Using underwater imagery to monitor invasive species in the Great Lakes

Buffalo State
Great Lakes Center
Since 1966

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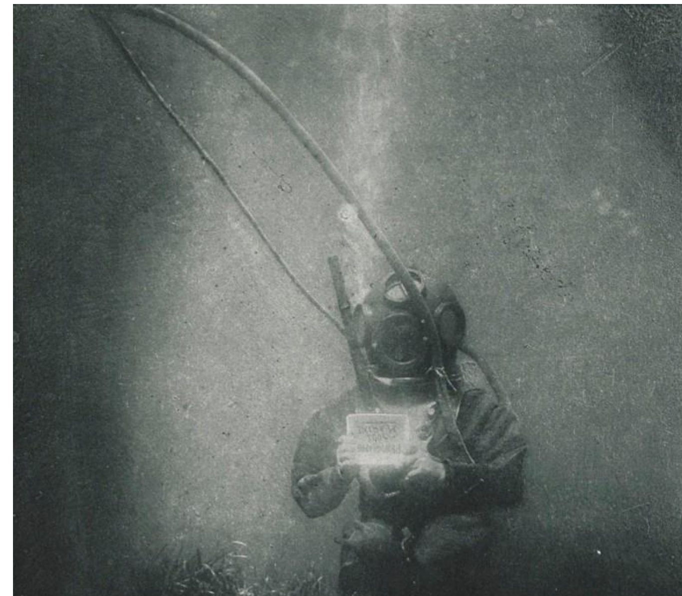
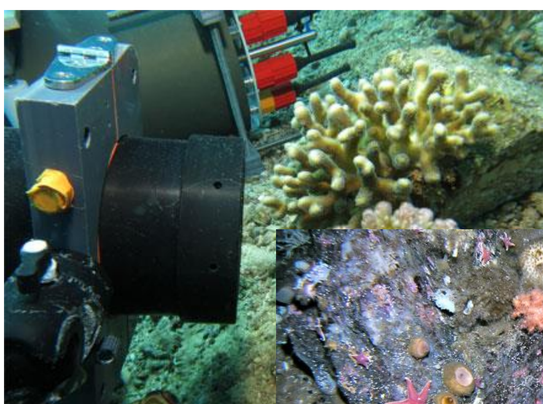
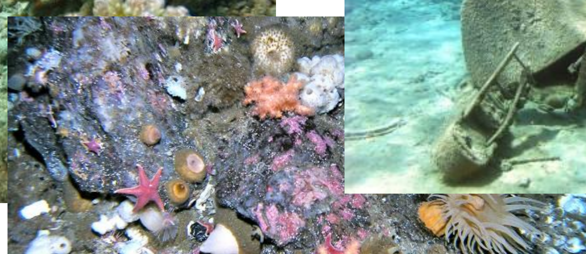
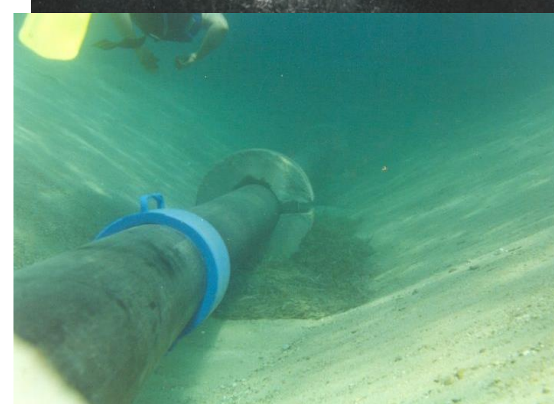
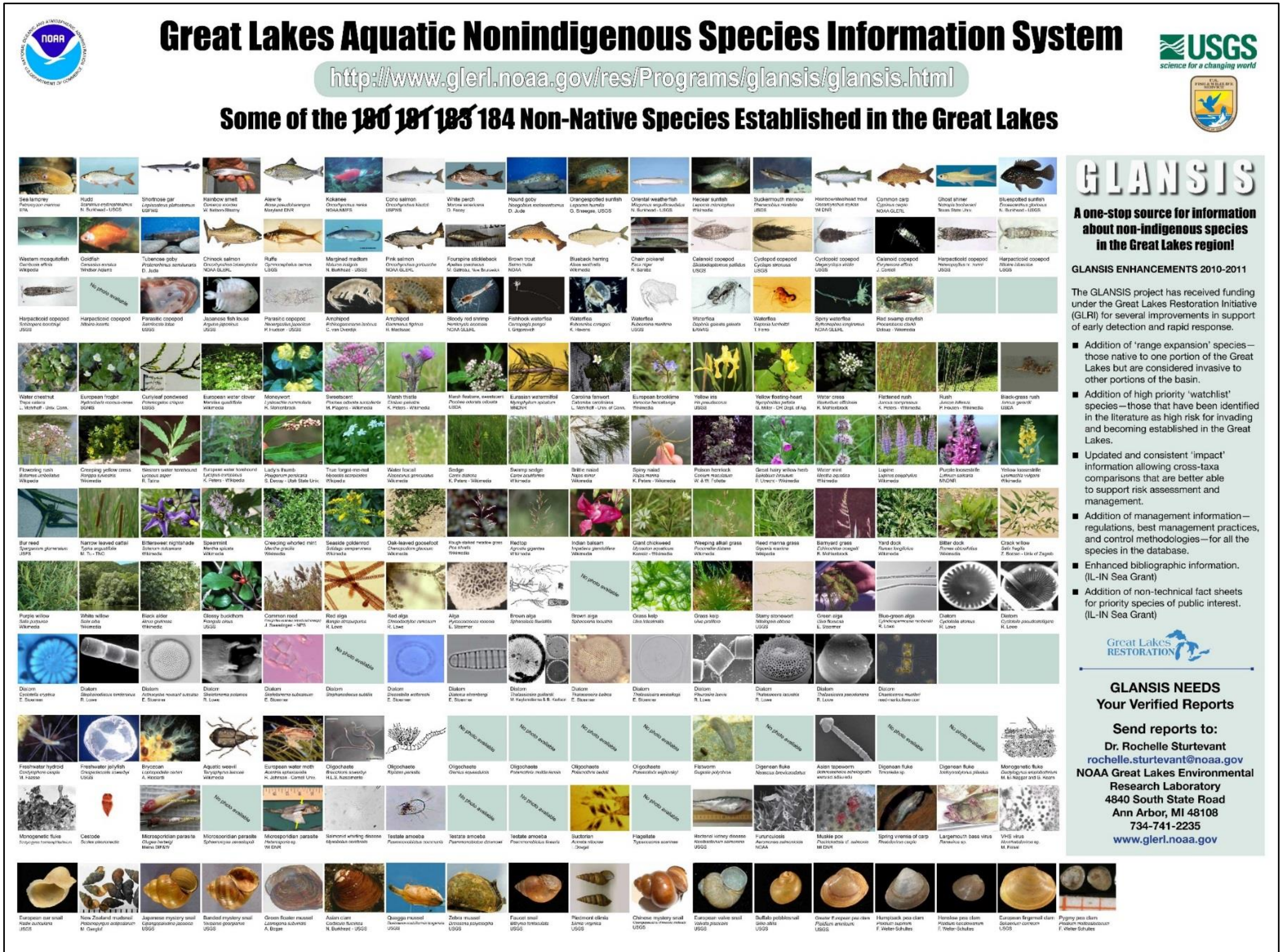
Underwater Imagery?

