Predicting the Spread of Asian Carp in the Mississippi River Basin

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Introduction to North America

- Asian carp were originally brought to the United States as a method of control for algae in water treatment plants in the 1970s
- The escaped captivity and spread quickly to the Mississippi, Missouri, and Illinois rivers
- Their range continues to expand and threaten native ecology and ecosystem services
- Species of Asian carp currently invasive in the Mississippi River Basin:

Management Strategies

- Physical and electrical barriers
- Use of sterile carp in algae management
- Hazard Analysis and Critical Control Point (HACCP) identify locations along the waterway where carp could most easily be removed

General Habitat Requirements

- Prefer low water flow speeds in tributaries and backwaters, but do not do well in completely stagnant water
- Require high level of water hardness for spawning
- Pond, lakes, and rivers that receive flooding
- Can live in bodies of water but must have access to riverine habitat
- Tolerate wide range in water temperatures
- Prefer freshwater but can survive some brackish water

Measurable Parameters

- Water temperature max/min range between 5 and 35 Celsius
- Water hardness should be above 200 mg/l $CaCO3$
- Reclassified raster with categorical water feature data including:
  - Reservoirs
  - Lakes
  - Ponds
  - Estuary
  - Swamp/Marsh
- Salinity between 1.5-12%

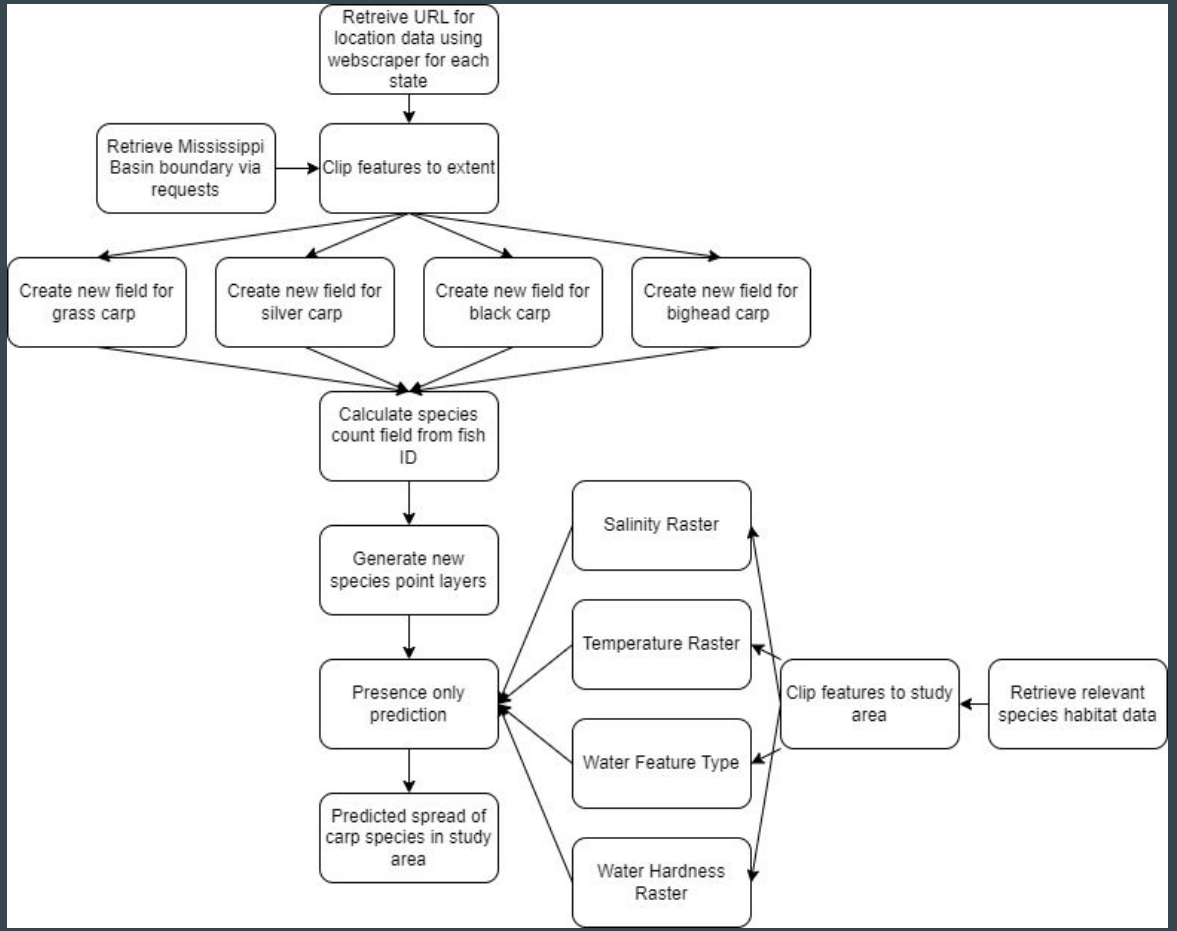
Data Sources

- USGS Nonindigenous Aquatic Species Database
  - Carp observations gathered from 2011-2018
- USGS Water-Quality Monthly Statistics
  - 2018 water hardness, salinity, water temperature
- USDA Critical Conservation Areas
  - Mississippi River Basin

