Find out more!

PING Mapper

Efficient & Reproducible **Substrate Mapping** with Recreation-grade **Sonar Systems**

Introduction

Satellites provide an unprecedented spatial and temporal resolution of the Earth's surface, enabling creation of highly detailed maps of land use and land cover. However, these methods provide little insight for aquatic systems. The dynamic benthic environment is ultimately mapped with blue lines and polygons. These maps provide limited information regarding habitat characteristics important for aquatic species, thereby hindering effective management and restoration.

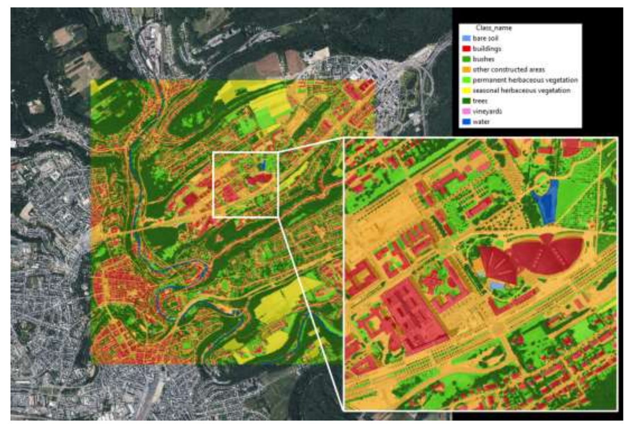


Image Credit: space4environment.com

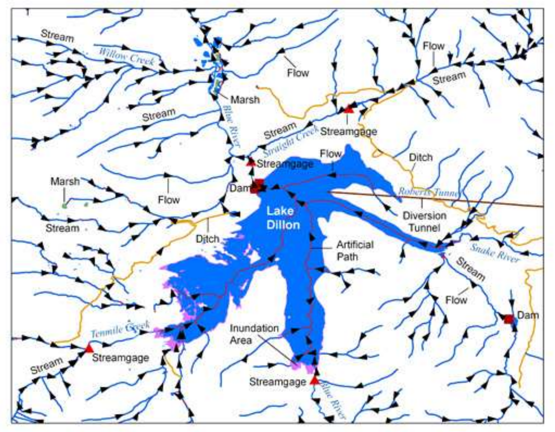


Image Credit: usgs.gov

Aquatic researchers increasingly use recreation-grade side-scan sonar (SSS) instruments, or fishfinders, to image the benthic zone. Through careful study, features such as substrates are visually identified and manually mapped. While these methods provide rich datasets of habitat distribution and availability, map production is time-consuming and can be highly variable.

Image Credit: humminbird.johnsonoutdoors.com

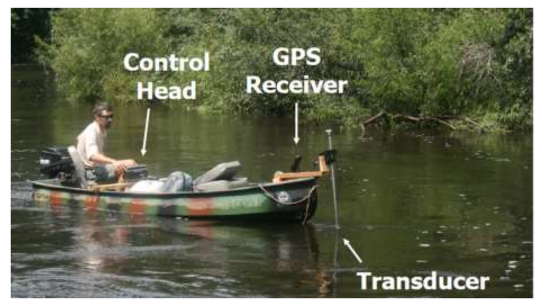


Image Credit: Kaeser & Litts, 2010

Open-source, efficient, and reproducible tools are needed for effective landscape-level substrate map production to help inform management, conservation, and restoration objectives.

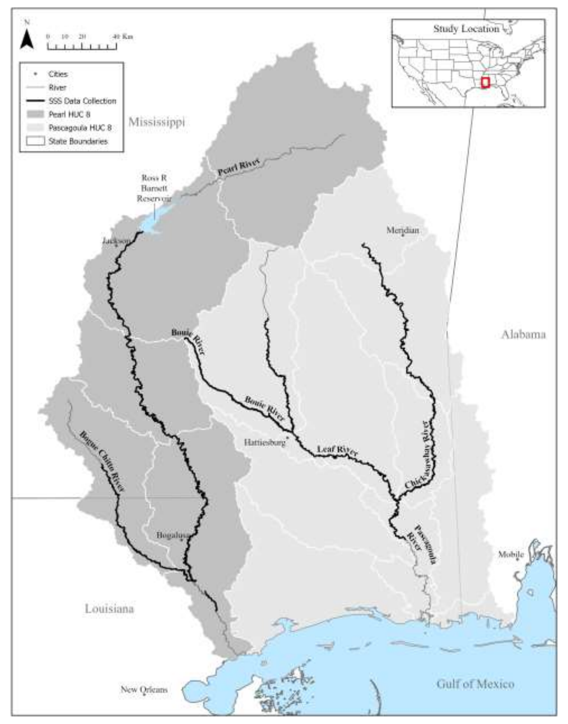
PING-Mapper is that tool!