- non-destructive sampling tool using photos and videos to map the seafloor, quantify benthic resources, document human pressure on benthic habitats
- Drop down cameras, towed systems, or ROV's
- Underwater imagery isn't really a new tool
- Boost in mid 1950 due to development of sophisticated and affordable camera systems
- Nowadays Underwater Imagery has become a common tool in freshwater and marine ecology, underwater archeology and engineering



The Great Lakes are one of the most heavily invaded aquatic systems in the world!



One of the most aggressive invasive invaders in the Great Lakes: *Dreissena* spp.

- Appeared in the Great Lakes in 1986 (ZM) and 1989 (QM)
- High fecundity, planktonic larvae, attached benthic adult stage
- Tremendous impacts on aquatic ecosystems
- Highly efficient filter feeders ➔ Increase in water clarity
- Outcompete native mussels and other benthic invertebrates
- Powerful ecosystem engineers
- Causes $ 1 billion/year in damage to water infrastructure, industries, and tourism
- Have infested all lakes but Lake Superior

Dreissena impacts depends on:

- population size
- population dynamics
- distribution within a waterbody

In order to accurately predict *Dreissena* ecological impacts we need to know:

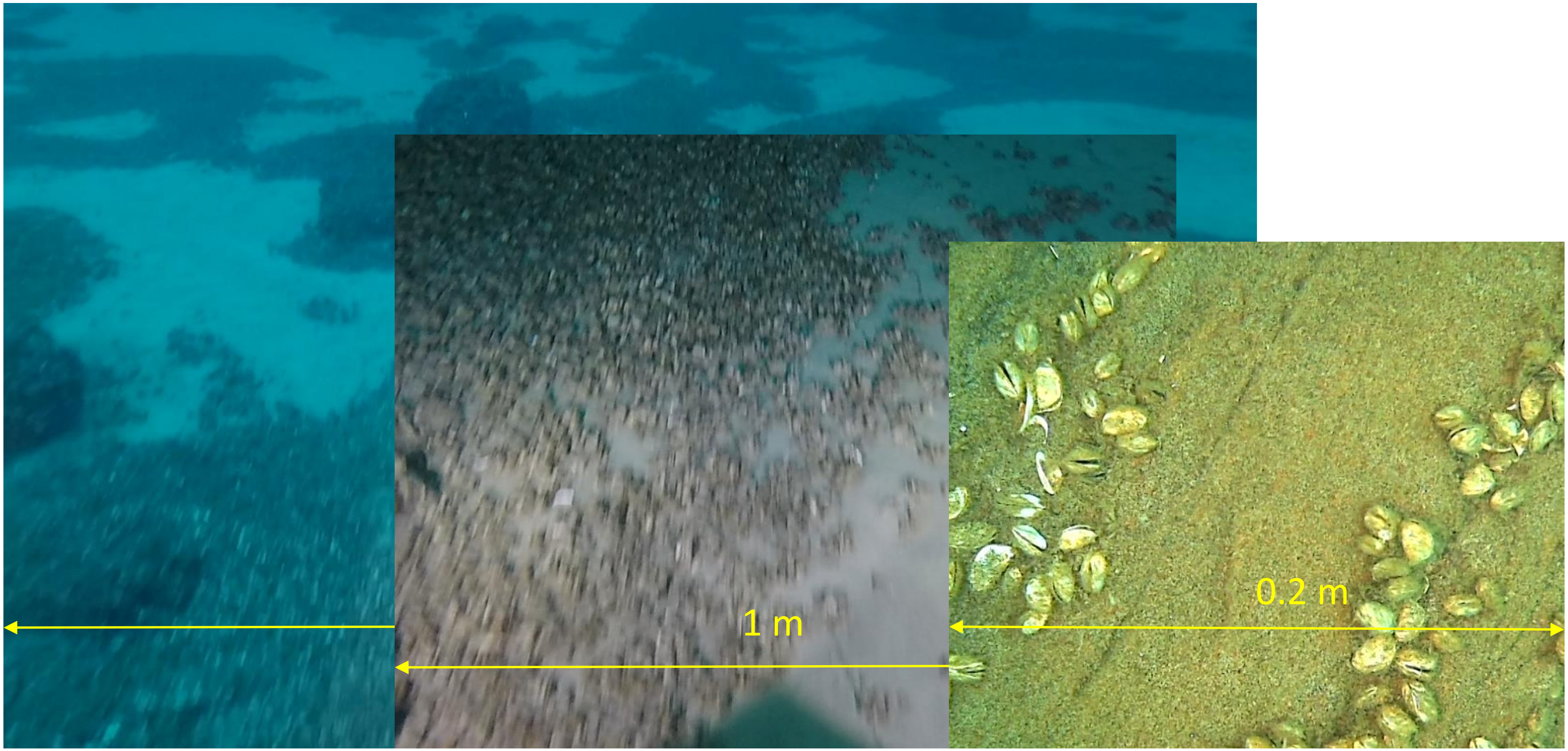
- How many of them are there?
- How they are distributed
- Is the population increasing or decreasing?

Great Lakes CSMI and LT-Monitoring

- Assessment of lake-wide water quality and food web components
- Long-term monitoring: 57 permanent benthic sampling stations in all 5 lakes sampled once a year
- Cooperative Science and Monitoring Initiative (CSMI): 60-100 benthic stations in each lake
- Triplicate sampling at each station using Ponar
- Determine density, biomass of macro-benthic species
- *Dreissena* monitoring

The world is patchy!

