



Mapping Dredged Material and a Sand Cap at Douglas Harbor, Juneau, AK, using Sediment-Profile Imaging (SPI) and a Semi-automated Image Processing System

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Olympia, WA

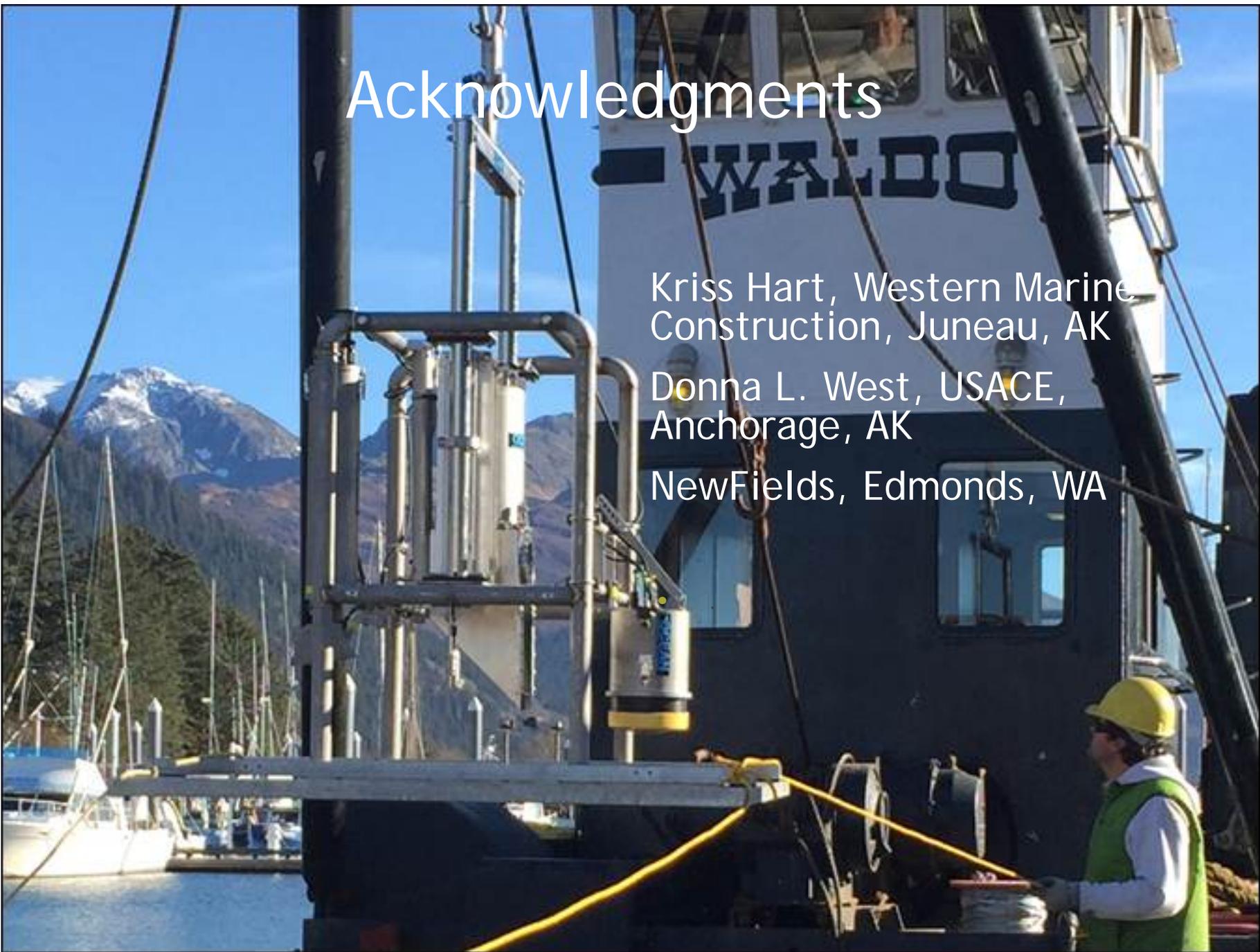


Acknowledgments