Methods

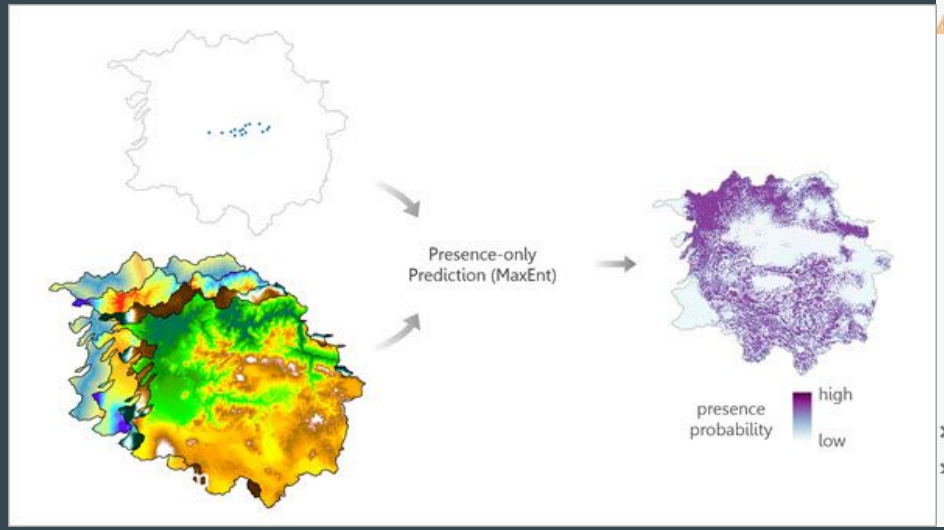
- Data Retrieval:
  - Used requests to download water feature data
  - Salinity and hardness information was downloaded in CSV format
- Data Processing:
  - Water features data for study area required querying
    - Only water bodies larger than .5 km were kept
    - Converted to raster format
  - Appended salinity and water hardness data to collection points
    - Joined with water features
  - Clipped features to river basin extent