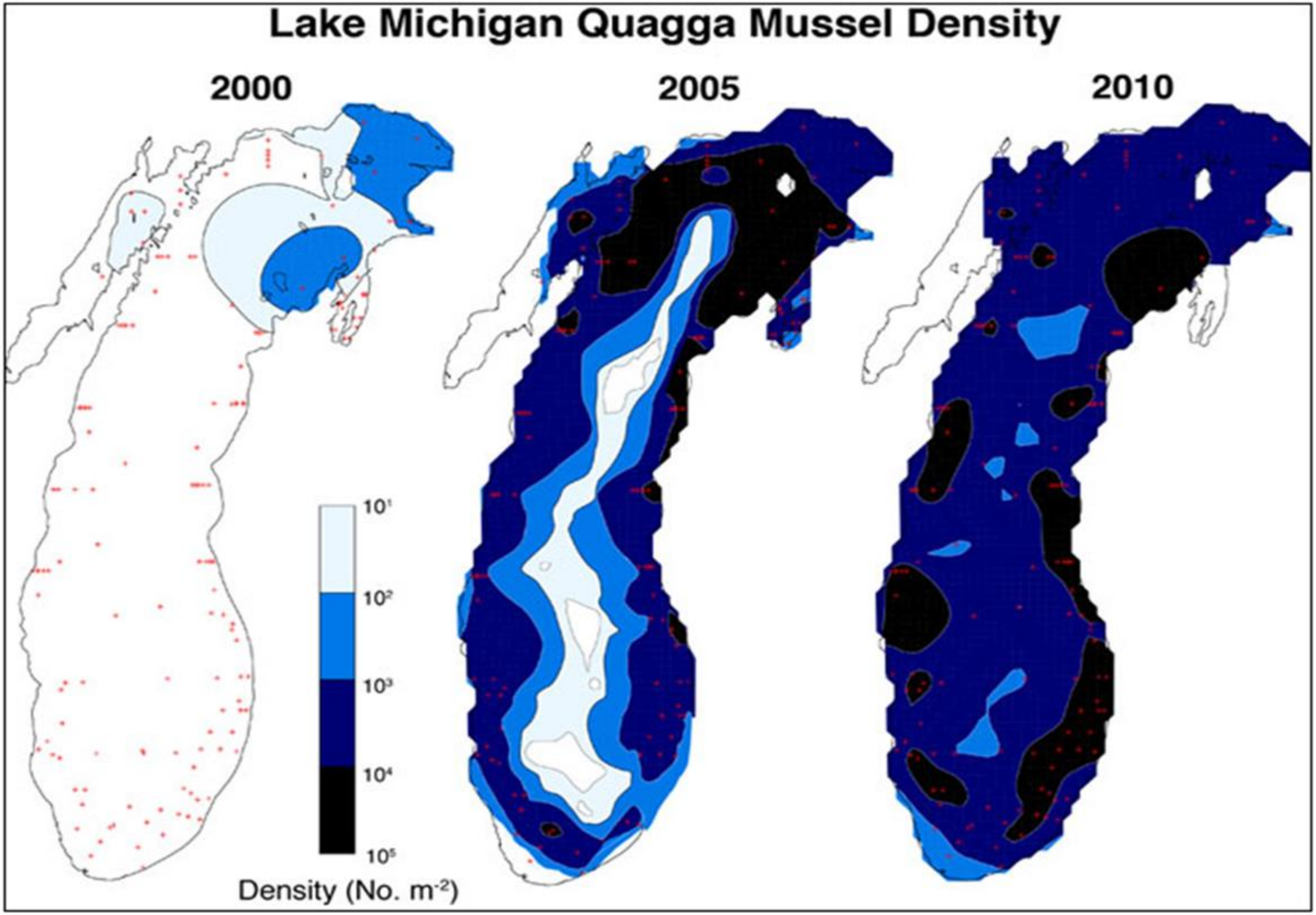
Dreissena distribution varies widely at all spatial scales



➔ To understand large scale distribution and estimate population size with a greater confidence combine traditional sampling with underwater imagery

Just take an old snow mobile!!!

Lake Michigan 2015 CSMI



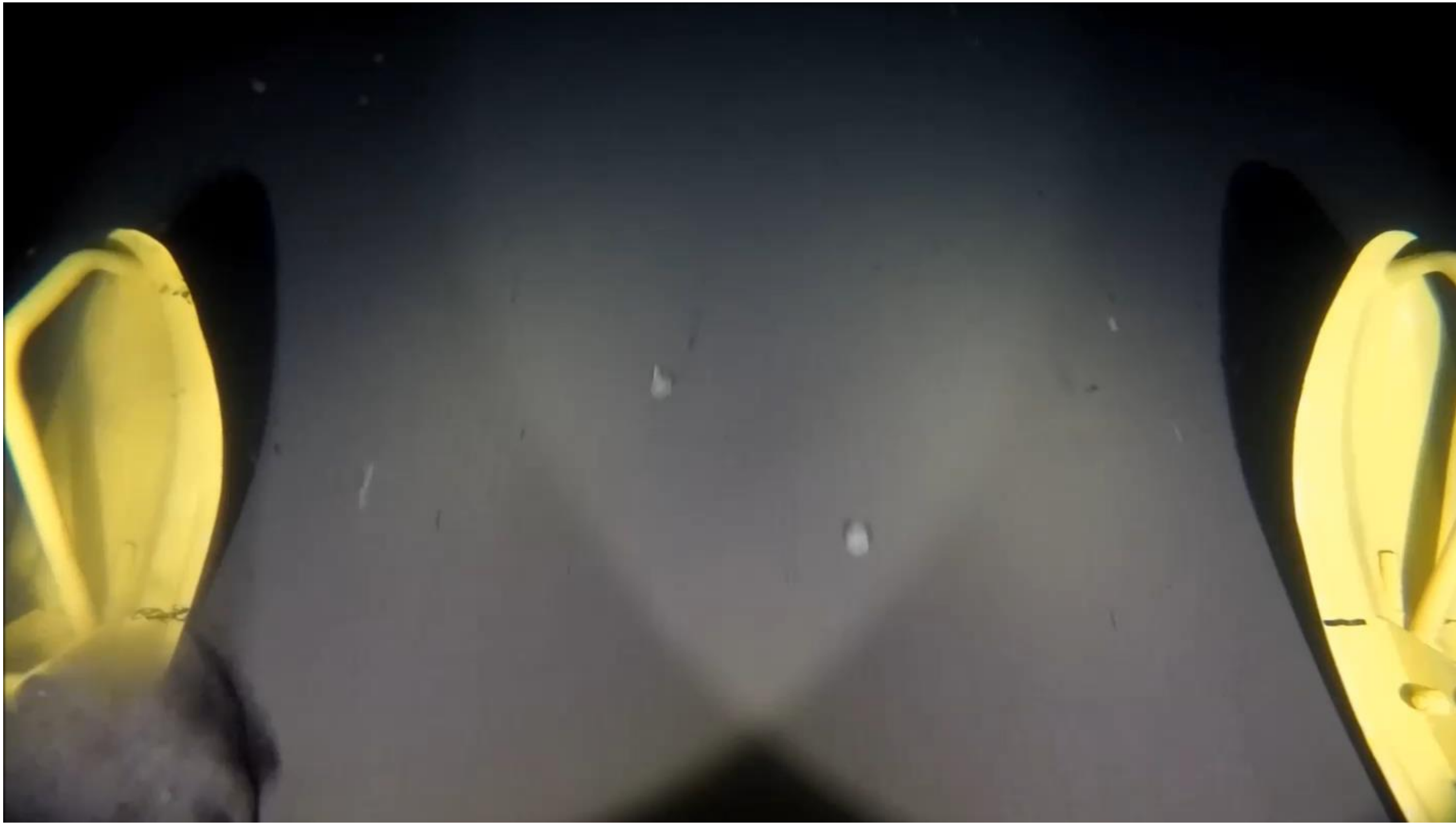
Source: Tom Nalepa, National Oceanic and Atmospheric Administration (NOAA)

