly habitat in 2010. In September 2010, an oil pipeline break occurred outside of Romeoville Prairie Nature Preserve in Romeoville, Illinois. Based on the analysis that was conducted following the Romeoville leak, no oil was detected in the habitat or the groundwater. In December 2010, another pipeline accident released oil into Hine's emerald dragonfly habitat at the Long Run parcel on private land in Lockport, Illinois. Clean up efforts were completed and the site was reclaimed to the extent practical. However, the Hine's larval habitat at the site was permanently destroyed and a restoration plan has been completed to mitigate for the associated impacts from the pipeline leak (United States Fish and Wildlife Service, United States Department of the Interior and Natural Resource Trustees for the State of Illinois 2023)."
2. In ArcPro, create a copy of template EPA polygon feature class for Hine's emerald dragonfly, named "Hines_emerald_dragonfly_CH" in file geodatabase. Go to the fields view of the layer and highlight the "Descriptio" and "Category" fields. **(Figure A2-3)** Paste the fields into the "Critical Habitat" shapefile. **(Figure A2-4)**

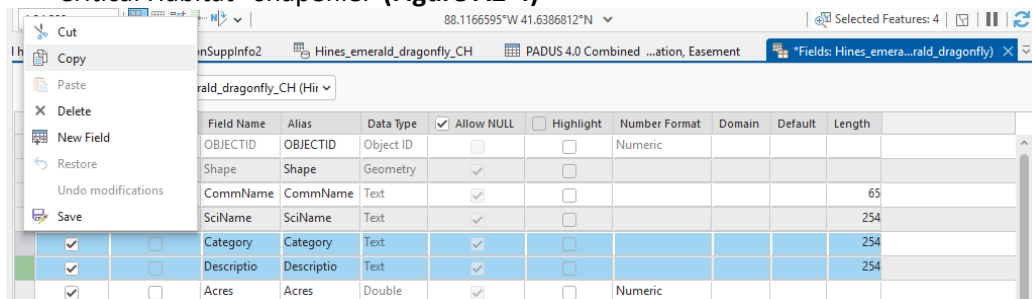


Figure A2-3. Screenshot of field view and copied fields

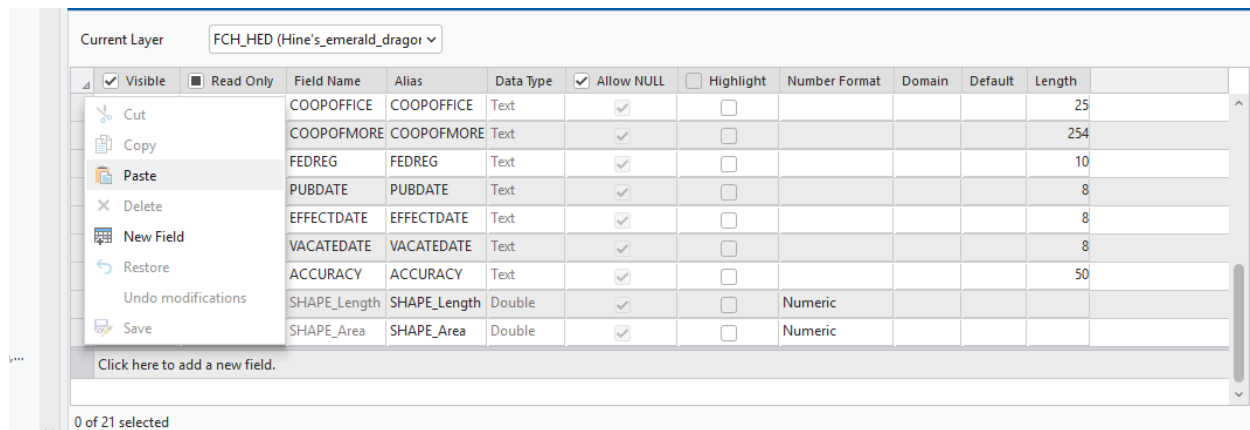


Figure A2-4. Screenshot of field view and paste option

- Click on “Category” field à Select “Calculate Field” à Type “Area of occupancy” as the expression à Click Apply (Figure A2-5)

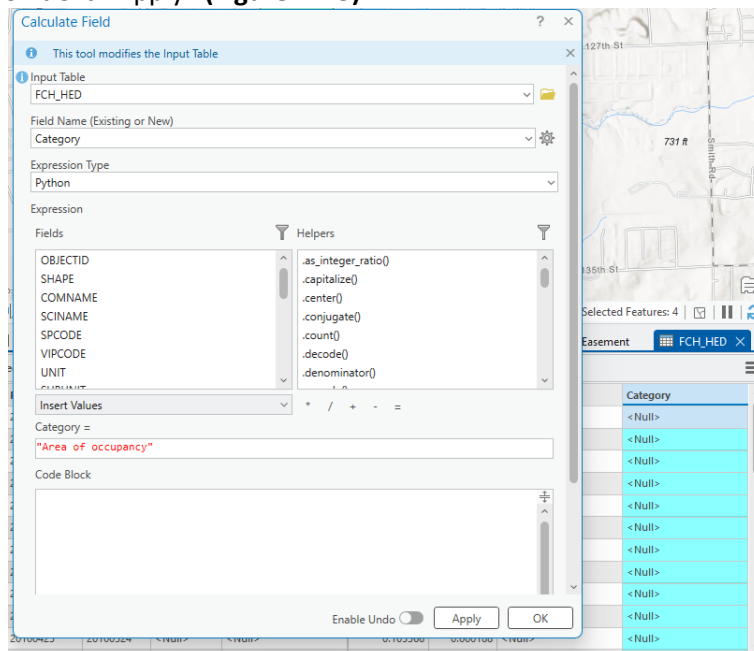


Figure A2-5. Screenshot of Calculate Field

- Because some critical habitat fields have a “SUBUNITNAME” value, two separate “Calculate Field” operations need to be done. In the first “Calculate Field” operation, begin with “Select by Attribute” to select where “SUBUNITNAME” is null (Figure A2-6) Right Click on “Descriptio” field à Select “Calculate Field” à enter "Hine's emerald dragonfly occupied critical habitat. Unit name is " + !UNITNAME! + "." as an expression à Click “Apply”. (Figure A2-7)

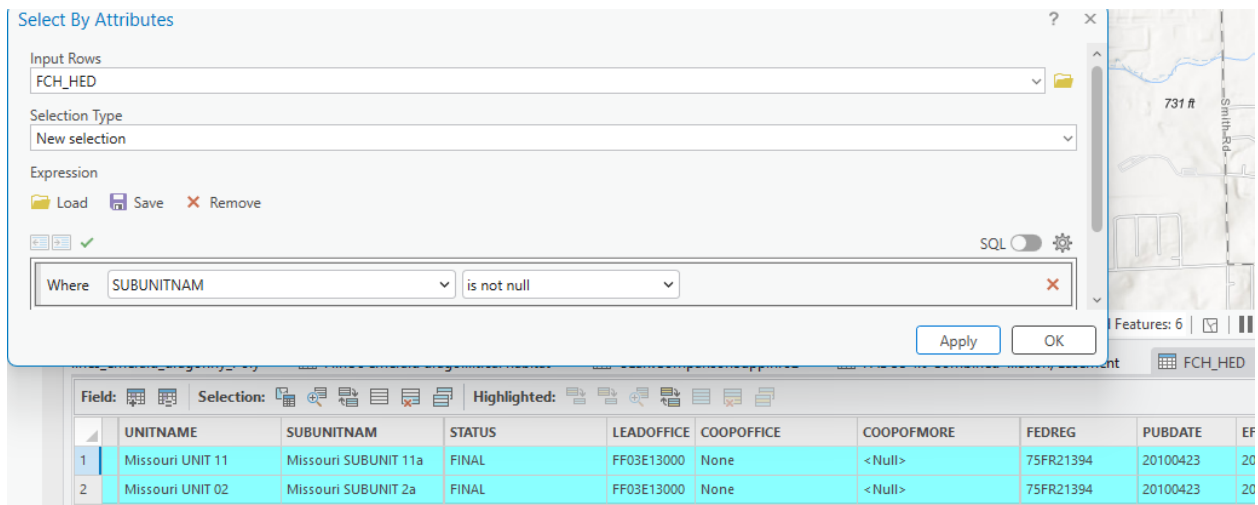


Figure A2-8. Screenshot of “Select by Attributes”

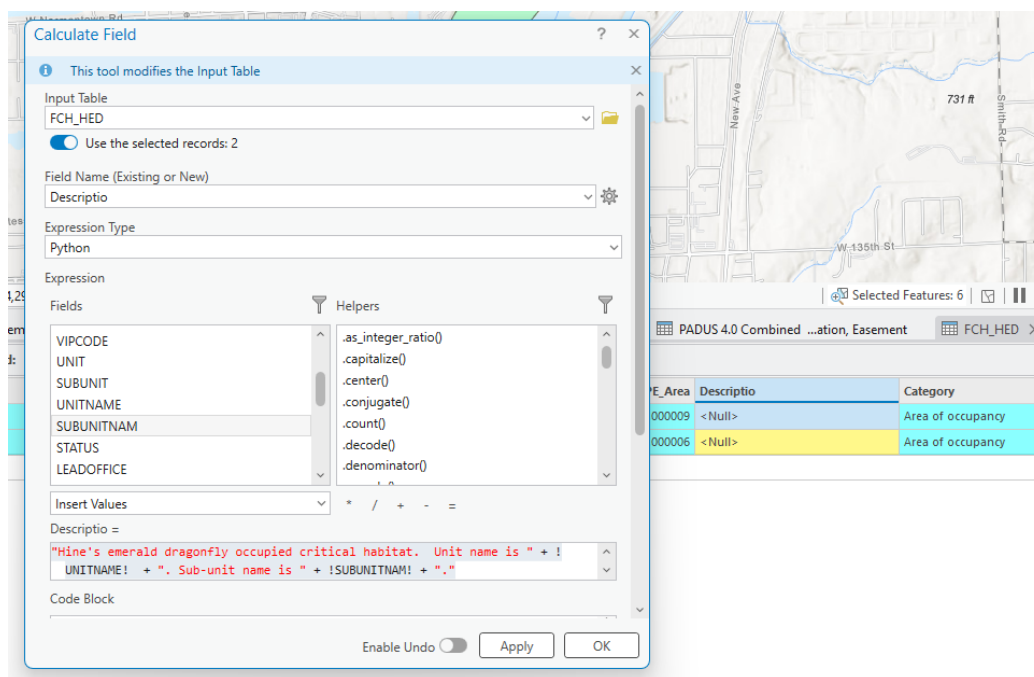


Figure A2-9. Screenshot of “Calculate Field”

- In the “Critical Habitat” shapefile, use “Select by attributes” to select all records except Illinois UNIT 03. **(Figure A2-10)** Copy and paste the selected records to “Hines_emerald_dragonfly_CH”.

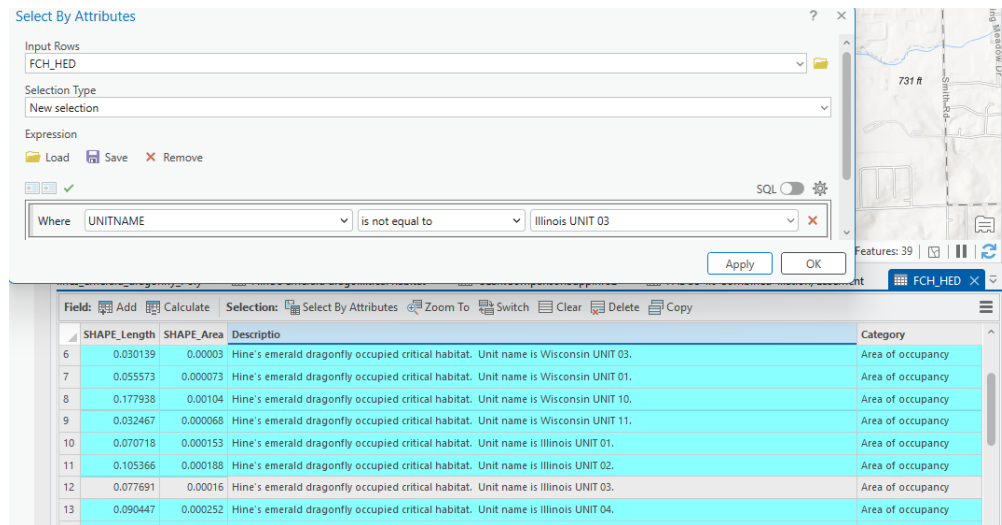


Figure A2-10. Screenshot of “Select by Attributes”

1.3. Create PADUS related records and remove overlapping critical habitat areas.

1. Create a definition query to select records from PAD-US V 4.0 for the following areas: Johnson's Shut-Ins State Park, Mud Lake Wildlife Area-Door, Mink River Estuary, and North Bay. **(Figure A2-11)** Dissolve the selected records by “Unit Name”, name it “HED_PADUS_Dissolve”. **(Figure A2-12)** Update the “Unit Name” with the name of the PADUS and Wisconsin Department of Natural Resources Natural Areas’ names.

