Integrating Remote Sensing and Underwater Imagery to Enhance Invasive Dreissena Distribution Assessment in Large Rivers

Knut Mehler[1,2], Lyubov Burlakova[1,2] Alexander Karatayev[1]

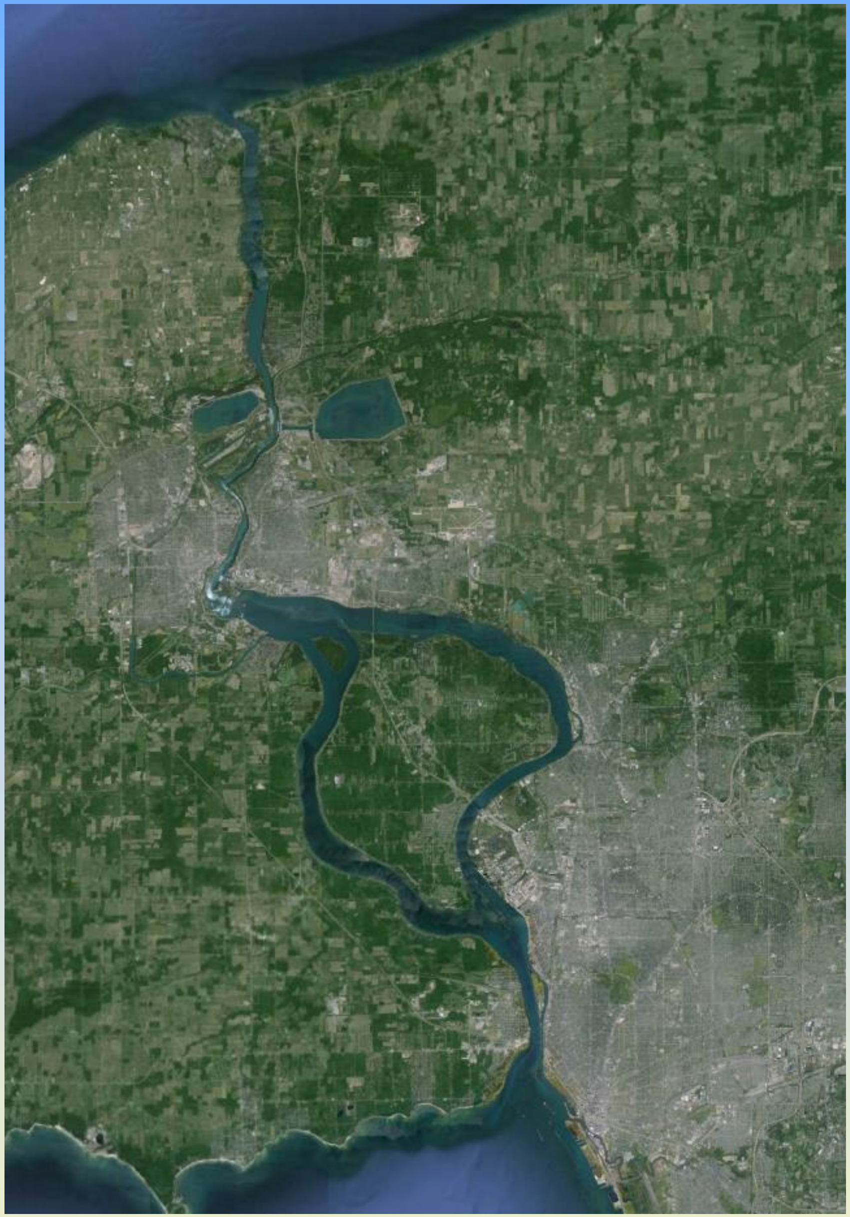
[1]Great Lakes Center, SUNY Buffalo State,

[2]The Research Foundation of The State University of New York, SUNY Buffalo State College

Outline

- Background
- Objective
- Methods
- Results
- Conclusions

Niagara River



Length: 34mi (58km)

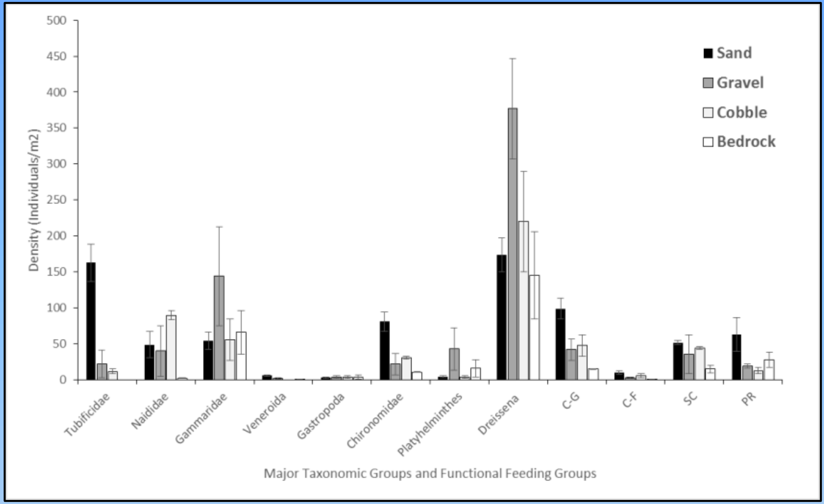
Discharge: 5800 m^3/s

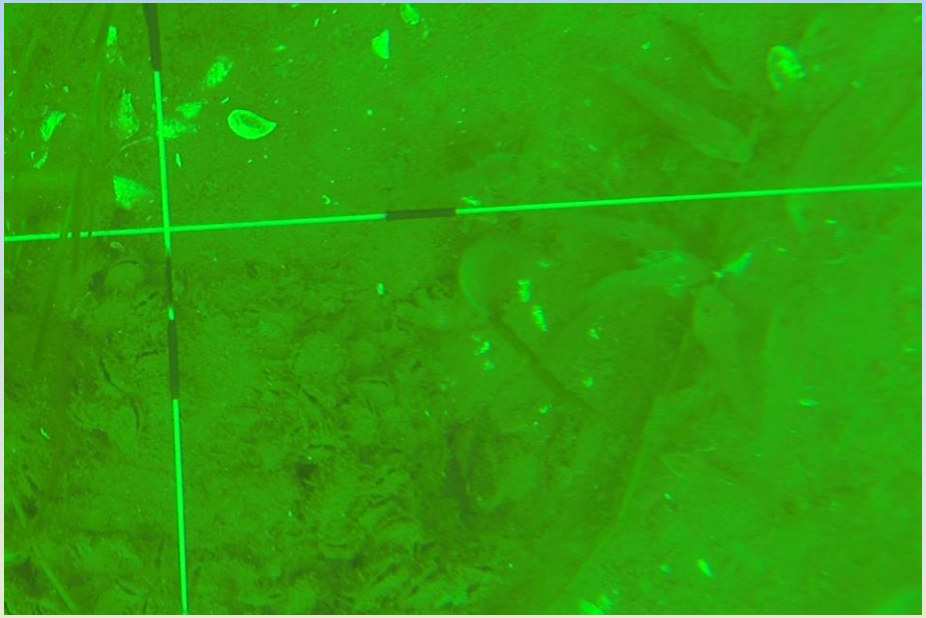
Calcium Concentration: 26-41 mg/L

Dreissena first detected near outflow of Lake Erie in October 1989 and near inflow of Lake Ontario in summer of 1990 (Howell et al. 1996)

Why do we care about *Dreissena* in Niagara River?