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Construction, Juneau, AK

Donna L. West, USACE,
Anchorage, AK

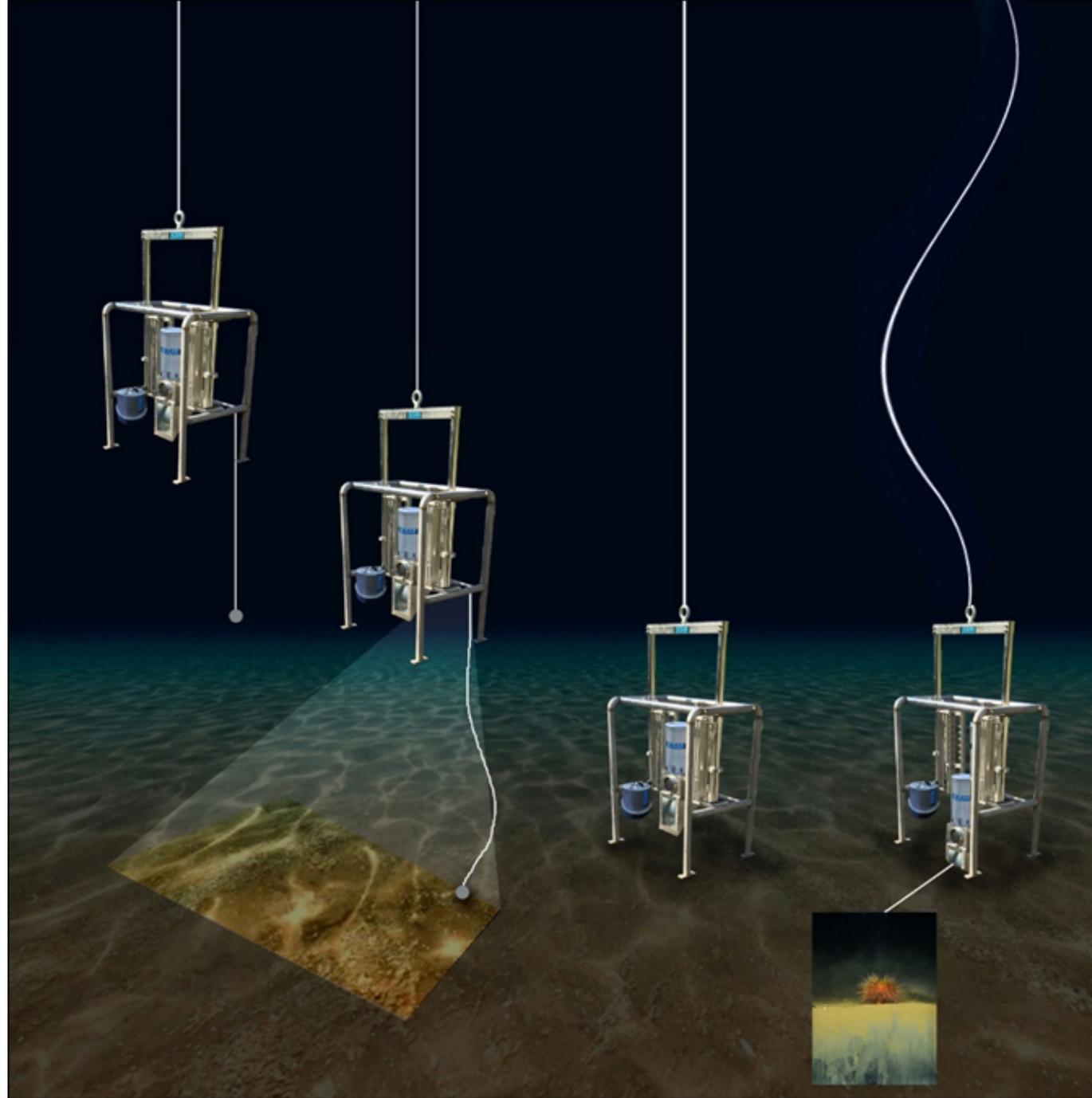
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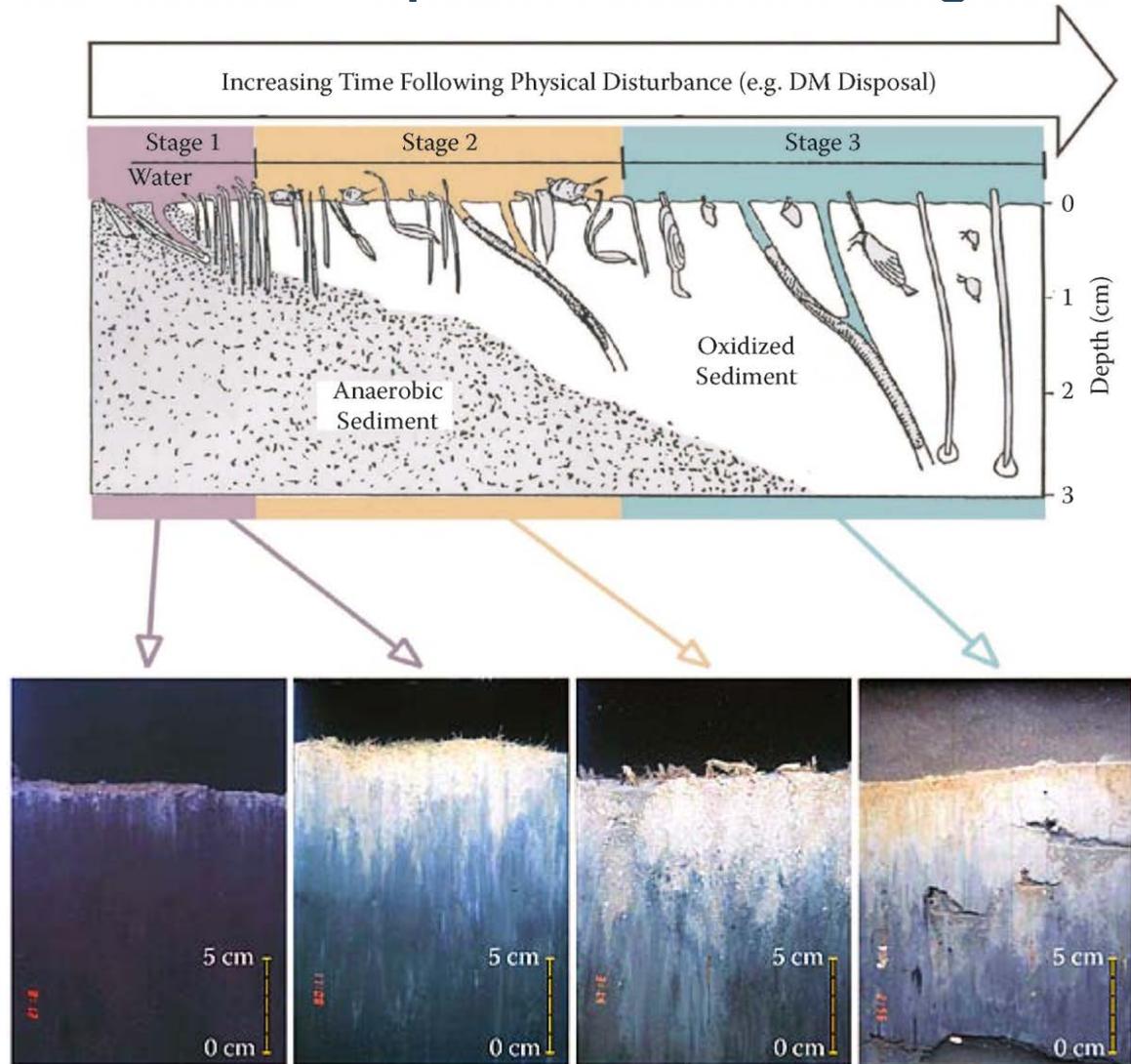
SPI/PV Image Collection

"You can observe a lot just by watching."