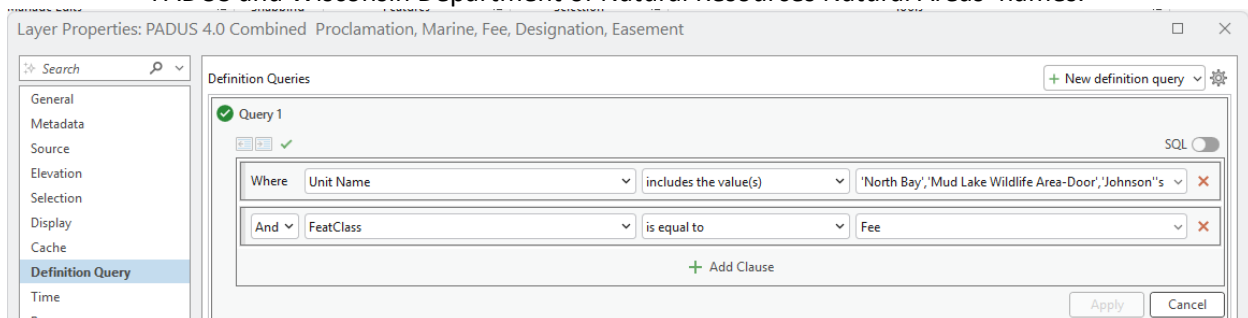


Figure A2-11. Screenshot of “Select by Attributes”

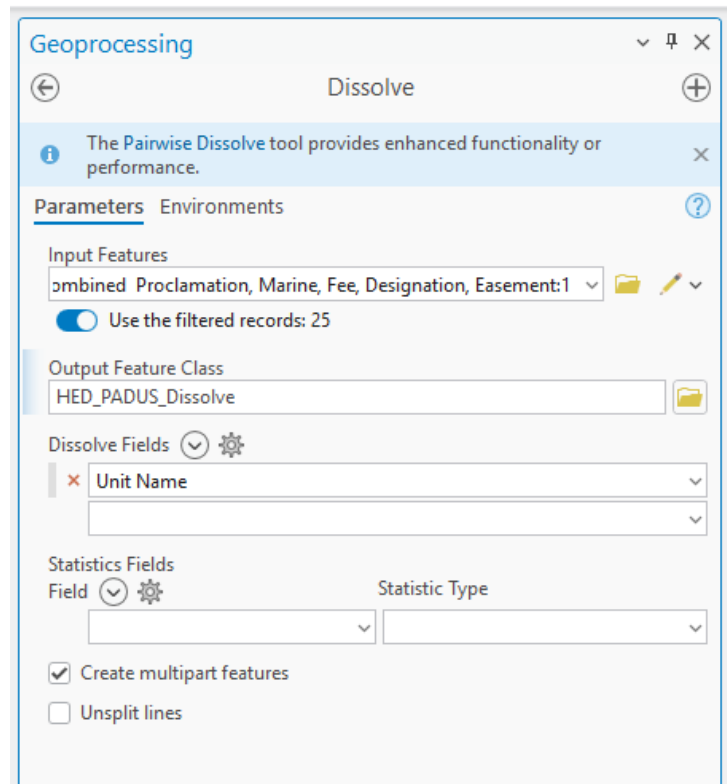
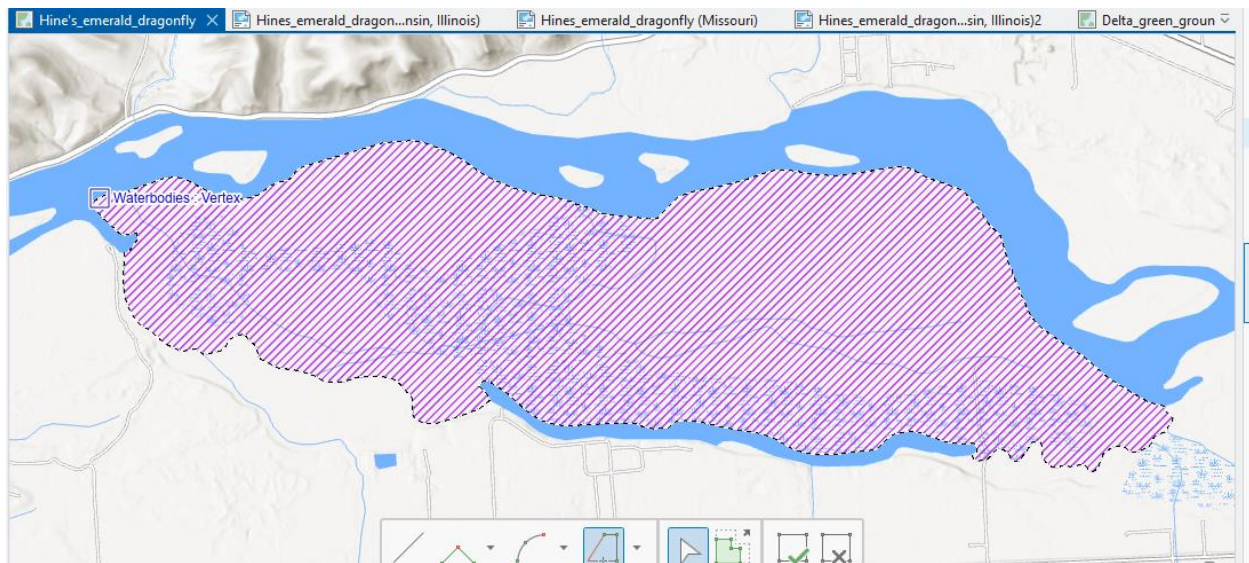


Figure A2-12. Screenshot of “Dissolve tool”

2. At the “Wisconsin Department of Natural Resources State Natural Area (Avoca Prairie and Savanna No 6)” website (<https://dnr.wisconsin.gov/topic/statenaturalareas/AvocaPrairieandSavanna>), there is tab named “map” where a map (https://widnr.widen.net/s/wnmtzcxgc/sna068_map) can be downloaded. The map shows waterbodies and river flowlines as the boundaries for the natural area. These will be used to manually create the record. Start “Editing” for “HED_PADUS_Dissolve”. Ensure that the NHD Plus V.21 waterbodies and flowline feature classes are turned on. Use the trace tool digitize and match the boundary shown on the downloaded map.



2. Use “Pairwise Erase” tool to remove “critical habitat” areas from the three PAD-US dissolve areas from the previous step. **(Figure A2-13)** Copy and paste the four polygons to “Hines_emerald_dragonfly_CH”. Update the “Description” field to mention the PAD-US unit name and any areas of critical habitat that are removed.

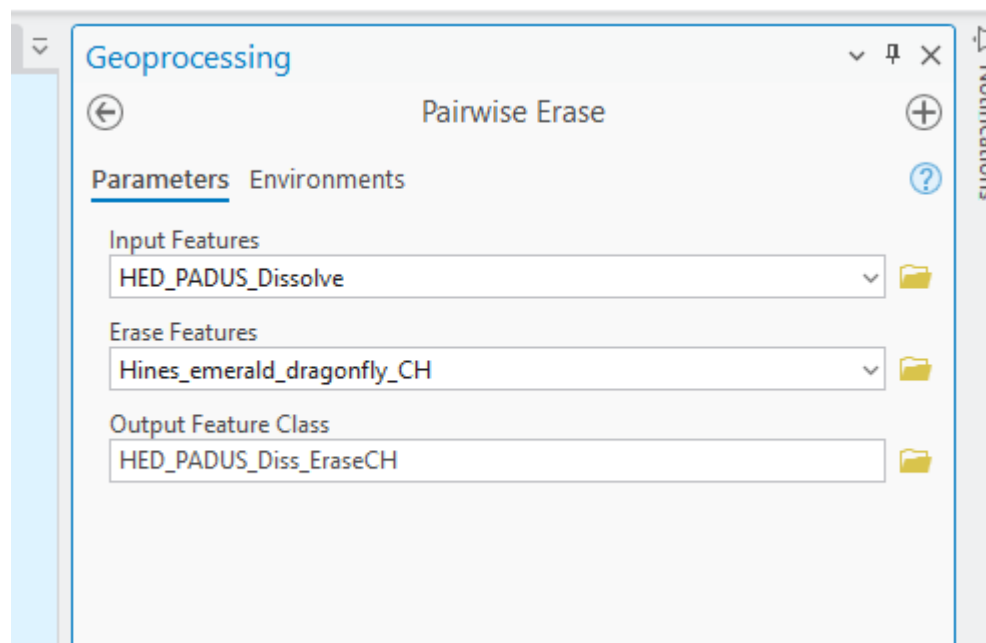


Figure A2-13. Screenshot of “Pairwise Erase tool”

1.4. Create core map records for Black Ash, Ephraim and Gardner Swamps from NHD PlusV2.1 waterbodies layer

1. In the National Hydrography Dataset Plus Version 2.1 waterbodies create a definition query for Black Ash, Ephraim and Gardner swamps. **(Figure A2-14)** With the definition query set

use “Pairwise Erase” tool to erase any area from the recently created core map against the NHD swamps. **(Figure A2-15)** Copy and paste these three records in “Hines_emerald_dragonfly_CH” and update the “Description” field.

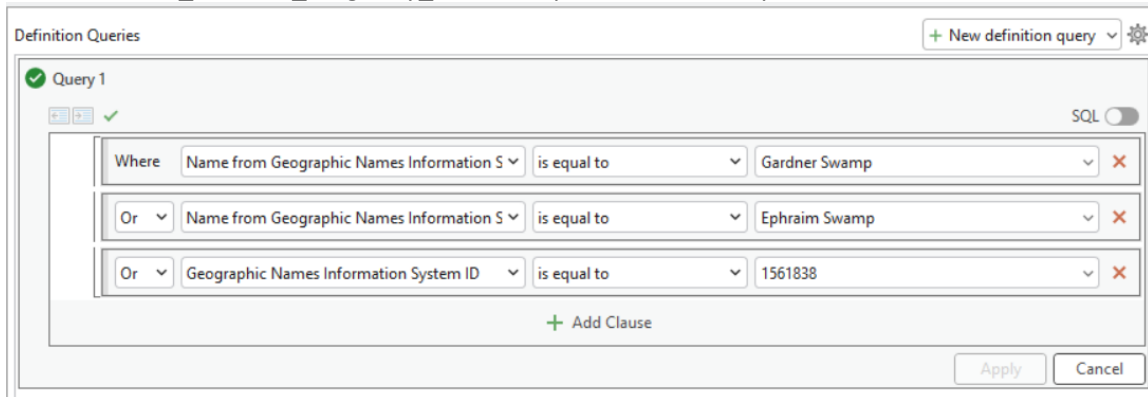


Figure A2-14. Screenshot of “Definition Query”

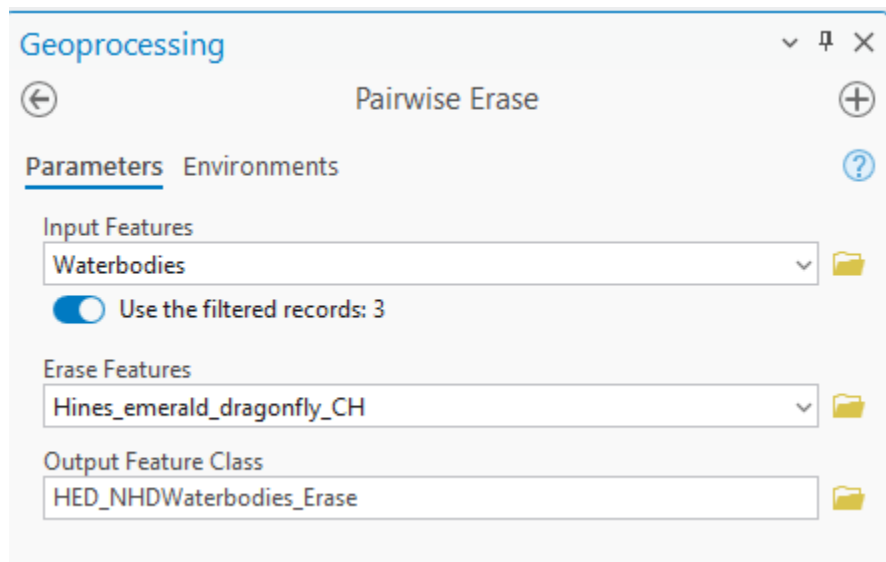


Figure A2-15. Screenshot of “Pairwise Erase”

- 1.5. **Create core map records for Arbter, Hay, Kendal and Round lakes from NHD PlusV2.1 waterbodies layer which are State National Wetland Inventory (NWI) polygons within a one-mile buffer of the lakes and erase previously created overlapping core map areas.**
 1. In the National Hydrography Dataset Plus Version 2.1 waterbodies create a definition query for Arbter, Hay, Kendall, and Round Lakes using the “Geographic Names Information System ID”. **(Figure A2-16)**

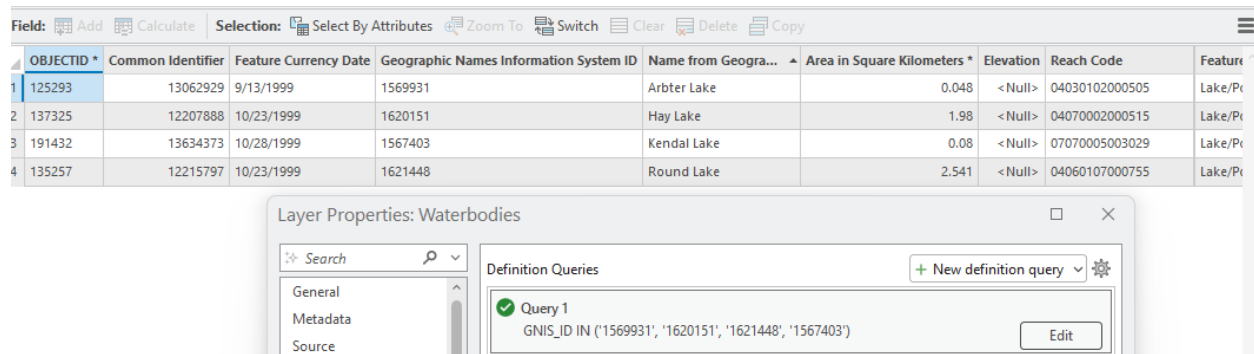


Figure A2-16. Screenshot of “Definition Query”

2. Use the buffer tool to create a one-mile buffer around the four lakes, excluding the lake itself. The result feature class is named, “HED_NHDLakes_Buffer”. (Figure A2-17)

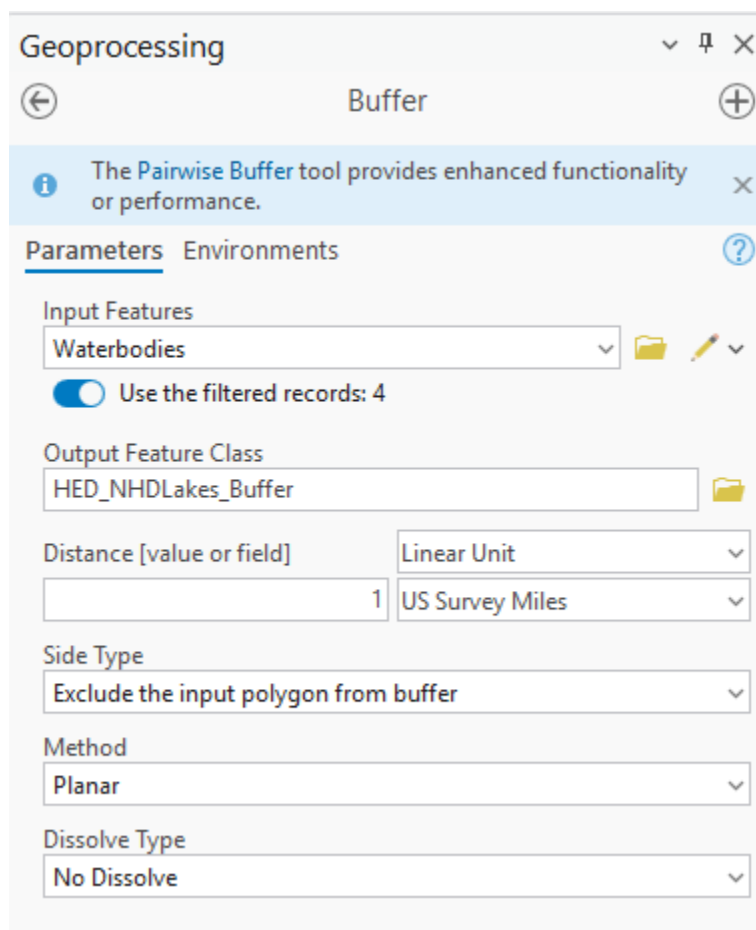


Figure A2-17. Screenshot of “Buffer” tool

3. Next is to clip the State NWI polygons with a definition query filter “WETLAND_TYPE” = “Freshwater Emergent Wetland” or “WETLAND_TYPE” = “Freshwater Forested/Shrub Wetland” that intersect the one-mile buffer. (Figure A2-18) As the lakes reside in two different states, this process will be done for each state. (Figure A2-19) (Figure A2-20) The resulting feature classes will be named, “WI_MI_Lake1MileBuffer_Clip” and

“NWI_WI_Lake1MileBuffer_Clip”. Next, dissolve the clipped wetlands around each lake into one polygon for each lake. (NWI_WI_Lake1MileBuf_Clip_DissolveRound, NWI_WI_Lake1MileBuf_Clip_DissolveHay, NWI_WI_Lake1MileBuf_Clip_DissolveArbter, NWI_WI_Lake1MileBuf_Clip_DissolveKendal) **(Figure A2-21) (Figure A2-22) (Figure A2-23) (Figure A2-24)** Use “Pairwise Erase” to remove each previous lake’s FC with polygons previously created in “Hines_emerald_dragonfly_CH” so there is no overlap.