Shallow Sites (30 m)

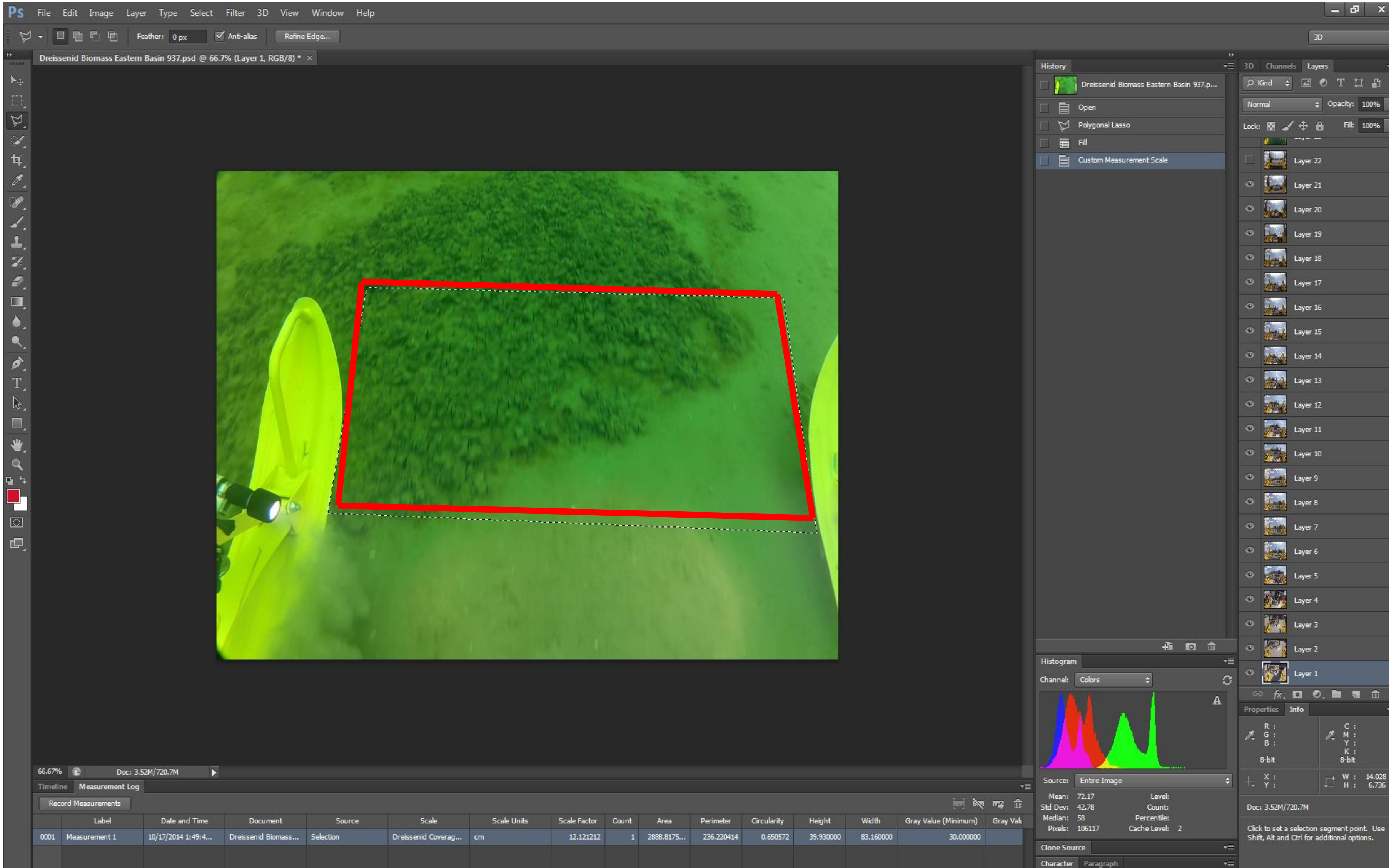
Shallow Sites (30 m)

Intermediate Depths (80m)

Deep Sites (> 100 m)

