

AUV Camera Systems

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Arthur Trembanis

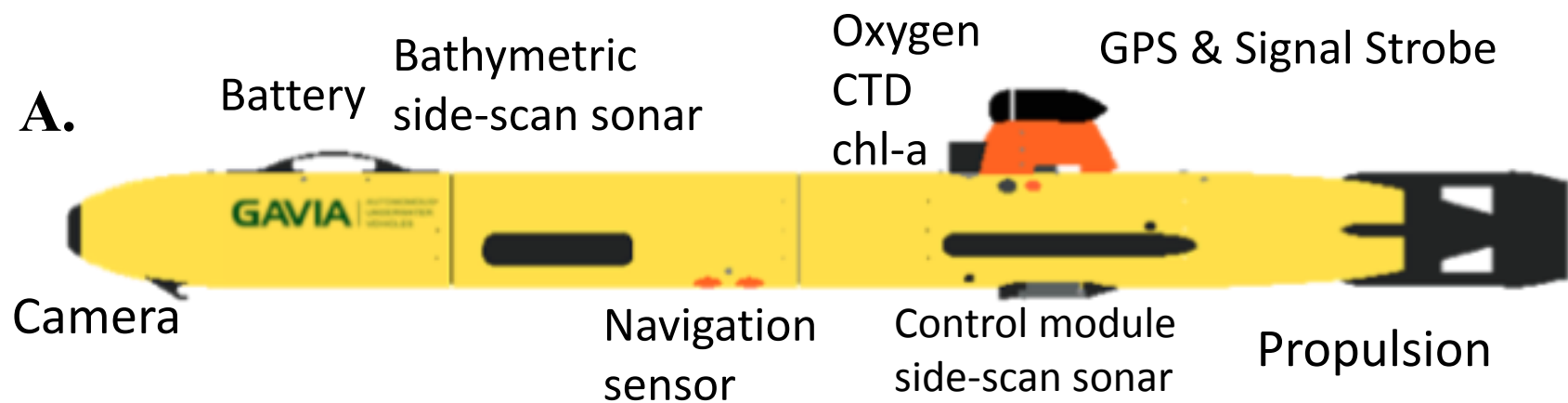
Ongoing Areas of Research and Development

- Advanced techniques for seafloor mapping and characterization
- Underwater Robotic Systems & Sensors
- Crowd Sourcing- Citizen Science
- Coastal Sediment Transport and Geomorphology
- Geovisualization

Corporate & Agency Partners/Sponsors



Opportunities for
new/continued partnerships...



B.



Technical Specifications:

Weight: 77 kg

Depth: 500 m depth rating

Length: 2 m

Duration: 4 hours

Habitat Mapping Sensors-

Side-scan sonar (900/1800 kHz)

Bathymetric side-scan sonar (500 kHz)

Digital Still Camera with Strobe

Water Quality Sensors-

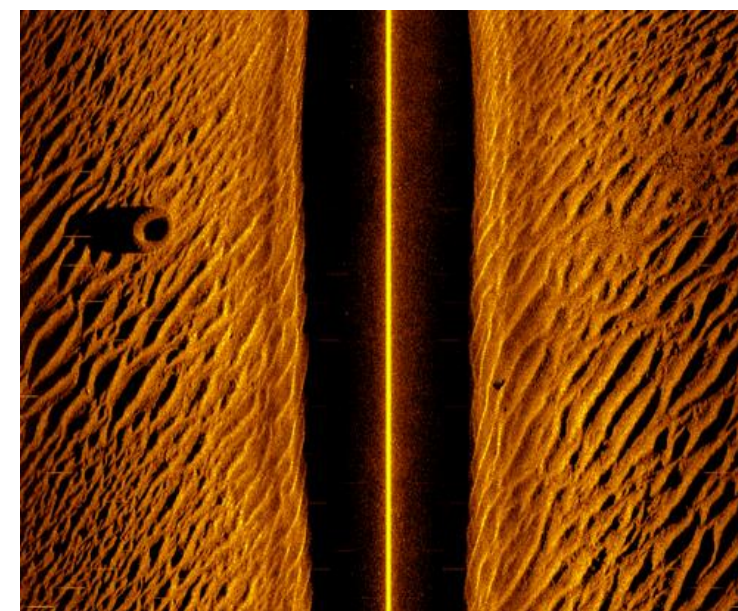
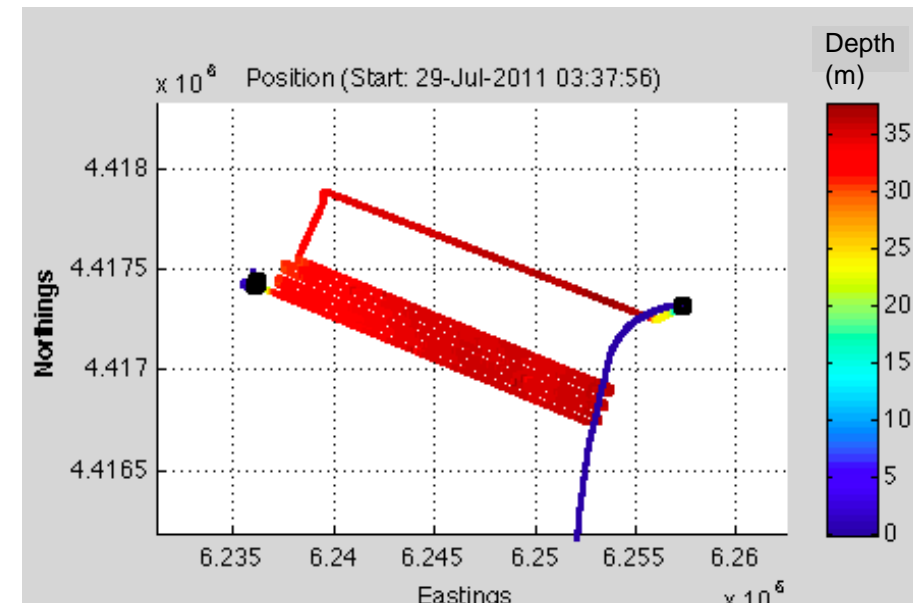
Salinity

Temperature

Oxygen

Turbidity

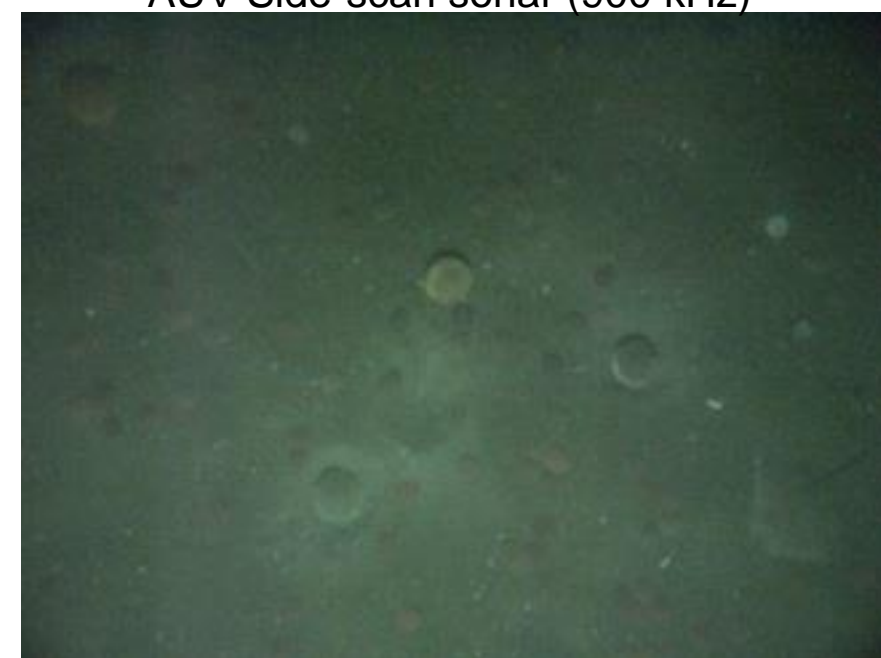
Chl-a



AUV Side-scan sonar (900 kHz)

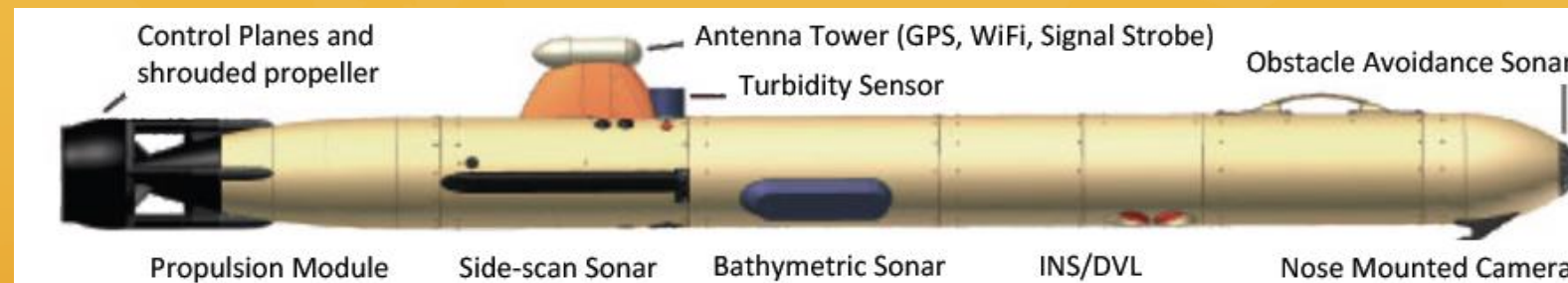
C.