(ArbterLakeNWIBufClip_Erase, HayLakeNWIBufClip_Erase, RoundLakeNWIBufClip_Erase, KendalLakeNWIBufClip_Erase) **(Figure A2-25) (Figure A2-26) (Figure A2-27) (Figure A2-28)** Copy and paste each of previous records on each lake into “Hines_emerald_dragonfly_CH” and update the “Descriptio” field to describe the work just done.

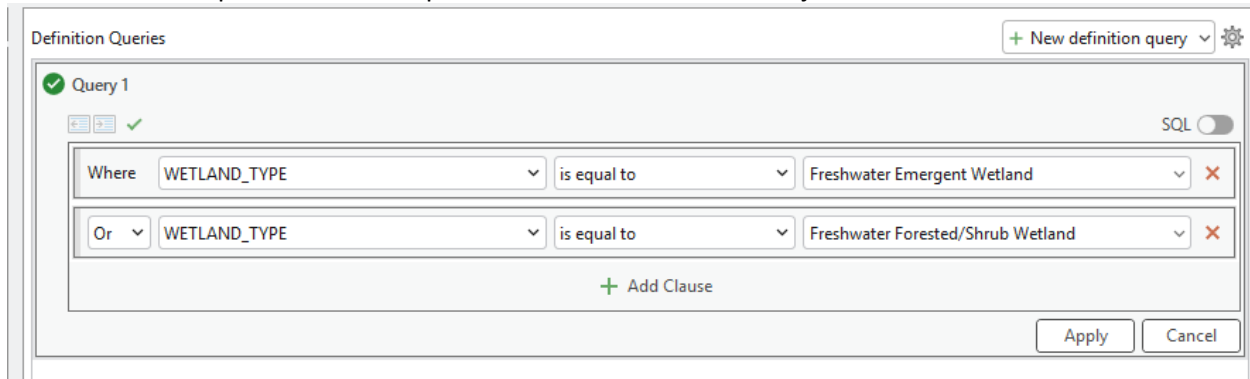


Figure A2-18. Screenshot of “Definition Query”