- Yogi Berra

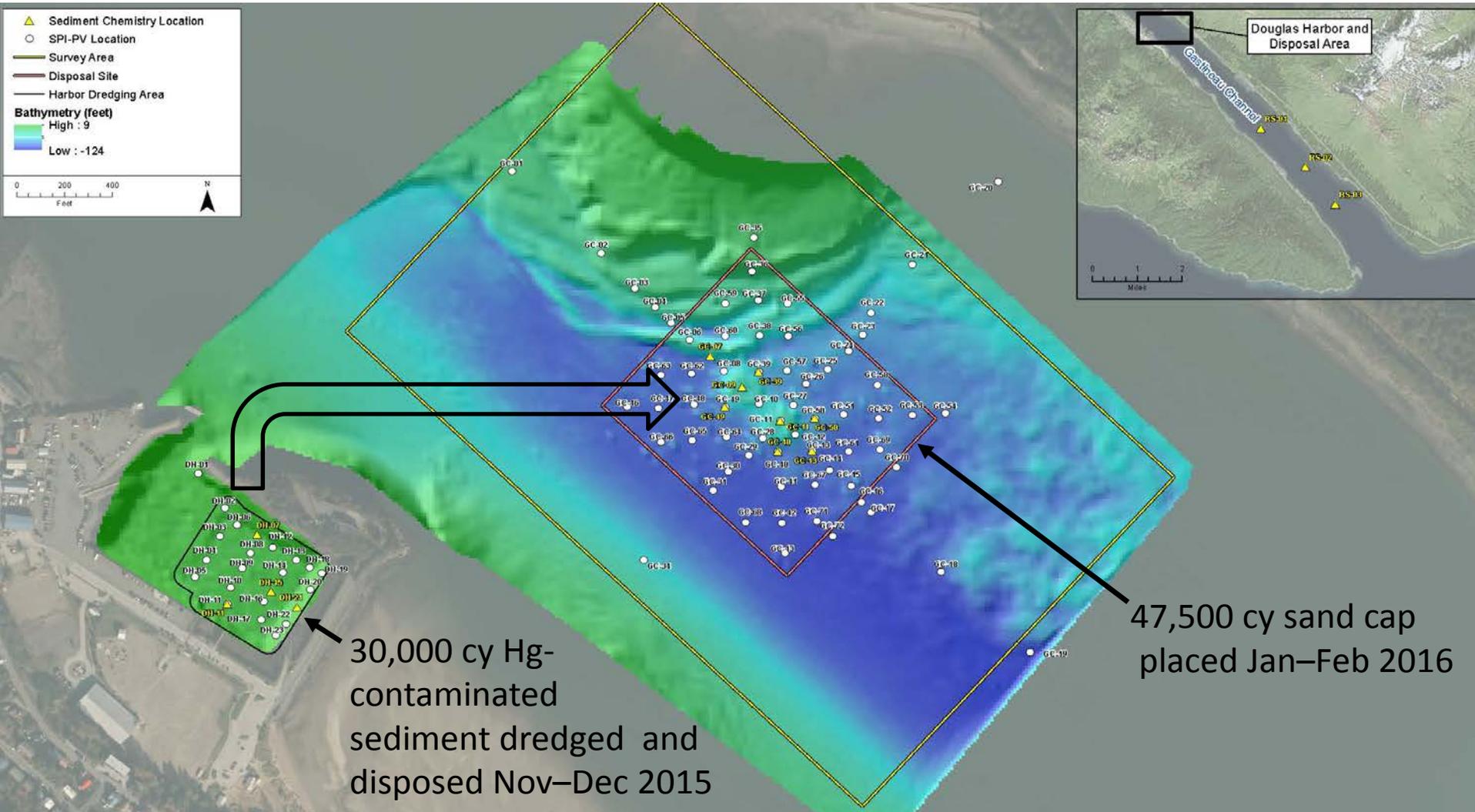
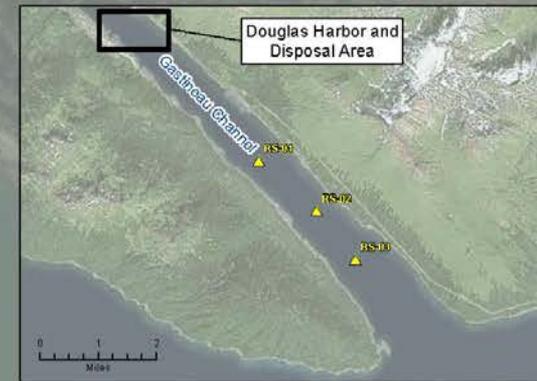
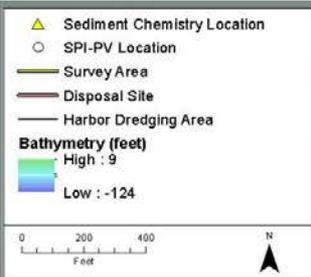


SPI Interpretive Paradigm



From Germano et al. 2011. The use of sediment profile imaging (SPI) for environmental impact assessments and monitoring studies – lessons learned from the past four decades. *Oceanography and Marine Biology: An Annual Review* 49: 247-310.

