Parameterize **numerical models** with **substrate** maps in **any aquatic system!**

PING mapper

Research Motivation

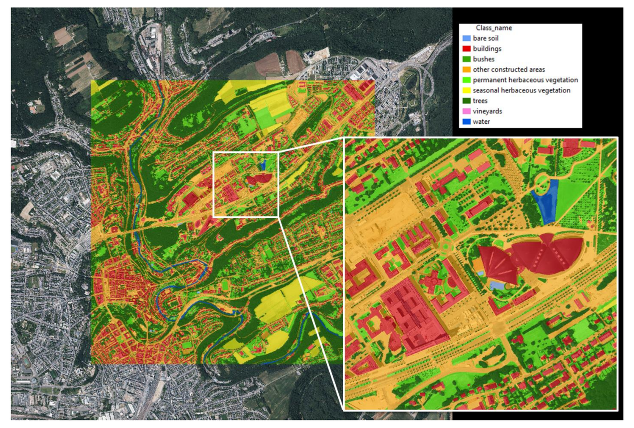


Image Credit: space4environment.com

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.

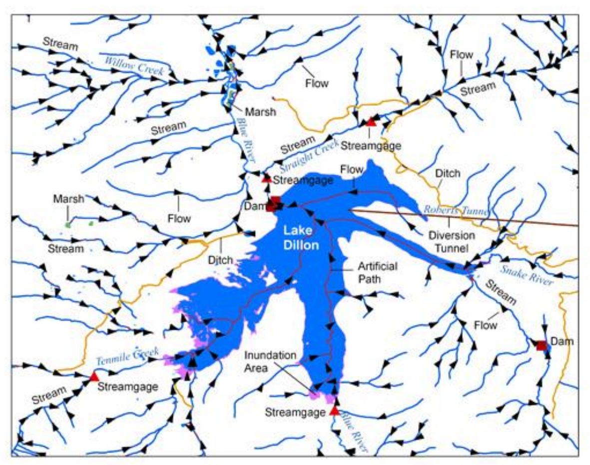


Image Credit: usgs.gov

WE CAN DO BETTER!

Mapping benthic substrates everywhere helps inform numerical models, ecological studies, and monitoring efforts. With PING-Mapper, anyone can map their system in four steps:

Image Credit: humminbird.johnsonoutdoors.com

STEP 1 Get a Humminbird© Side Imaging System ~$500-1,000+

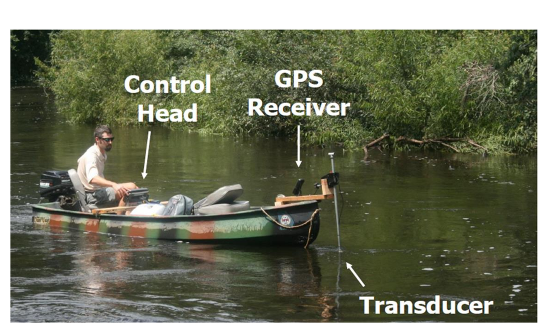
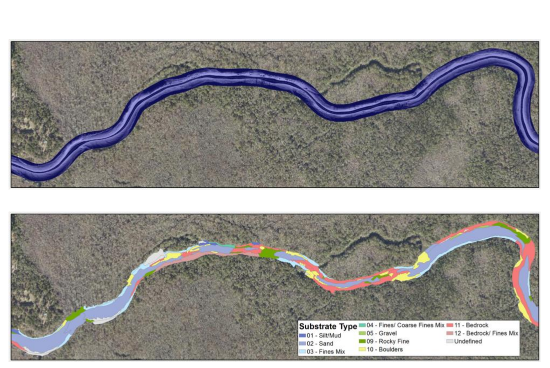


Image Credit: Kaeser & Litts, 2010

STEP 2 Jump in a boat and start scanning your aquatic system!

PING Mapper

STEP 3 Scan QR code to download PING Mapper to generate detailed benthic maps!



STEP 4 Use the benthic maps to inform your management objectives!