Sensor	Frequency/Resolution	Phenomenon
Side-scan Sonar	900/1500 kHz ~20 cm	Backscatter
<u>Geoswath</u>	500 kHz 1 m gridded	Bathymetry and Backscatter
Camera	4 Hz 2 mm	Color Images
Inertial Navigation System (INS)	~2m horizontal positioning accuracy	Position and Attitude



AUV color photo of the seabed

Equipment – AUV



A

General key features:

Modular

Length: ~2.6 m

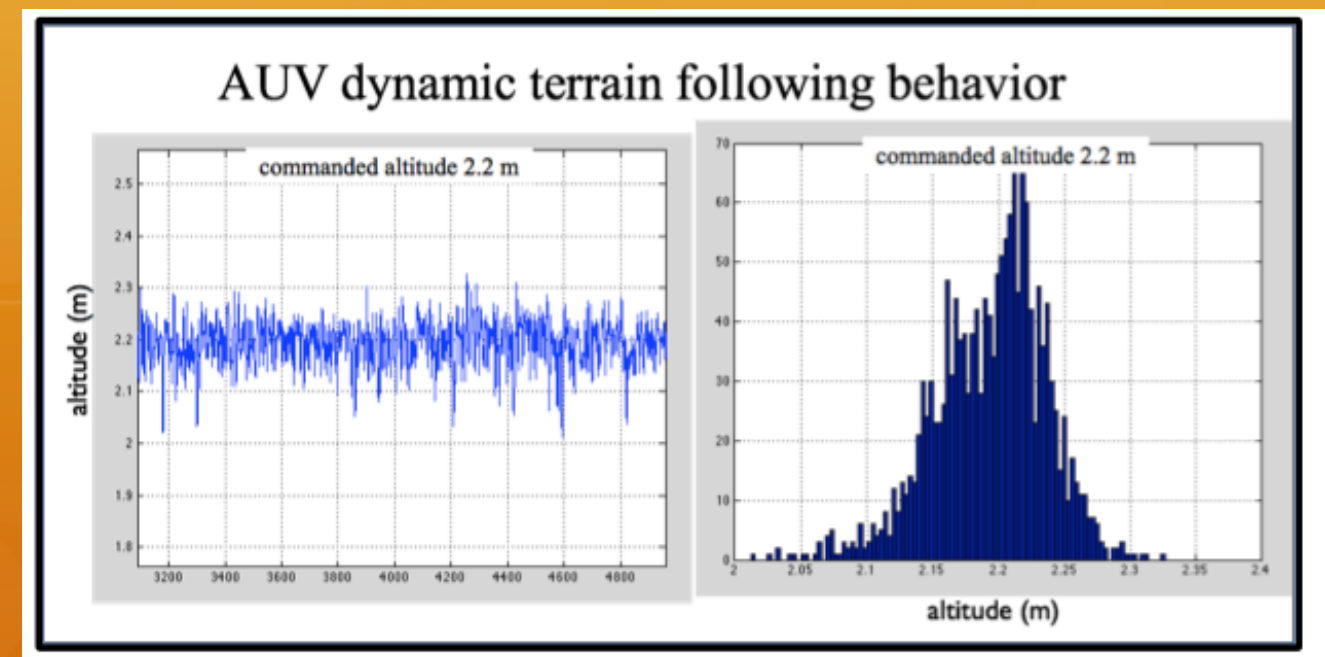
Weight: 77 kg

Battery life: 3-4 hours

Deployed from a surface vessel

Navigation: Differential GPS, INS,
DVL, pressure sensor,
obstacle avoidance sonar

Depth capabilities: 500 m

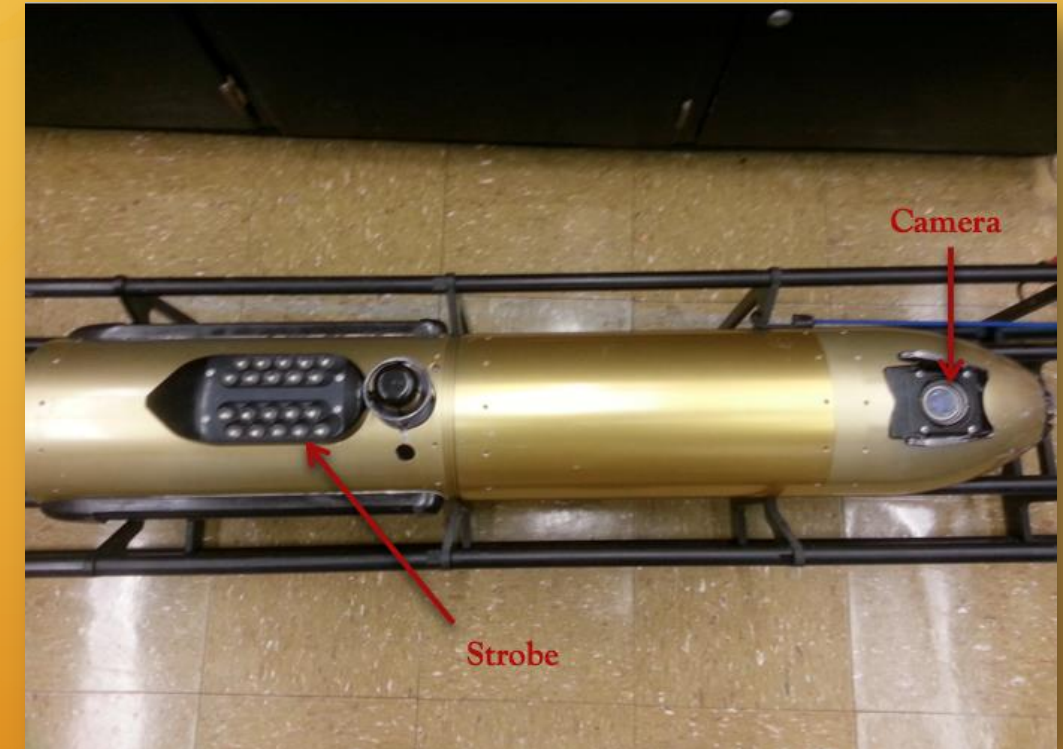


B1

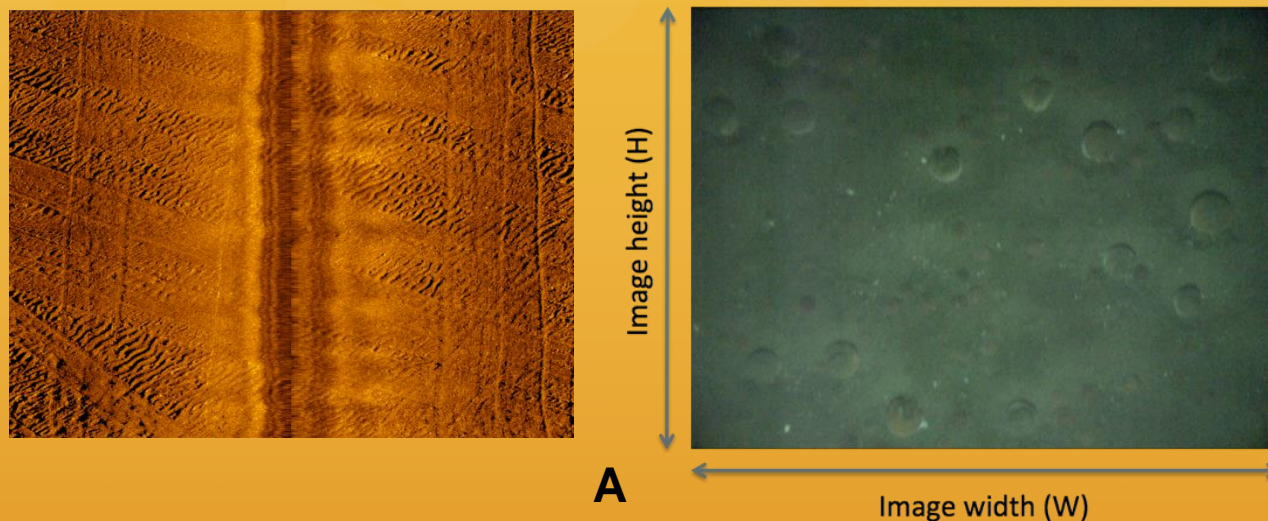
B2

AUV Camera

Point Grey Scorpion 20SO Research Camera	
Mega Pixels	2.11 (2.01 effective)
Sensor Resolution	1600x1200*
Image Sensor	8.923mm (diagonally) Sony CCD
Shutter Speed	0.03ms – 533ms
Dimensions	50mm x 50mm x 40mm
Operational Temperature	0 – 45 degrees Celsius
Power Consumption	< 3.5W
Mass	125 grams
Analogue to Digital Converter	12-bit A/D
Horizontal Viewing Angle	44.65 degrees (seawater)
Memory	Computer in the nose cone of AUV



