Datasets: Transferring Lake Superior NERR Habitat Mapping Tools and Methods to the Wisconsin-Minnesota St. Louis River Estuary

This document provides detailed information about 3 datasets that were generated through a 1 year science transfer project titled *Transferring Lake Superior NERR Habitat Mapping Tools and Methods to the Wisconsin-Minnesota St. Louis River Estuary.* This webpage provides information about the project. The project was supported by the National Estuarine Research Reserve System (NERRS) Science Collaborative, which is funded by the National Oceanic and Atmospheric Administration. All Science Collaborative supported projects that collect new data adhere to federal data sharing and archiving requirements.

About the Associated Project

Project page: https://nerrssciencecollaborative.org/project/Veregin23
Grant Type: Science Transfer
Focus Area(s): Habitat Restoration
Keyword(s): habitat mapping

Reserve(s): Lake Superior, WI

Project Duration: October 2023 - March 2025
Grant Amount: $139,196.00

Project Contacts:
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Project Description
The St. Louis River Estuary, which runs along the boundary between Wisconsin and Minnesota in the Duluth-Superior metro area, is a vital resource ecologically, culturally, and economically. The St. Louis River is the largest U.S. tributary to Lake Superior and the second largest tributary in the Lake Superior watershed. In 1987, the Great Lakes Water Quality Agreement designated the 12,000-acre freshwater estuary a Great Lakes Area of Concern because legacy contaminants and disturbances had led to nine key impairments, including loss of fish and wildlife habitat.

This project addressed a need identified by the St. Louis River Habitat Workgroup to support the identification and prioritization of areas for future restoration and conservation. The project approach included the transfer of a repeatable habitat mapping process developed by the Lake Superior Reserve to a larger area encompassing 57,000 acres of wetlands and adjacent uplands spanning the lower twenty-one miles of the St. Louis River below the Fond du Lac dam. The team applied accessible image classification methods–including use of common machine learning classifiers and freely available, non-proprietary data–to create a reproducible approach that can easily be adopted in other locations and redeployed at regular intervals to illuminate change over time. In addition to the habitat map and reproducible workflow, the team also produced a change analysis report comparing the 2024 habitat map to the previous St. Louis River Estuary map from 2002.

Overview of Datasets

3 related datasets are described in this document:

- **Dataset 1: NAIP imagery, training polygons and classified land cover map**
  The imagery source for the habitat map is the National Agriculture Imagery Program (NAIP). A summer mosaic of NAIP images was created for the study area. Training polygons were produced by visual interpretation of the NAIP imagery. The final land cover map was produced with a machine learning algorithm called UNET. Data have been archived in a public AWS S3 bucket, managed by the University of Minnesota and can be downloaded directly from the links provided below.

- **Dataset 2: Post-processing GIS layers, field data, final habitat map and change map**
  This dataset is an Esri geodatabase containing feature classes used in the post-processing of the UNET land cover map to produce the final habitat map and change map. Available on GeoData@Wisconsin via the following link: https://geodata.wisc.edu/catalog/4BEDD9CC-8E09-477D-B372-151BD36E9FFA

- **Dataset 3: Drone Imagery**
  Hi-resolution multi-spectral imagery of selected areas within the St Louis River Estuary. Available on GeoData@Wisconsin via the following link: https://geodata.wisc.edu/catalog/A2B11A46-9B56-4187-8B60-A2C0DF6D193B

Questions about these datasets can be directed to:

Howard Veregin, Wisconsin State Cartographer's Office, University of Wisconsin, veregin@wisc.edu

About the Project Datasets

Detailed dataset descriptions are provided below.

Dataset 1: NAIP imagery, training polygons and classified land cover map

Data overview

The imagery source for the habitat map is the National Agriculture Imagery Program (NAIP). A summer mosaic of NAIP images was created for the study area. Training polygons were produced by visual interpretation of the NAIP imagery. The final land cover map was produced with a machine learning algorithm called UNET.