- Most abundant invertebrate in the river
- Facilitate other invasive species (*E. ischnus* and *N. melanostomus*)
- May indirectly facilitate lake sturgeon (*A. fulvescens*)





- ➔ Effects of invasive *Dreissena* on benthos and higher trophic levels depends on population size (i.e. biomass) and production

- ➔ Knowledge about spatial distribution of *Dreissena* important to assess potential impacts

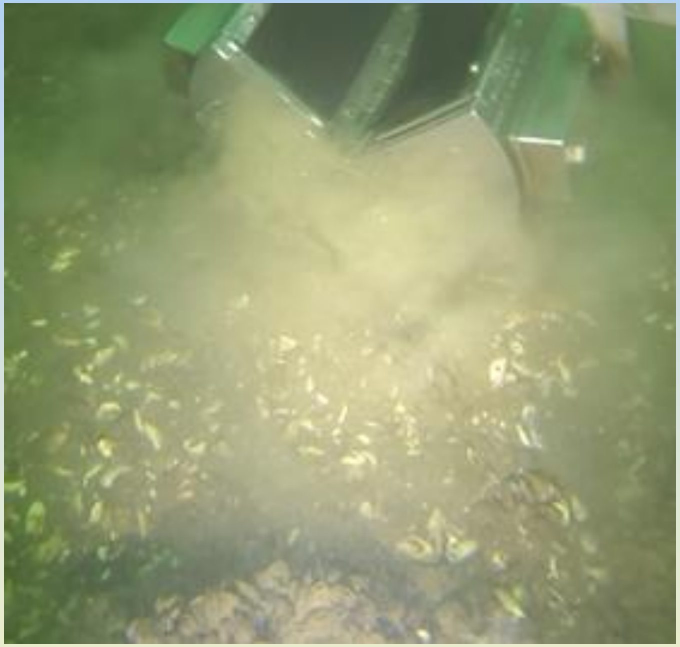
Problem!

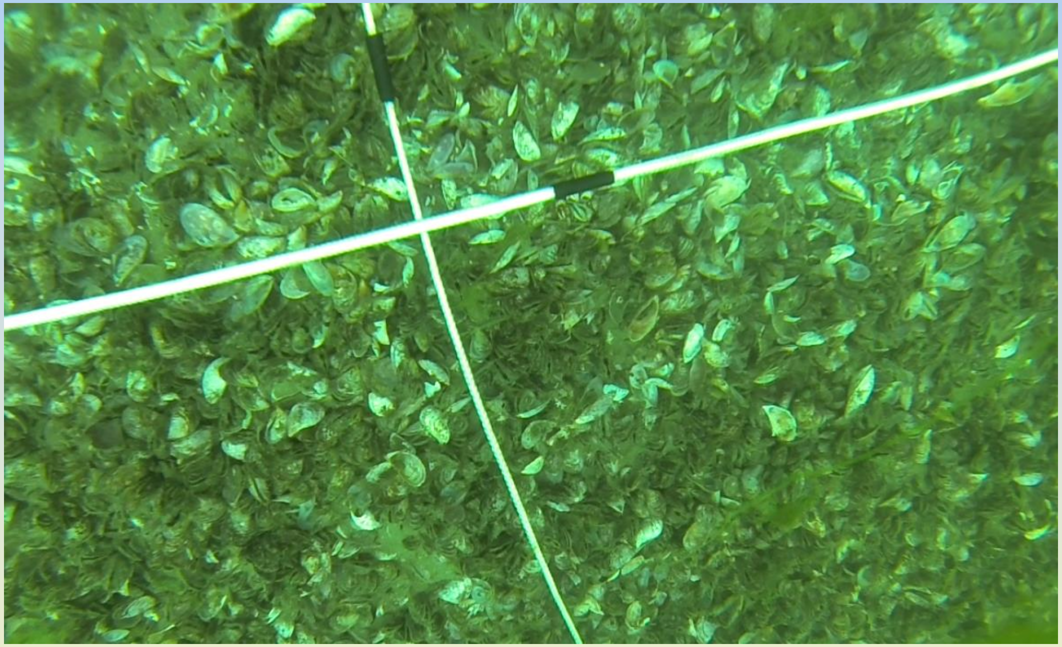
➔ Difficult to take samples with traditional methods due to high variability of substrate and near-bottom flow

➔ Therefore, a combination of remote sensing, traditional sampling and species distribution models may improve the assessment of *Dreissena* distribution in large rivers with coarse substrate

Objective

Assess the feasibility of using remote sensing and species distribution models (SDM) to study *Dreissena* distribution in the lower Niagara River





Question

Which environmental factors are most important according to *Dreissena* distribution in the Niagara River?