Side-scan Sonar and Camera



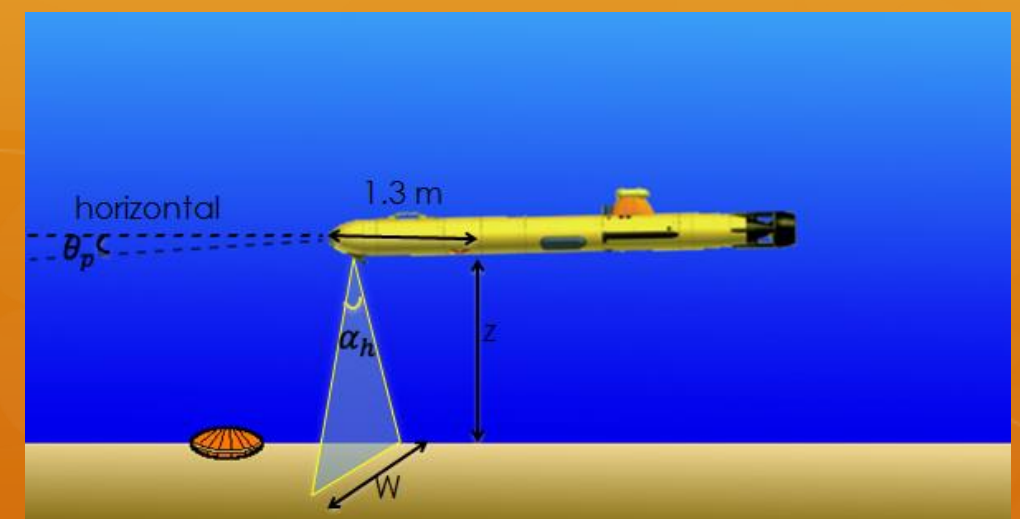
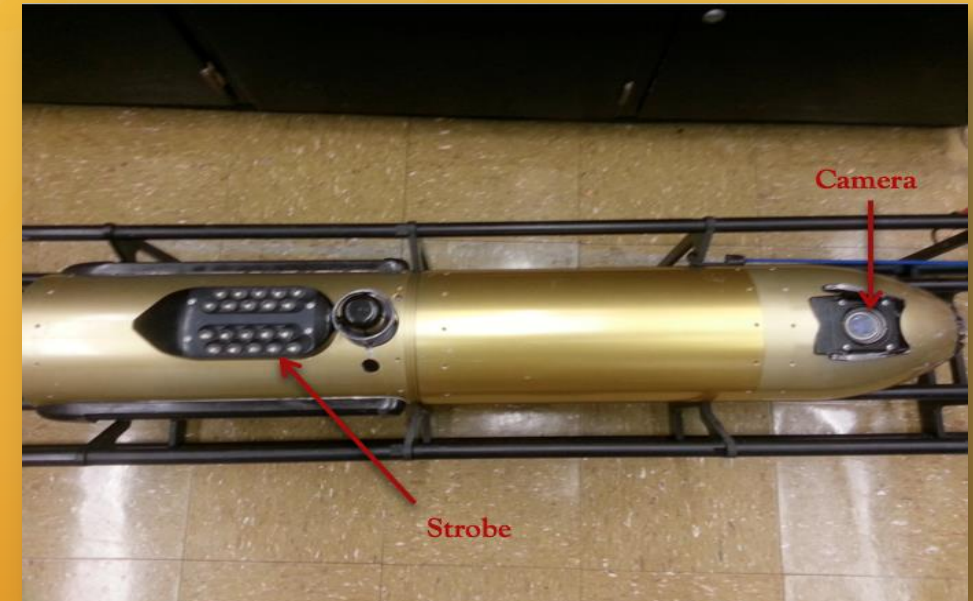
Sample Side-scan sonar mosaic (left) and camera image (right)

❁ Sonar

- ❁ 900/1800kHz
- ❁ Range of 40m at 900kHz
- ❁ Range of 10m at 1800kHz

❁ Camera

- ❁ 2.1 Megapixel
- ❁ 1600 X 1200 max resolution



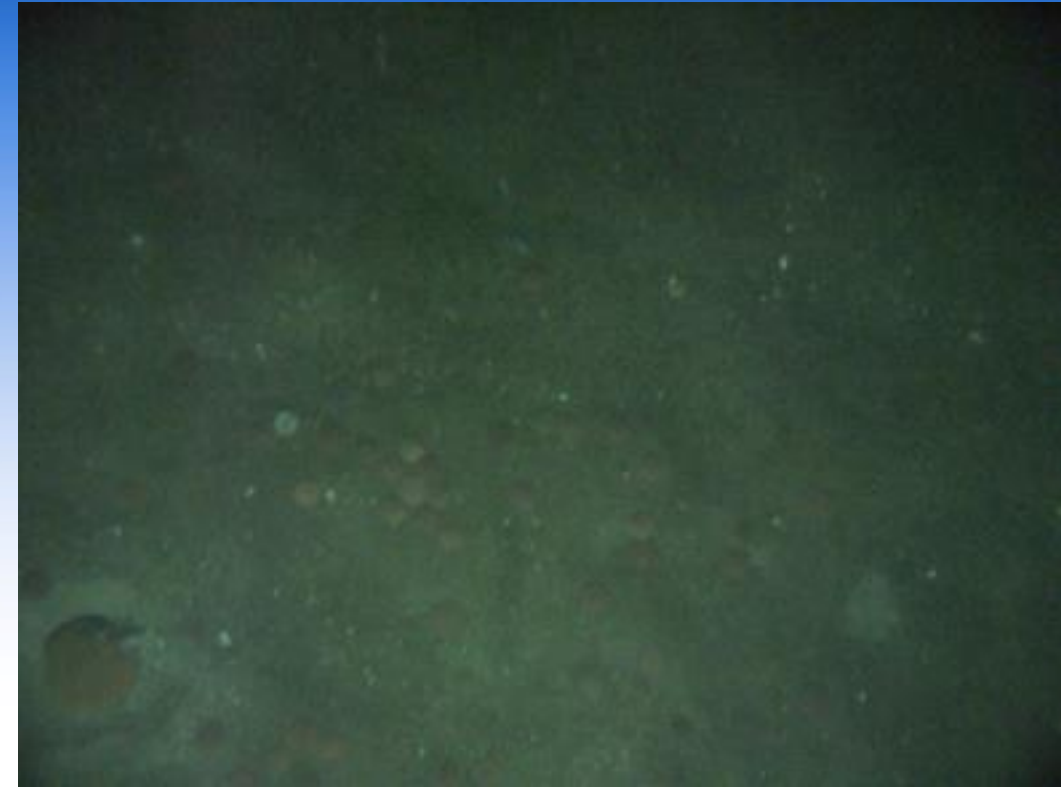
Horizontal FOV in seawater 44.65°
Vertical FOV in seawater 34.91°
Image dimensions at 2.0 m altitude
= 1.64 x 1.23 m

Drinking from the Firehose

Strategies and techniques for dealing with large imagery datasets.



How to process through >238,000 images?