Douglas Harbor, Juneau, AK—Dredging Project



SPI/PV Surveys and Objectives

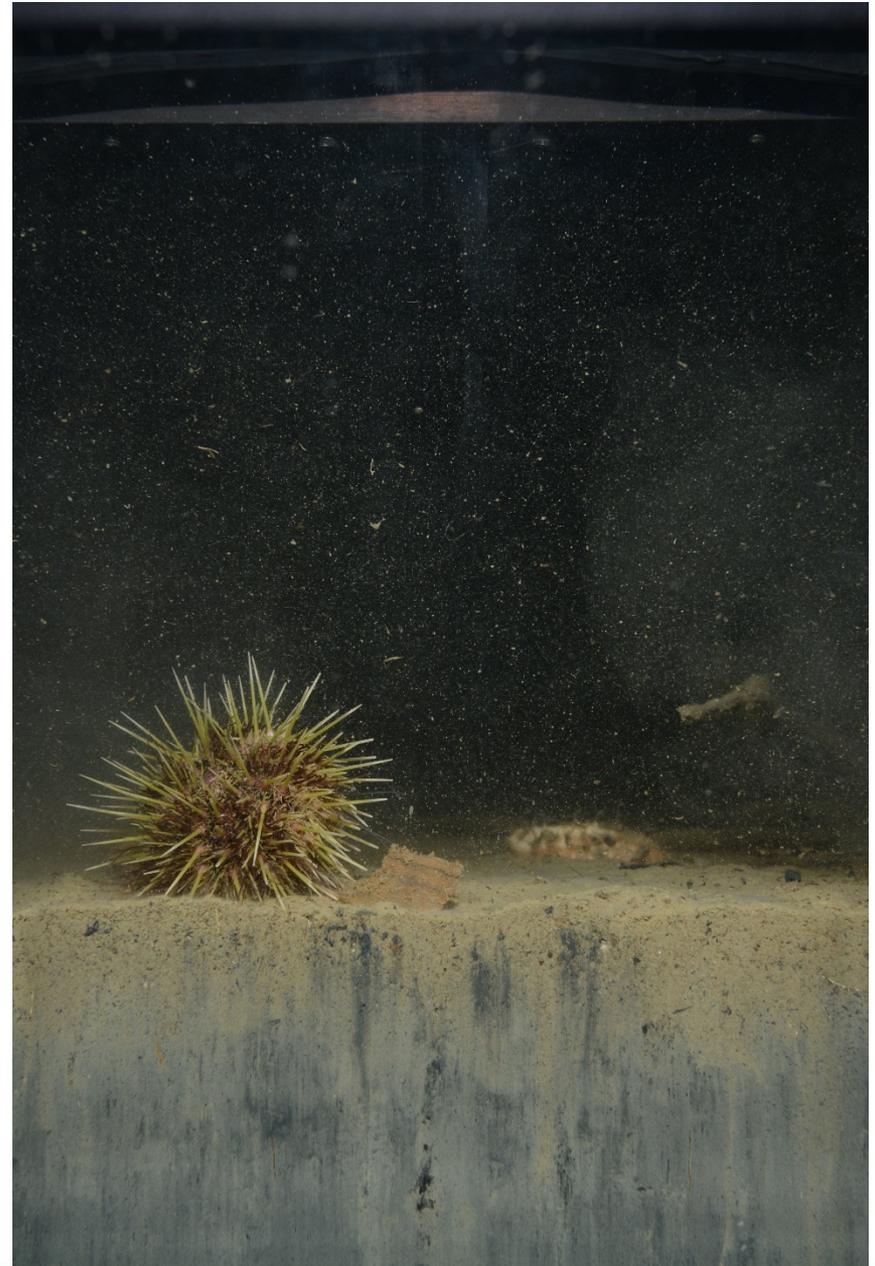
1. **Baseline:** Map Benthic Conditions in Douglas Harbor and at Gastineau Channel Disposal Site—October 2015
2. **Post Dredged Material Disposal:** Map Benthic Conditions and Dredged Material (DM) Footprint at Disposal Site—January 2016
3. **Interim Sand Cap Placement Survey:** Map Interim Extent and Thickness of Sand Cover at Disposal Site—February 2016
4. **Post-construction Survey:** Map Final Extent and Thickness of Sand Cap—March 2016
5. **One-year Post-construction Survey:** Map Benthic Recovery—scheduled for March 2017