The methodology is described on the University of Minnesota U-Spatial GitHub repository: https://github.com/umn-uspa/StLouisEstuary_LandCover

More about the data:

- NAIP tiles were downloaded from USGS Earth Explorer. To cover the entire study area, we merged images with different acquisition dates: 08/13/2021 in Minnesota and 08/04/2022 and 07/21/2022 in Wisconsin. In the overlapping regions, Wisconsin imagery took precedence, as they were more recent. The spatial resolution of the resulting mosaic is 0.6 meters. The coordinate reference system is NAD 1983 UTM Zone 15N.
- “Desktop” training polygons for the classifier had the following distribution by class: HUMAN-MADE STRUCTURES (118), HERBACEOUS (72), WATER (56), SCRUB- SHRUB (55), UNVEGETATED ROCKY (51), UNVEGETATED UNCONSOLIDATED (50), and FORESTED (49). Total: 451 polygons.
- The final land cover map is in raster format at the same resolution and CRS as the NAIP imagery.

Data collection period:

[08/2021] to [12/2024]

Geographic extent:

46.6 deg N, 91.9 deg W to 46.8 deg N, 92.3 deg W

File format:

There are several file formats. The NAIP mosaic is a GeoTIFF (3.2 GB). This file can be opened in GIS or with image viewing software. The desktop training polygons and outline of the study area are Esri shapefiles (70 KB and 23 KB, respectively, as ZIP archives). These files can be opened in GIS. The final classified map, as well as a class probability raster for the classified map, are GeoTIFFs (41 MB and 1 GB, respectively).

File name(s):

- NAIP mosaic of the study area: https://s3.msi.umn.edu/stlouis-estuary-habitat/NAIP_summer_mosaic_cropped.tif
- Shapefile of the study area: https://s3.msi.umn.edu/stlouis-estuary-habitat/study_area_extended.zip

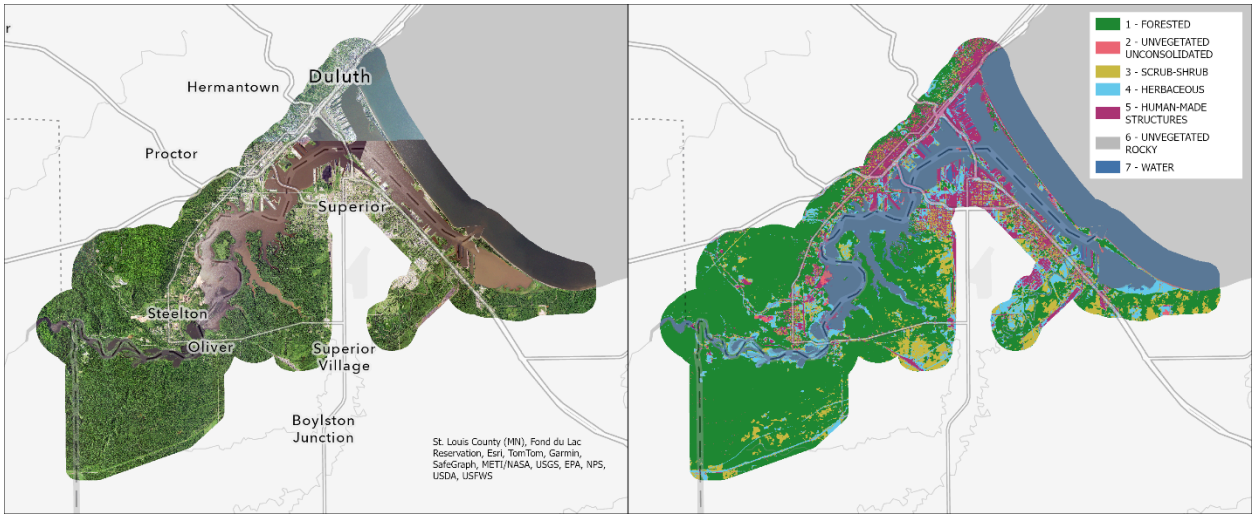
- Shapefile with desktop training polygons: https://s3.msi.umn.edu/stlouis-estuary-habitat/TrainingPolygons.zip

- Final classified map generated from ensemble of 10 U-Net models: https://s3.msi.umn.edu/stlouis-estuary-habitat/st_louis_naip_unet_ensemble_10mods_predict.tif

- Class probability for the final classified map generated from ensemble of 10 U-Net models: https://s3.msi.umn.edu/stlouis-estuary-habitat/st_louis_naip_unet_ensemble_10mods_max_probability.tif

Data access and archival:
Data have been archived in a public AWS S3 bucket, managed by the University of Minnesota. File names are listed above as links. Data can be downloaded from the links.