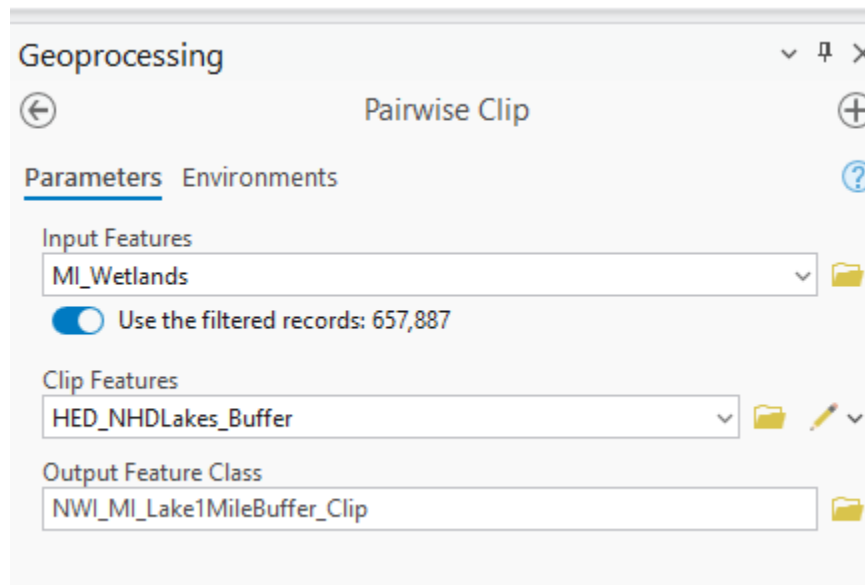


Figure A2-19. Screenshot of “Pairwise Clip” tool

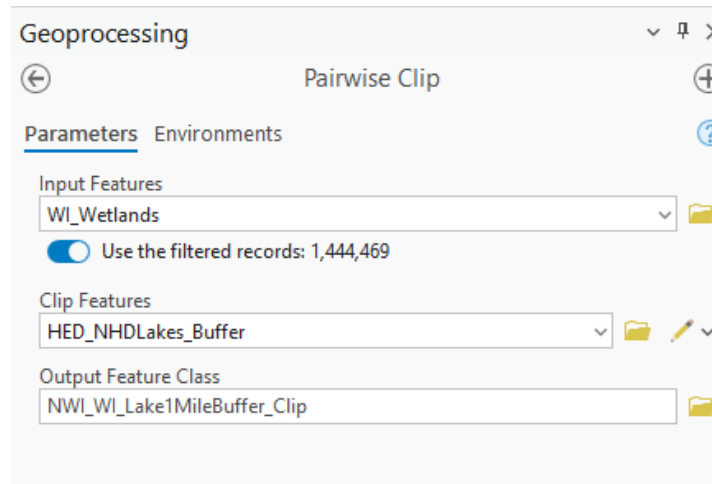


Figure A2-20. Screenshot of “Pairwise Clip” tool

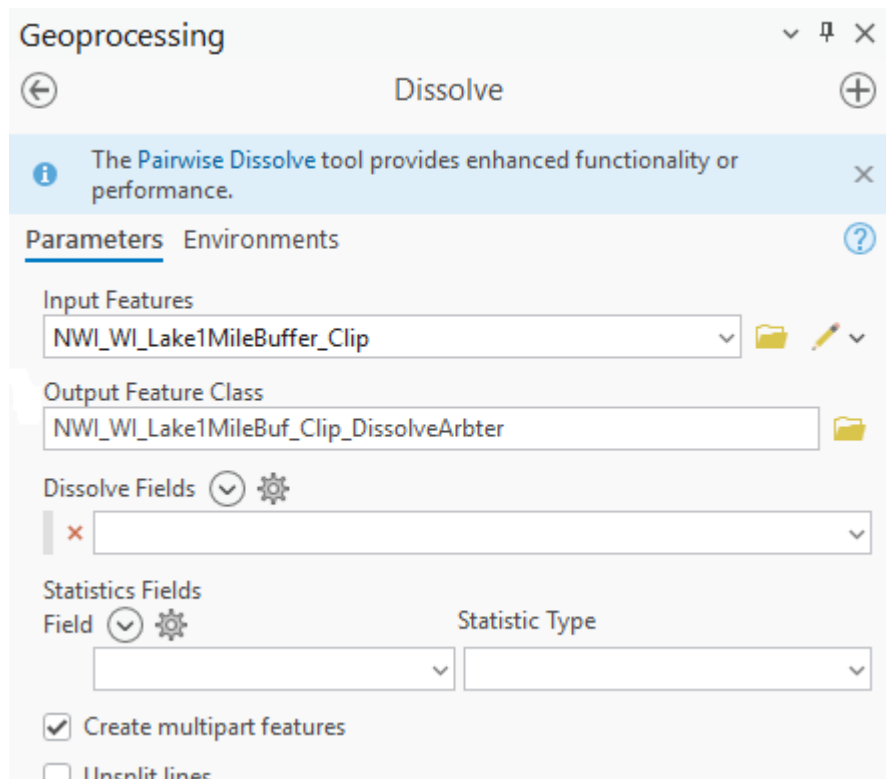


Figure A2-21. Screenshot of “Dissolve” tool

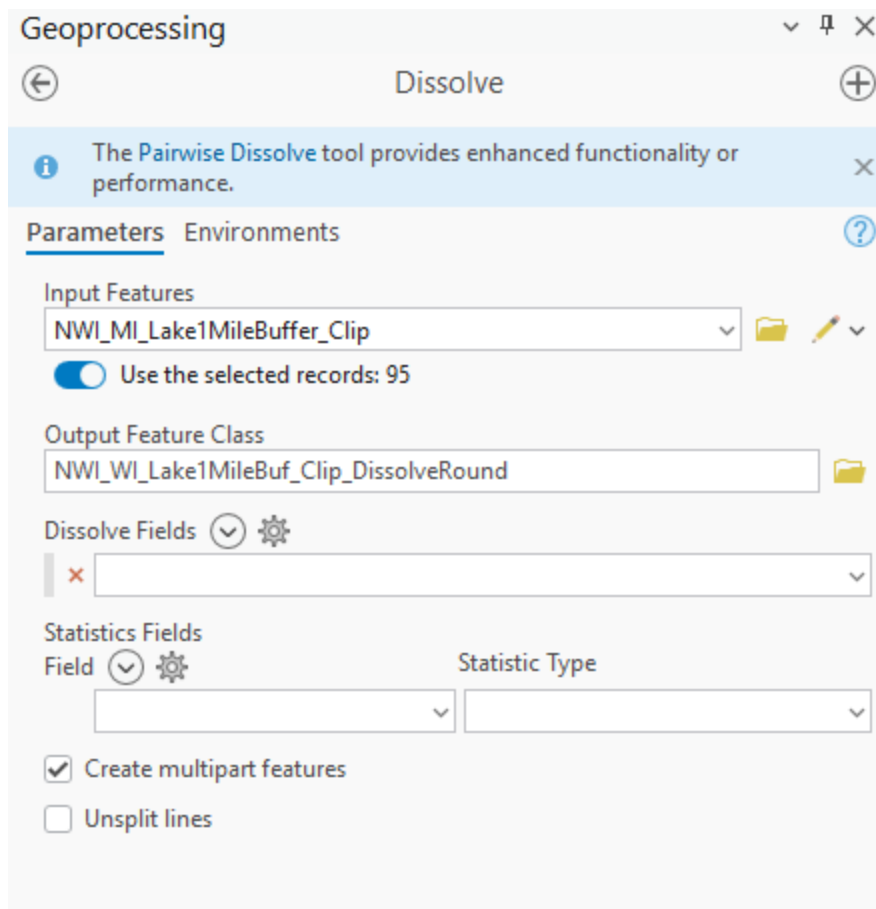


Figure A2-22. Screenshot of “Dissolve” tool

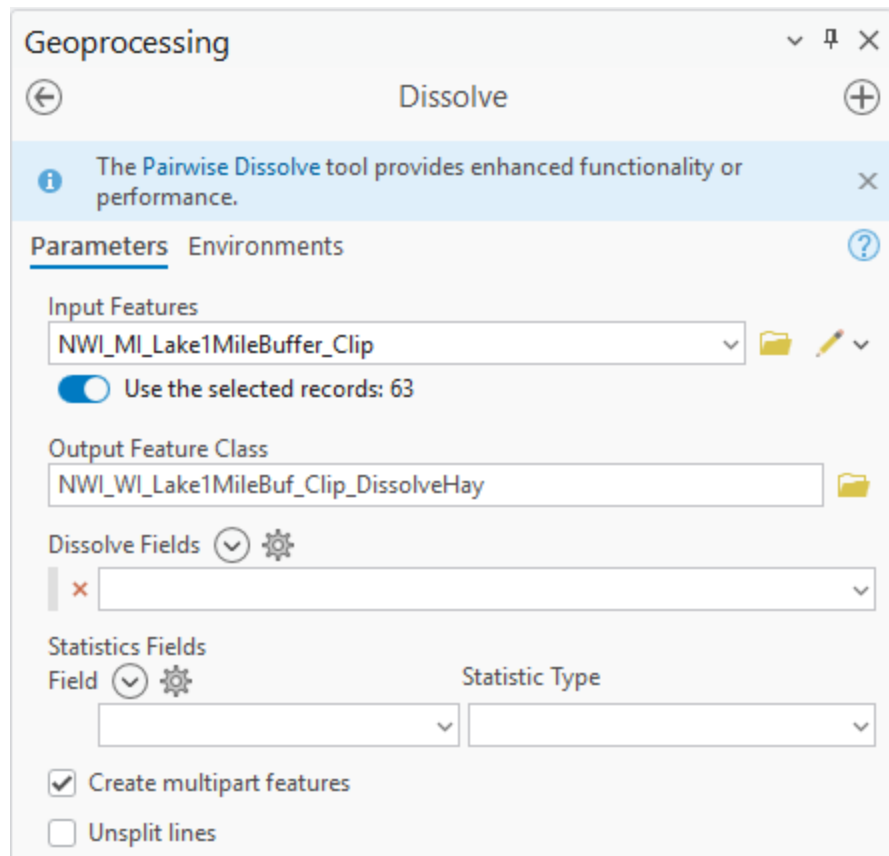


Figure A2-23. Screenshot of “Dissolve” tool

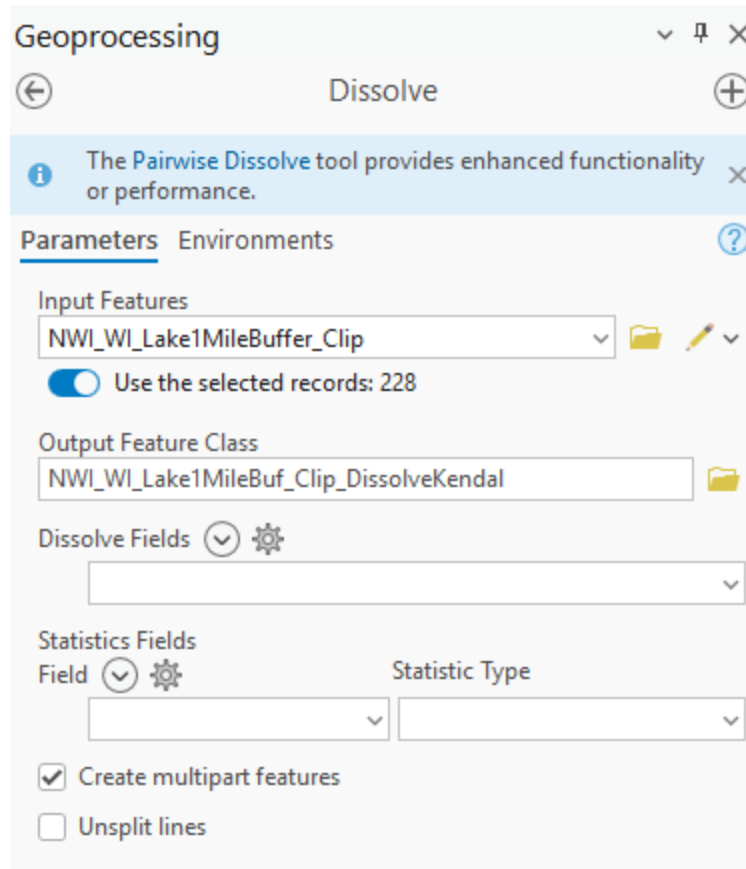


Figure A2-24. Screenshot of “Dissolve” tool

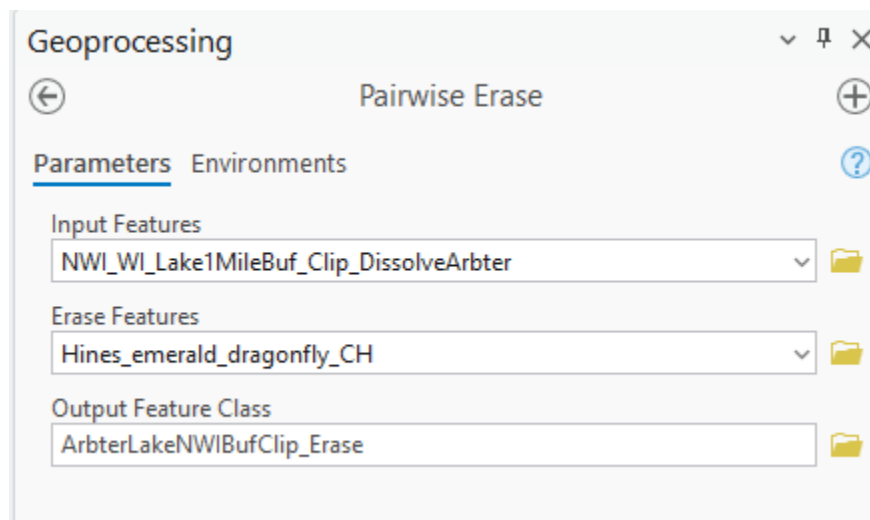


Figure A2-25. Screenshot of “Pairwise Erase” tool

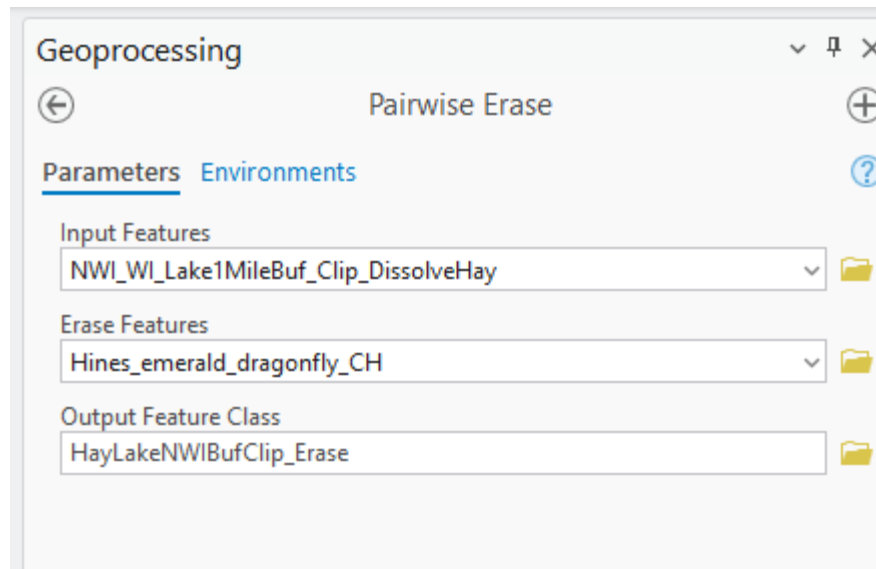


Figure A2-26. Screenshot of “Pairwise Erase” tool

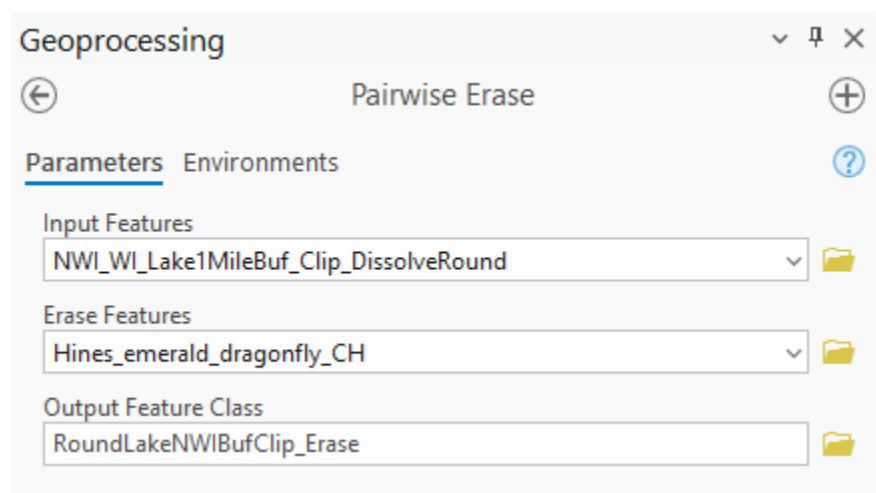


Figure A2-27. Screenshot of “Pairwise Erase” tool

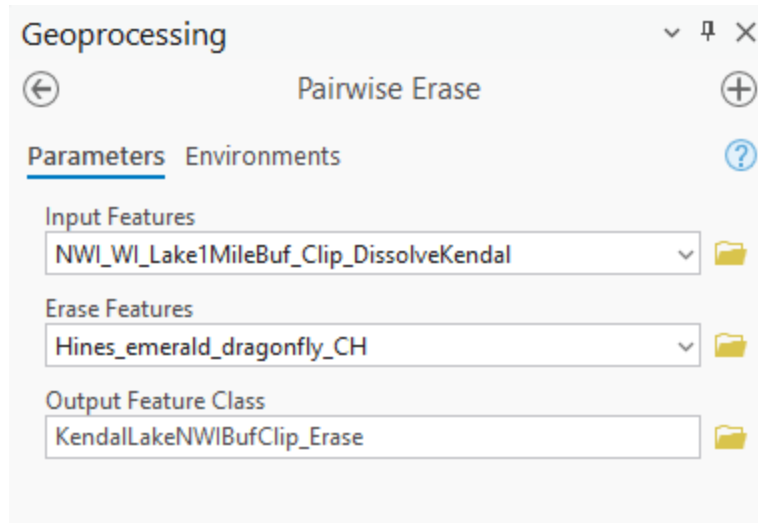


Figure A2-28. Screenshot of “Pairwise Erase” tool

1.6. For each NHD Plus V2.1 identified river segment(s), buffer 1 mile, clip intersecting State NWI wetlands within one-mile buffer, dissolve wetlands into one polygon, and erase previous overlapping core map areas.

1. These are the identified river segment areas:
 - a. Bee Fork and un-named river in Grasshopper Hollow MO
 - b. Kay Branch and Parker, MO
 - c. South Prong Little Black River (two miles east and west of Overcup Fen Natural Area) and North Prong Little Black River, MO
 - d. Knapp Creek, WI
 - e. Piel Creek, WI
2. For each river segment, select by attribute. (i.e. “Feature Name from the Geographic Name Information System” equal to “North Prong Little Black River”) **(Figure A2-29)** Copy and paste selected records to “Hines_emerald_dragonfly_Line” feature class. Merge them into one record. Update attributes.

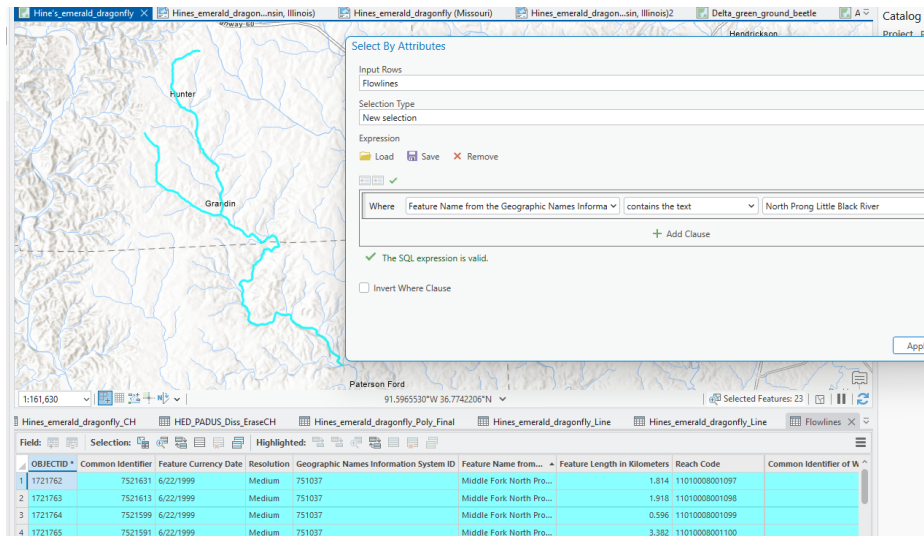


Figure A2-29. Screenshot of “Select by Attribute”

3. Buffer “Hine_emerald_dragonfly_Line” by one mile. Name it “Hines_emerald_dragonfly_1MileBuffer”. **(Figure A2-30)**

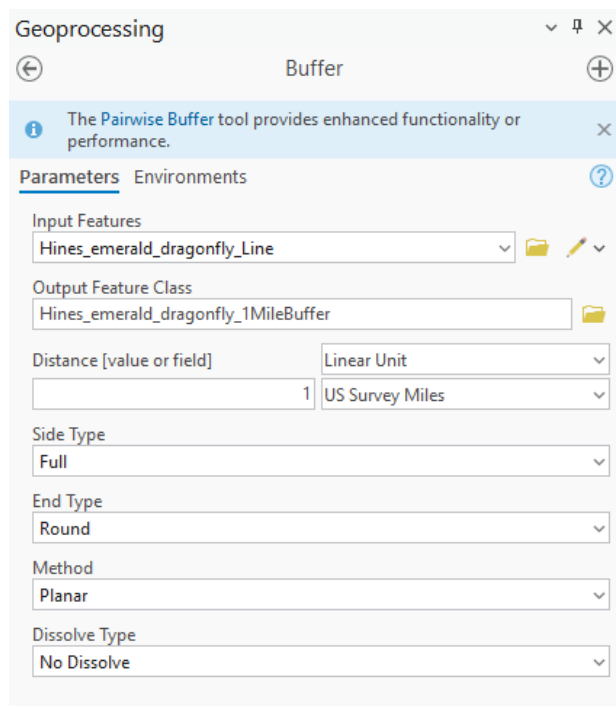


Figure A2-30. Screenshot of “Buffer” tool

4. Select buffer area(s) that reside in one State, either Missouri or Wisconsin. Ensure that NWI feature class still has a definition query where “WETLAND_TYPE” = “Freshwater Emergent Wetland” or “WETLAND_TYPE” = “Freshwater Forested/Shrub Wetland”. **(Figure A2-31)**

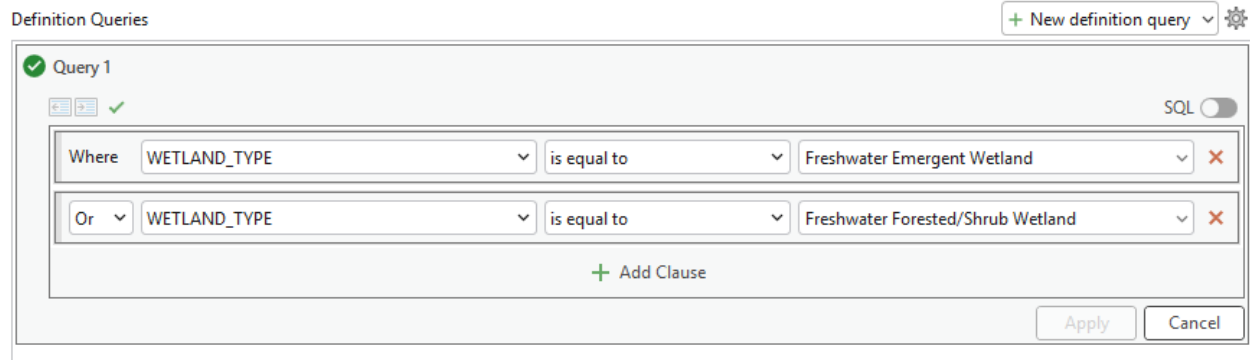


Figure A2-31. Screenshot of Definition Query

5. Use “Pairwise Clip” to create a feature class named either “MO_Wetlands_1MileBuf_Clip” or “WI_Wetlands_1MileBuf_Clip”. (Figure A2-32) (Figure A2-33)

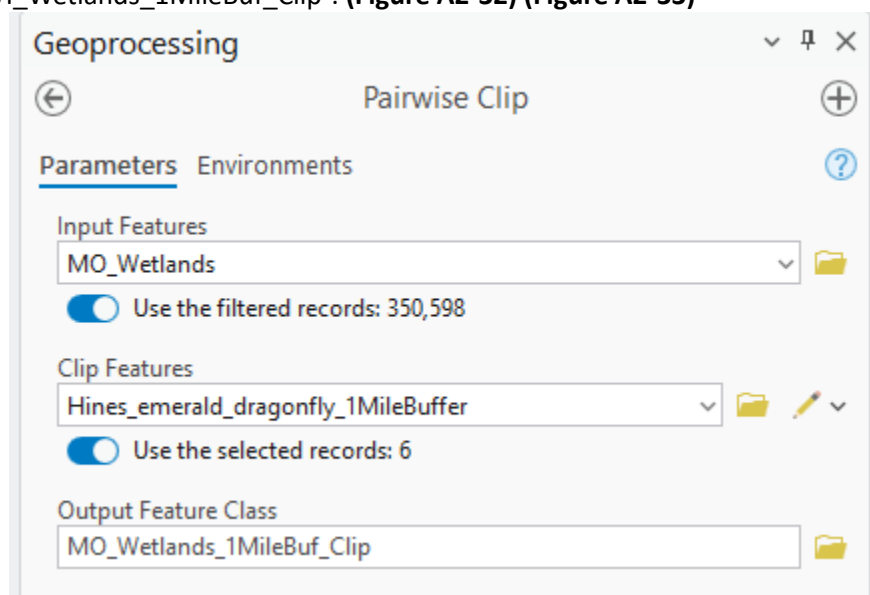


Figure A2-32. Screenshot of “Pairwise Clip” tool

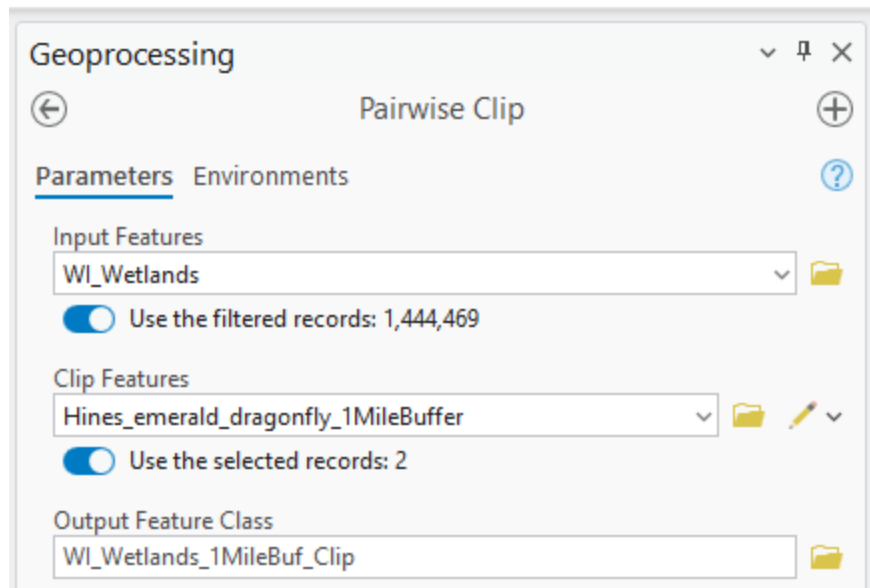


Figure A2-33. Screenshot of “Pairwise Clip” tool

6. Use “Dissolve” tool to merge selected clipped wetland areas based on rivers segments listed in step 1 of this section. (i.e. Bee Fork and un-named river in Grasshopper Hollow MO) First use the manual select tool to “draw” an area that surrounds clipped wetlands. **(Figure A2-34)** For each area, the result feature classes are named, “BeeGrasshopper_ClipWetland_Dissolve”, “ParkerKay_ClipWetland_Dissolve”, “NorthSouthProngLittleBlackRiver_ClipWetland_Dissolve”, “Knapp_ClipWetland_Dissolve”, “Piel_ClipWetland_Dissolve” **(Figure A2-35) (Figure A2-36) (Figure A2-37) (Figure A2-38) (Figure A2-39)**