Objectives

1) Develop open-source and reproducible toolset for processing sonar recordings from Humminbird® sonar instruments.
2) Develop automated and reproducible approach for segmenting and classifying benthic substrates from sonar mosaics.
3) Map and validate substrate distribution across 1,200 river kilometers (RKM) on the Pearl and Pascagoula river systems.
4) Identify river reaches with suitable Gulf Sturgeon spawning substrate.

Relevance

The threatened Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) is a long-lived anadromous fish. They travel hundreds of kilometers in search for freshwater spawning habitat. Sonar data have been collected across ~1,200 km on the Pearl and Pascagoula watershed in Mississippi to locate and map suitable spawning substrates. This will inform future conservation of the species.



Decode Sonar File & Export Attributes

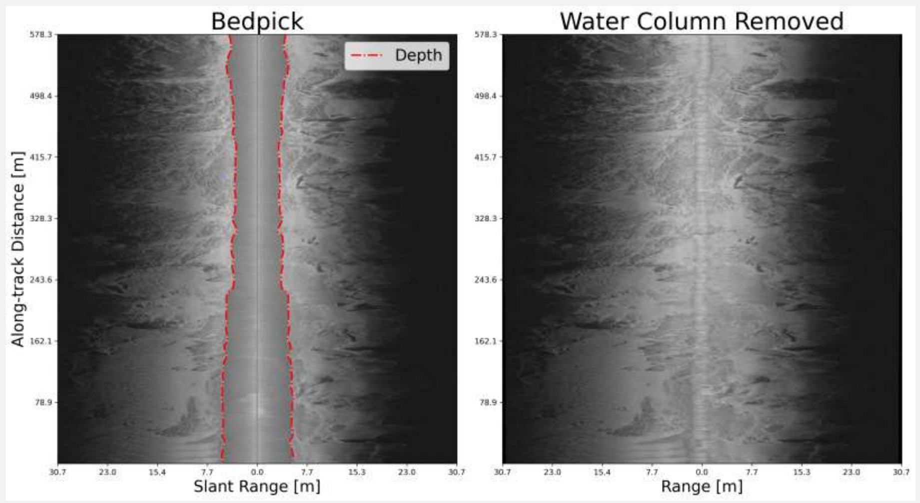
Sonar recordings from any Humminbird© side imaging system are automatically decoded. Attributes from each ping are exported to file.

```
Rec00001.DAT
 └── Rec00001
      ├── B001.IDX
      ├── B001.SON
      ├── B002.IDX
      ├── B002.SON
      ├── B003.IDX
      ├── B003.SON
      ├── B004.IDX
      └── B004.IDX
```

Record idx	37833
Longitude	-90.23365
Latitude	32.08823
Heading	134°
Speed	2.7 [m/s]
Depth	4.2 [m]
Time	487.811 [s]
Frequency	455 [kHz]
Beam	starboard