Maps and schematics for data collection:



Left: NAIP imagery summer mosaic. Right: Classified UNET land cover map.

Dataset 2: Post-processing GIS layers, field data, final habitat map and change map

Data overview
This dataset is an Esri geodatabase containing feature classes used in the post-processing of the UNET land cover map to produce the final habitat map and change map. Data came from several different sources and in some cases was digitized by hand. Also included in the database is the final habitat map and a change map showing differences between the habitat map and a 2002 plant communities map of the same area. The database also includes all field data collected to perform accuracy assessment, with photographs.

The methodology is described on the University of Wisconsin State Cartographer's Office GitHub repository: https://github.com/WIStCart/StLouisEstuary-HabitatMap

This repository also includes the look-up tables to decode the "value" fields in the rasters.

More about the data:

- A raster land cover map, produced by project partners at U-Spatial using the UNET classifier, is the starting point for post-processing.
- For each of the eight rulesets applied in post-processing, a raster layer (and in some cases a polygon layer) was created specifying the way in which map values were to be changed.
- The final habitat map is the result of applying the eight rulesets to the original UNET land cover map. Both raster and vector versions were created.
- Accuracy assessment used field data collected over two summer seasons in 2023 and 2024. These feature classes contain attributes describing the system, subsystem, class and subclass of the NERRS system as identified on the ground. Additional attributes include dominant species, invasive species, whether wild rice or hemi-marsh was observed, the date of collection, the name of the record creator, and other notes.
- For final accuracy assessment, an internal buffer of 5 feet was applied to training polygons to eliminate edge effects.
- A change map, showing the differences between the final habitat map and a 2002 Plant Communities and Aquatic Habitats map, was also produced (raster and vector).

Search keywords:
St. Louis River Estuary, Minnesota, Wisconsin, land cover, habitat, change analysis.

Data collection period:
[06/2023] to [09/2024] Training polygons

Geographic extent:
46.6 deg N, 91.9 deg W to 46.8 deg N, 92.3 deg W

File format:
Files are in Esri format as feature classes within a geodatabase. Both vector and raster data are included. In addition, there are several attached files.

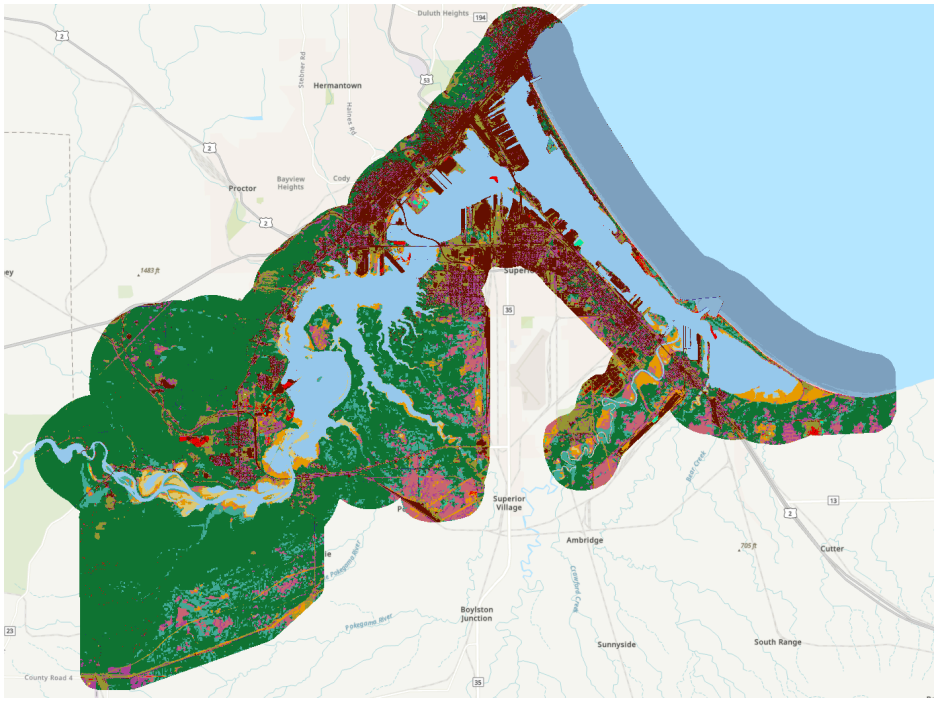
File name(s):