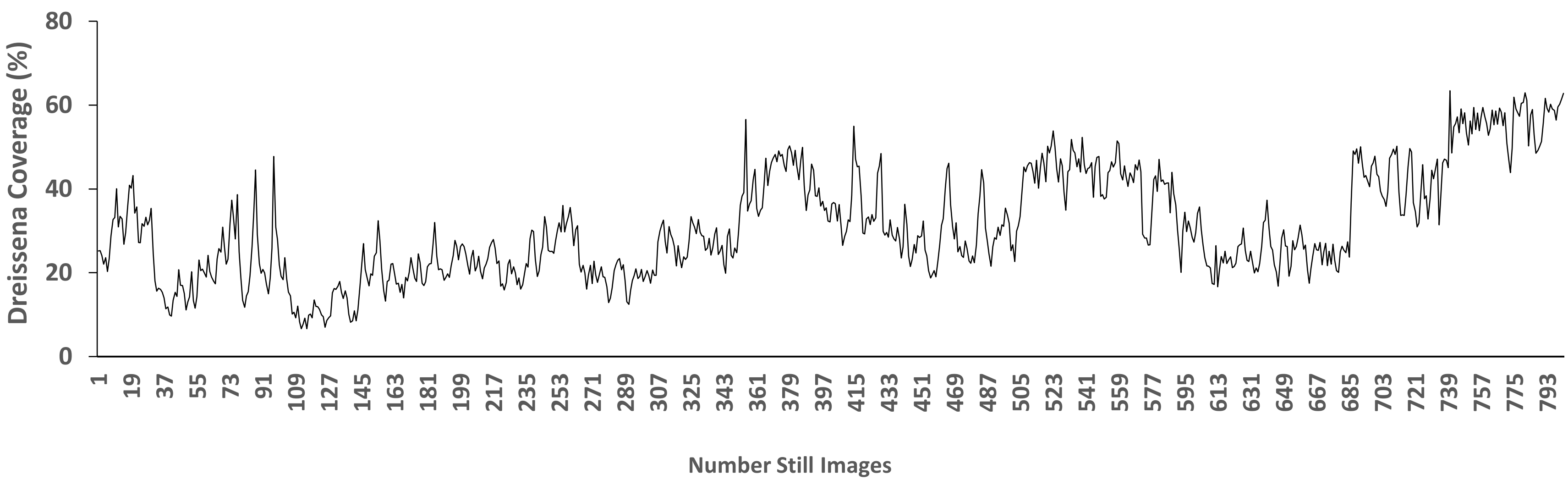


Estimating *Dreissena* coverage from a sled tow

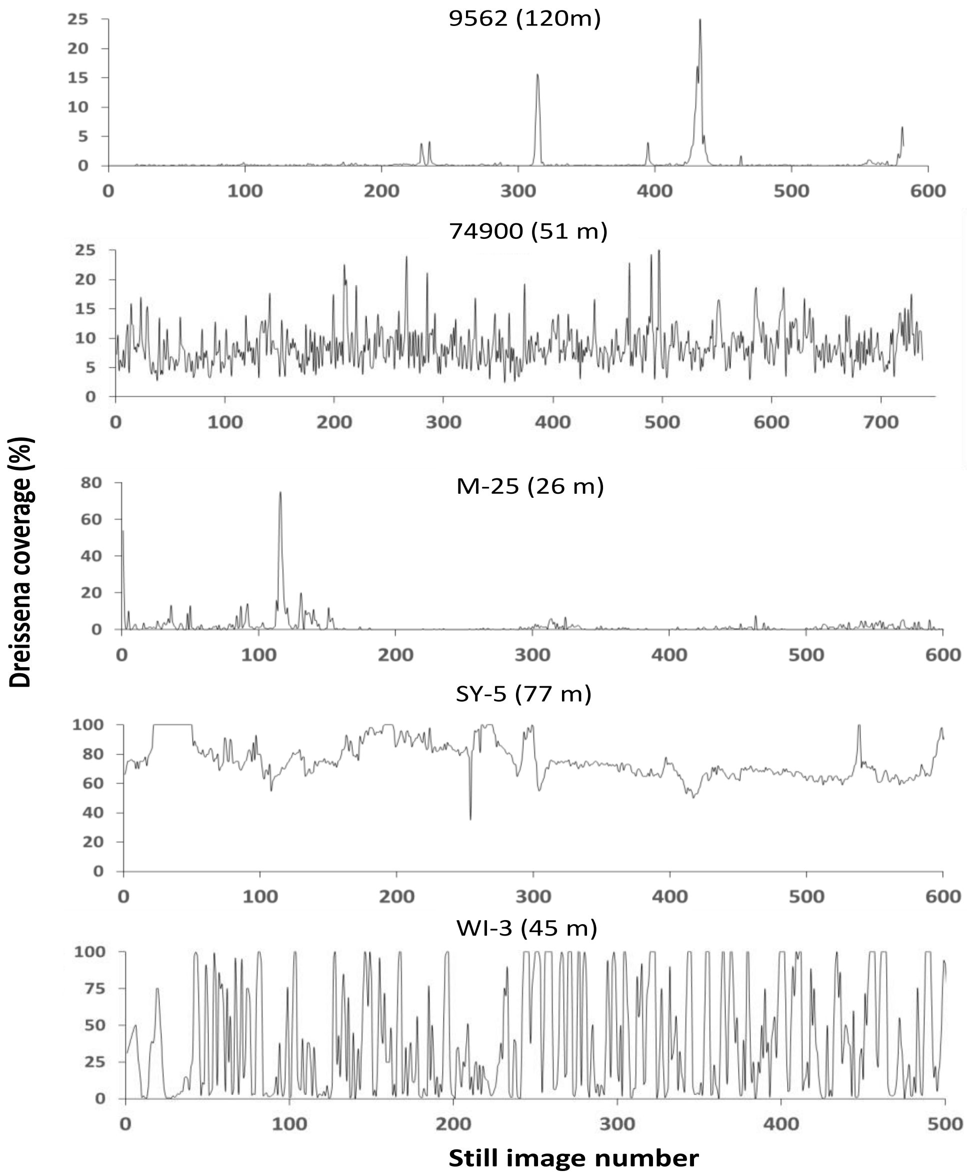


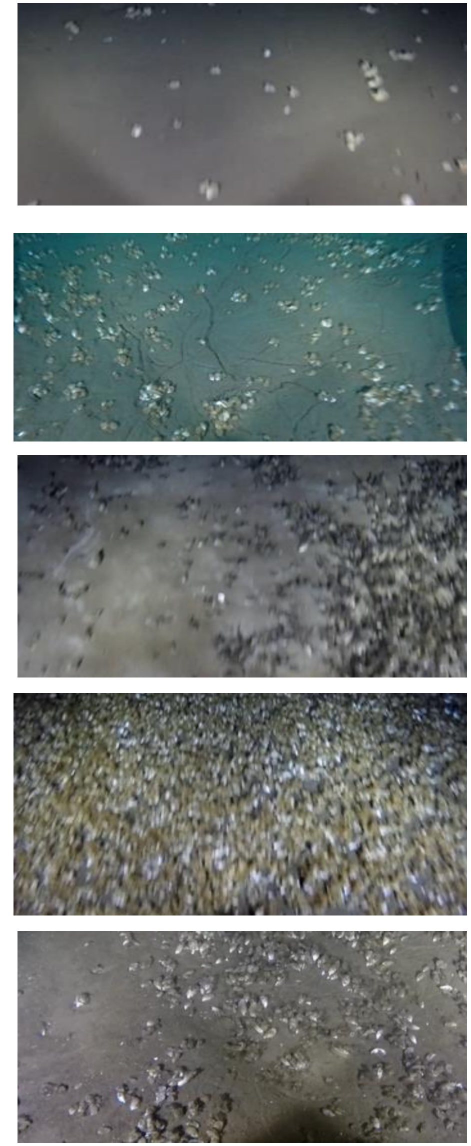
Original still image

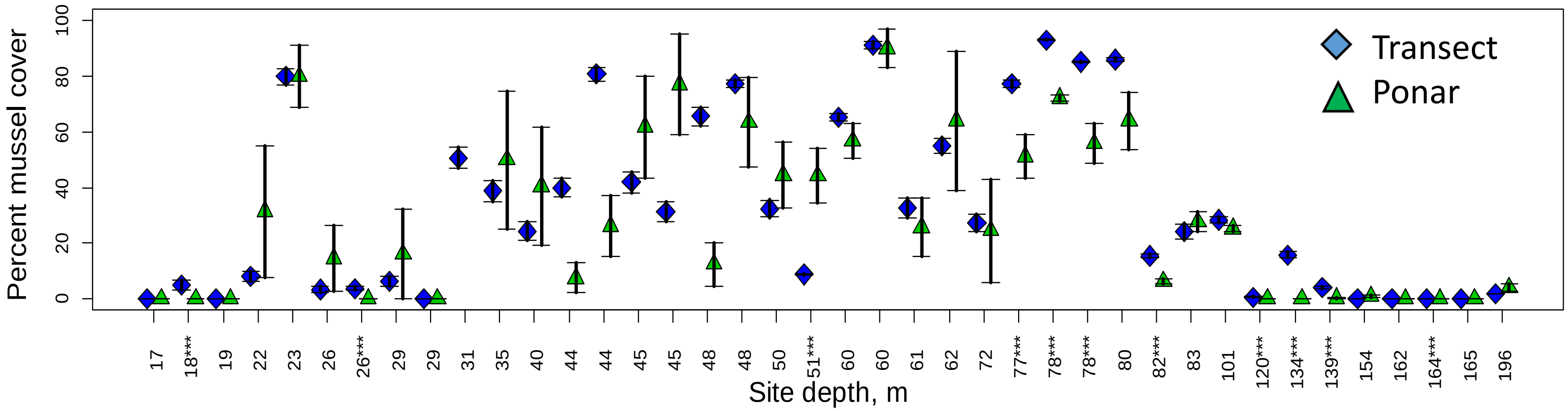
Dreissena coverage (%)



Variation in *Dreissena* coverage at different depths

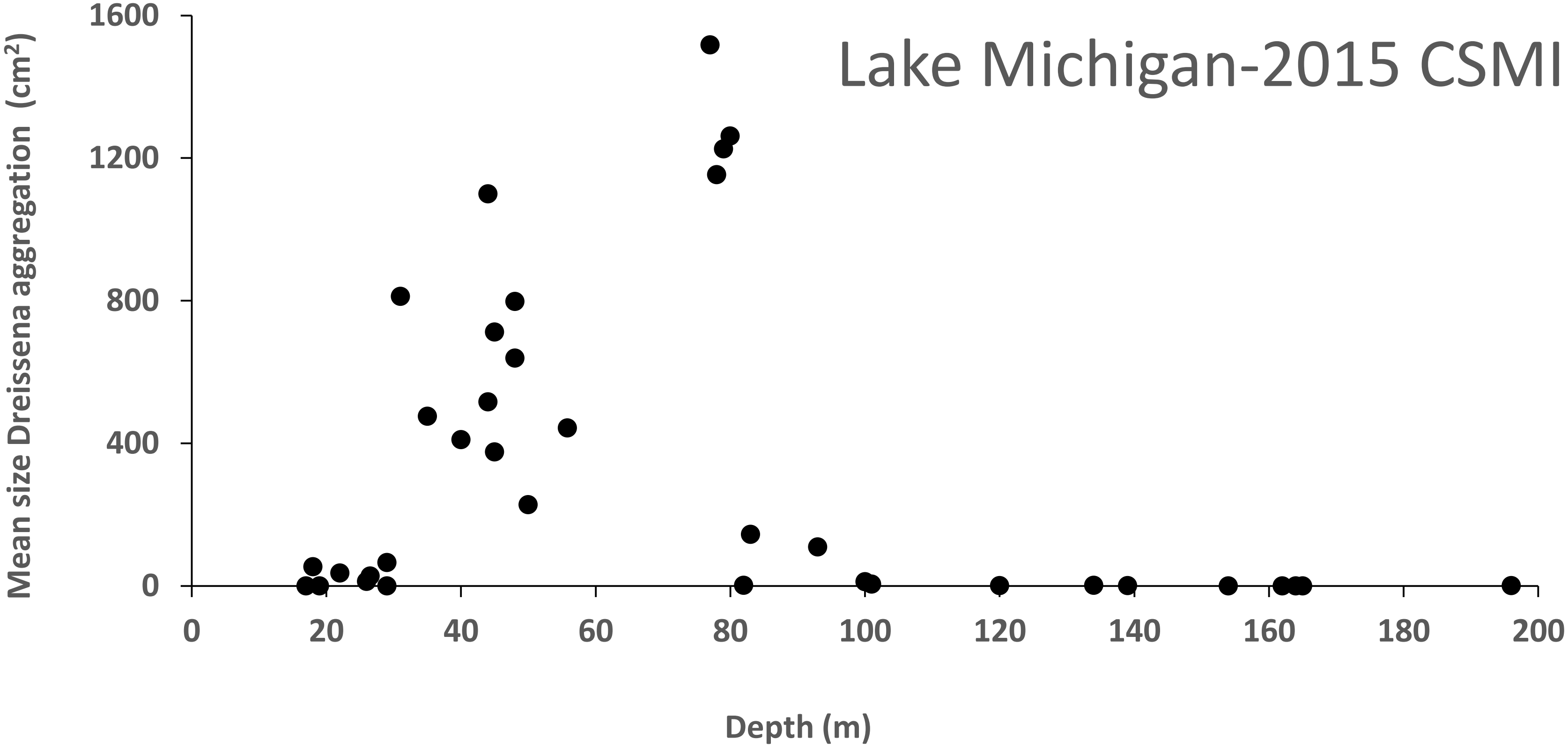






- In shallow areas (<50 m) extreme patchiness of *Dreissena* likely due to large scale environmental factors (e.g. substrate, hydrology, etc.)
- At intermediate depths (50 – 110 m) virtually all bottom is often covered with *Dreissena* (homogeneous substrate, no wave action)
- At depths >110 m *Dreissena* forms very small druses evenly distributed on the bottom (intraspecific competition for food?)