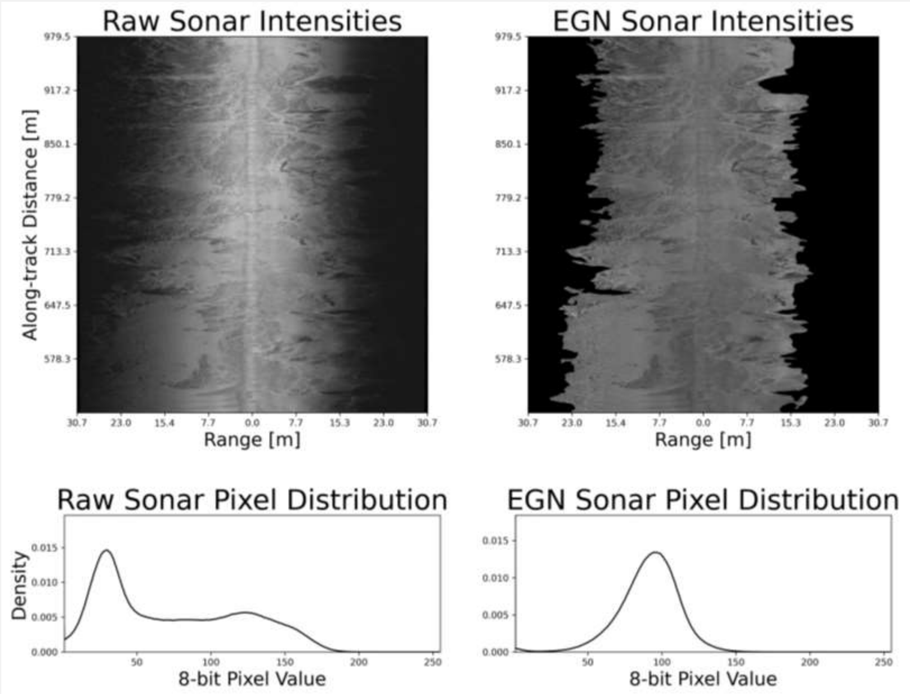
Geometric Corrections

The water column at nadir, present in raw side scan imagery, is removed based on the depth. The slant-range and depth are used to estimate the range. Pixels are then relocated, resulting in a spatially accurate image of the bed.



Empirical Gain Normalization

Empirical gain normalization is applied to the raw sonar intensities based on range and depth. These averages are used to normalize the raw intensities by dividing the raw value by the associated average return. This corrects the effect of attenuation and distance on the strength of the signal, resulting in a balanced image.