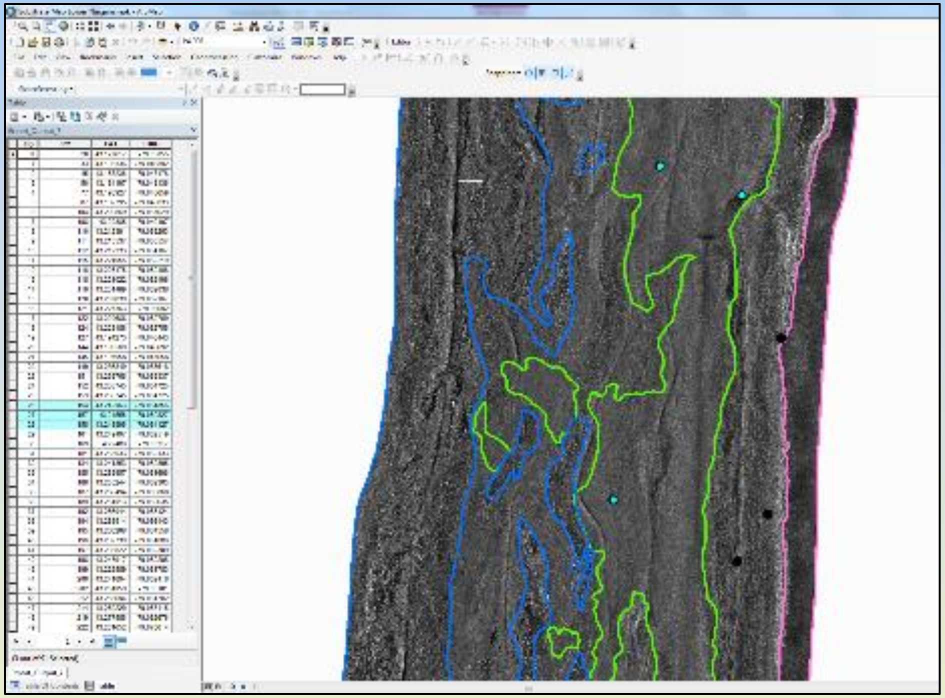
Study Site: Lower Niagara River

- 14 km long
- Width: 500m
- Depth: 10m (26m max)
- Presence of Lake Sturgeon

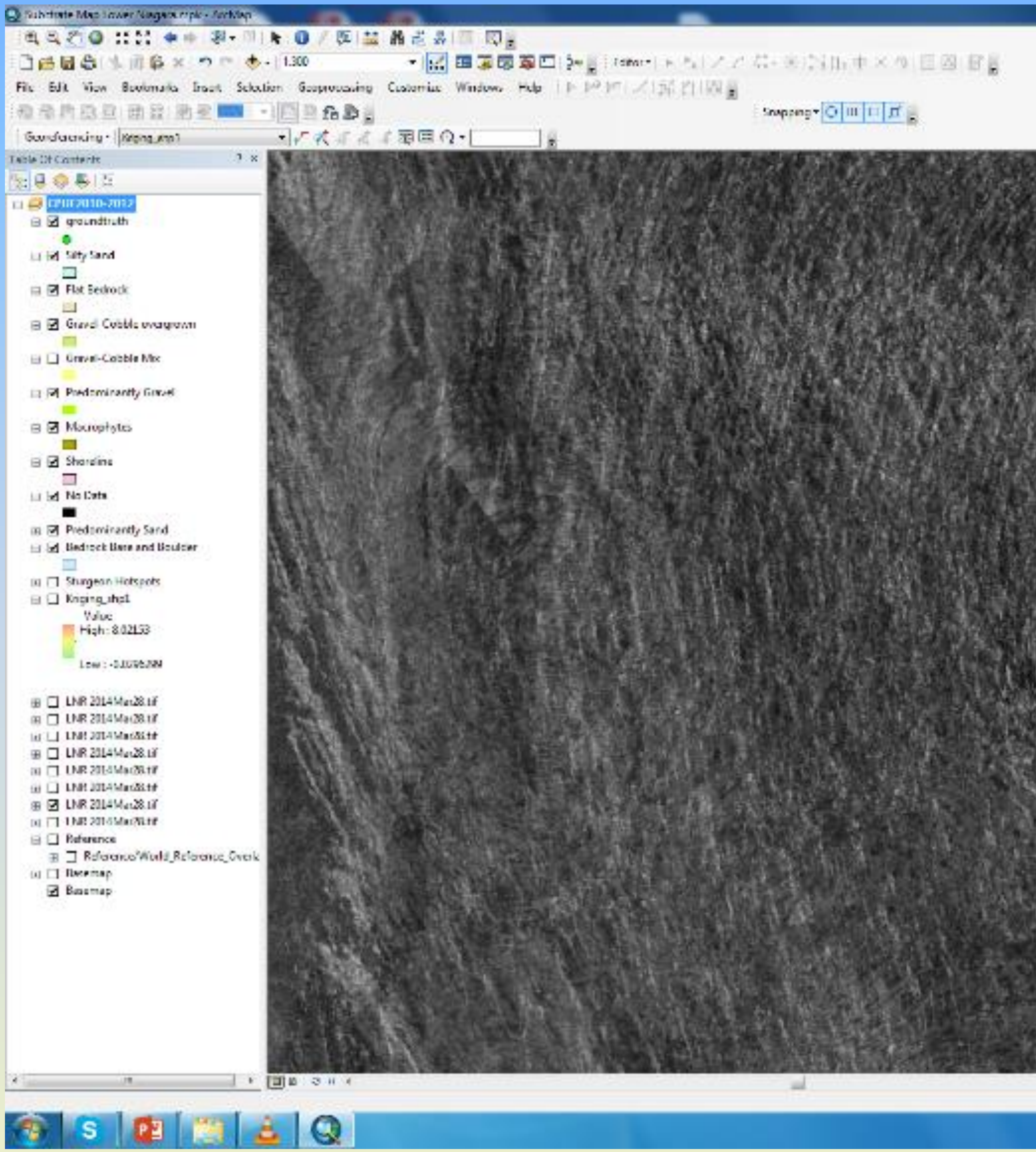
Gathering Physical Habitat Data

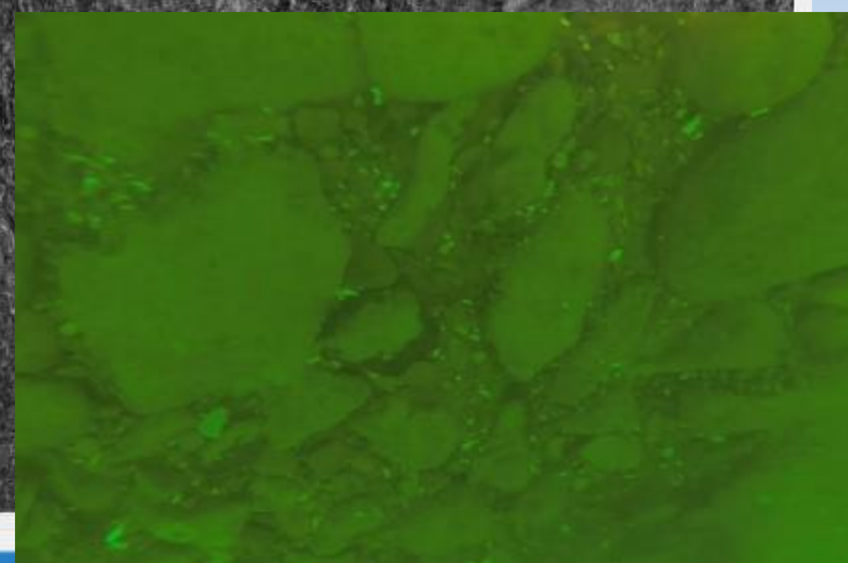
Side scan sonar survey by U.S.FWS

Import data into ArcGIS 10 for digitizing substrate

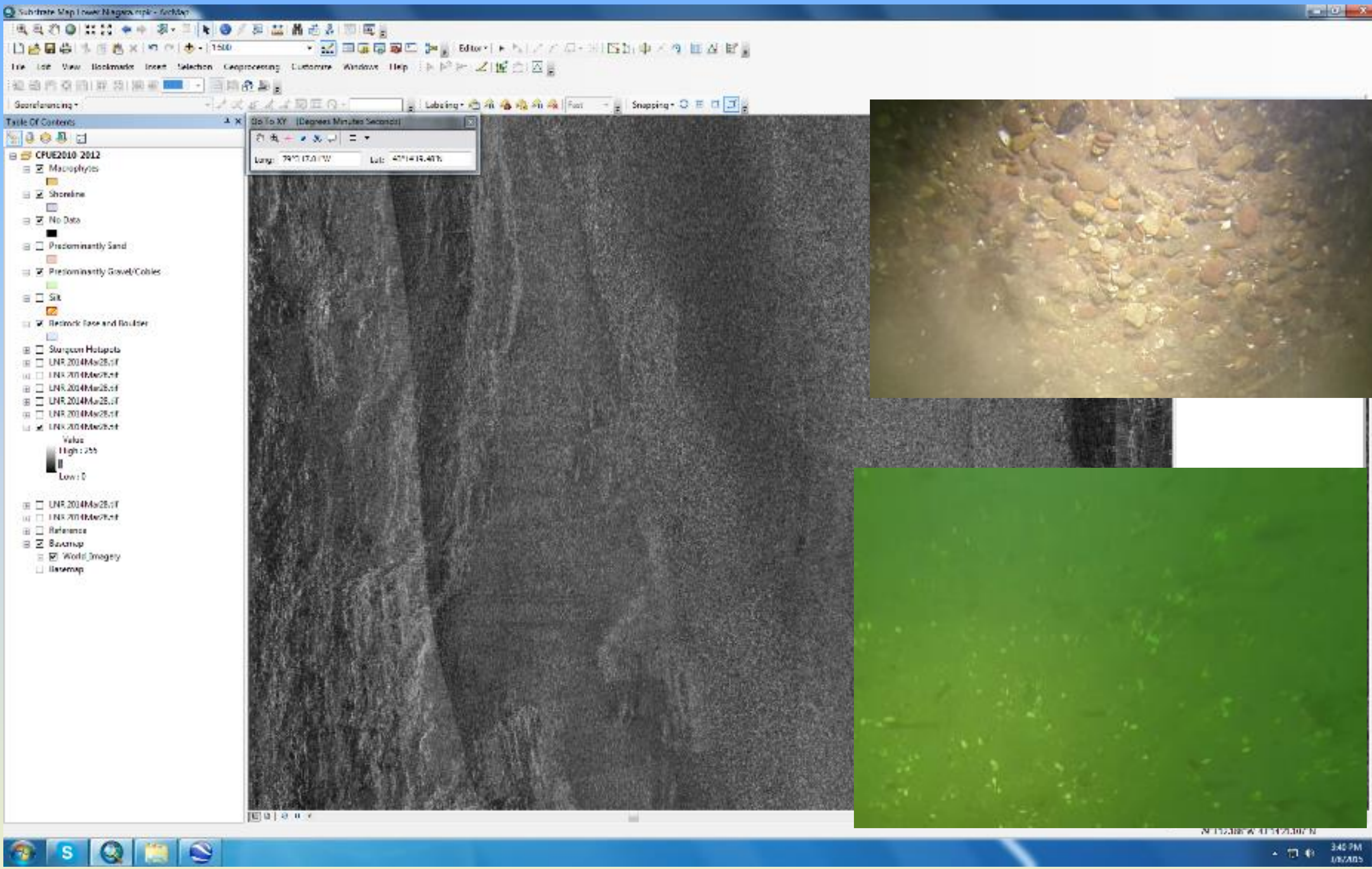


Gravel-Cobble Mixture

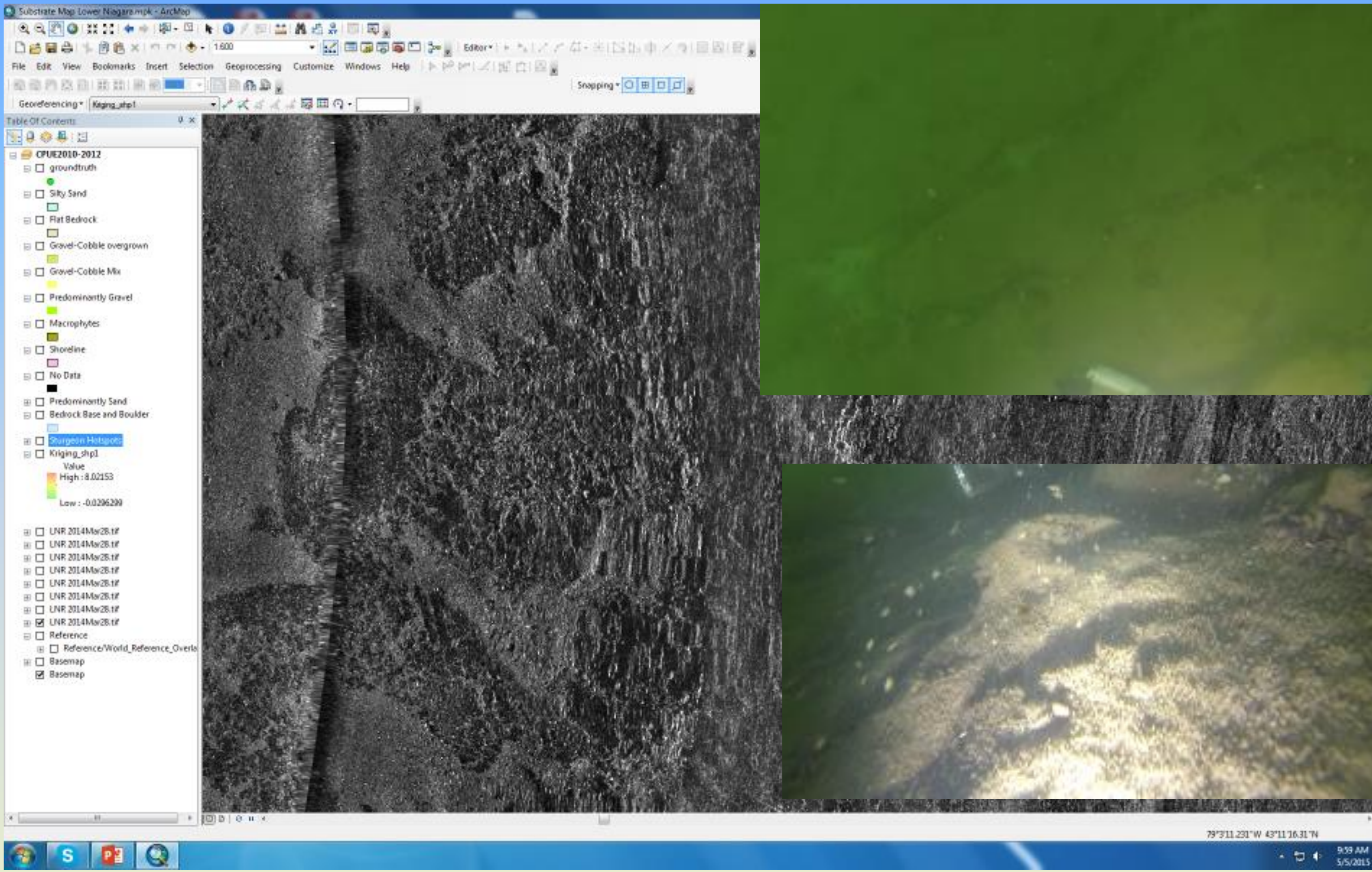