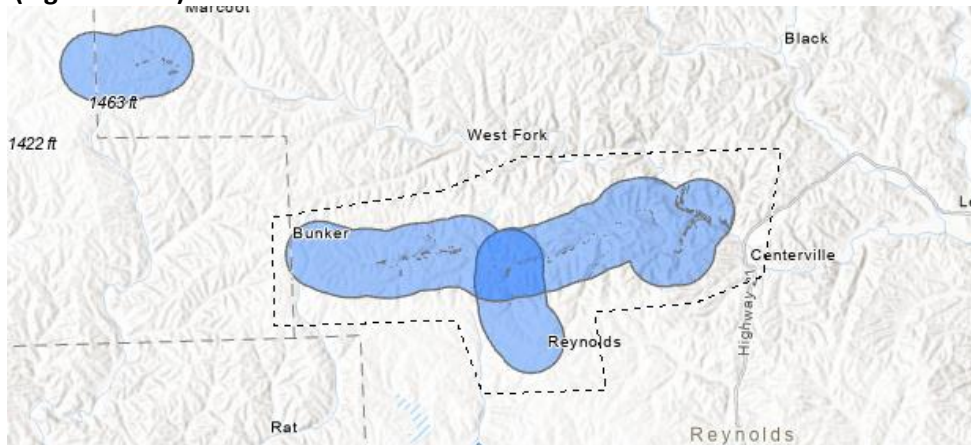


Figure A2-34. Screenshot of “Select by Polygon” tool

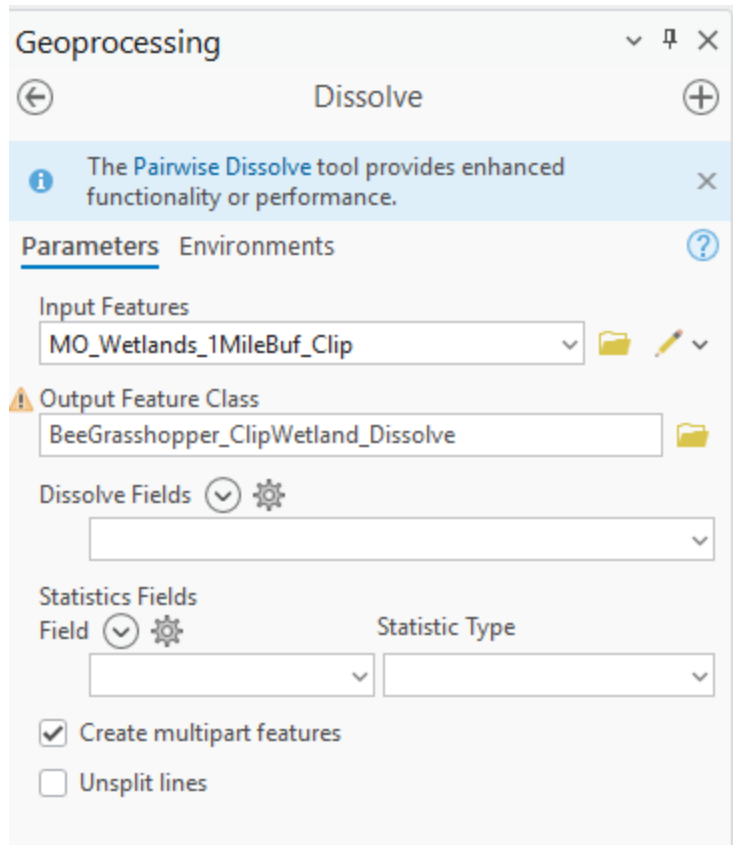


Figure A2-35. Screenshot of “Dissolve” tool

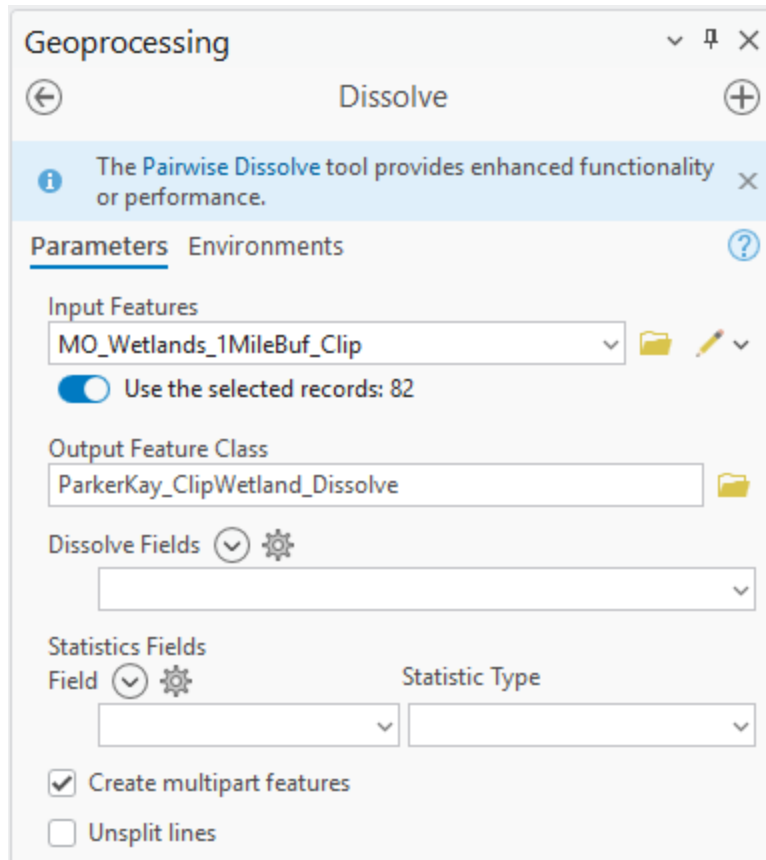


Figure A2-36. Screenshot of “Dissolve” tool

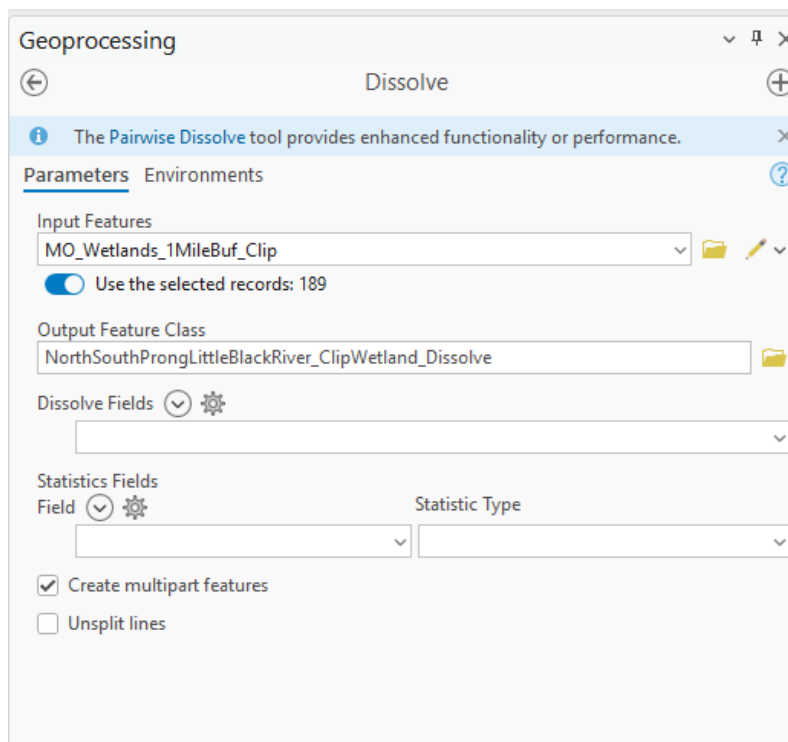


Figure A2-37. Screenshot of “Dissolve” tool

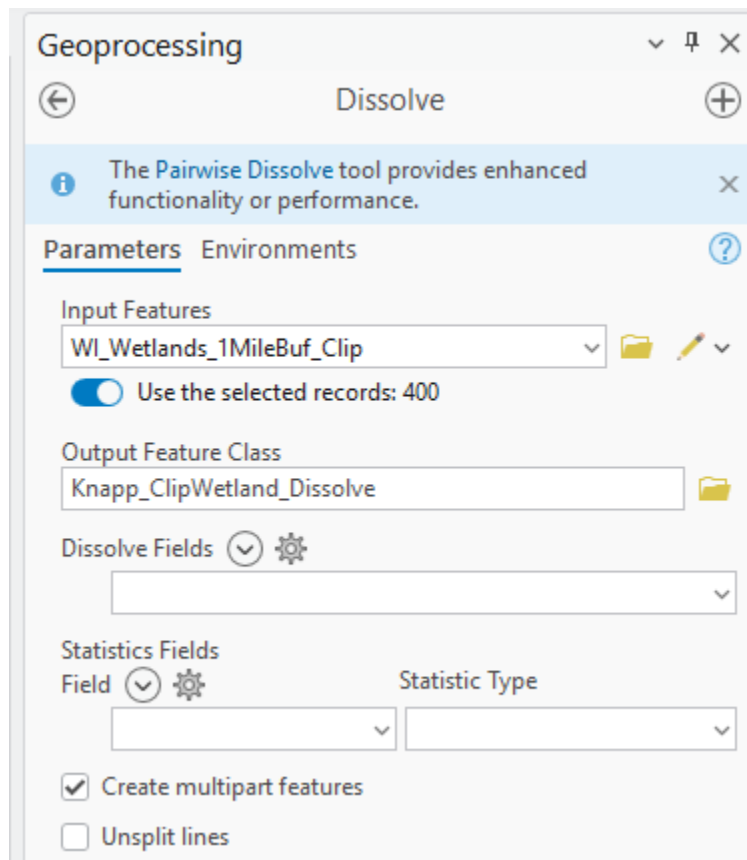


Figure A2-38. Screenshot of “Dissolve” tool

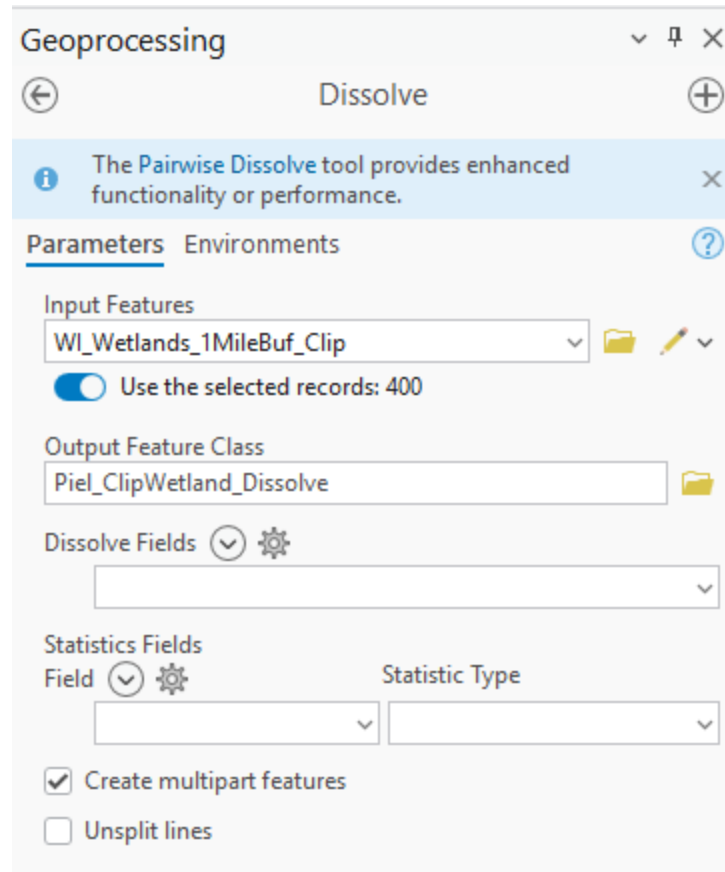


Figure A2-39. Screenshot of “Dissolve” tool

7. To facilitate being able to use “Pairwise Erase” tool once instead of multiple times, the “Append” tool is used to combine the five dissolved clipped area polygons into one feature class. **(Figure A2-40)**

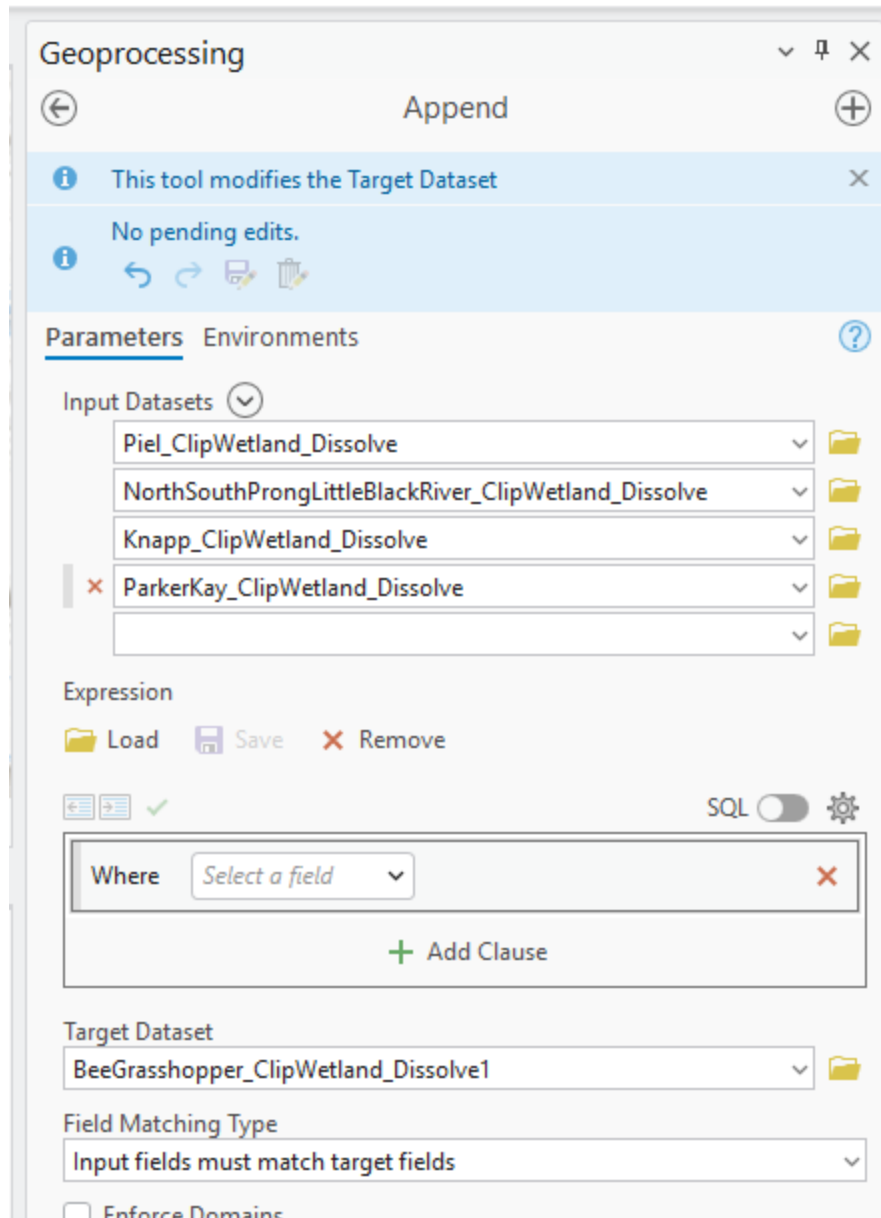


Figure A2-40. Screenshot of “Append” tool

8. Use the “Pairwise Erase” tool to remove areas of previously created core map area in the process from the clipped NWI wetland areas that are within a one-mile buffer of known locations of named river segments. **(Figure A2-41)** The resulting feature class is named, “RiverSeg_ClipWetland_Dissolve_Erase”. Copy and paste the records to “Hines_emerald_dragonfly_CH” feature class. Update “Descriptio” field with information about the river(s) segment, buffer distance, NWI wetlands and remove areas.