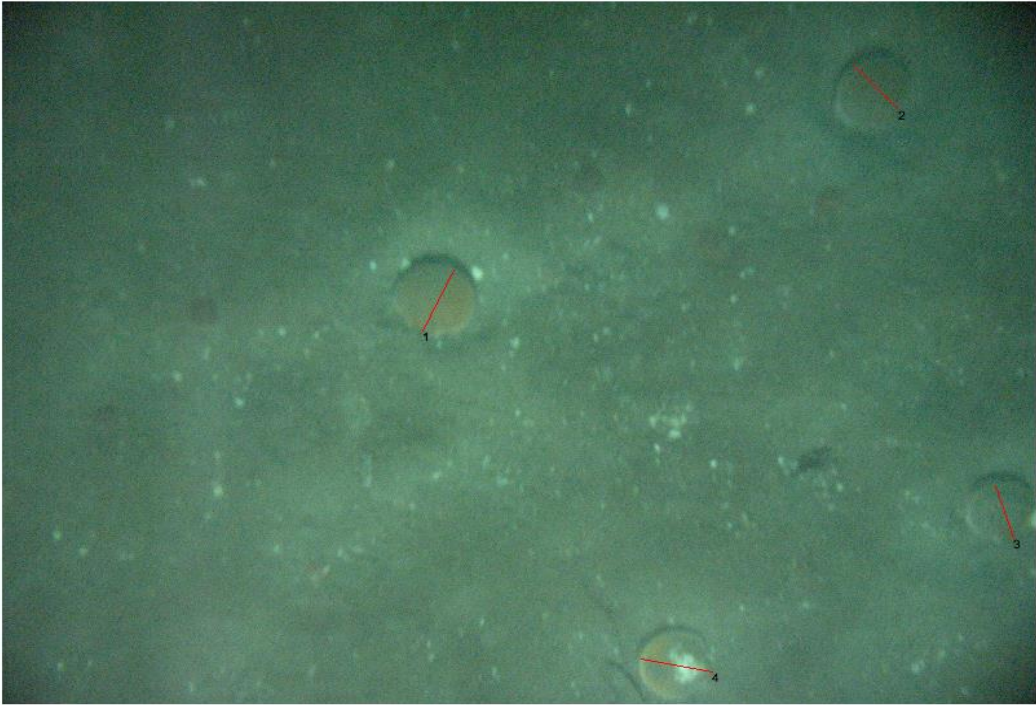
Scallop Enumeration & Sizing

SizingData.java Scallop Sizing

http://localhost:8080/Scallops/Scallop_Sizing.jsp

Image File Number :

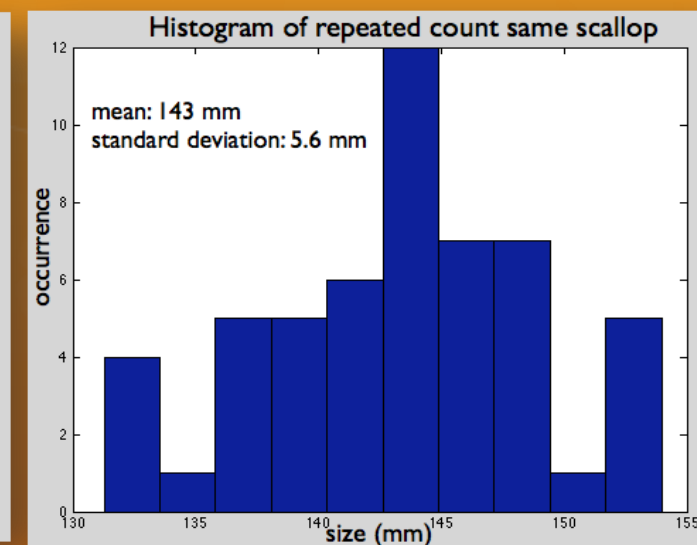
Bed Type : Image Quality : X Y



Sr.No	X1	Y1	X2	Y2	Physical Length
1	325	281	349	229	12.4640
2	693	92	658	54	11.2433
3	782	458	768	413	10.2564
4	549	572	494	561	12.2067

Time Stamp : Latitude : Longitude :

Altitude : Depth : Total Depth :



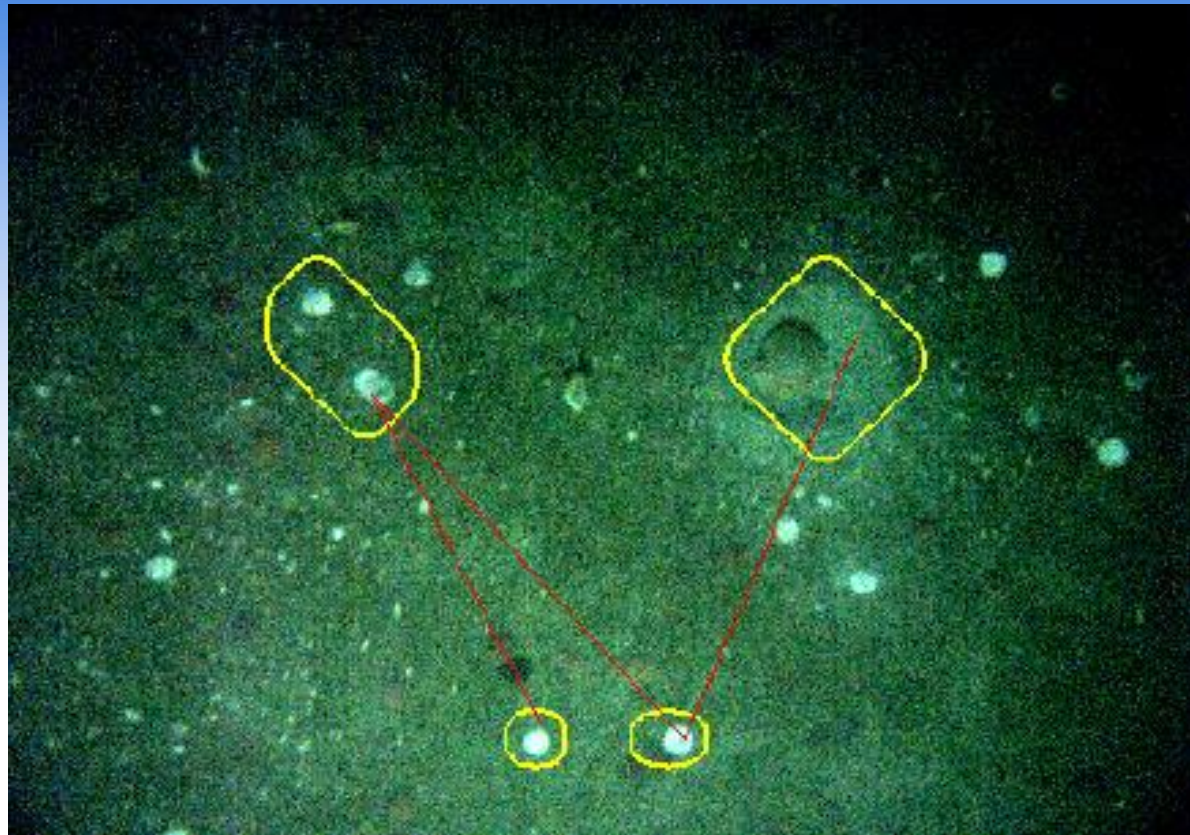


Figure A: Visual
Attention Process
Flow

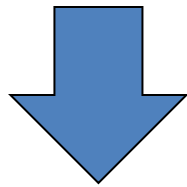


Figure B: Segmentation Steps

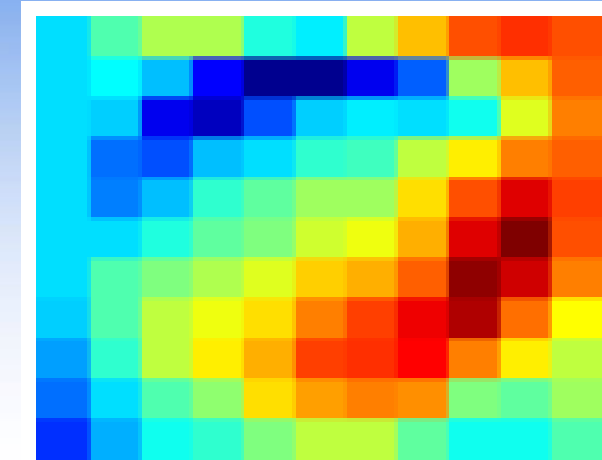
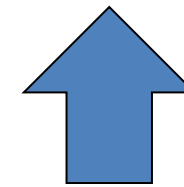
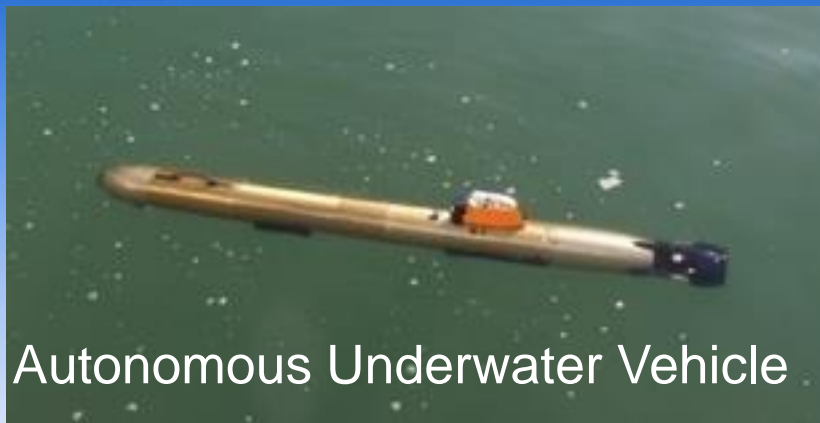