Gravel and Sand



Bedrock


Substrate Map Lower Niagara.mpk - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:600
Editor
Snapping
Georeferencing
Kriging_shp1
Table Of Contents
CPUE2010-2012
groundtruth
Silty Sand
Flat Bedrock
Gravel-Cobble overgrown
Gravel-Cobble Mix
Predominantly Gravel
Macrophytes
Shoreline
No Data
Predominantly Sand
Bedrock Base and Boulder
Sturgeon Hotspots
Kriging_shp1
Value
High : 8.02153
Low : -0.0296299
LNR 2014Mar28.tif
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Reference
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Basemap
Basemap
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9:59 AM
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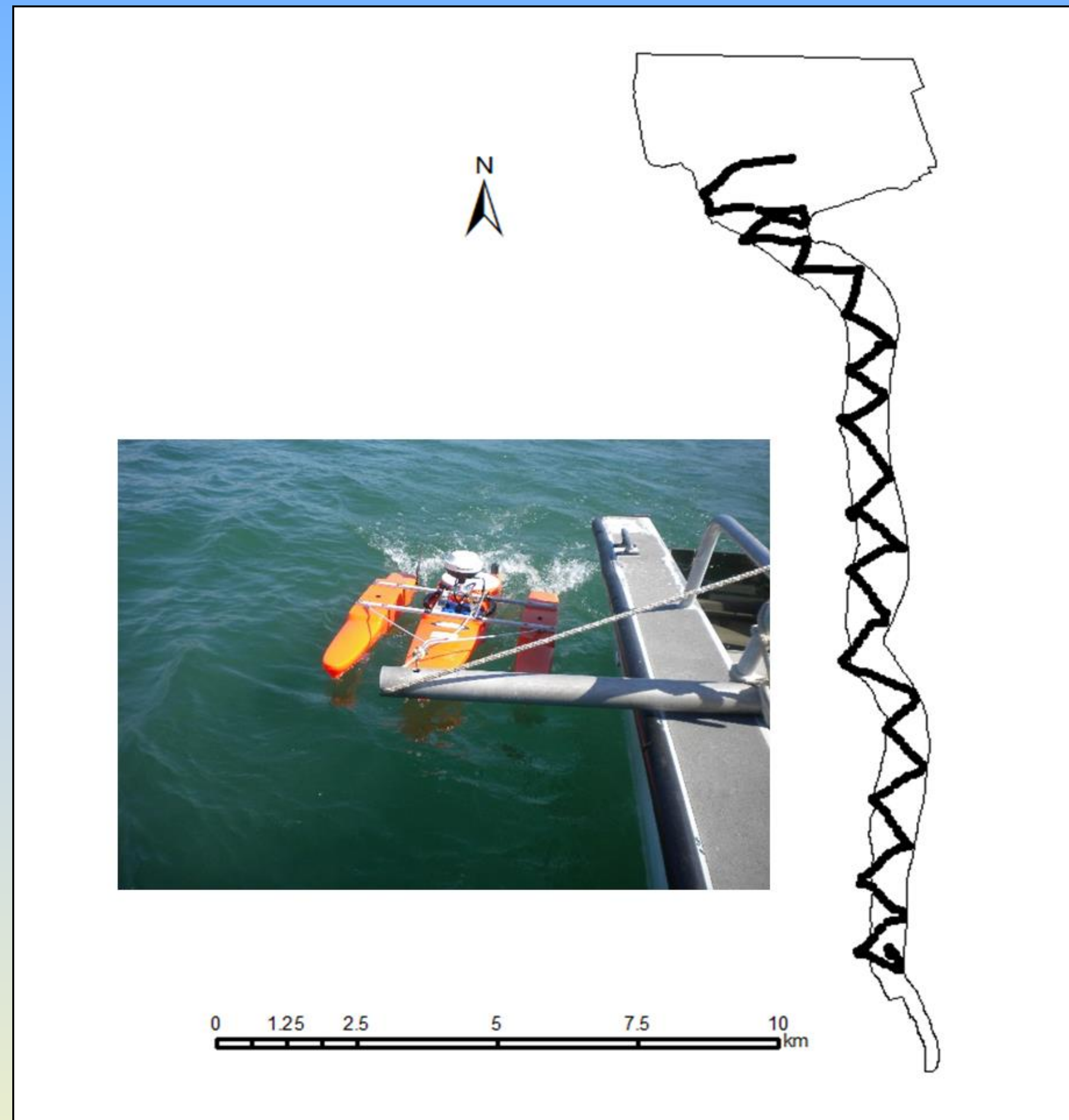
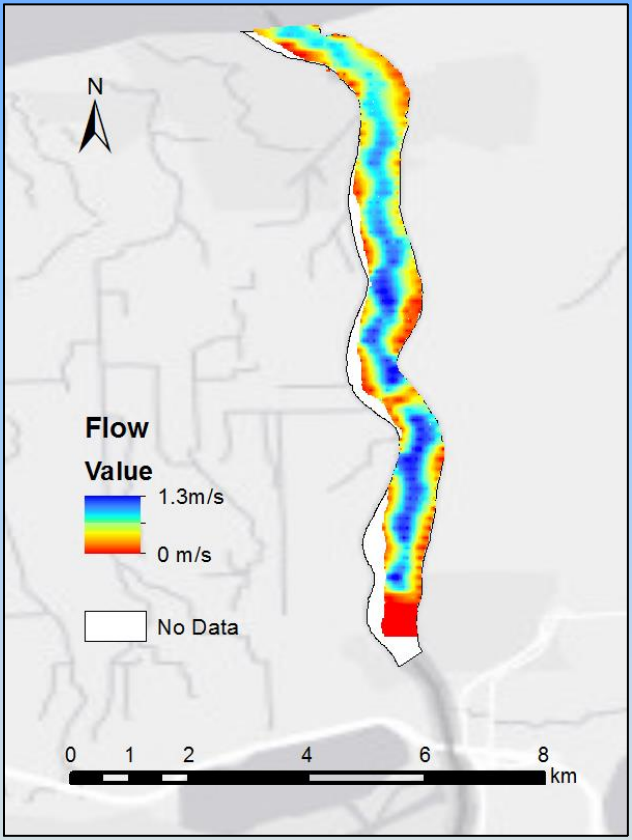
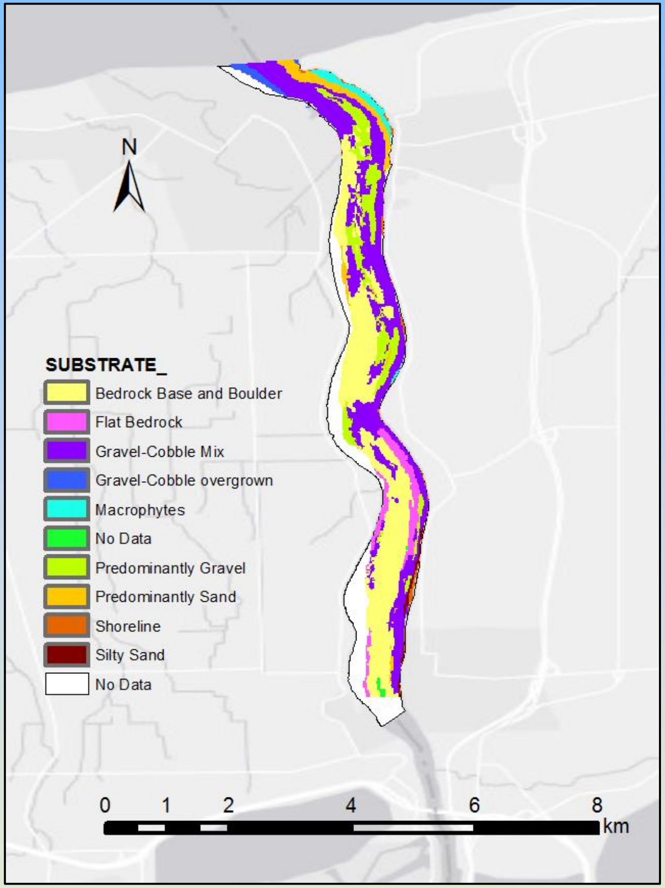
Bottom-Flow and Depth

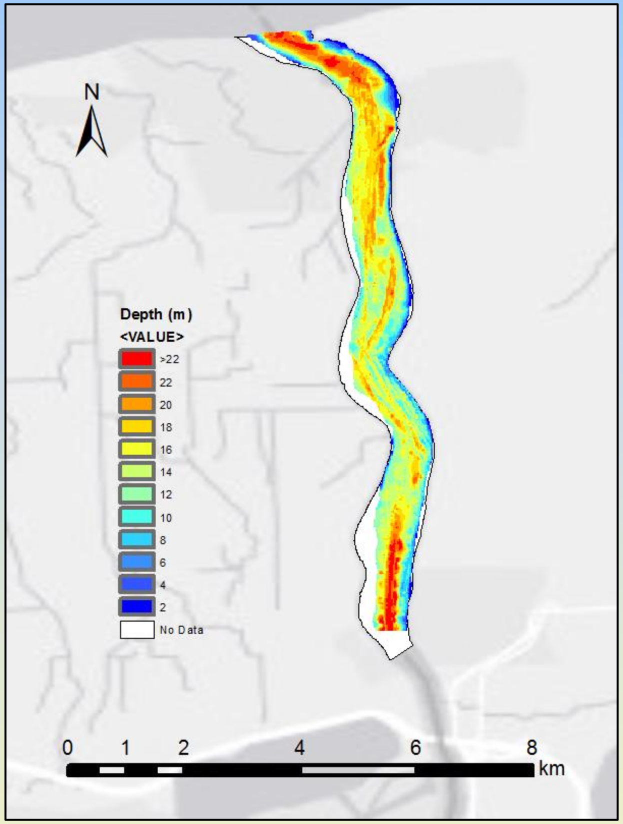


Bottom Flow Velocity (Acoustic Doppler Current Profiler)