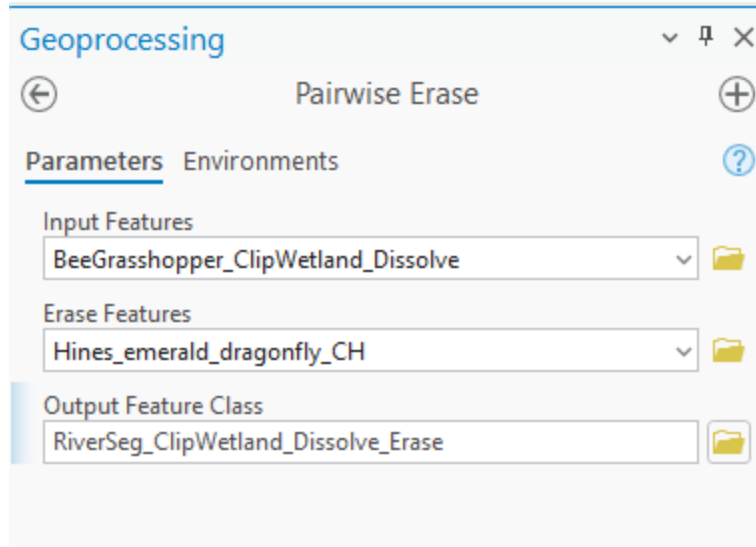


Figure A2-41. Screenshot of “Pairwise Erase”

1.7. Use Wisconsin (WI) State Cartographer’s Office Statewide Parcels with filter for The Nature Conservancy’s Three Springs Nature Preserve

1. Use definition query on WI State Cartographer’s Office parcel download where “Primary Owner Name” = “DOOR COUNTY LAND TRUST INC” and “Place Name” = “TOWN OF LIBERTY”. **(Figure A2-42)**

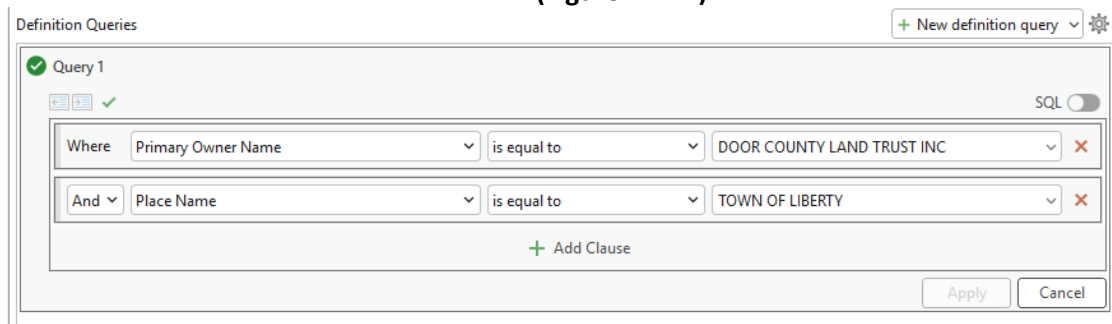


Figure A2-43. Screenshot of “Definition Query”

2. Use “Select by Polygon” tool to select parcels that are east of Old Stage Rd and south of County Road ZZ. **(Figure A2-44)** Use “Dissolve” to merge selected parcels into one record named, “ThreeSpringTNC”. Use “Pairwise Erase” tool to remove previously created core map areas from “ThreeSpringTNC” so there is no overlap. It is named, “ThreeSpringTNC_PairwiseErase”. **(Figure A2-45)** Copy and paste it into “Hines_emerald_dragonfly_CH”. Update the “Descriptio” field regarding the parcel source, query, name of Nature Reserve and removal of critical habitat area.

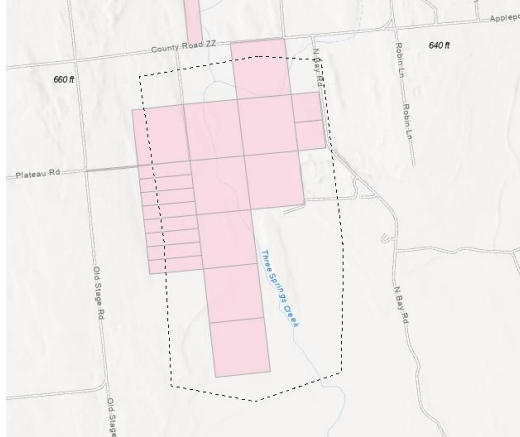


Figure A2-44. Screenshot of “Select by Polygon” tool

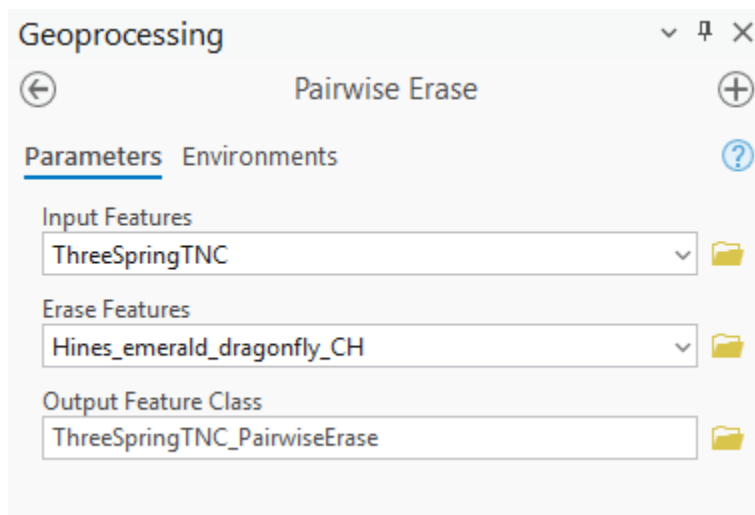


Figure A2-45. Screenshot of “Pairwise Erase” tool

1.8. Use Public Land Survey System (PLSS) GIS data to create a core map area for Ruble Meadows.

1. There is a 1990 Missouri Department of Natural Resources Wetlands report named “An Evaluation and Potential assimilation of Missouri Wetland Inventories (<https://share.mo.gov/nr/mgs/MGSDData/Open%20File%20Reports/An%20Evaluation%20and%20Potential%20Assimilation%20of%20Missouri%20Wetlands%20Inventories/OFR-90-81-WR.pdf>). On page 16, there is a note that says Ruble Meadow is located in Township (T) 29N, Range (R) 01E, Section (S) 36. When ArcPro zooms to this TRS, it shows the small town of Ruble. Based on these pieces of information, it is likely that Ruble Meadows is located within section 36. Use “Select by Polygon” tool to select Township (T) 29N, Range (R) 01E, Section (S) 36 from the GIS PLSS feature class and paste it into “Hines_emerald_dragonfly_CH”. Update “Descriptio” field with source of location and TRS information.
2. Found text that describes location of “Centerville Slough”
Centerville Slough (Site 9 in Figure 2) is adjacent to the West Fork of the Black River, which runs along its southwestern boundary. The northern boundary is a field adjacent to Highway 21 to the west. The southeastern boundary is an oak/hickory woodland that rises to a ridge.

North of the town of Centerville, MO, there is an area that matches this description. **(Figure A2-46)** Start “Editing” in “Hines_emerald_dragonfly_CH” and manually create polygon based on description above. Update “Descriptio” field with source of location information. **(Figure A2-47)**



Figure A2-46. Screenshot of North of Centerville, MO

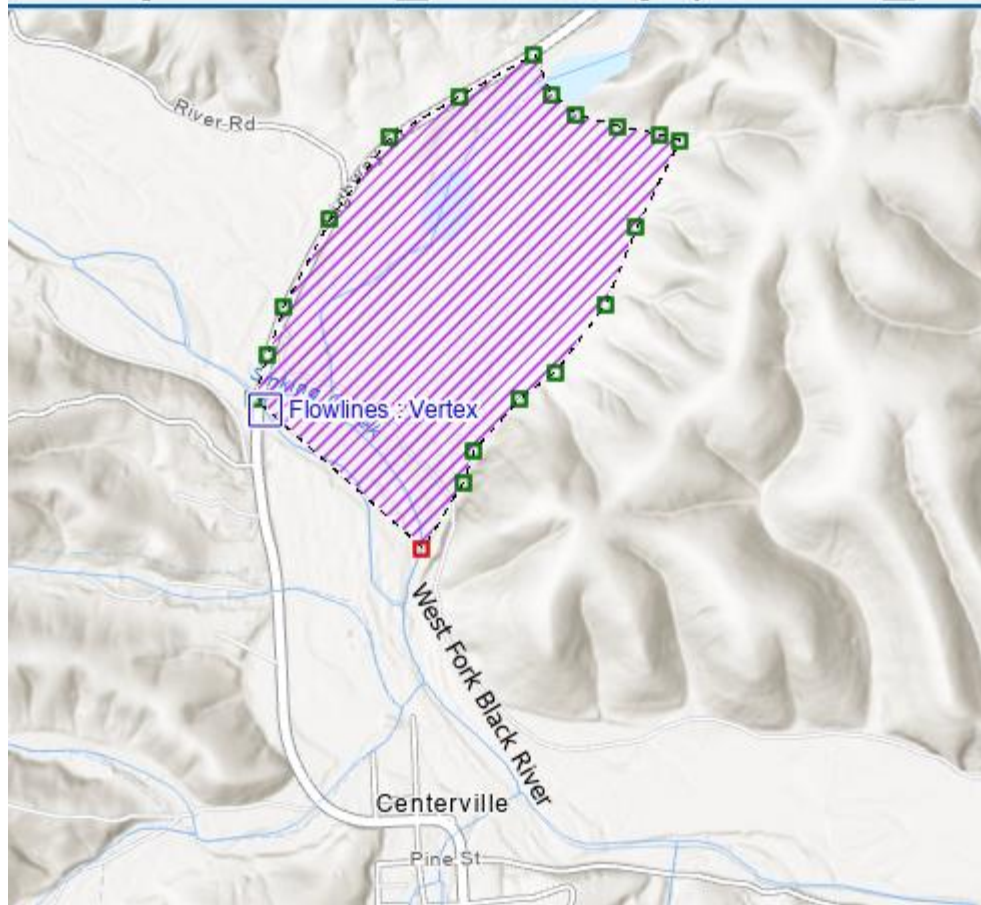


Figure A2-47. Screenshot of “Centerville Slough” polygon

1.9. Use EPA’s “CultivatedAreas_Over25acres” to “Pairwise Erase” on “Hines_emerald_dragonfly_CH”

1. In an effort to refine the core map boundaries, use “Pairwise Erase” to erase the core map “Hines_emerald_dragonfly_CH” by “CultivatedAreas_Over25acres”. The resulting layer is named, “Hines_emerald_dragonfly_NoCultLand”. **(Figure A2-48)**

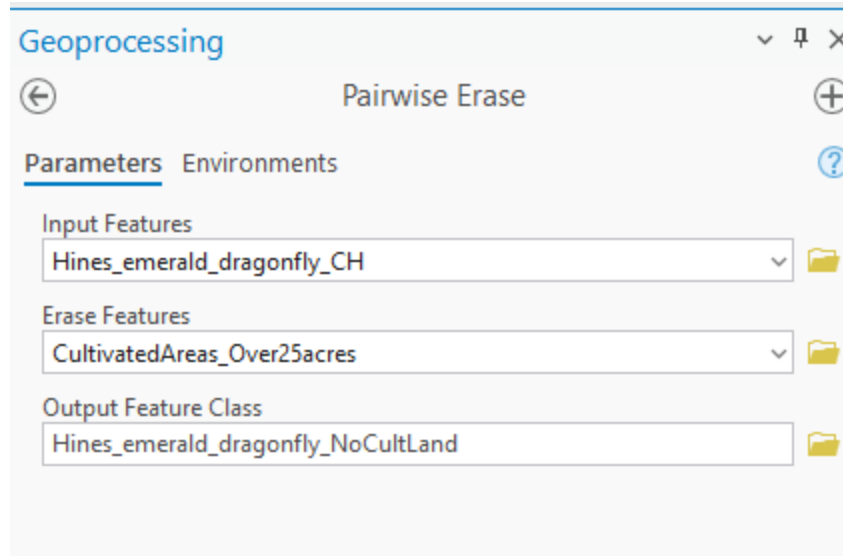


Figure A2-48. Screenshot of “Pairwise Erase” tool

- 1.10. Use EPA’s QA/QC process to remove small, disconnected patches less than 2 acres
1. Buffer “Hines_emerald_dragonfly_NoCultLand” by 1,000 US survey feet, with the option “Dissolve all output features into a single feature” choice. The output feature class is named, “Hines_emerald_dragonfly_NoCultLand_Buffer”. (Figure A2-49)