Baseline Conditions—Douglas Harbor



21 cm



Baseline Conditions—Gastineau Channel Disposal Site



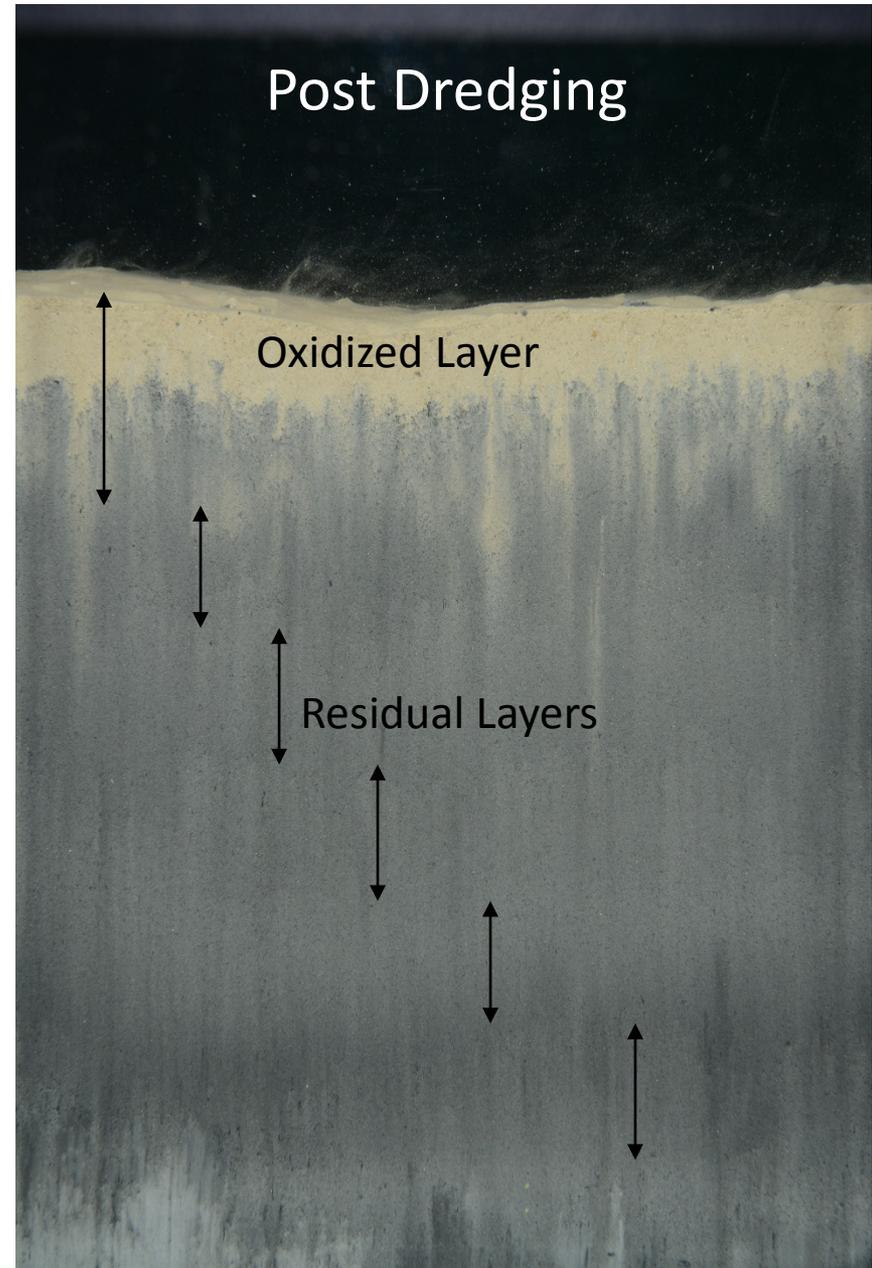
21 cm



Douglas Harbor—Post-dredge Survey



21 cm



Disposal Site—Post-dredge Survey

Baseline



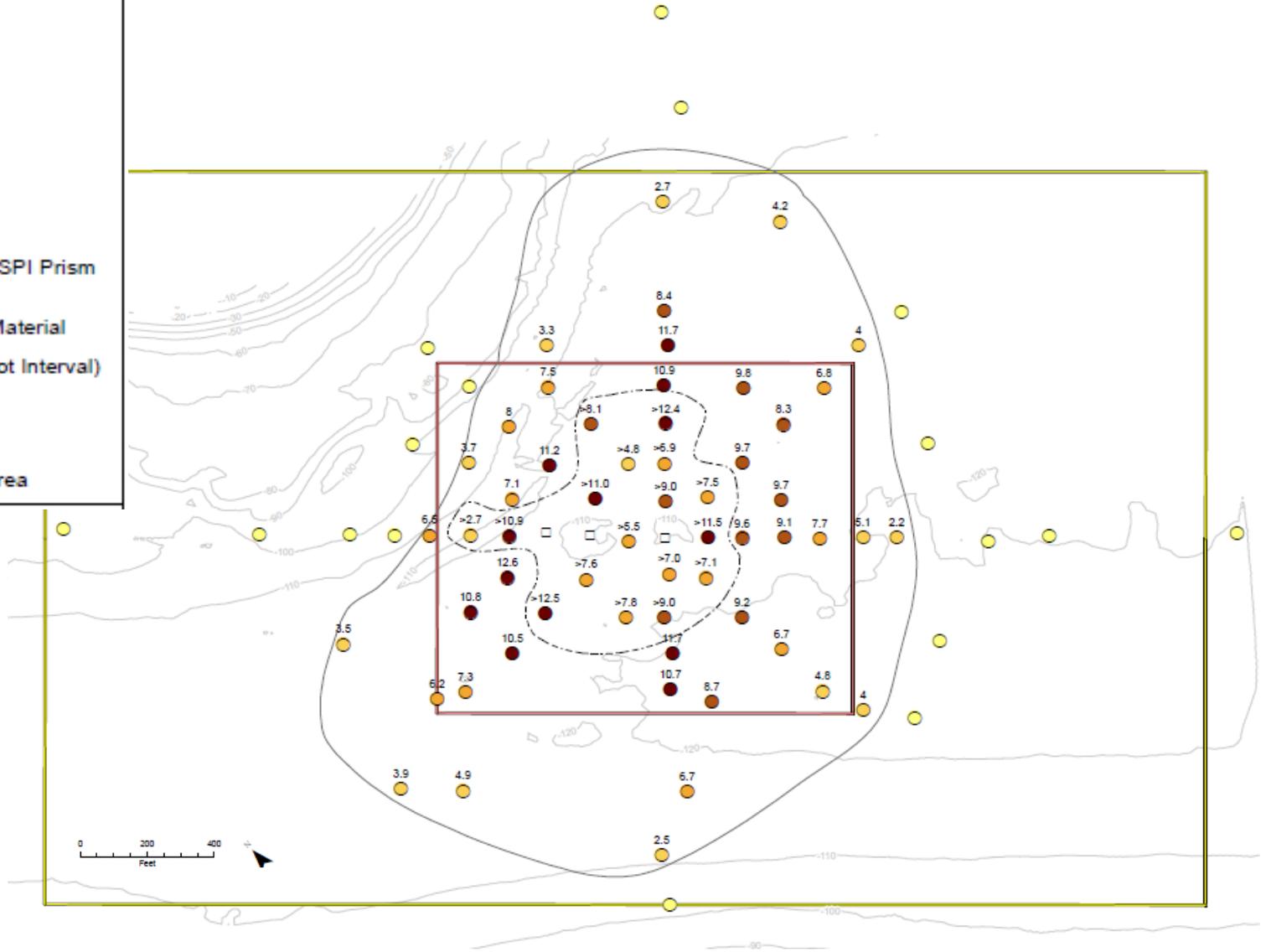
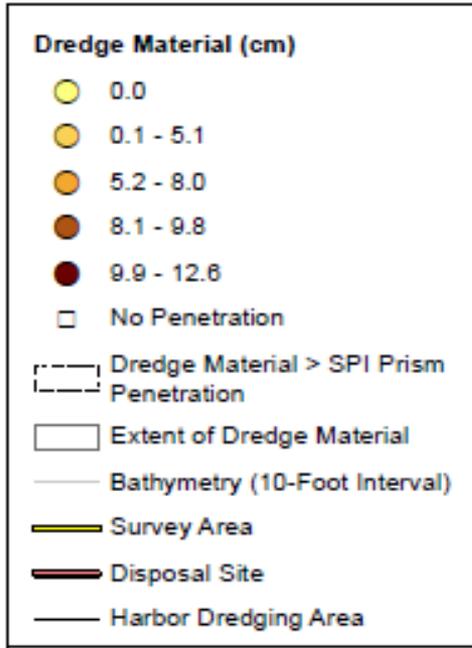
21 cm