Decode Sonar File & Export Attributes

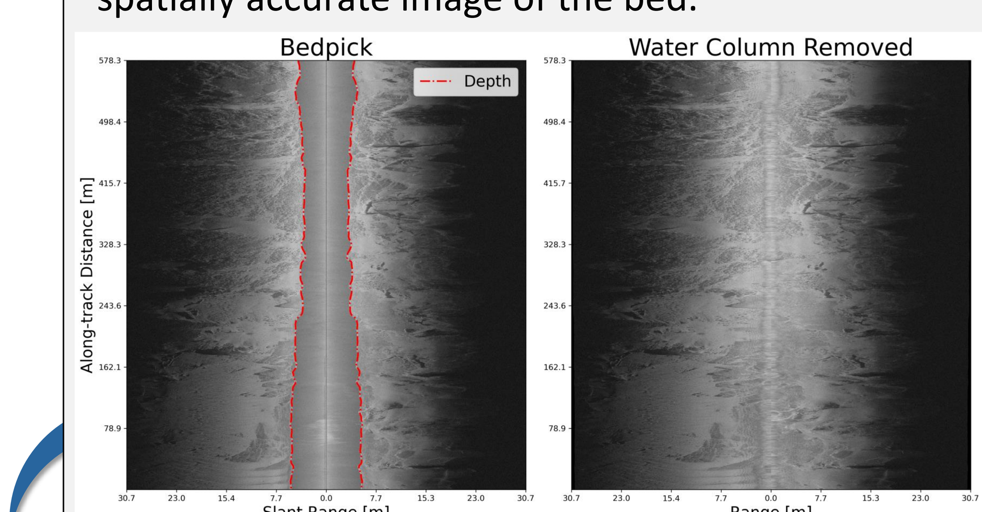
Sonar recordings from any Humminbird© side imaging system are automatically decoded. Attributes from each ping are exported to file.

```
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

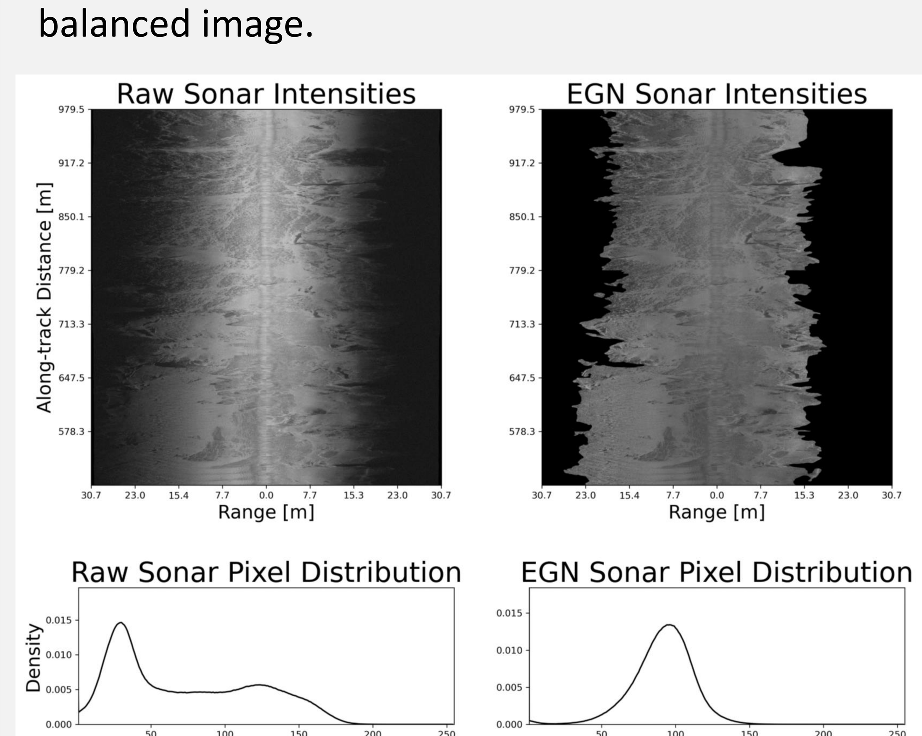
Geometric Corrections

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.

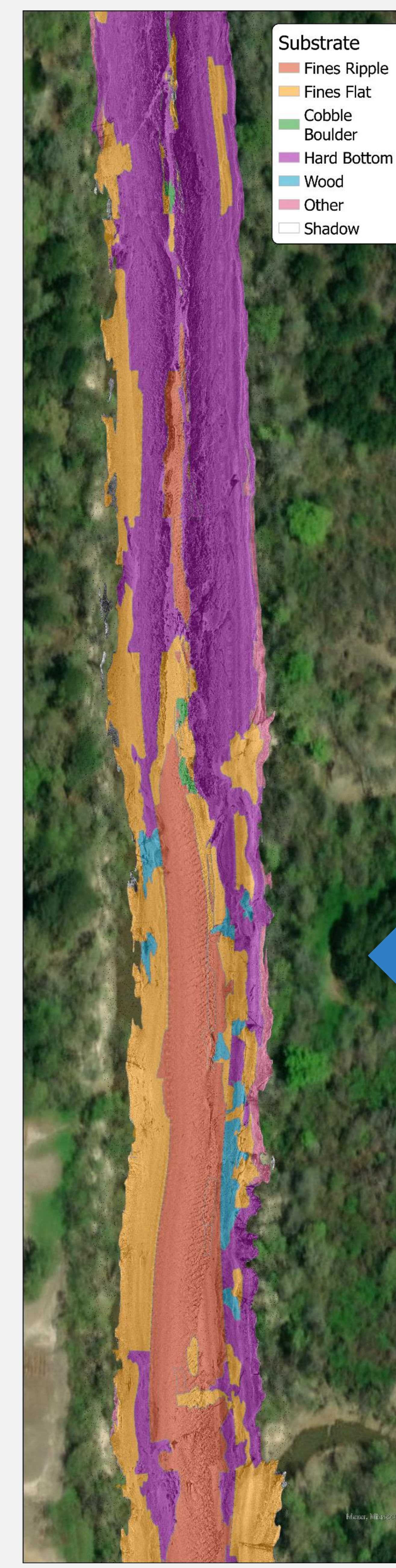


GIS Datasets

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.

Sonar Mosaic

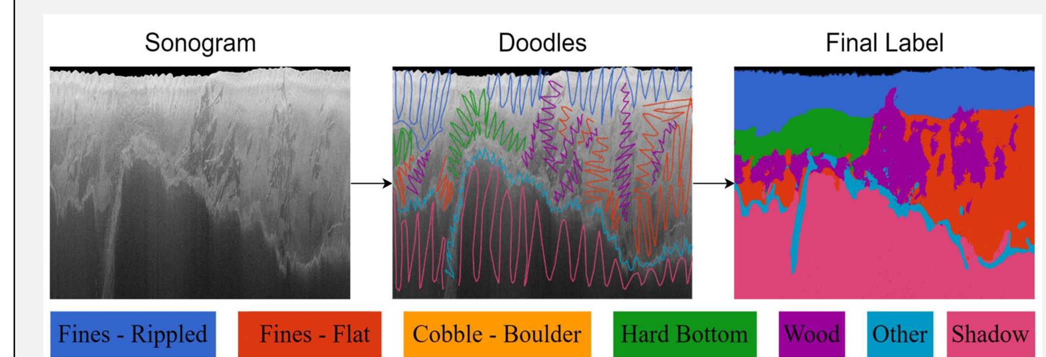
Substrate Map



Dataset Creation

Doodler

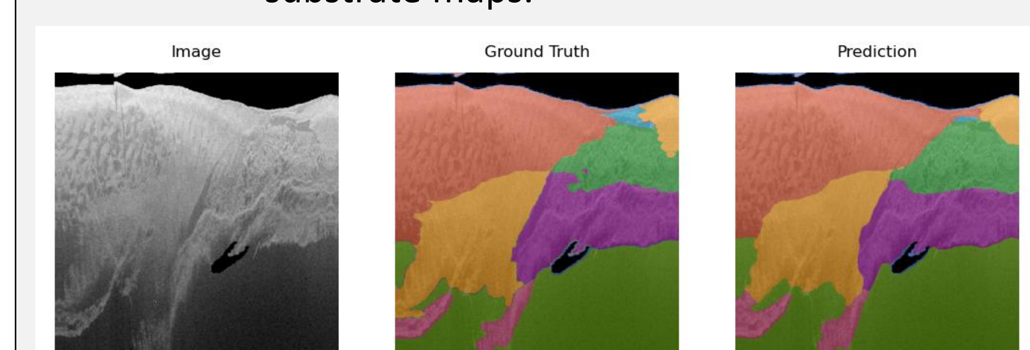