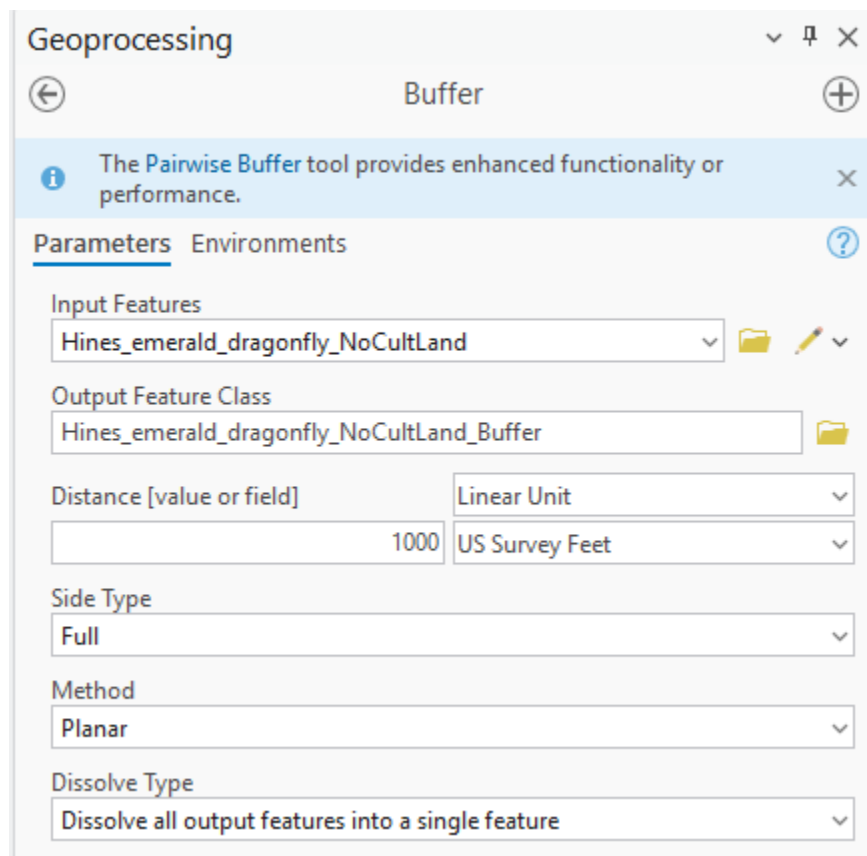


Figure A2-49. Screenshot of “Buffer” tool

2. Use the “Eliminate Polygon Part” tool as step 1 to eliminate polygon parts that are less than 2 acres and more than 1,000 feet away from another polygon. The resulting output is named, “Hines_emerald_dragonfly_No2Acre”. **(Figure A2-50)**

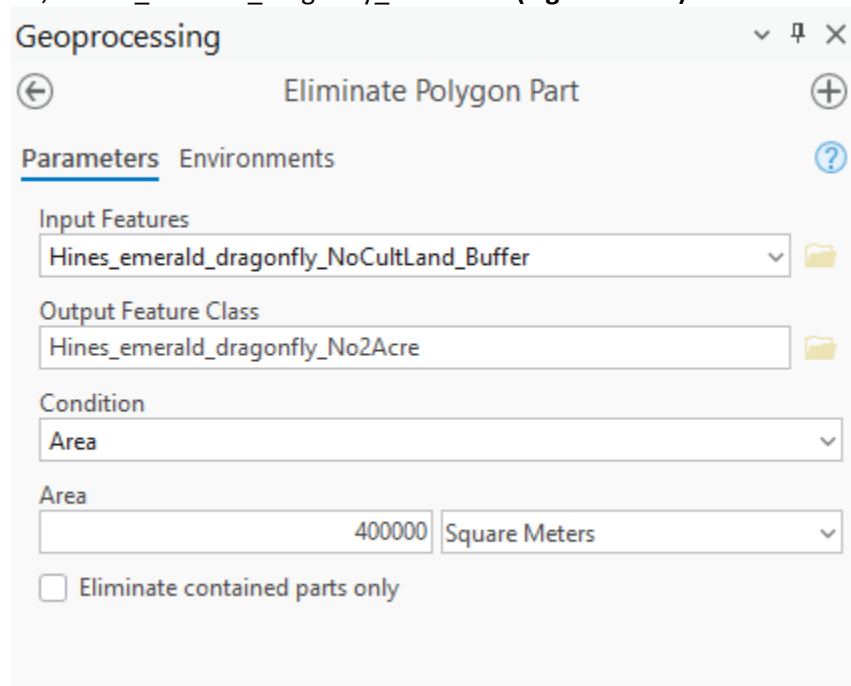


Figure A2-50. Screenshot of “Eliminate Polygon Part” tool

3. Use “Pairwise Clip” tool as step 2 to remove any polygon parts that are less than 2 acres and more than 1,000 feet away from another polygon. The resulting output is named, “Hines_emerald_dragonfly_Clip”. **(Figure A2-51)**

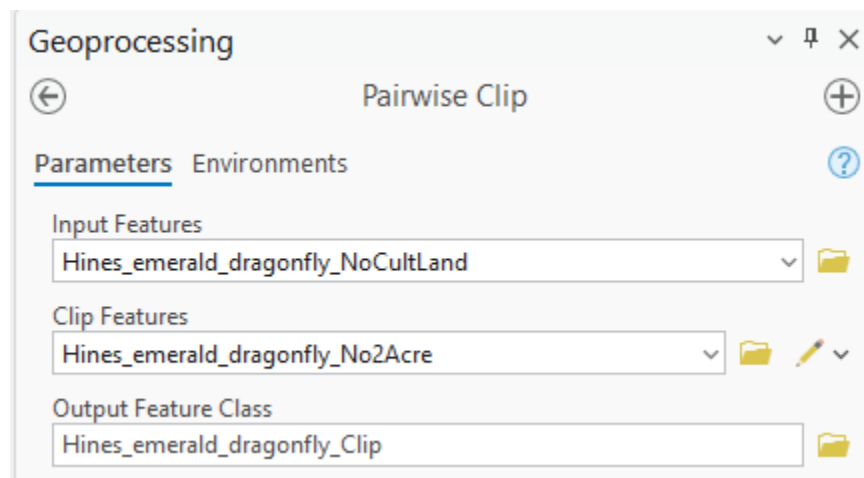


Figure A2-51. Screenshot of “Pairwise Clip” tool

- 1.11. Use EPA’s QA/QC process to “smooth” by filling in gaps or holes and update attributes
 1. Use the “Dissolve” tool to merge polygons from “Hines_emerald_dragonfly _Clip” into one polygon. The resulting output is named, “Hines_emerald_dragonfly_Dissolve” **(Figure A2-52)**

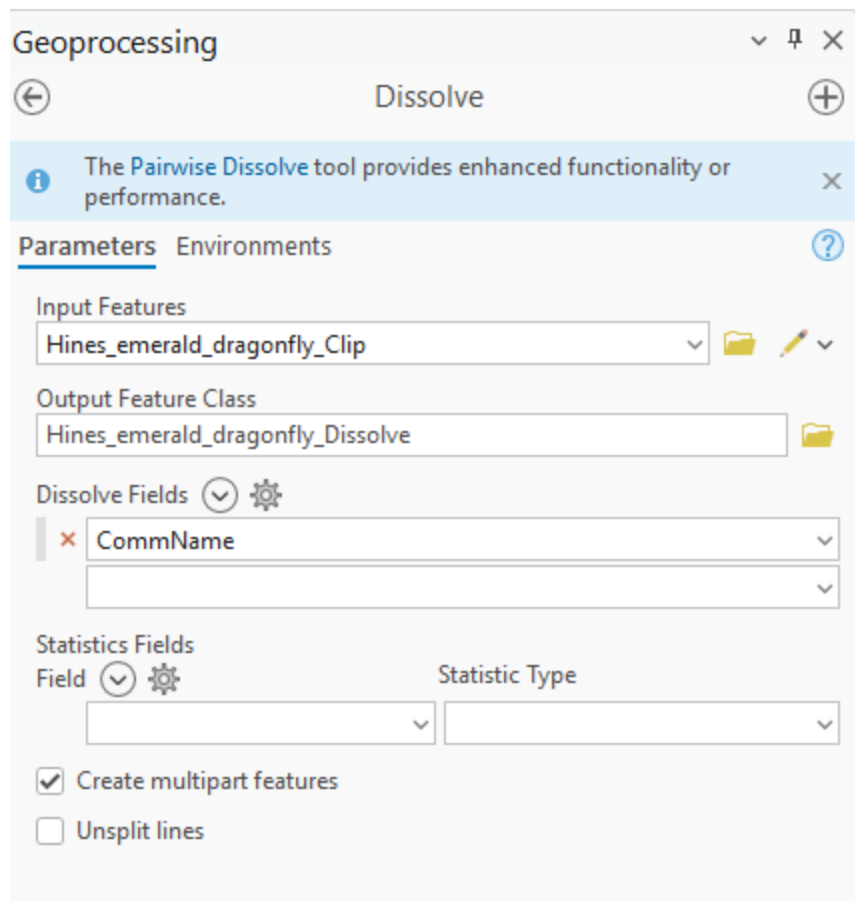


Figure A2-52. Screenshot of “Dissolve” tool

2. Use “Eliminate Polygon Part” tool to fill in gaps and holes less than 25 acres. Resulting output is named, “Hines_emerald_dragonfly_Smooth”. **(Figure A2-53)**

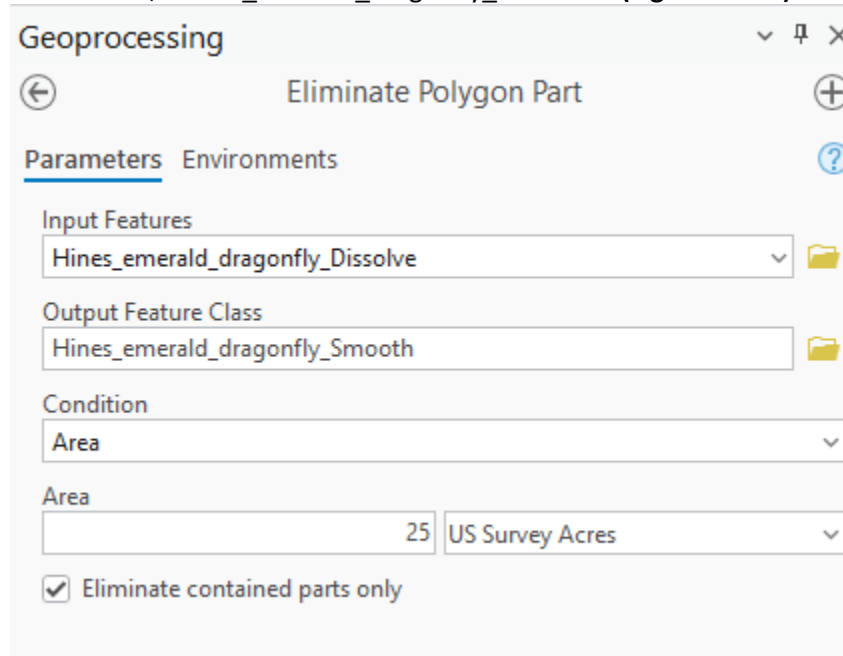


Figure A2-53. Screenshot of “Eliminate Polygon Part” tool

3. Although the “Eliminate Polygon Part” tool did remove internal gaps and holes less than 25 acres, there were narrow strips that are less than 2 meters wide that can be removed by deleting vertices manually. **(Figure A2-54) (Figure A2-55)**



Figure A2-54. Screenshot of Vertices to be deleted



Figure A2-55. Screenshot of Polygon after vertices deleted

1.12. Update Attributes and “Calculate Geometry”

1. Create a copy of the template EPA polygon feature class for Hine’s emerald dragonfly named “Hines_emerald_dragonfly_Poly_Final” (core map shapefile). Copy and paste record from “Hines_emerald_dragonfly_Smooth” to “Hines_emerald_dragonfly_Poly_Final”.
2. Since there is only one record in “Hines Emerald Dragonfly”, update each field manually with:
 - a. CommName = “Hine's emerald dragonfly”
 - b. SciName = “Somatochlora hineana”
 - c. Description = “Area of USFWS Hines emerald dragonfly (HED) critical habitats, known HED locations from 2103 USFWS 5YR Review table 1 that are not already overlapping the critical habitats. All clipped by EPA Cultivated Land.”
 - d. Category = “Area of occupancy”
 - e. EPA_Code = “445”
 - f. FWS_Code = “I06P”
 - g. CBD_Code = “1917”
 - h. Heritage = “0”
 - i. ECOS_WebPg = “<https://ecos.fws.gov/ecp/species/7877>”
3. Turn on the “World UTM Grid” layer and identify the UTM zone as “15”. Right-click on the “Acres” fieldàleft-click on “CalculateGeometry”. “Calculate Geometry” dialog box appears. Select “Area” under “Property”, “US Survey Acres” in “Area Unit” and “NAD_1983_UTM_Zone_15N” in the Coordinate System” boxes. Click Apply. Click OK.

(Figure A2-56)

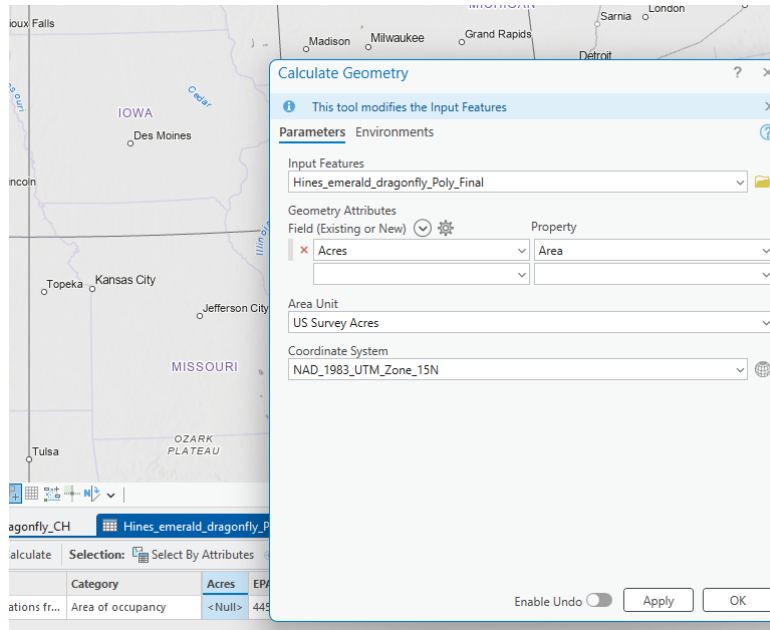


Figure A2-15. Screenshot “Calculate Geometry”

1.1. Use Download USA NLCD Land Cover raster process to determine Percentage of Interim Core Map Represented by NLCD Land Covers

1. Using the MRLC viewer (<https://www.mrlc.gov/viewer/>) and uploaded four shapefile of areas to use as an extents to download the NLCD that covers all the “Hines_emerald_dragonfly_Poly_Final” records. The file was downloaded and added to ArcPro and renamed them, “NLCD_VPFS_Area1.tiff”, “NLCD_VPFS_Area2.tiff”, “NLCD_VPFS_Area3.tiff”, “NLCD_VPFS_Area4.tiff”. **(Figure A2-57)**