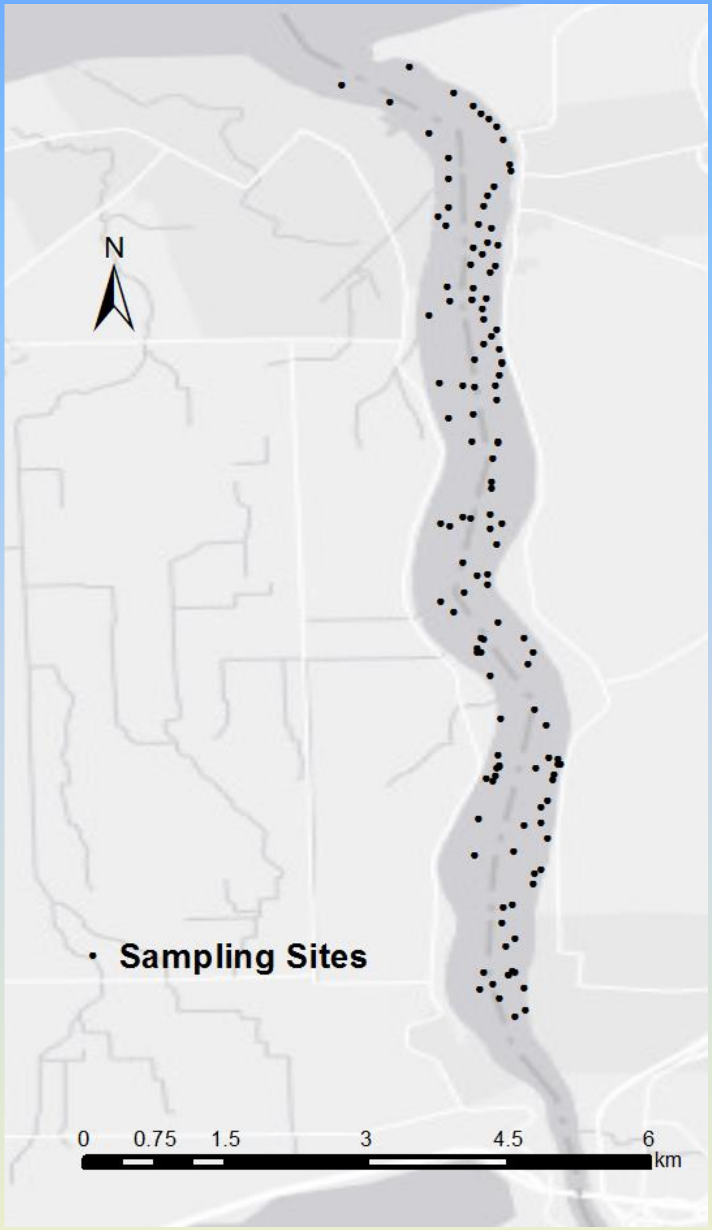
Create Data Layers





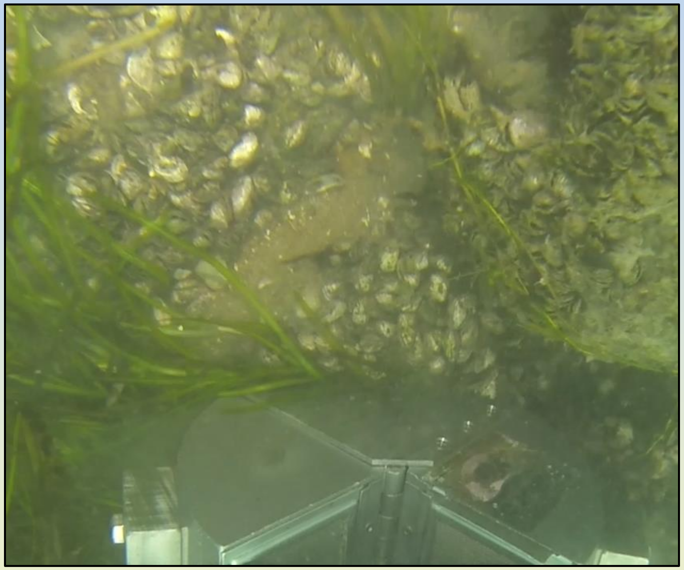


Biological Data



102 sites were surveyed with:

- Ponar grab sampler (soft substrate)
- Underwater video camera and frame (hard substrate)
- Presence data used for model

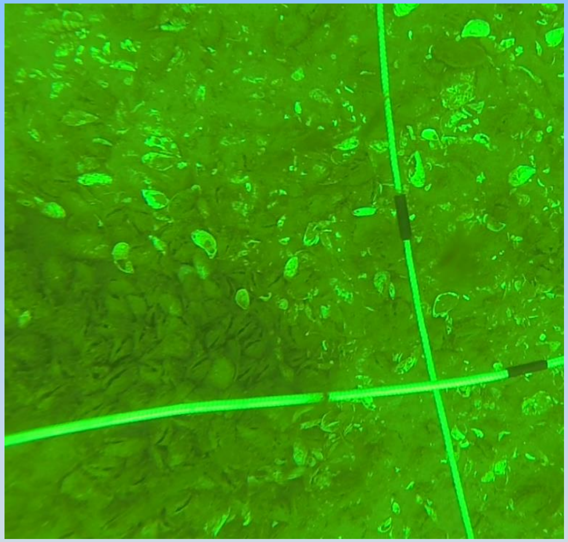


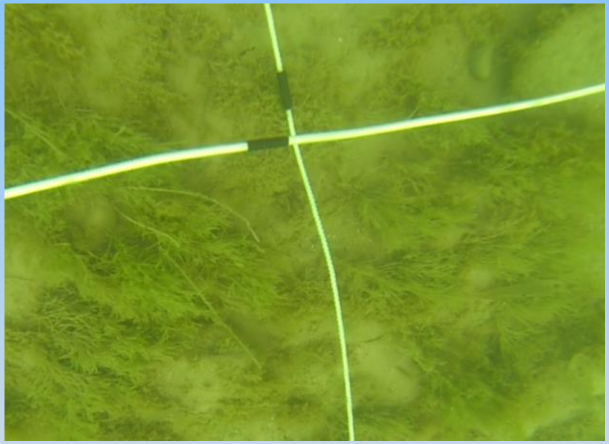
Video Quality Assessment

Excellent

Marginal

Poor





Used in presence/absence analysis

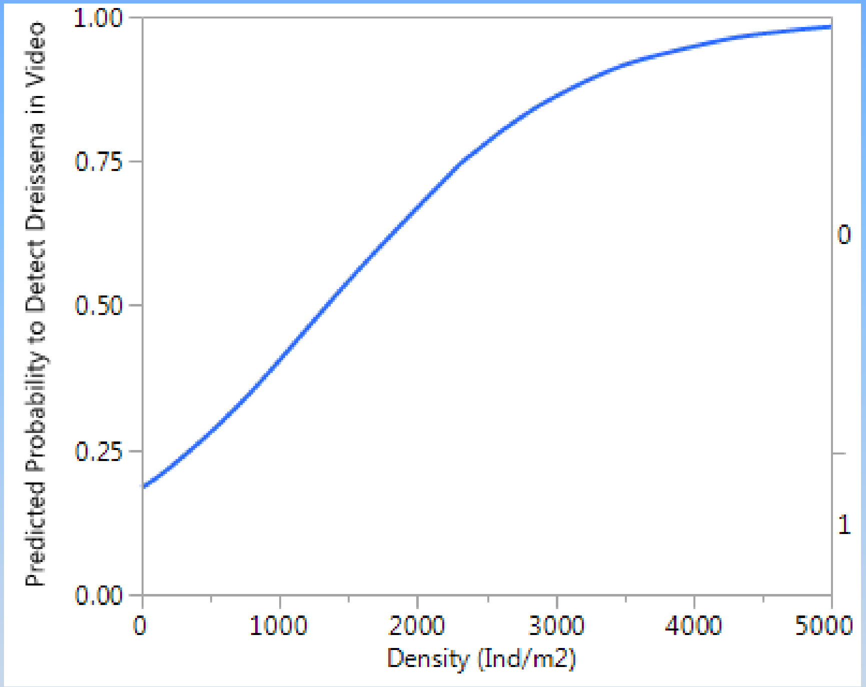
Not used in presence/absence analysis

Underwater Video Detection Ability

- 70% of videos excellent
- 15% marginal
- 15% poor

At 17 sites *Dreissena* were detected in video but not in Ponar (25% of all Ponar samples)