- Habitat_map_raster: Final habitat map, raster format
- Habitat_map_vector: Final habitat map, vector format
- UNET: Land cover map created by U-Spatial based on NAIP imagery
- Aquatic_habitats_2002: 2002 Aquatic Habitats Map
- Plant_communities_2002: 2002 Plant Communities Map
- Change_raster: Change map (2002 map vs new habitat map), raster format
- Change_poly: Change map (2002 map vs new habitat map), vector format
- Bathy_30m: 2019 USACE merged bathymetry data. Source: https://noaa-nos-coastal-lidar-pds.s3.amazonaws.com/laz/geoid18/8832/index.html Available through: https://coast.noaa.gov/dataviewer/#/
- Bath: Raster layer used to separate lake limnetic from lake littoral
- CWMP: Great Lakes Coastal Wetlands Monitoring Program polygons, raster format, used to correct miscoded areas on map. Viewable here: https://www.greatlakeswetlands.org/Map.vbhtml
- CWMP_poly: Coastal Wetlands Monitoring Program polygons, vector format
- Expert1: Raster layer used to correct miscoded areas
- Expert1_poly: Vector version of Expert1
- Expert2: Raster layer used to correct miscoded areas. Source: C. Reschke and C. Hill, 2020, Aquatic Habitat Mapping in the St. Louis River Estuary, Report NRRI/TR-2020/19. https://conservancy.umn.edu/server/api/core/bitstreams/a456bdbe-8434-4d8f-a8f2-e52d990b9a6b/content
- Expert2_poly: Vector version of Expert2
- Lake: Raster layer used to separate river and lake
- Lake_poly: Vector version of Lake raster
- Landfire: 2023 Landfire grid used to separate upland and wetland, based on EVT_PHYS “riparian” classification on Landfire Vegetation Type grid. (LF2023_EVT_240 available at https://www.landfire.gov/viewer/) .
- Uncons: Raster layer used to separate unconsolidated classes
- Uncons_poly: Vector version of Uncons
- Waterfix: Raster layer used to correct miscodings on land cover map
- Waterfix_poly: Vector version of Waterfix
- Training_polys_2023: 2023 training data
- Training_polys_2023__ATTACH: 2023 training data photos
- Training_polys_2023__ATTACHREL: 2023 training data photos/feature x-walk
- Training_polys_2024: 2024 training data
- Training_polys_2024__ATTACH: 2024 training data photos
- Training_polys_2024__ATTACHREL: 2024 training data photos/feature x-walk
- Training_polys_2023_2024_skinny: Merged 2023 and 2024 training data, with 5 foot internal buffer applied to remove edge effects

Data access and archival:

Data is publicly available at https://geodata.wisc.edu/catalog/4BEDD9CC-8E09-477D-B372-151BD36E9FFA

Maps and schematics for data collection:



Screenshot of final habitat map

Dataset 3: Drone Imagery

Data overview
Hi-resolution multi-spectral imagery of selected areas within the St Louis River Estuary. The source imagery was collected in August and September 2024 with the WingtraOne Gen2 fixed-wing drone equipped with the Sony a6100 RGB camera or MicaSense RedEdge-P multispectral (MSP) camera. All flights occurred under fully cloudy conditions except for the final flight day (Nemadji RGB). MSP imagery collection was prioritized. Spectral bands collected include red, green, blue, red-edge, near infrared, and panchromatic. With the multispectral camera, the drone was flown at an altitude of 386 feet, resulting in a ground sampling distance of 3.7 cm. With the RGB camera, the drone was flown at an altitude of 394 feet, resulting in a ground sampling distance of 2.2 cm. PPK service provided by MNCors was utilized for accuracy corrections. Imagery was orthorectified and mosaicked using Pix4DFields mapping software. Pix4DFields was also used to calculate the normalized vegetation difference index (NDVI) and surface model elevation (meters above mean sea level) rasters.

Search keywords:
Drone imagery, aerial photography, St. Louis River Estuary, Minnesota, Wisconsin, land cover, habitat map.

More about the data:
Drone imagery was collected by project partners at the University of Minnesota's Natural Resources Research Institute.