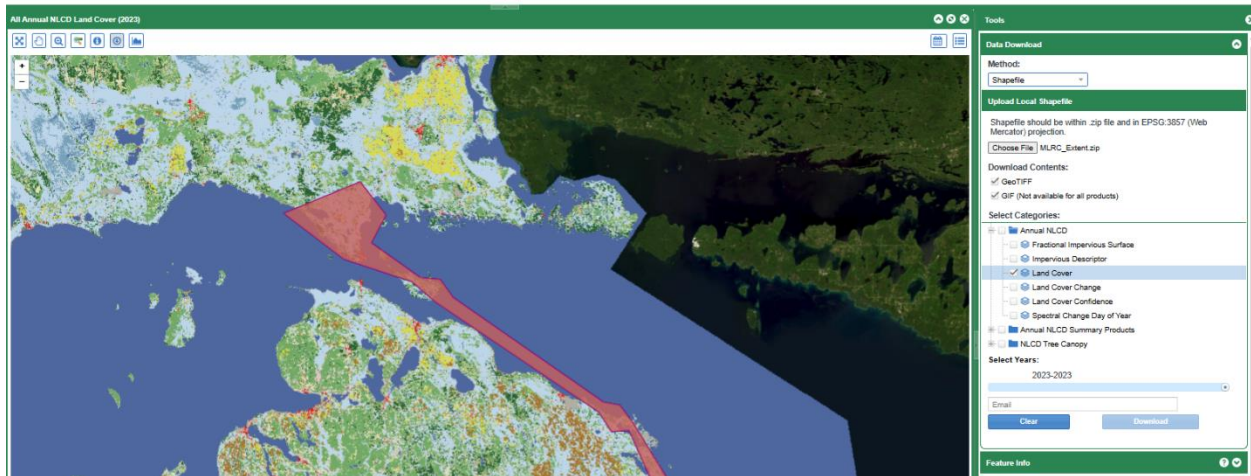


Figure A2-57. Screenshot MRLC Viewer with Shapefile Extent

2. Use the “extract by Mask” tool with each of the four MRLC downloads filtered by “Hines_emerald_dragonfly_Poly_Final” as the extent. (Figure A2-61) In the “Environments” tab, change the output coordinate system to match “Hines_emerald_dragonfly_Poly_Final”, which in this case is “USA_Contiguous_Albers_Equals_Area_Conic_USGS_version”. The output is named, “NLCD_MaskArea1”, “NLCD_MaskArea2”, “NLCD_MaskArea3”, “NLCD_MaskArea4”. **(Figure A2-58) (Figure A2-59)**

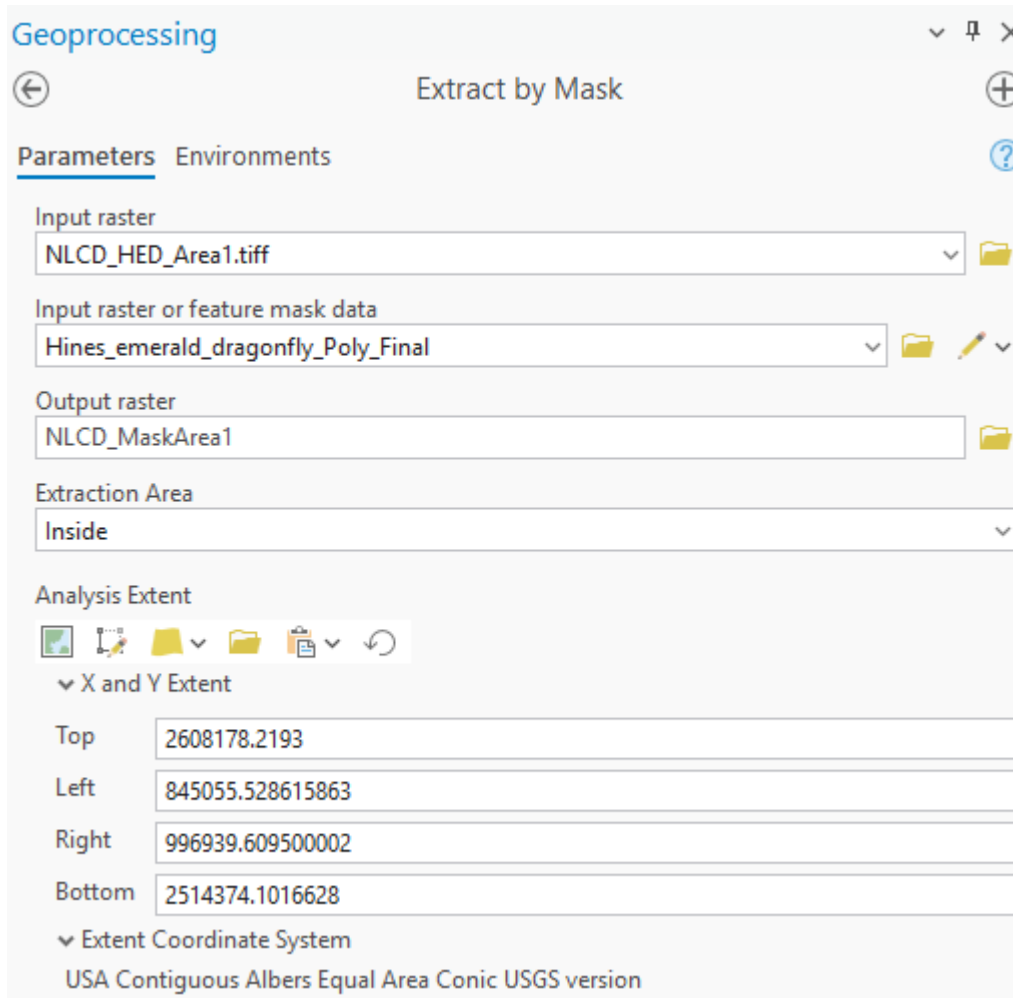


Figure A2-58. Screenshot “Extract by Mask” tool Parameters

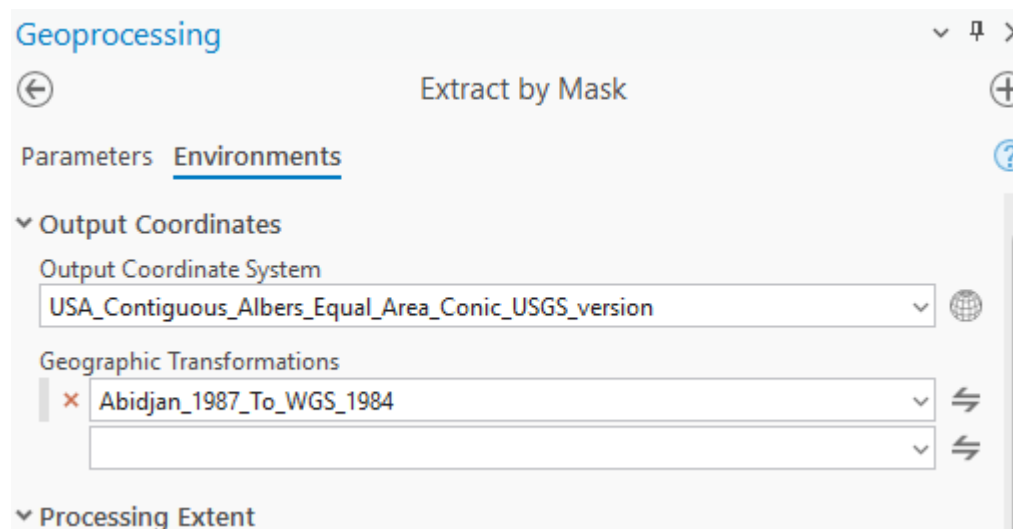


Figure A2-59. Screenshot “Extract by Mask” tool Environment

3. Use the “Mosaic To New Raster” tool to gather all four into one output. (Figure A2-60)

Geoprocessing ⌵ 📏 ✕

← Mosaic To New Raster ⊕

Parameters Environments ?

Input Rasters ⌵

NLCD_MaskArea1	⌵	📁
NLCD_MaskArea2	⌵	📁
NLCD_MaskArea3	⌵	📁
✕ NLCD_MaskArea4	⌵	📁
	⌵	📁

Output Location

EPA_Hines_emerald_dragonfly_doc.gdb 📁

Raster Dataset Name with Extension

NLCD_1_2_3_4

Spatial Reference for Raster

USA_Contiguous_Albers_Equal_Area_Conic_USGS_version ⌵ 🌐

Pixel Type

8 bit unsigned ⌵

Cellsize

Number of Bands

Mosaic Operator

Last ⌵

Mosaic Colormap Mode

First ⌵

Figure A2-60. Screenshot “Extract by Mask” tool Environment

4. Use the “Tabulate Area” tool to determine the count of area for each NLCD code. **(Figure A2-61)**

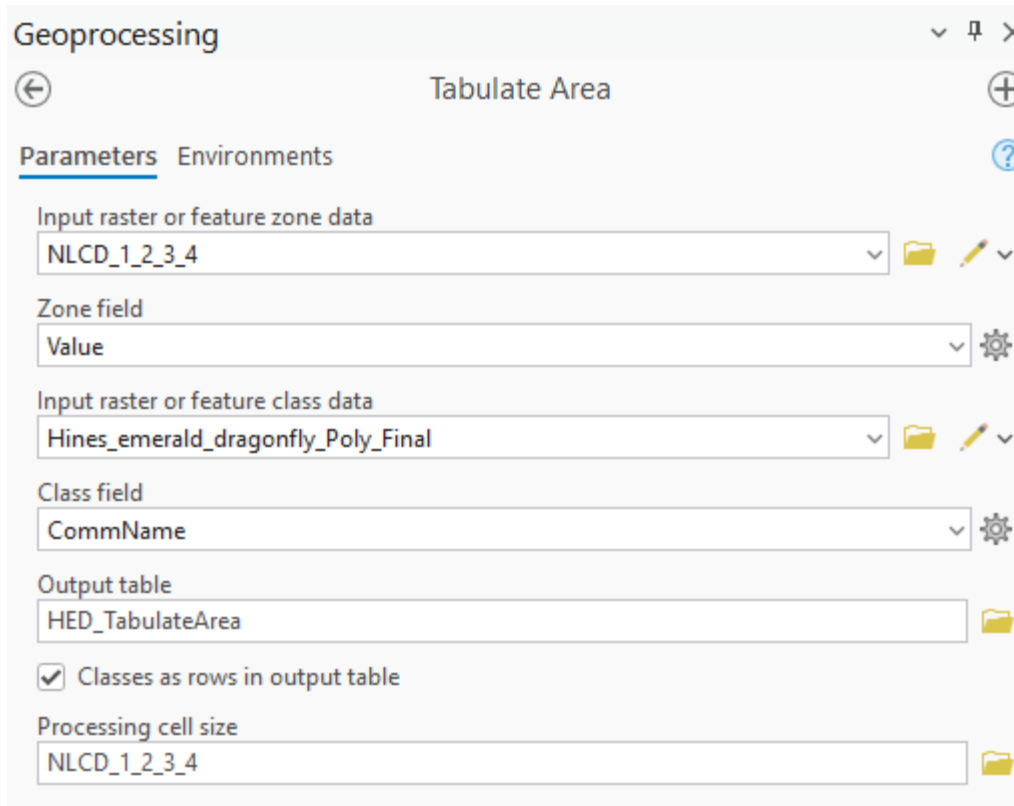


Figure A2-60. Screenshot “Tabulate Area” tool

5. Add a double field named, “Per” to the “HED_TabulateArea1” table. Right clicked on field and select “Calculate Field”. Entered the formula “(!Count!/ 246680)*100”. This calculates the percentage of NLCD within the core map area. **(Figure A2-61)** Review results and input into (Table 1. Percentage of Interim Core Map Represented by NLCD Land Covers and Associated Example Pesticide Use Sites/Types.)

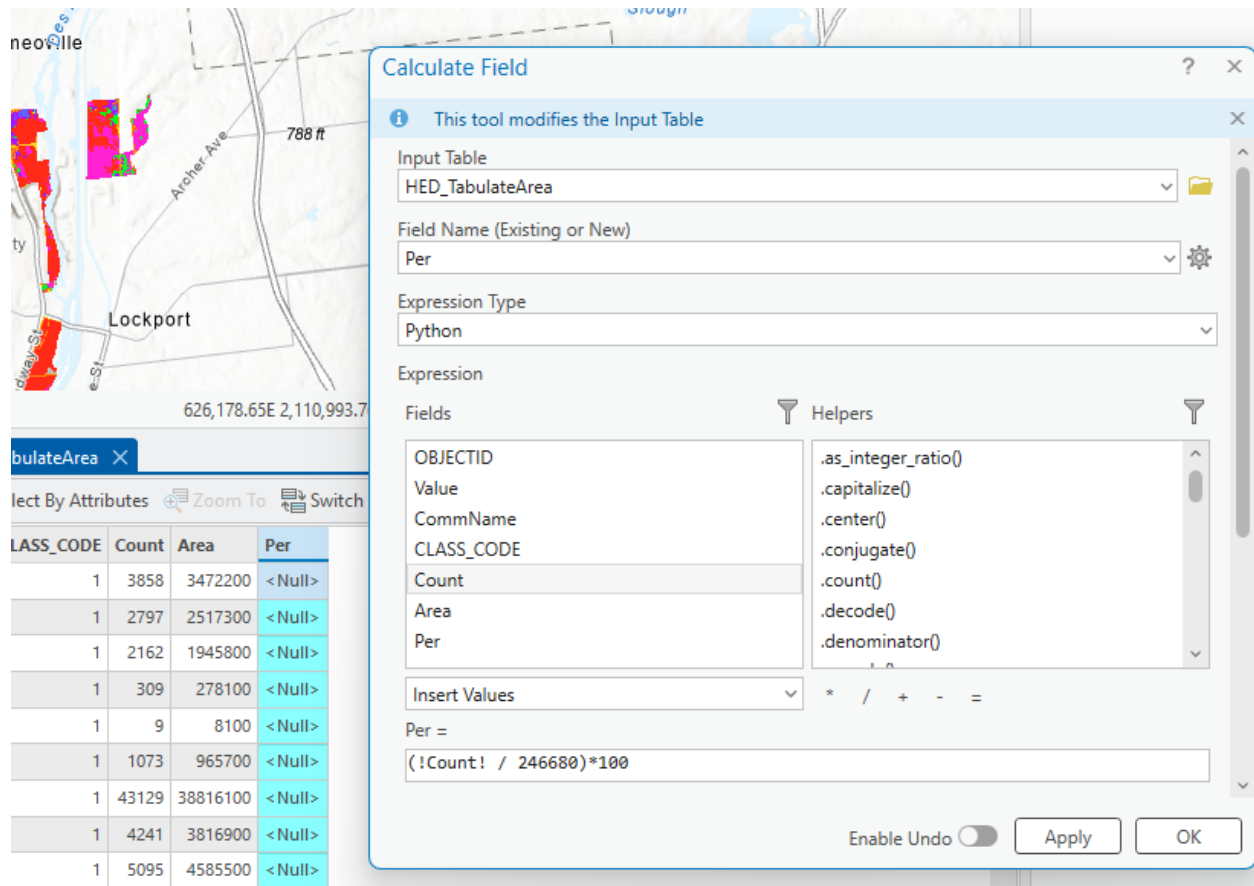


Figure A2-61. Screenshot “Calculate Field” tool