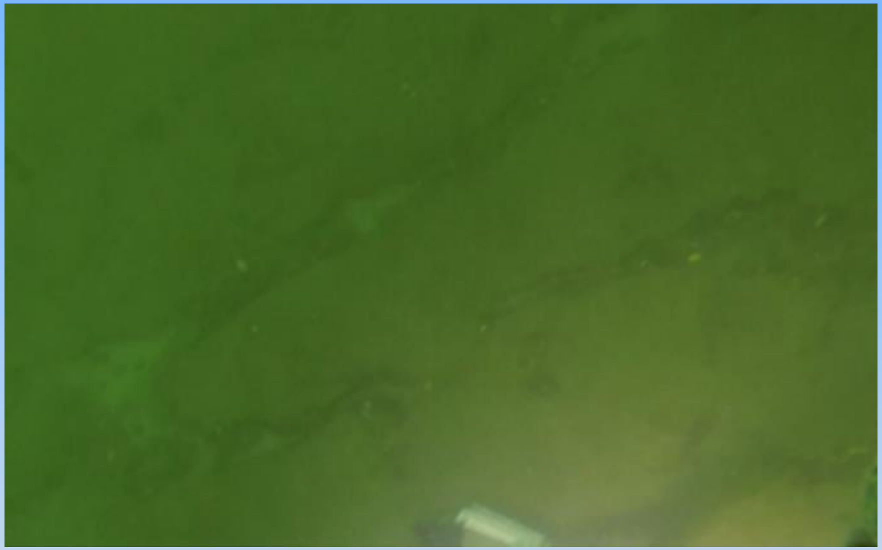
At 6 sites *Dreissena* detected in Ponar but not in video (< 5 Dreissenids in Ponar)

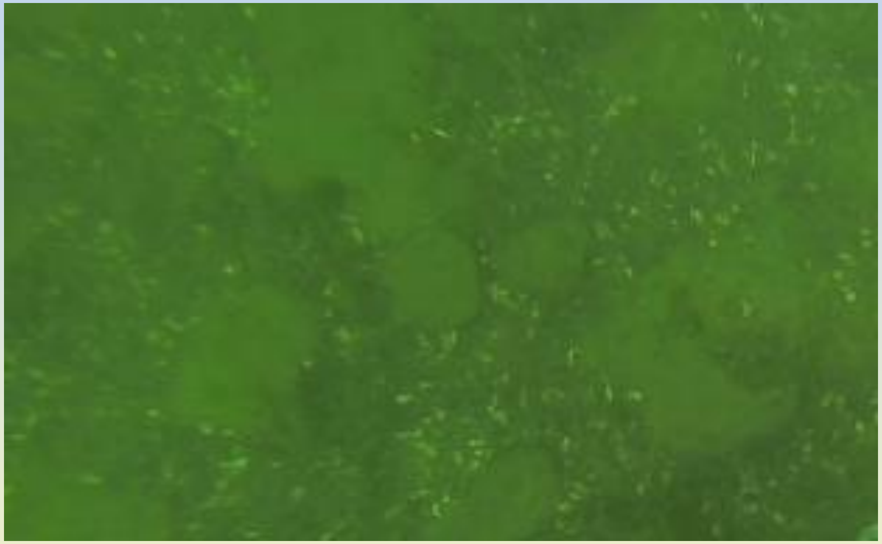


Logistic regression model to test how *Dreissena* detection probability in videos was related to Dreissena density

Dreissena presence based on underwater videos

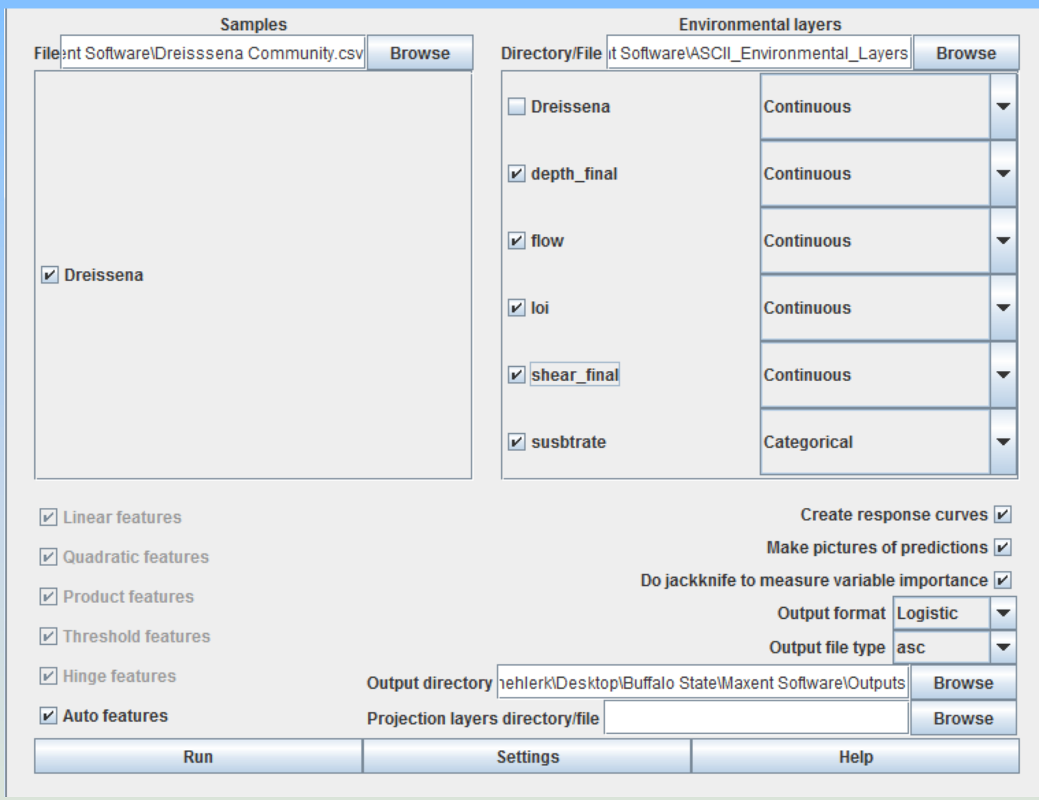
- Depth: 1.5-26m
- Bottom Flow Velocity: 0.1-1.1m/s
- No mussels found in currents < 1.2m/s