Post Dredging

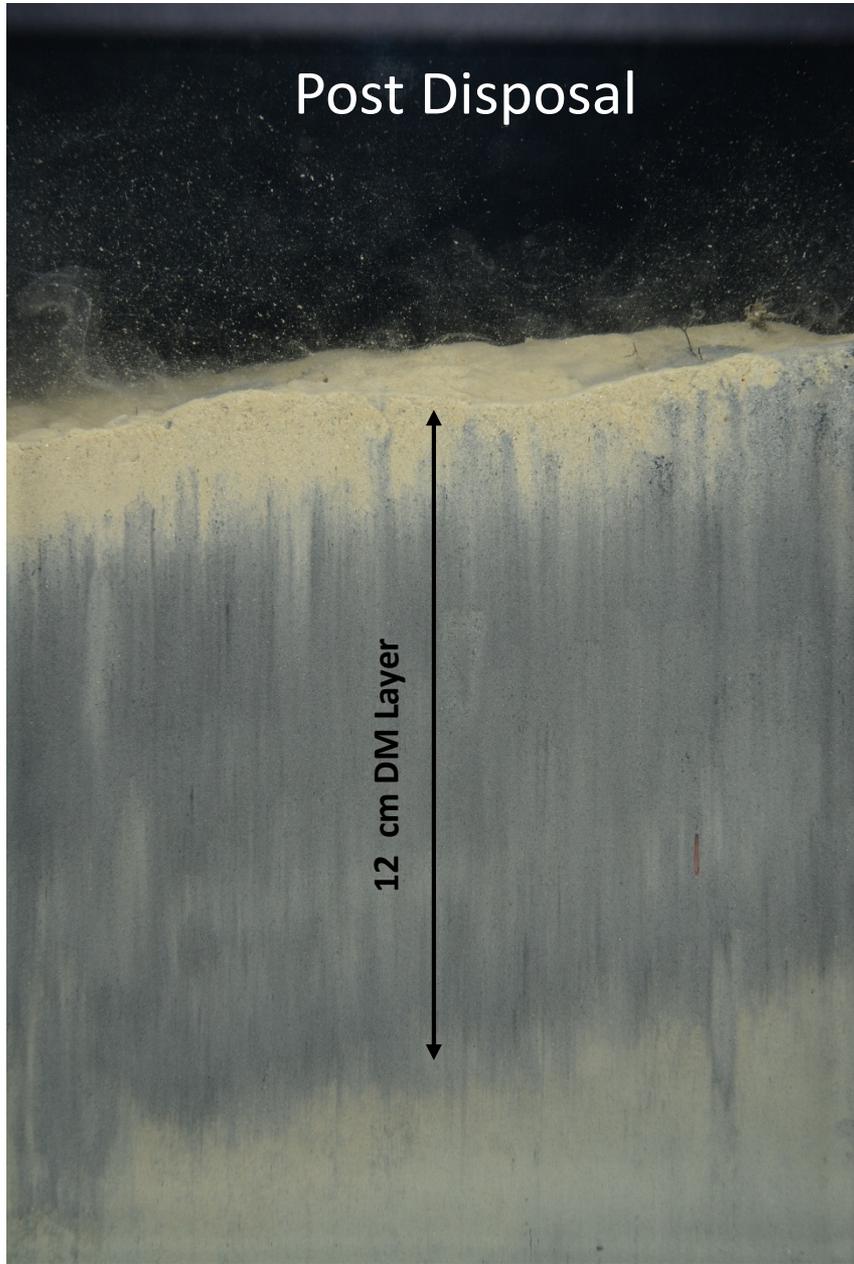


7 cm DM Layer

Disposed Dredged Material Footprint

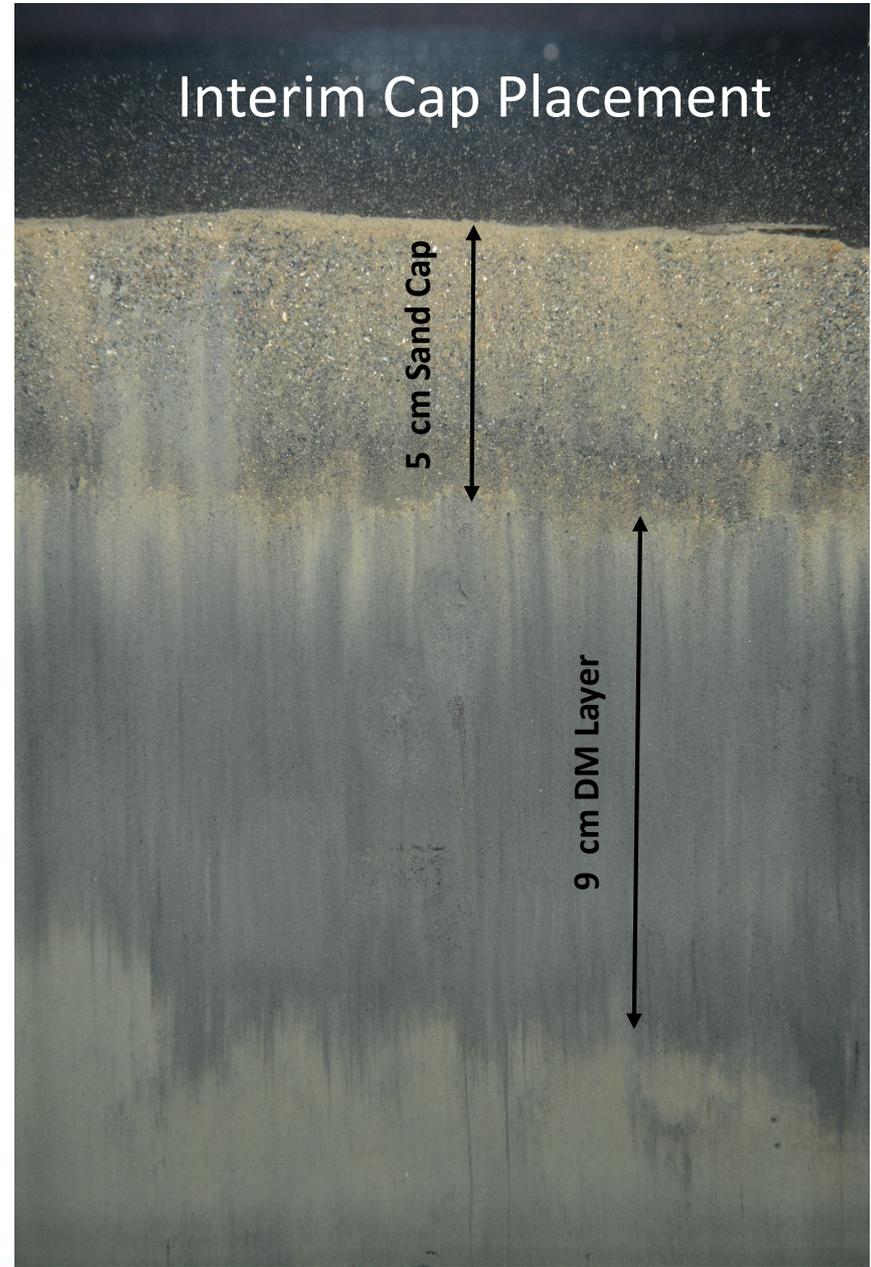