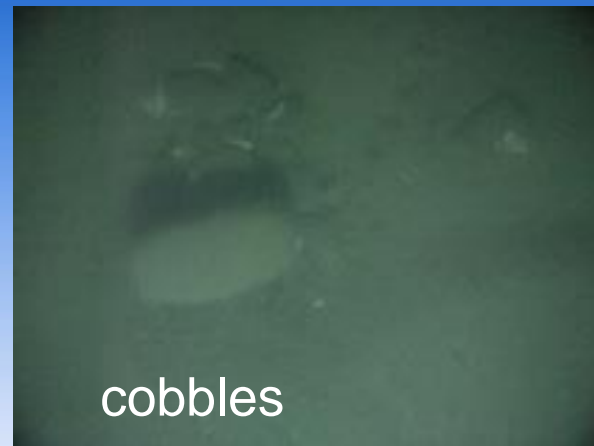
Figure C:
Sample Scallop
Template



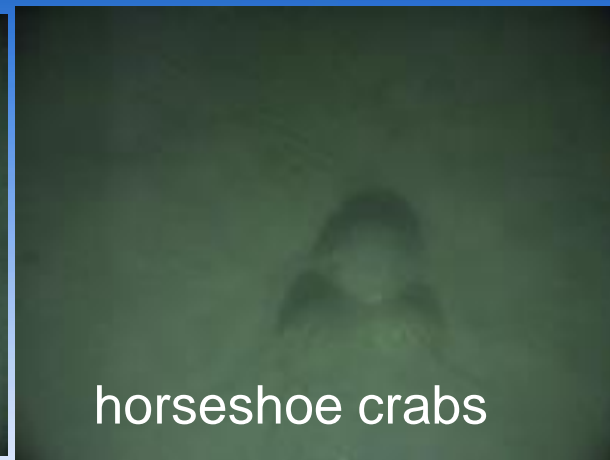
AUV survey of seabed conditions



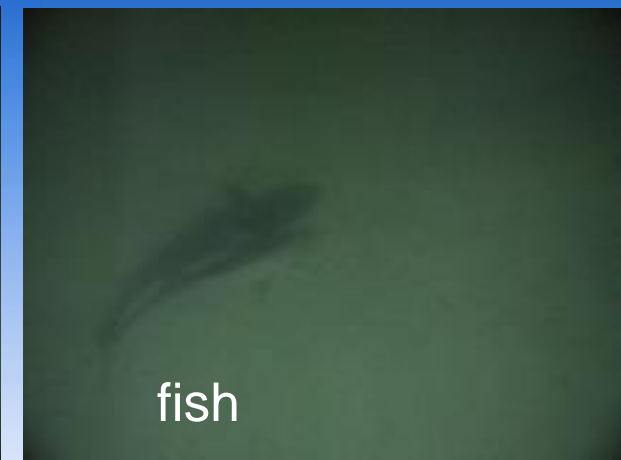
Autonomous Underwater Vehicle



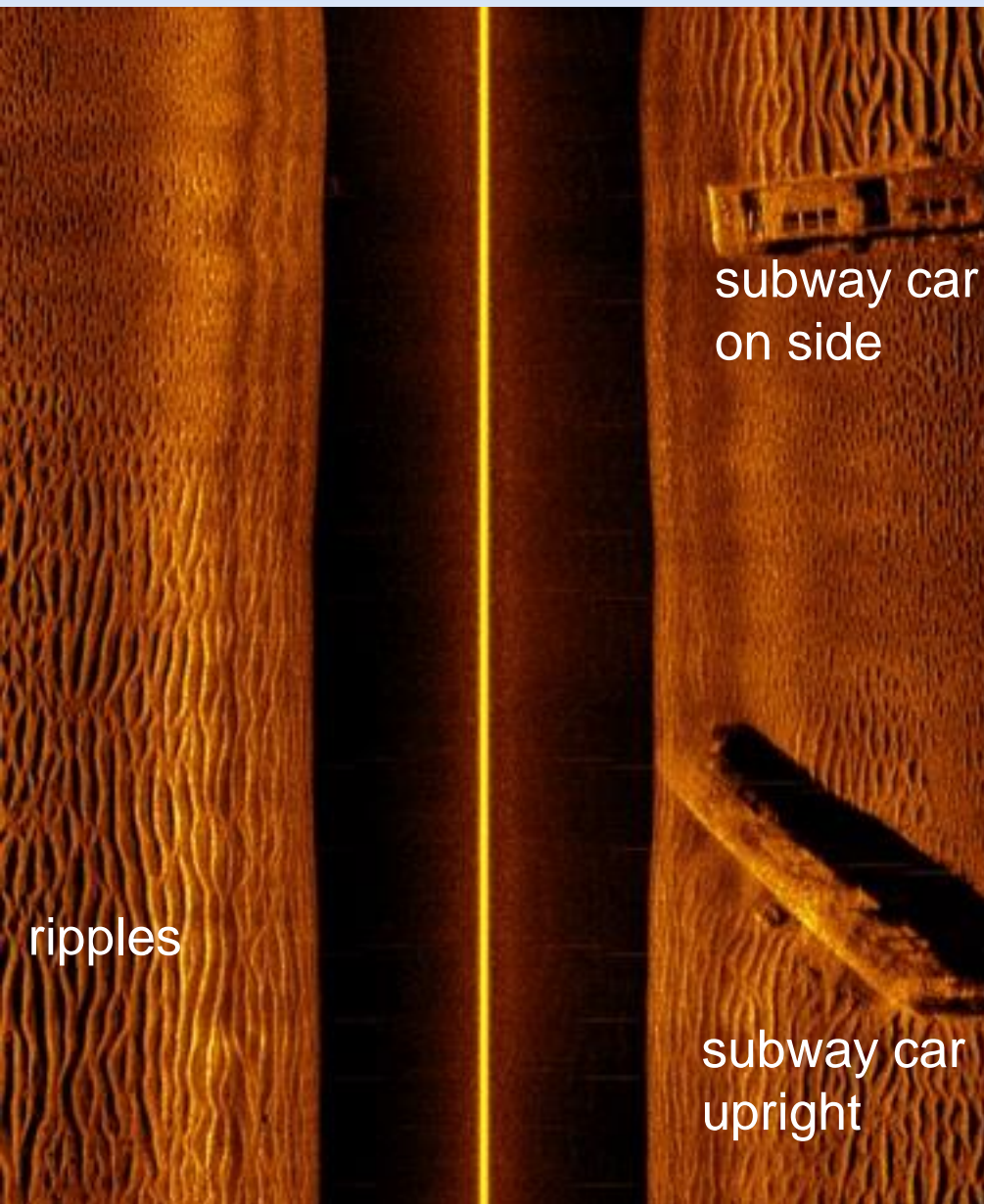
cobbles



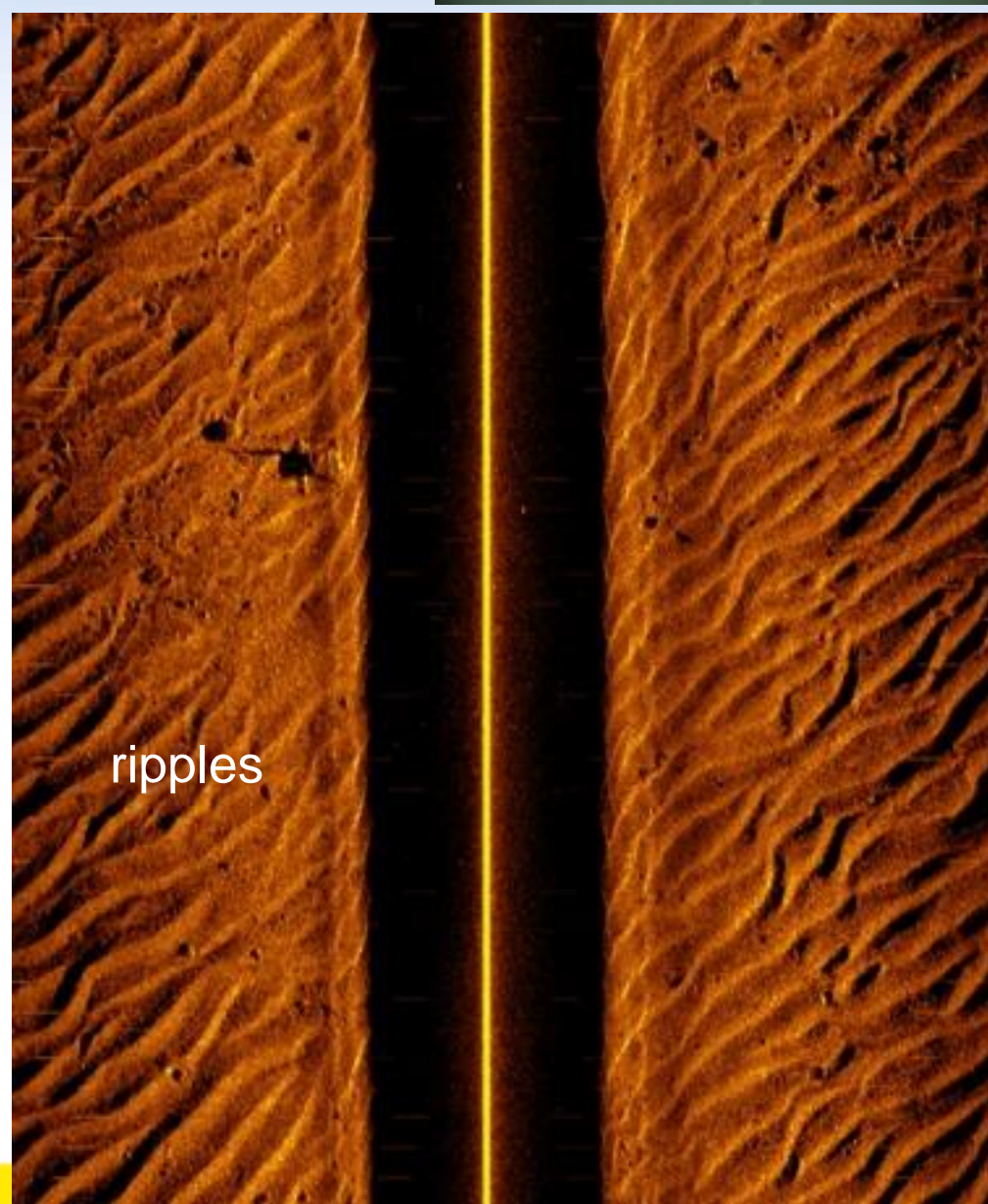
horseshoe crabs



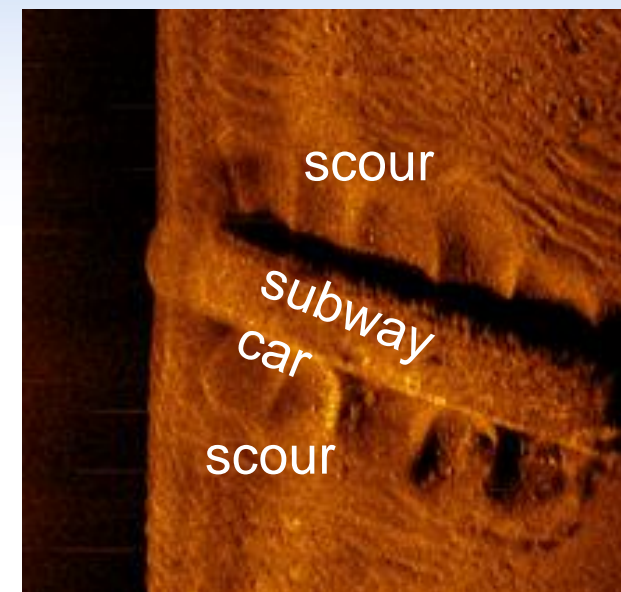
fish



subway car
on side



ripples

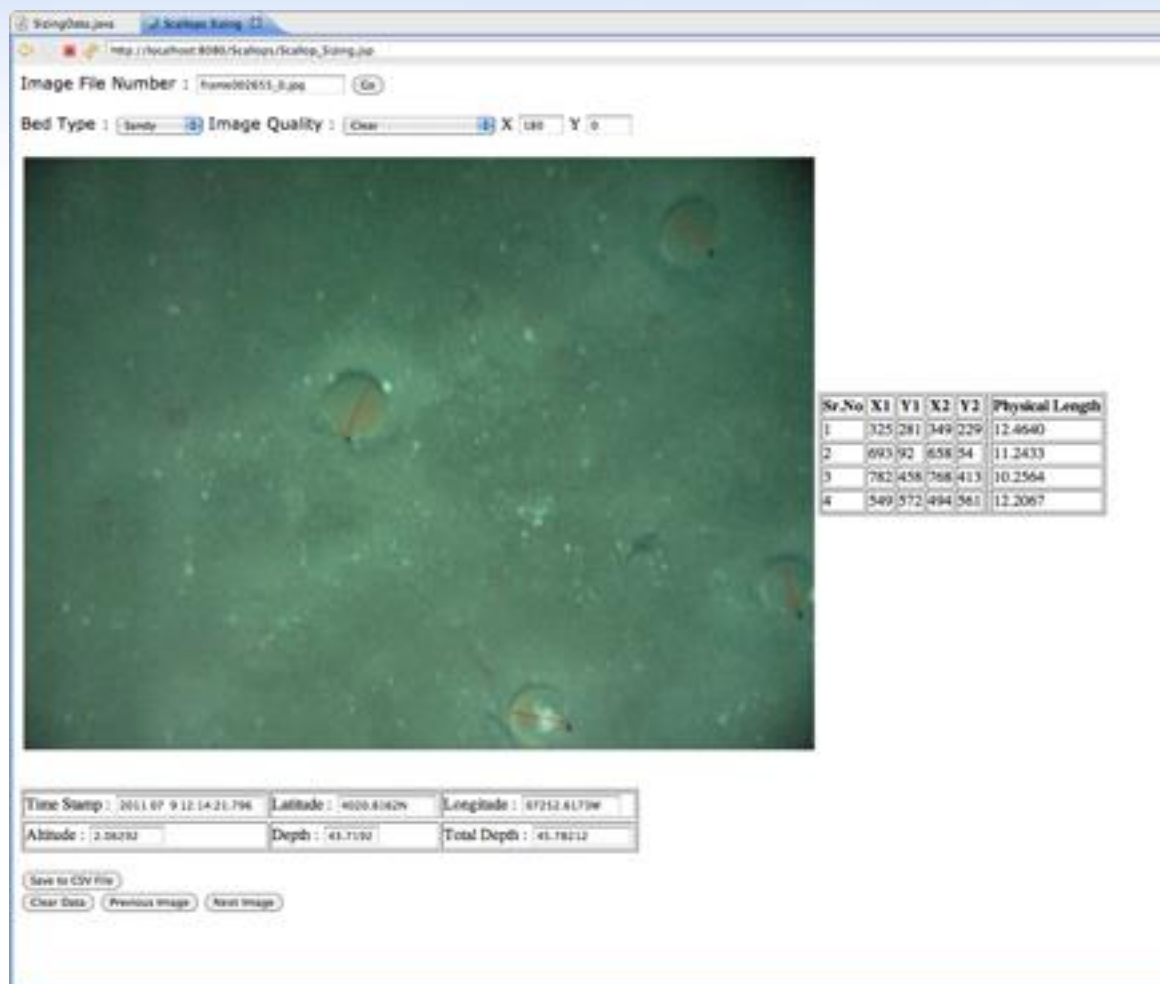


scour
subway
car
scour



tire

Objective- Utilize web 2.0 technology for **human computation initiative**- The purpose of the application is to allow the fast classification of georeferenced images using crowdsourcing for data analysis and public outreach. Directly involve the public in science activities, communicate findings, improve scientific literacy. **Games with a purpose** (*sensu* von Ahn, 2006)



Point and click
If you eat
scallops...
please count
them!