What's next?



Lake Michigan-2015 CSMI
Mean size Dreissena aggregation (cm²)
1600
1200
800
400
0
0
20
40
60
80
100
120
140
160
180
200
Depth (m)

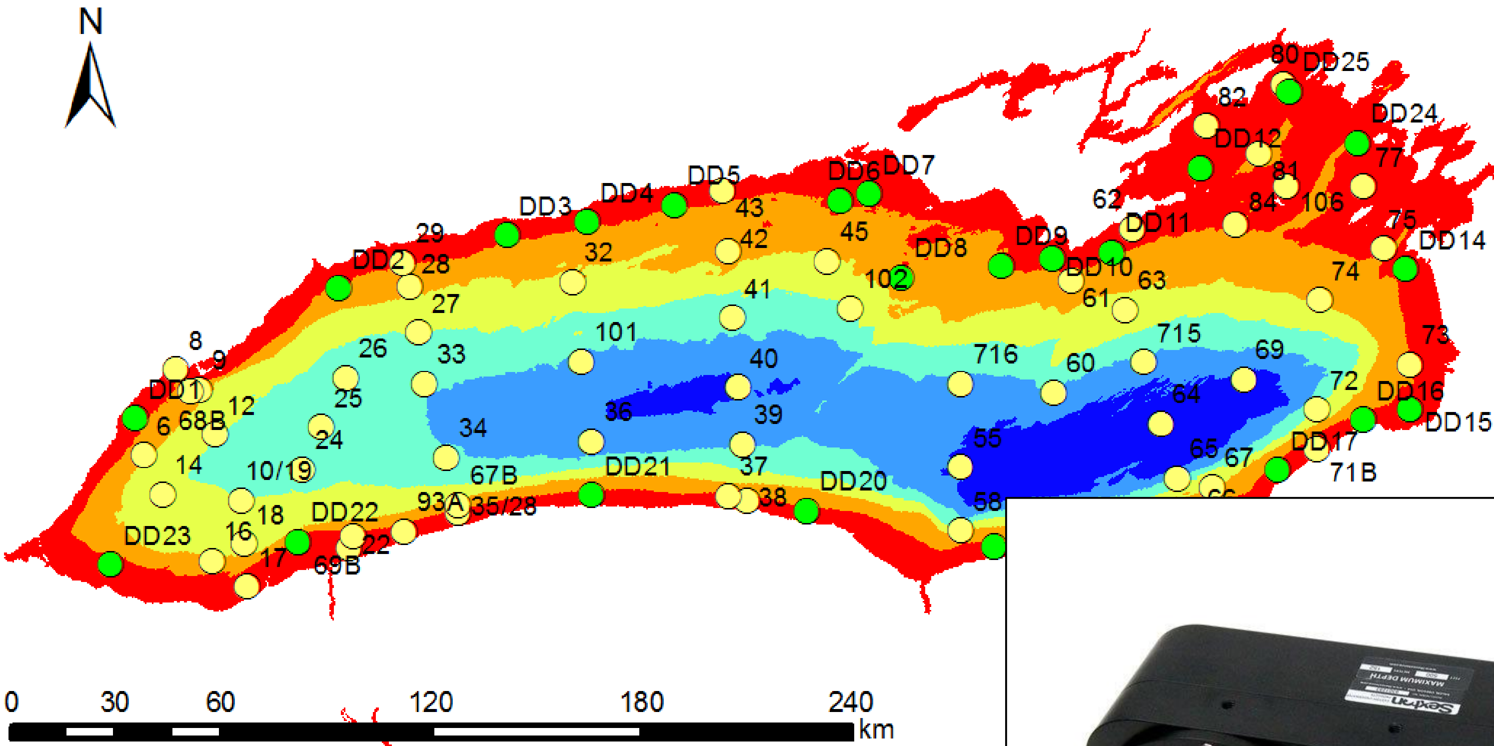
Conclusions

- *Dreissena* is the only freshwater invertebrate that, due to their large body size and high density, can be detected using remote sensing, allowing for rapid collection and processing of information

- Underwater video is a very efficient tool and a great supplement to traditional sampling for monitoring *Dreissena* distribution, coverage, and biomass in Great Lakes

- Underwater video could also be used to estimate macrophytes coverage (e.g., algae), benthic fish and other benthos