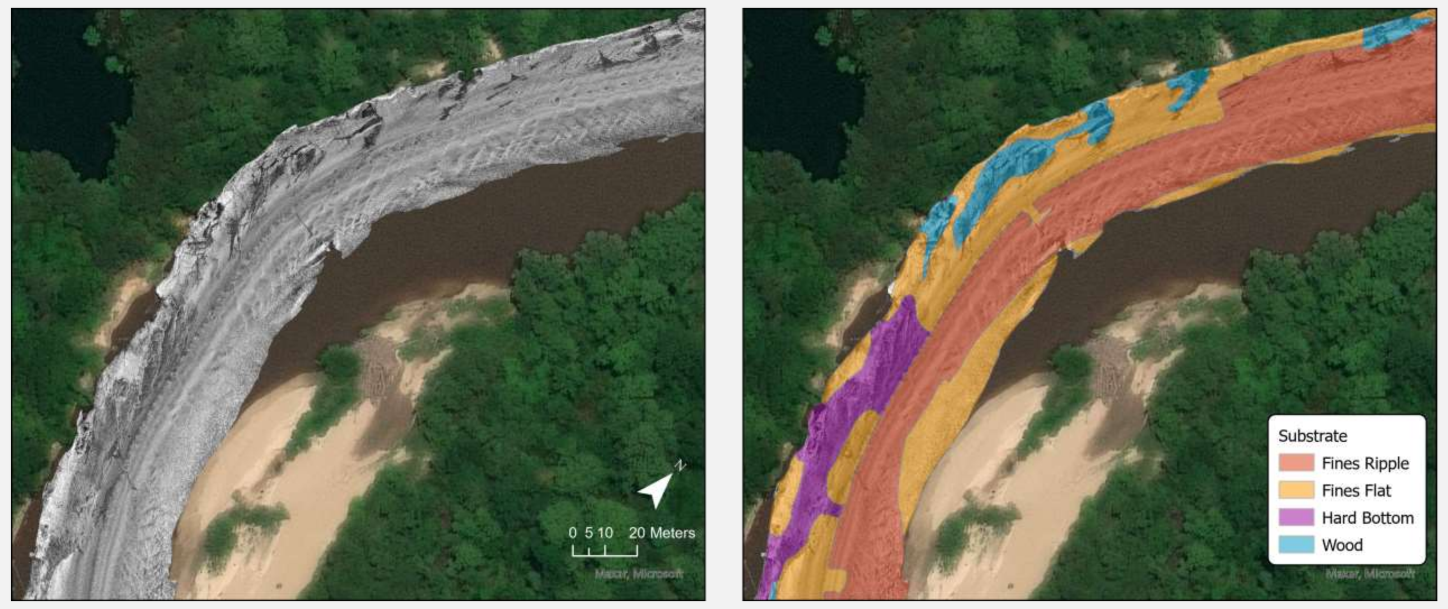


GIS Datasets

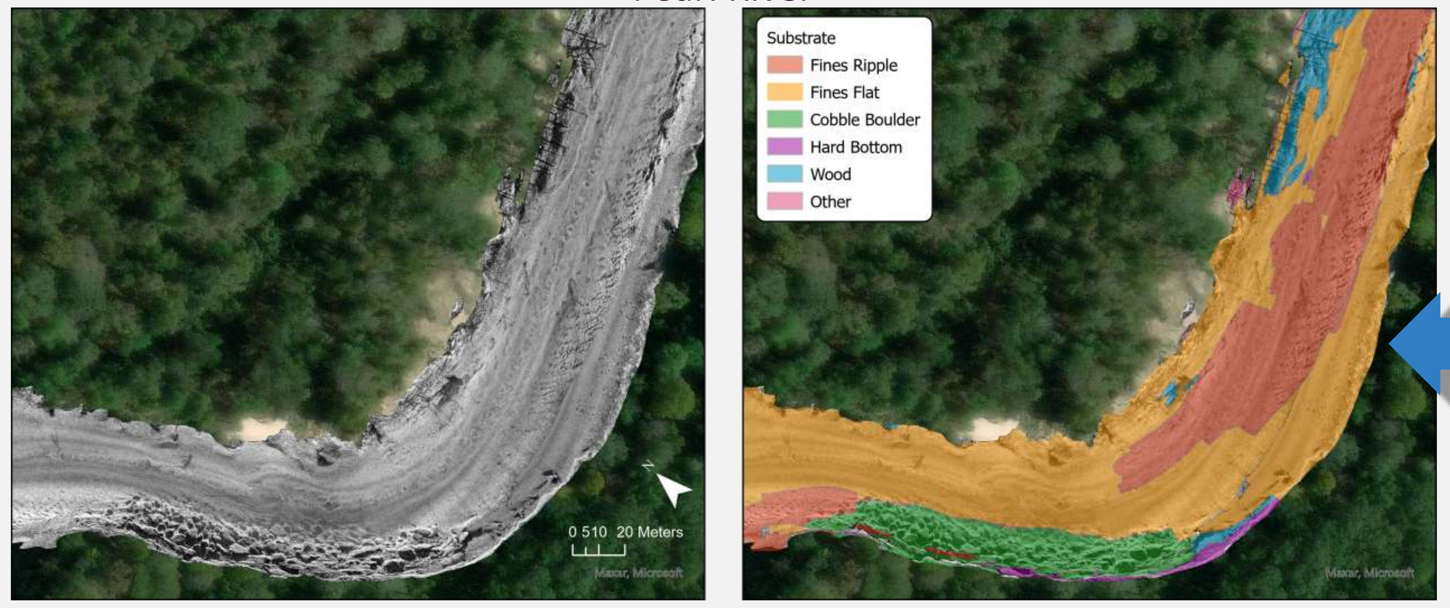
PING-Mapper automatically decodes sonar recordings from Humminbird© side imaging systems to generate georeferenced sonar mosaics. Neural network models are used to predict substrate type from the imagery. Substrate predictions are georeferenced to generate substrate maps. Example reaches are shown below.