Data collection period:
[08/2024] to [09/2024]

Geographic extent:
552975.309113416
577126.192157868
5183074.72038815
5162534.94498873
UTM Zone 15N NAD83 meters

File format:
GeoTIFF

File name(s):
NERRS_Nemadji_msp_data.tif 86.89 GB
NERRS_Nemadji_msp_ndvi.tif 13.19 GB
NERRS_Nemadji_rgb_data.tif 16.81 GB
NERRS_Nemadji_rgb_surfacemodel.tif 10.7 GB
NERRS_Pokegama_msp_data.tif 27.96 GB
NERRS_Pokegama_msp_ndvi.tif 5.75 GB
NERRS_Pokegama_rgb_data.tif 9.37 GB

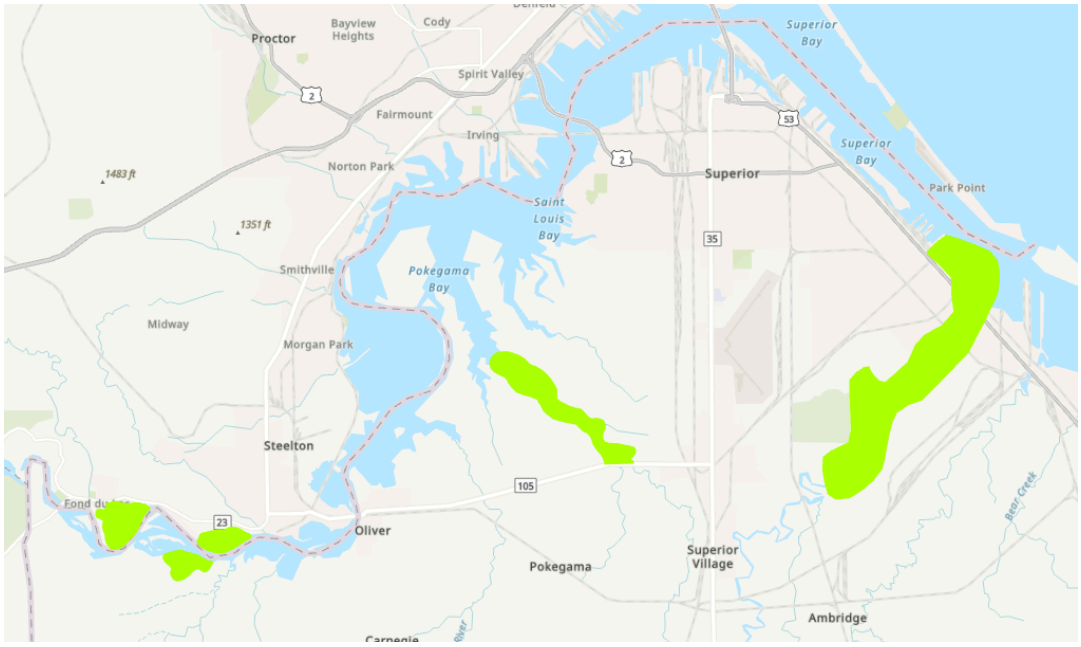
NERRS_Pokegama_rgb_surfacemodel.tif 6.35 GB
NERRS_Rask_msp_data.tif 18.39 GB
NERRS_Rask_msp_ndvi.tif 2.91 GB
NERRS_WeaselNorth_msp_data.tif 23.34 GB
NERRS_WeaselNorth_msp_ndvi.tif 3.64 GB
NERRS_WeaselNorth_rgb_data.tif 6.54 GB
NERRS_WeaselNorth_rgb_surfacemodel.tif 4.32 GB

Data access and archival:
Data is available on
https://geodata.wisc.edu/catalog/A2B11A46-9B56-4187-8B60-A2C0DF6D193B

Most of the imagery is also available for viewing on ArcGIS Online:

Weasel and North Bays:
https://umn.maps.arcgis.com/apps/mapviewer/index.html?webmap=8b84ade075d24121b4a8a37a1c2e8d11
Pokegama Bay:
https://umn.maps.arcgis.com/apps/mapviewer/index.html?webmap=12458ec7e8294025ba6e457b1cbca25d
Rask Bay:
https://umn.maps.arcgis.com/apps/mapviewer/index.html?webmap=ab4fd57076c14313b3e8585cbf2aaaf7
Nemadji:
https://umn.maps.arcgis.com/apps/mapviewer/index.html?webmap=0fa05f3d6e3c40de9ecbf65867613490

Maps and schematics for data collection:



Approximate coverage areas of drone imagery (in green).