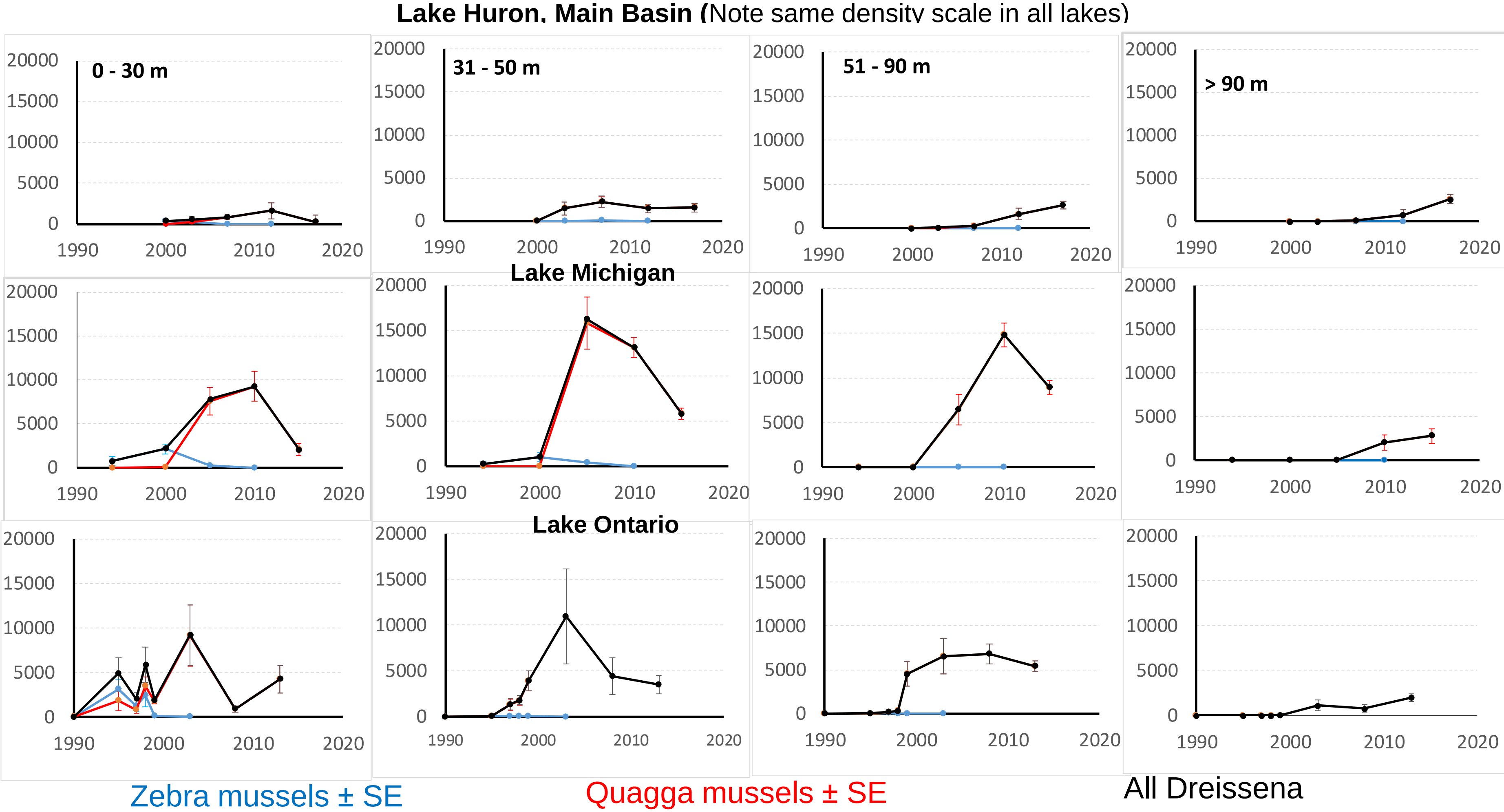
2018 CSMI Lake Ontario



Acknowledgments

- EPA and USGS for funding the project
- Buffalo State employees and students for their help in collecting and processing samples
- Our special thanks to *Lake Guardian'* Captain and crew

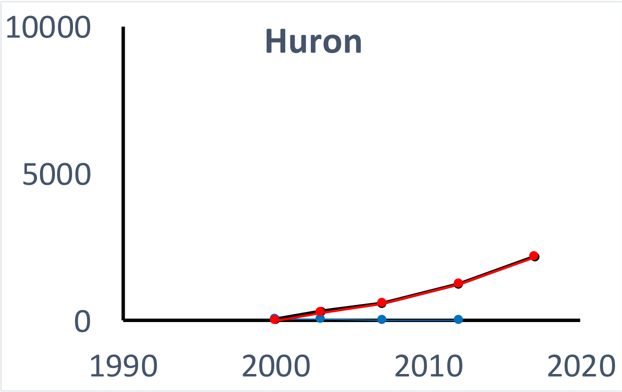
Dreissena Population dynamics

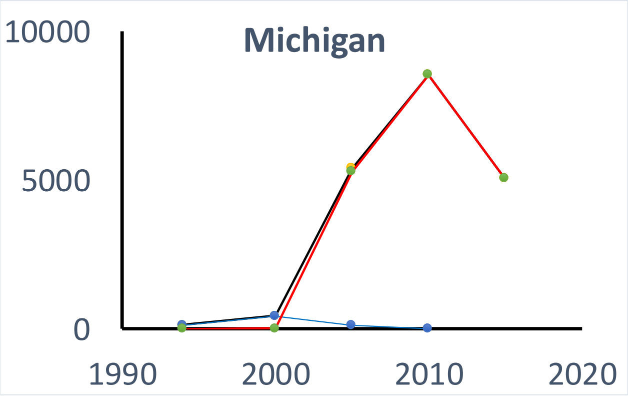


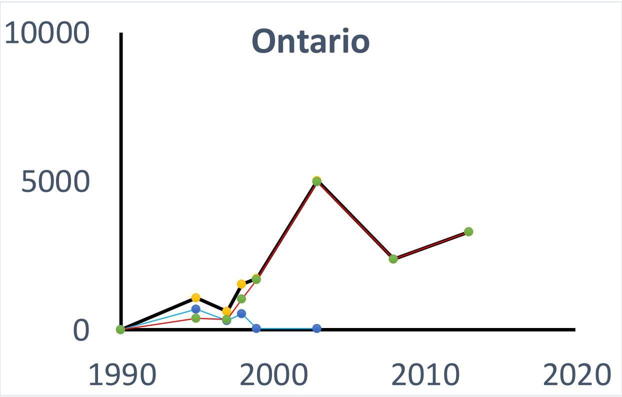
- Historically *Dreissena* density in Lake Huron was always lower than in Michigan and Ontario
- **However, recently in the deepest zone (>90 m) *Dreissena* density in Huron became similar to that in other lakes**

Most recent population estimation of *Dreissena* in Great Lakes

(In 2017 only 143 samples out of 240 processed)







Average ± SE *Dreissena* densities, m^{-2} (Lake Huron Main Basin only)

Depth Interval	Ontario 2013	Michigan 2015	Huron 2012	Huron 2017
0 – 30 m	4244±1543 (9)	2052±697 (29)	1652±988 (15)	300±795 (6)
31 – 50 m	3492±1021 (5)	5800±640 (46)	1472±481 (30)	1553±509 (19)
51 – 90 m	5408±625 (9)	8955±762 (42)	1622±634 (30)	2684±435 (25)
> 90 m	2000±437 (22)	2797±824 (18)	754±610 (8)	2603±538 (12)
Lake Average	3307	5050	1245	2179

- Lake-wide average *Dreissena* density in in Lake Ontario was 1.5 times higher and in Lake Michigan was 2.3 times higher than in Lake Huron
- In Michigan and Ontario *Dreissena* density declining, while in Huron still climbing