Sonar Mosaic / Substrate Map

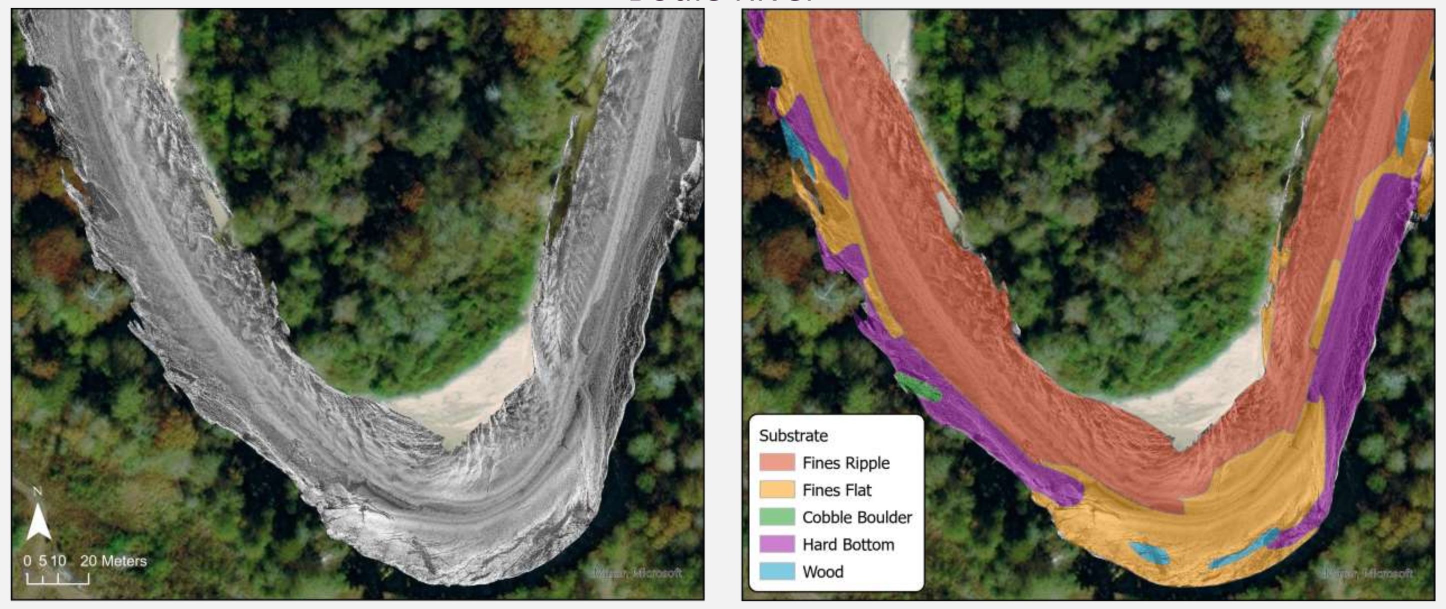
Bogue Chitto River



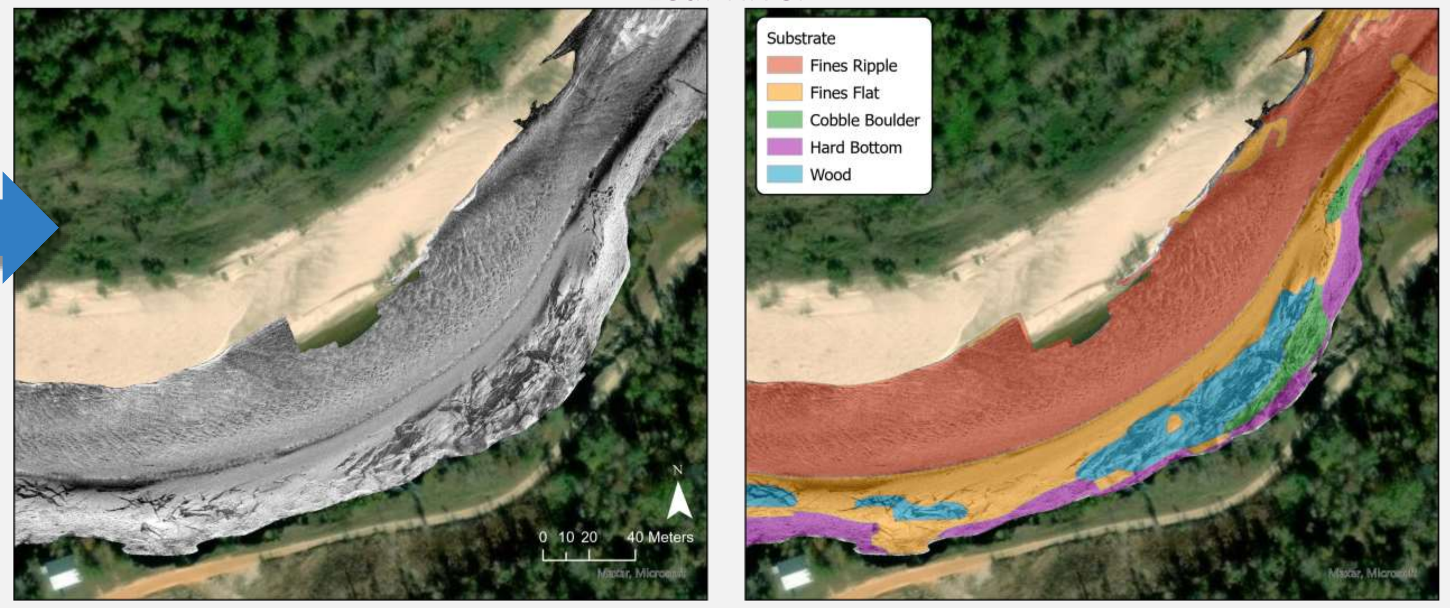
Pearl River



Bouie River



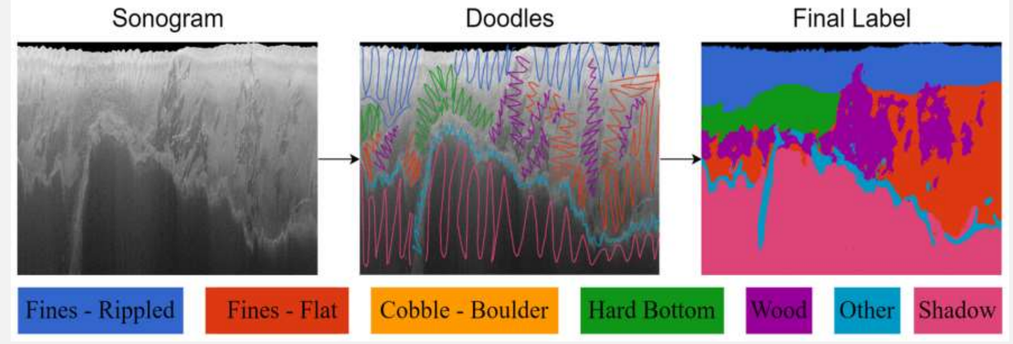
Leaf River



Dataset Creation

Doodler

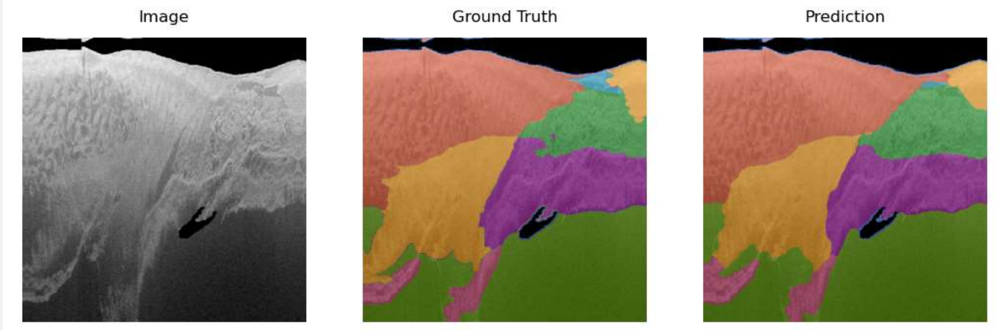
Interpretation of sonar intensity and textures enable characterization of different substrate patches. Doodler is used to assign every pixel to a substrate class. The dataset is used to train neural networks for image segmentation.



Substrate Modeling

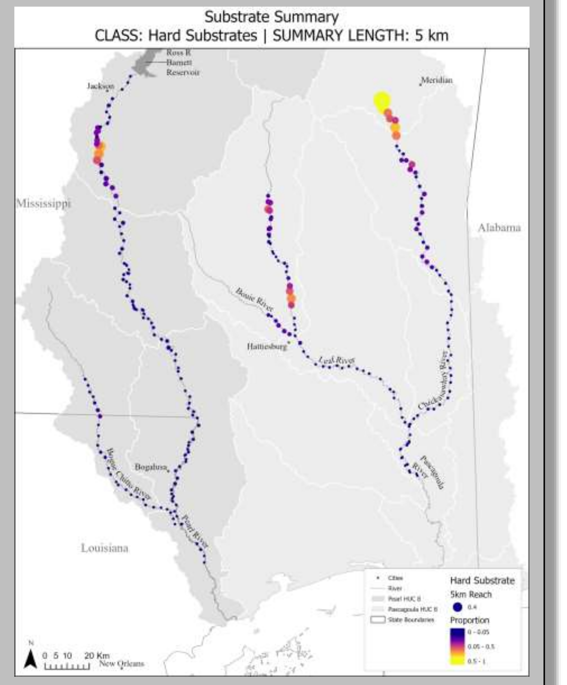
Gym

Substrate datasets are used to train neural networks provided by Segmentation Gym. Pixel-wise likelihoods are calculated for each substrate class. The likelihoods are used to assign a substrate classification. Classifications are then rectified to create georeferenced substrate maps.



Results and Conclusion

Substrate models achieve 78% accuracy on test sets. Maps are currently being validated in the field to determine real-world accuracy. Map summaries (to the right) show hard (gravel, cobble, bedrock) substrate distribution, which may support Gulf Sturgeon spawning. Future work will use field samples to improve model predictions.



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