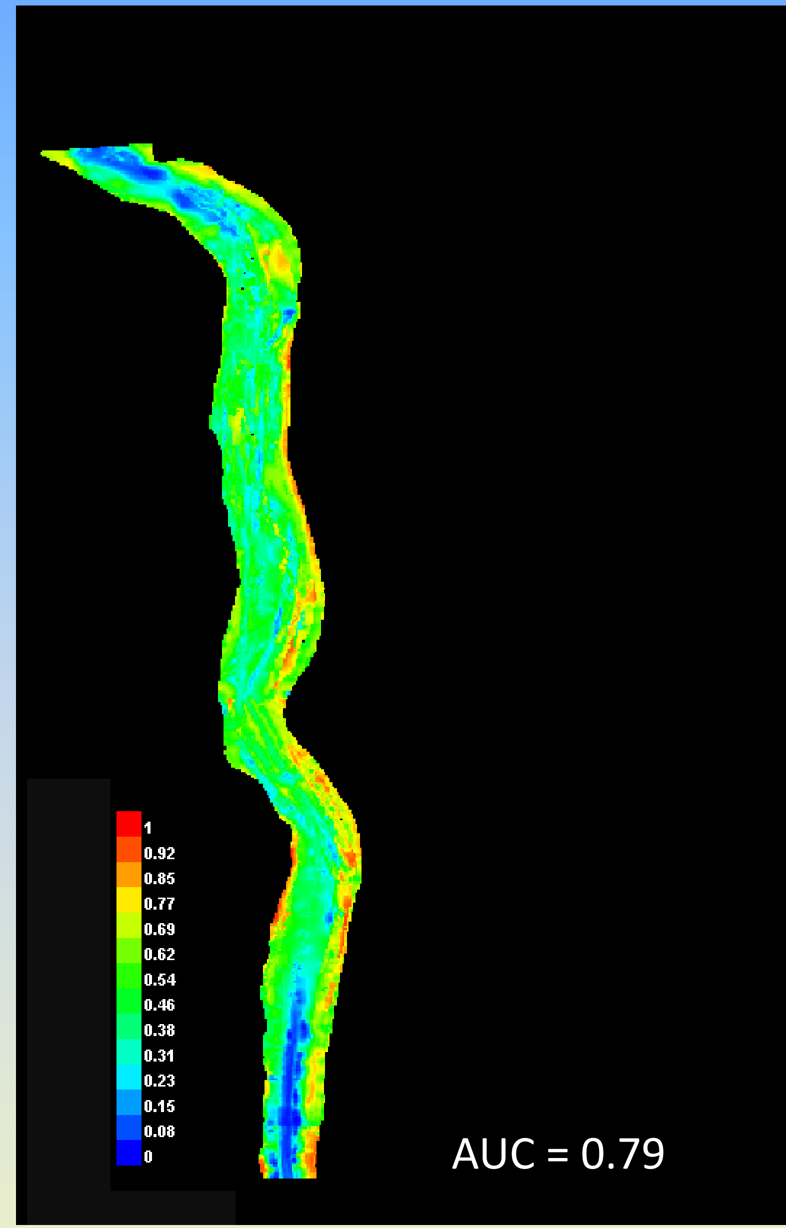




From Point Data to Area

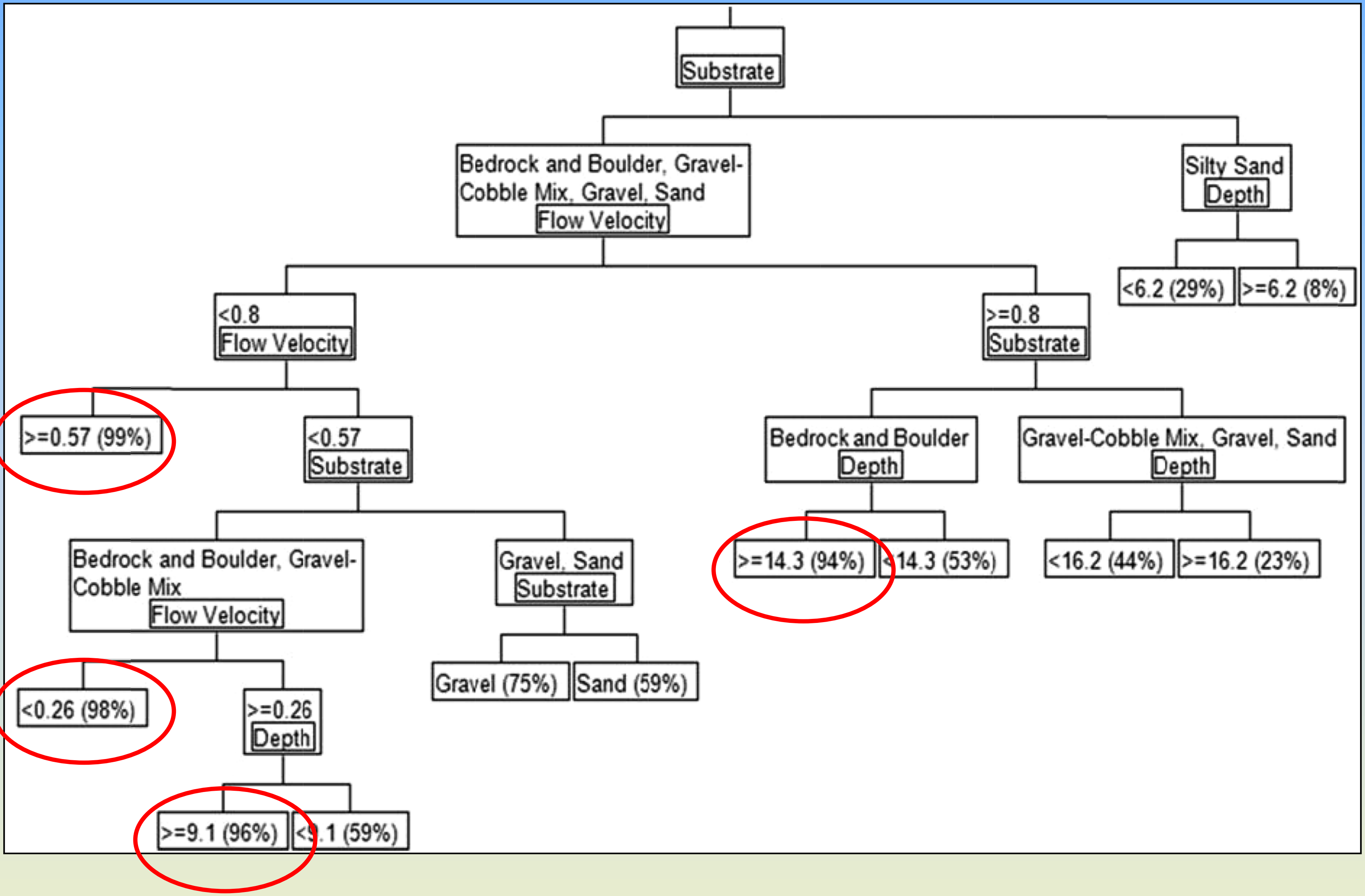
- Maximum Entropy Model





Output: Probability map

Classification Tree



Quality Control

Based on independent data:

In 87 % of high-probability habitat *Dreissena* was found
13 % of high-probability habitat *Dreissena* was absent

- Sediment Movement
- High Spatial Variability
- Higher Predation

Advantages

- Cost and time-efficient
- Large areas can be covered
- Turbid areas can be covered by side scan sonar
- Underwater videos can substantially increase survey area in deep and rocky rivers
- Underwater video can provide information on small scale distribution
- Sampling gear and areas of interest can be chosen before sampling
- Method not restricted to *Dreissena*

Disadvantages

- Side scan sonar rather indirect method
- Video not useable in turbid streams
- No direct density estimates

Conclusions

Remote sensing techniques are useful tools for *Dreissena* distribution assessment in large, rocky, and deep rivers

Remote sensing coupled with SDM can be used for *Dreissena* pre- invasion assessment

Underwater videos and GIS can be used as tools for any river with low turbidity and are not restricted to invasive *Dreissena*

However additional factors such as sediment movement and predation need to be considered

Acknowledgements

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