Interpretation of sonar intensity and textures enable characterization of different substrate patches. Doodler is used to assign every pixel to a substrate class. The dataset is used to train neural networks for image segmentation.



Substrate Modeling

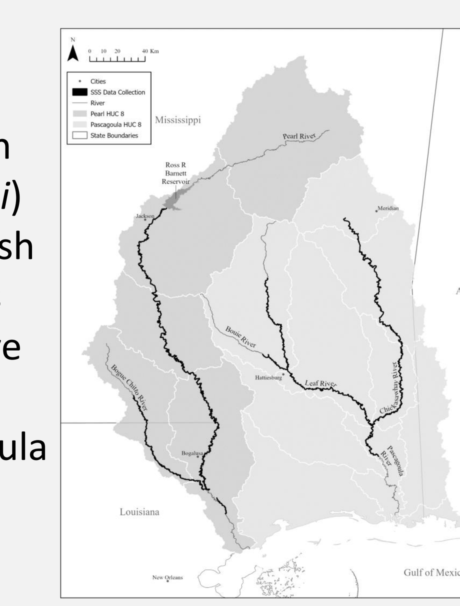
Gym

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.



Application

The threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is a long-lived anadromous fish that rely on freshwater rivers for spawning. Sonar data have been collected across ~1,200 km on the Pearl and Pascagoula watershed in Mississippi to locate and map suitable spawning substrates.



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