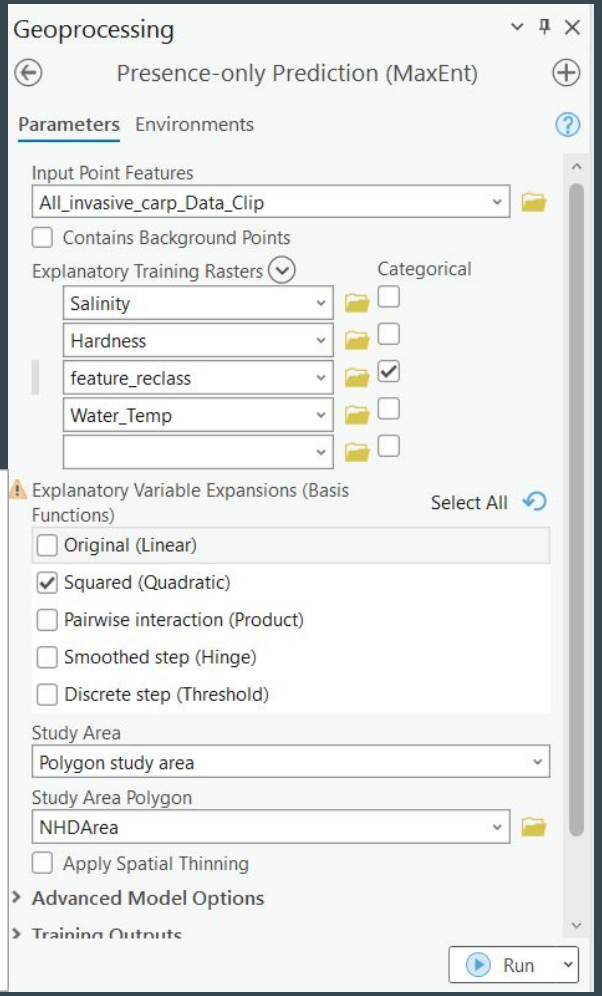
Data Flow Diagram



Presence-Only Prediction

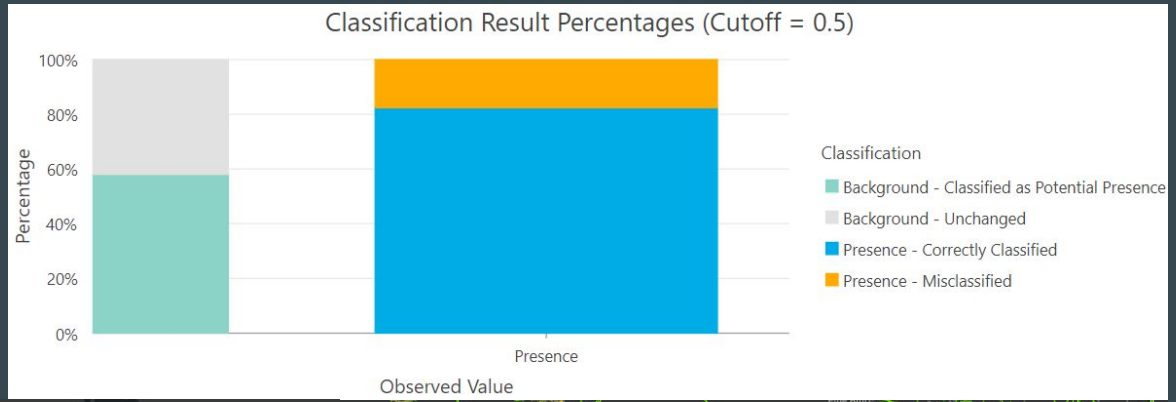
- Used to estimate the overall prevalence of a feature based on point and raster inputs
- Output limited to water feature locations
- Feature output reclassified based on suitability

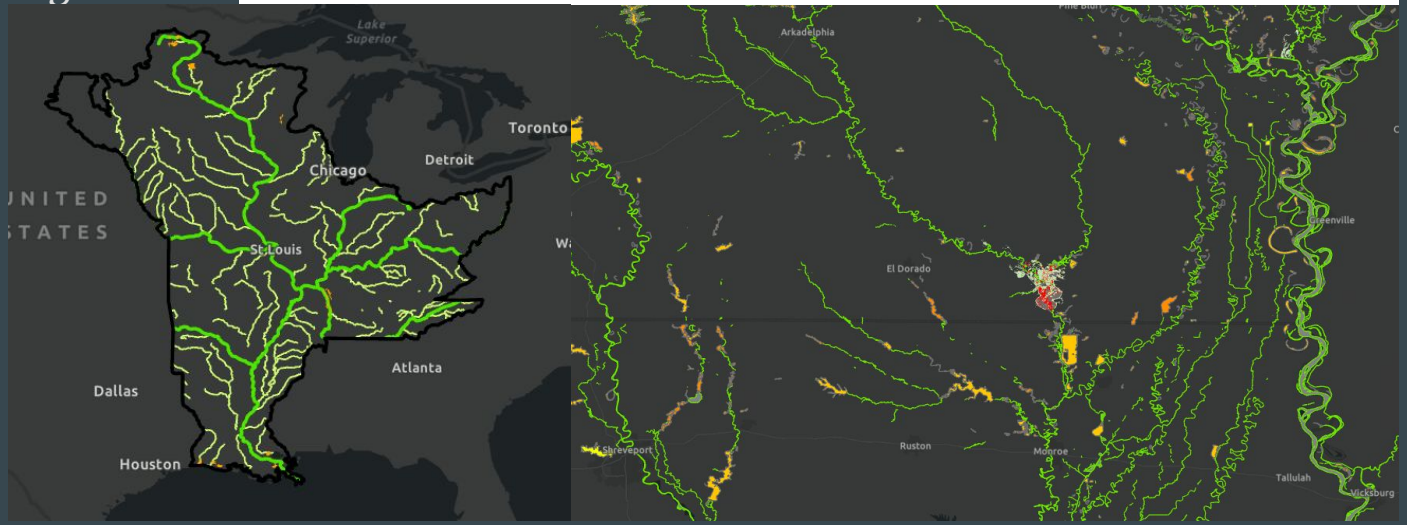




Results

- Prediction classification assigned based on correctly/incorrectly classified
- Prediction for large and small features





Limitations

- Not species specific
- Requires high resolution water conditions for effective estimation
- Processing time for study extent
- Water bodies/river feature differences
- Current modelling does not take into account effects of drastic flow changes on habitat suitability
    - Dams and other forms of impoundment along rivers and streams can cause the flow to temporarily fall below 2 cm/s
    - This causes issues for Asian carp spawning in the form of egg settling
    - Key impoundment features could be identified and a buffer could be used according to affected area

References

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Data Sources

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