<http://neemo.zooniverse.org/>



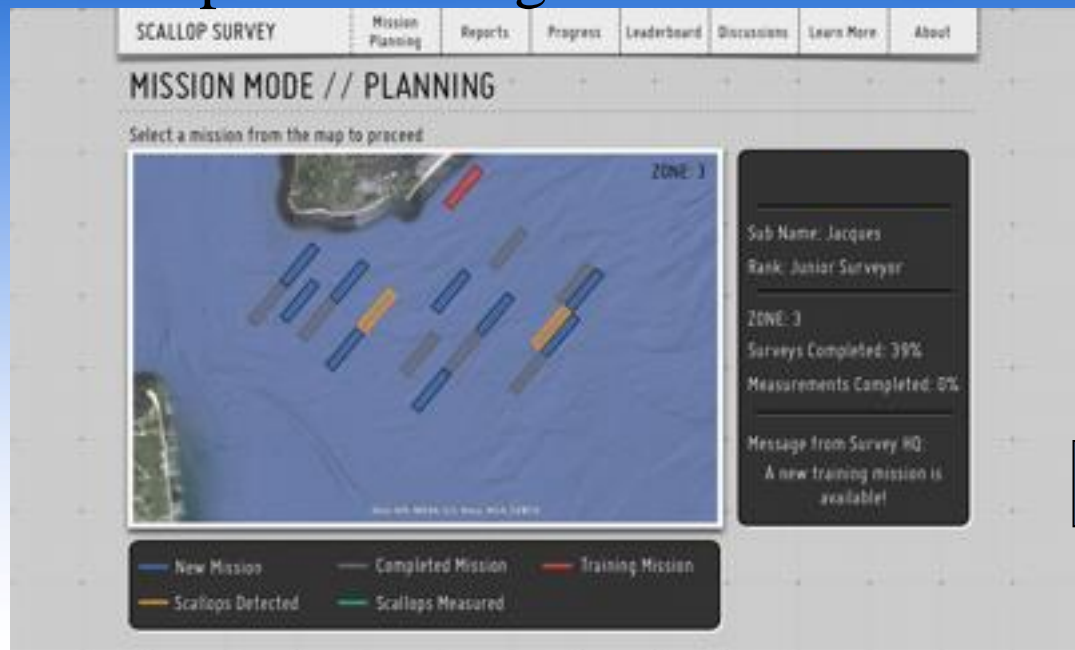
<http://getmapper.com/>



<http://cshel.geology.udel.edu:8080/Scallops/Home.jsp>

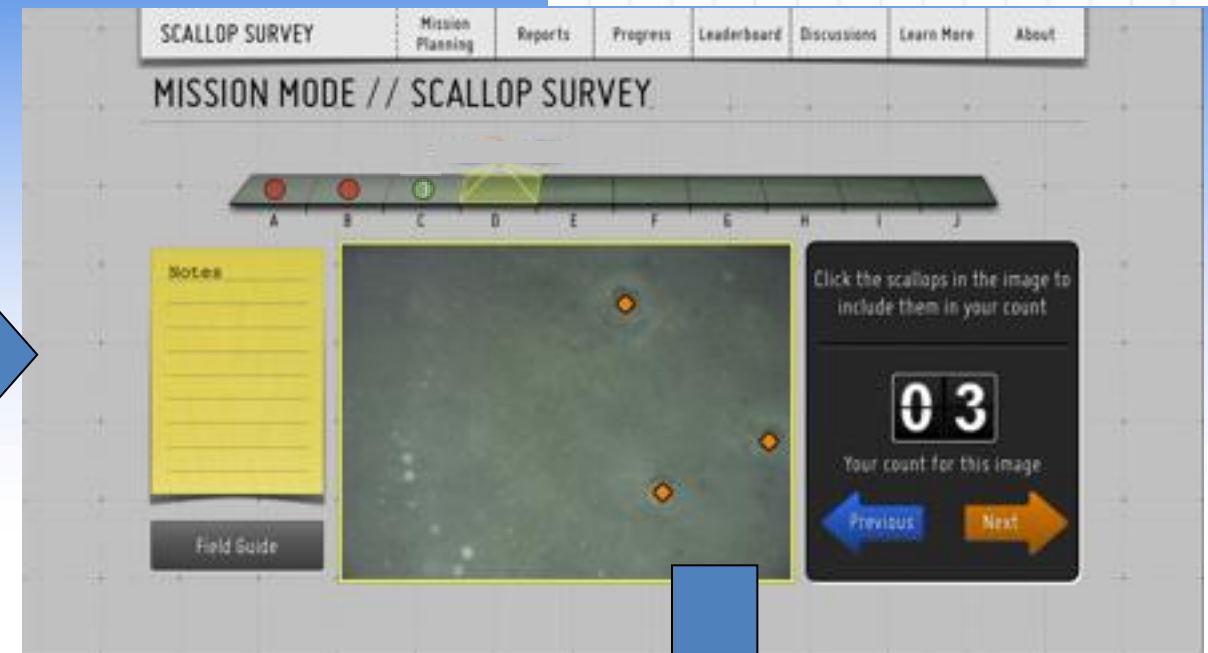
<http://subseaobservers.com>

Step 1- Training

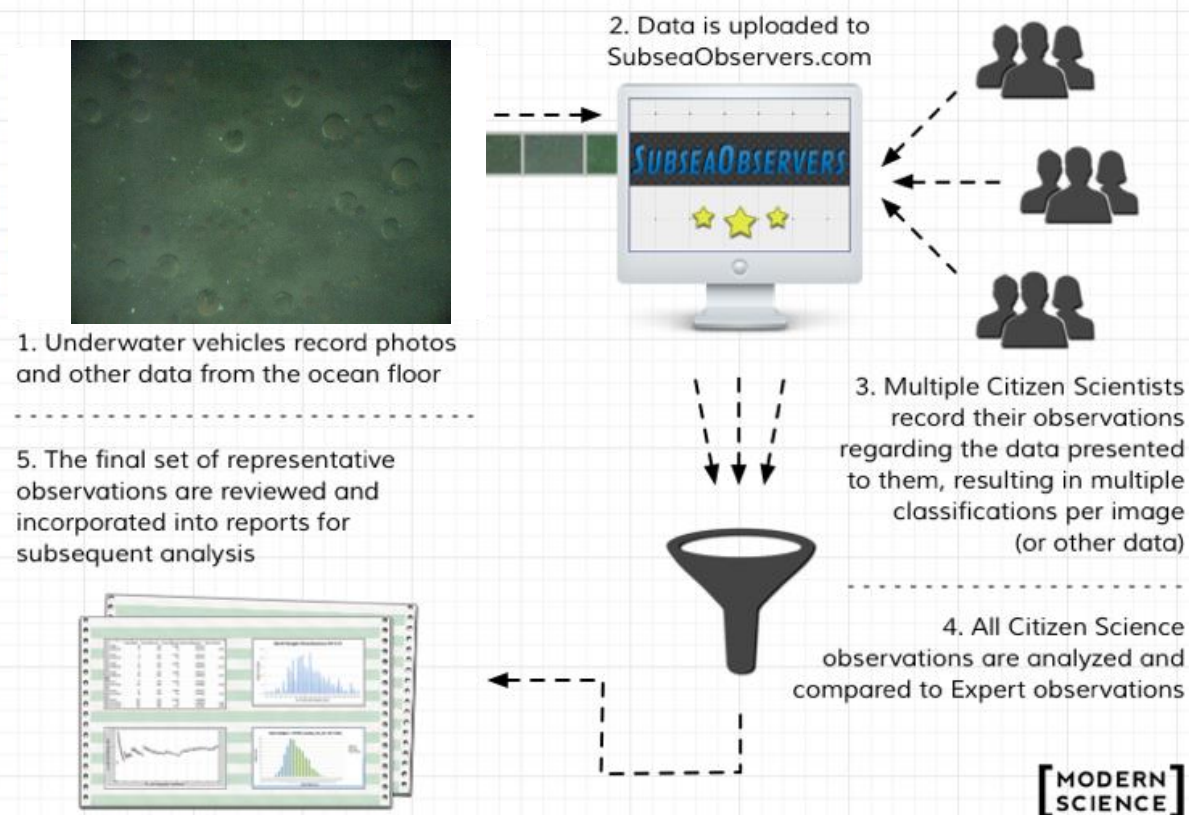


Step 2- Counting

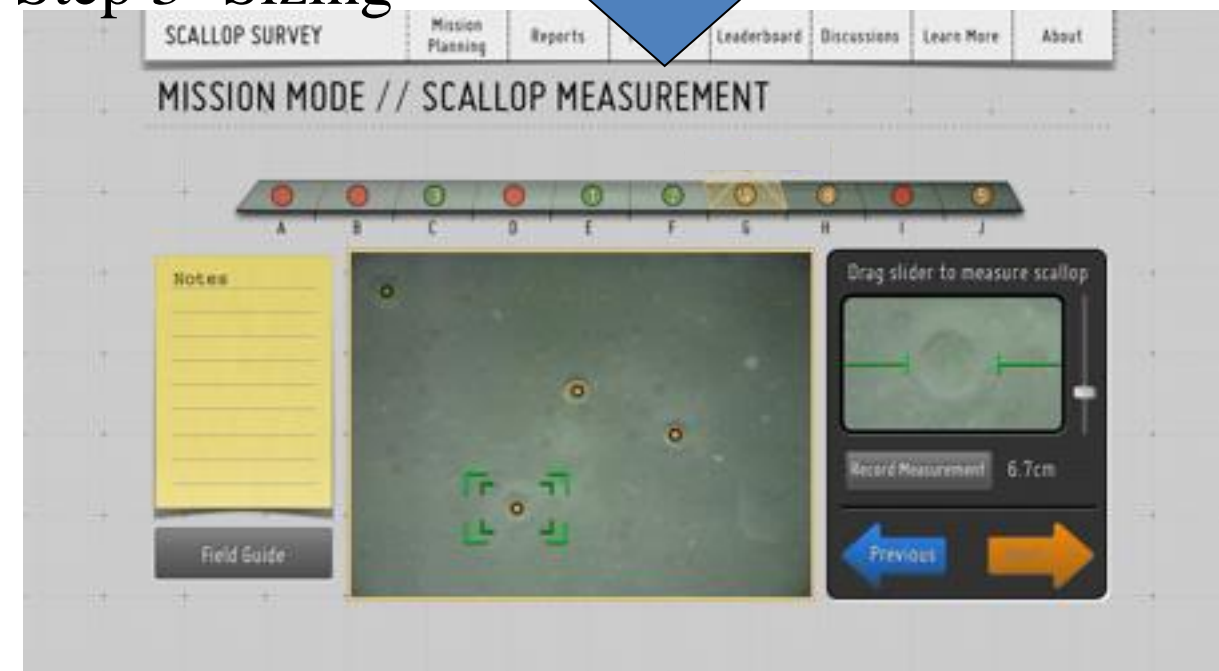
SUBSEA OBSERVERS
HELP ASSESS THE HEALTH AND ABUNDANCE
OF THE EAST COAST SCALLOP FISHERY