Disposal Site—Interim Cap Survey

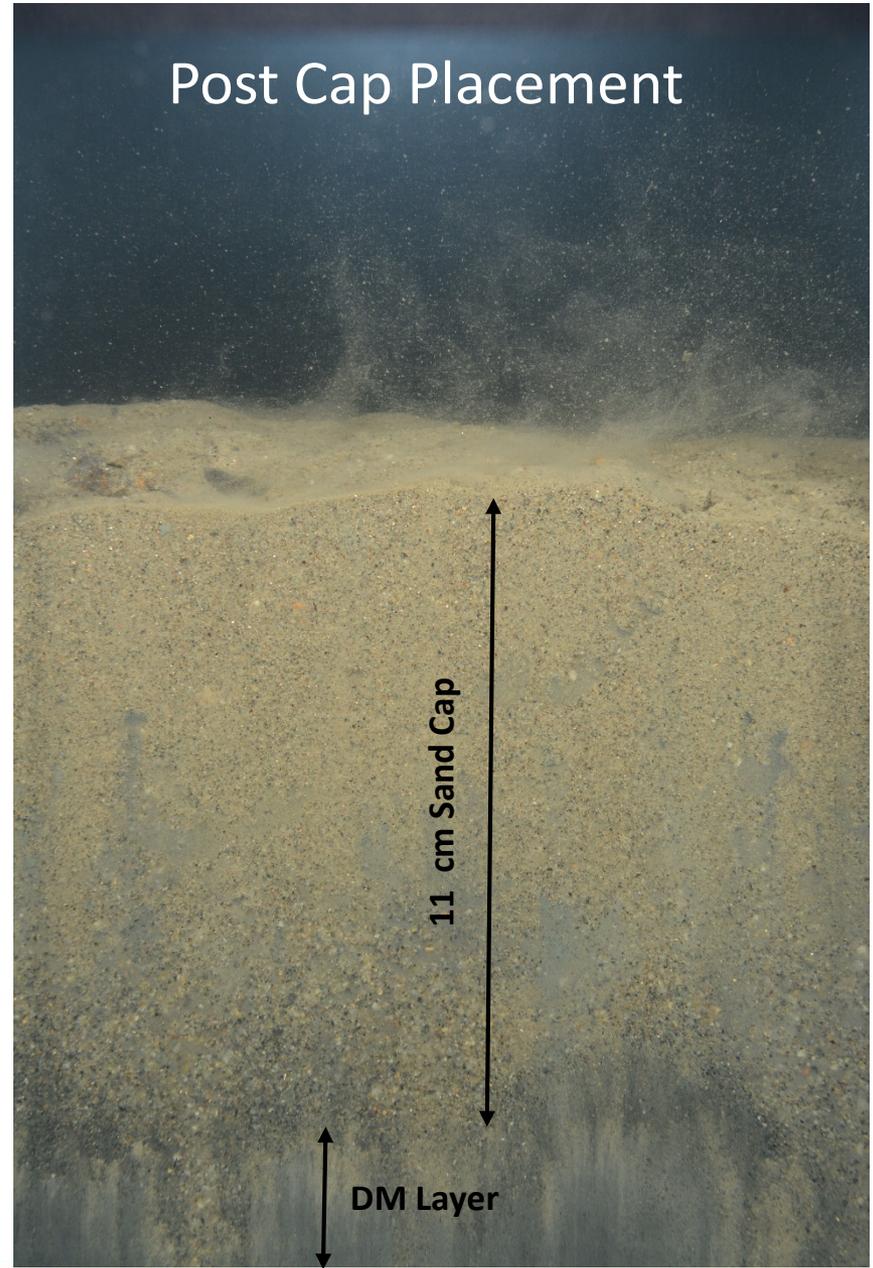
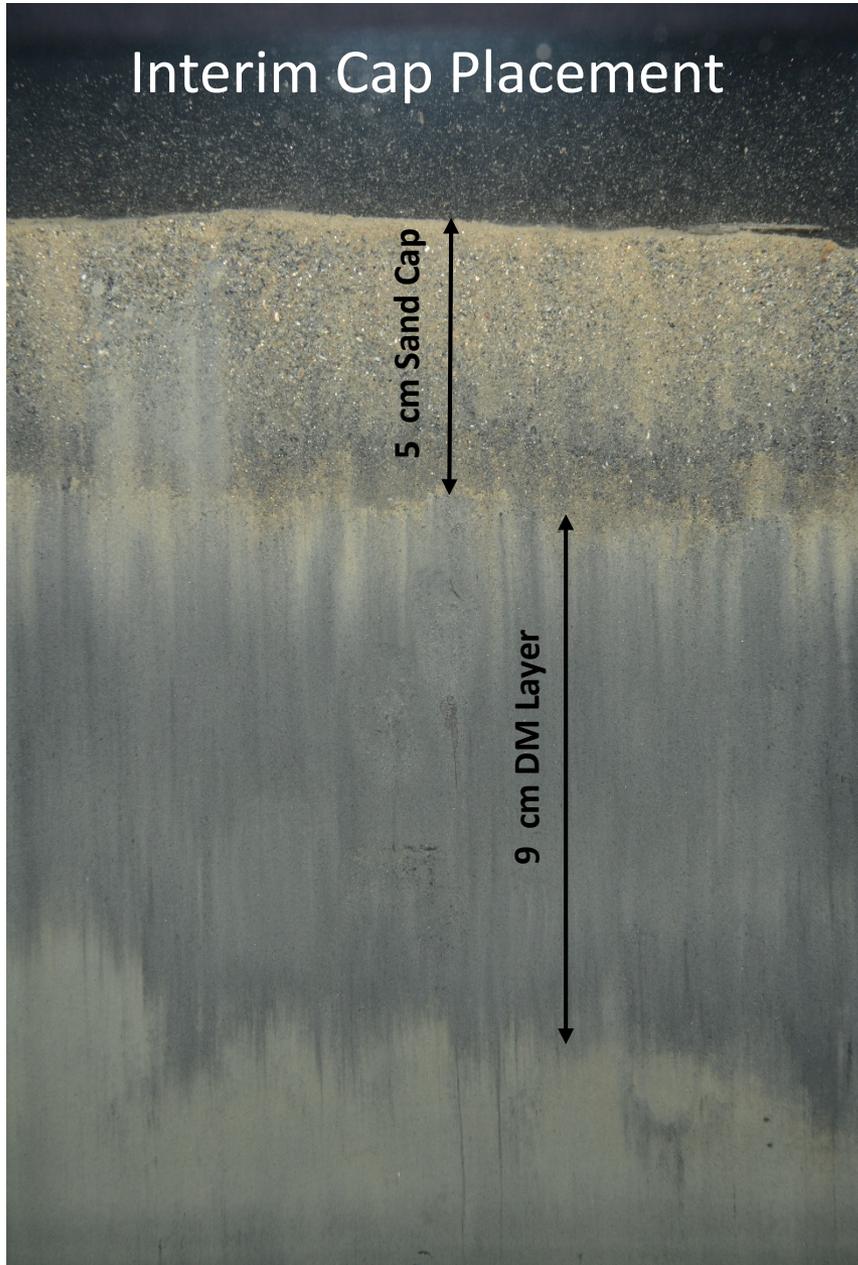