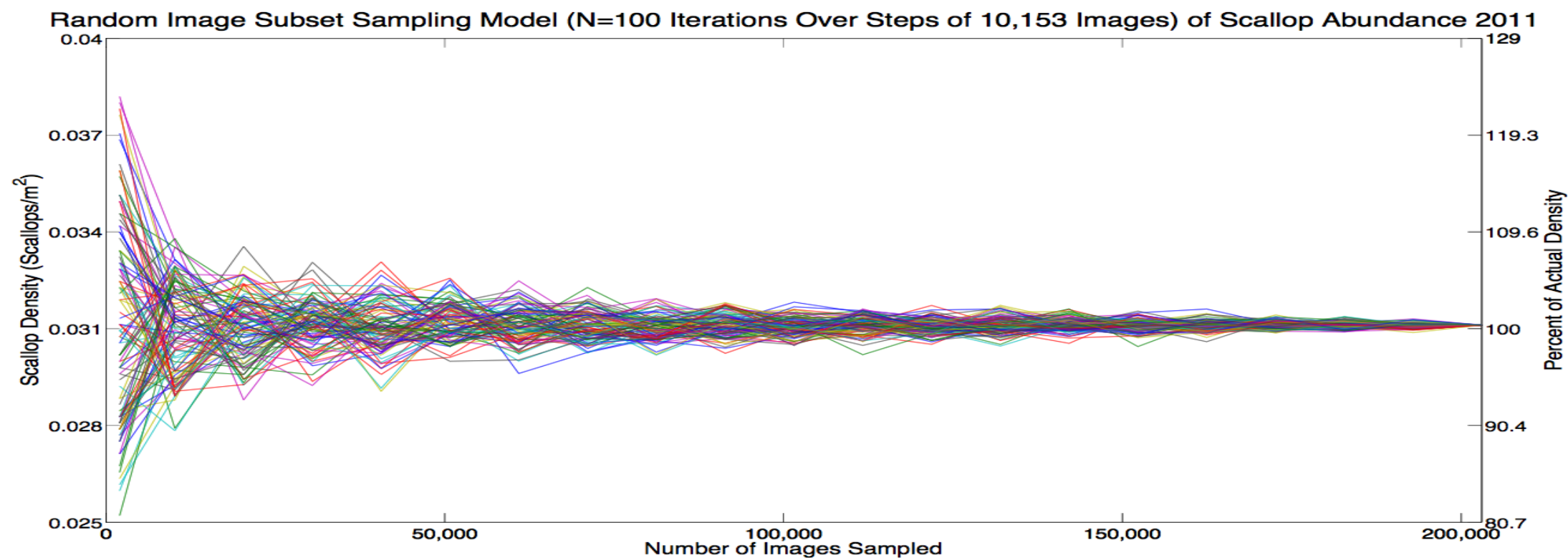
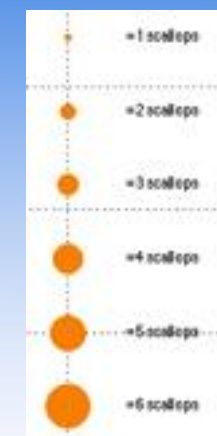
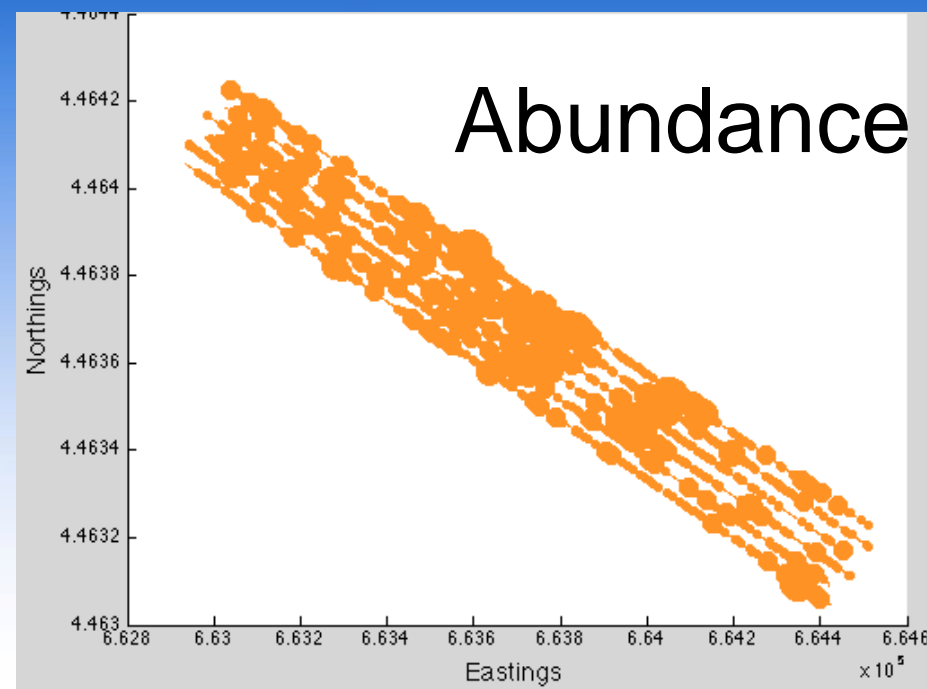
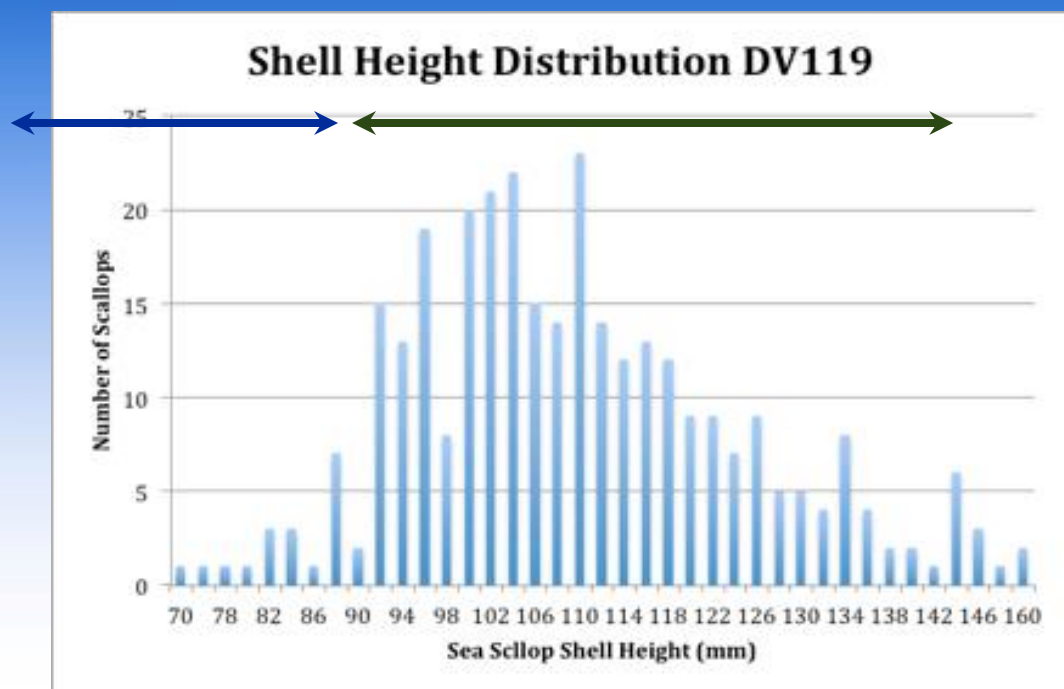
[SubseaObservers workflow]



Step 3- Sizing



Some Results



AUV Imaging

- Advantages
 - No Tether management problems.
 - Easy to deploy and use, does not require an operator to oversee its operation.
 - Dynamic terrain following and good localization capabilities of AUVs help in running very precise missions with close transect lines ensuring complete survey of the required area.
 - Since the localization is accurate, we can gather imagery with minimum overlap without losing area coverage.
- Shortcomings
 - There is no live streaming of images, the communication bandwidth is limited.
 - The image quality needs improvement (better light/color correction).
 - There is limited onboard power.

Thank You