21 cm

A vertical double-headed arrow spanning the height of both photographs, labeled 21 cm.



Disposal Site—Post-capping Survey



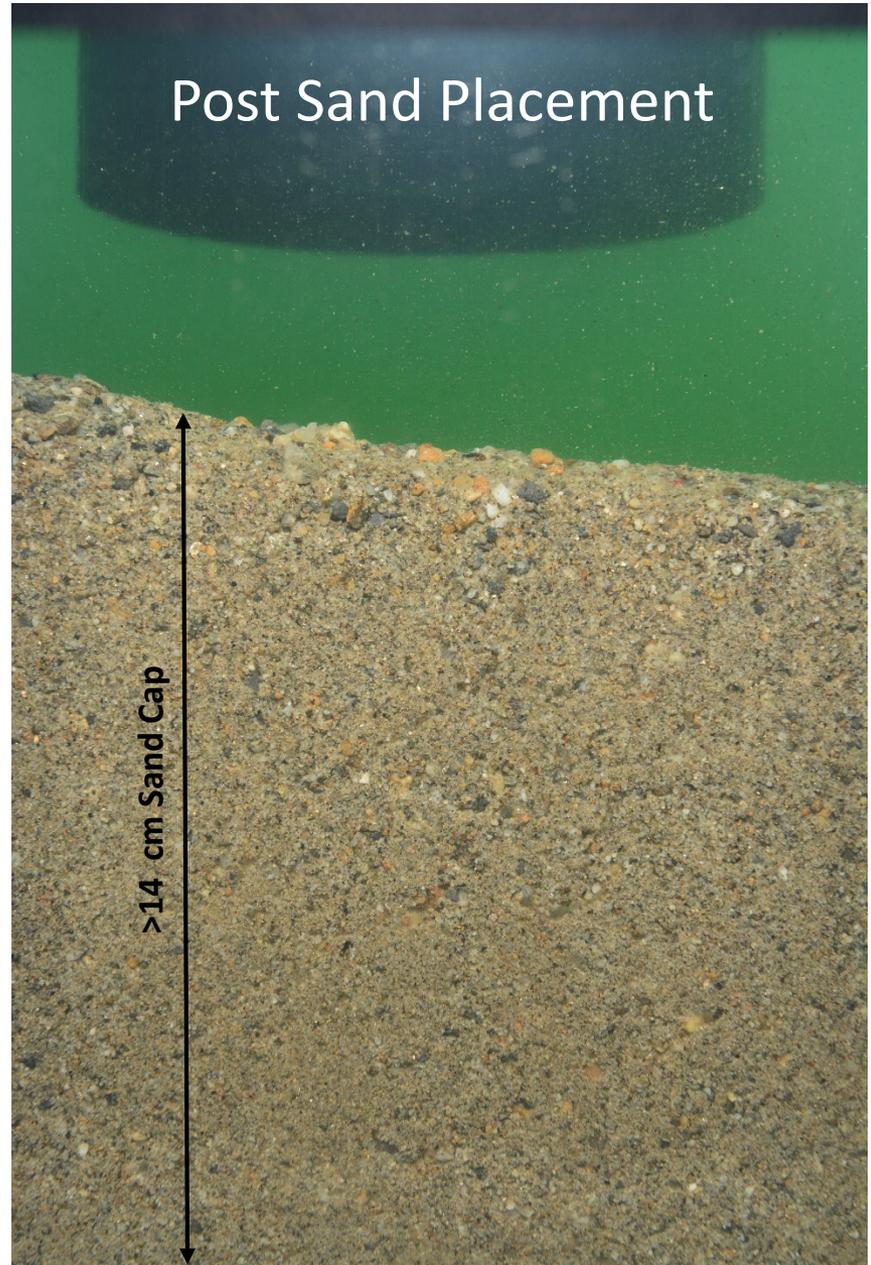
Douglas Harbor—Post-capping Survey

Post Dredging



21 cm

Post Sand Placement

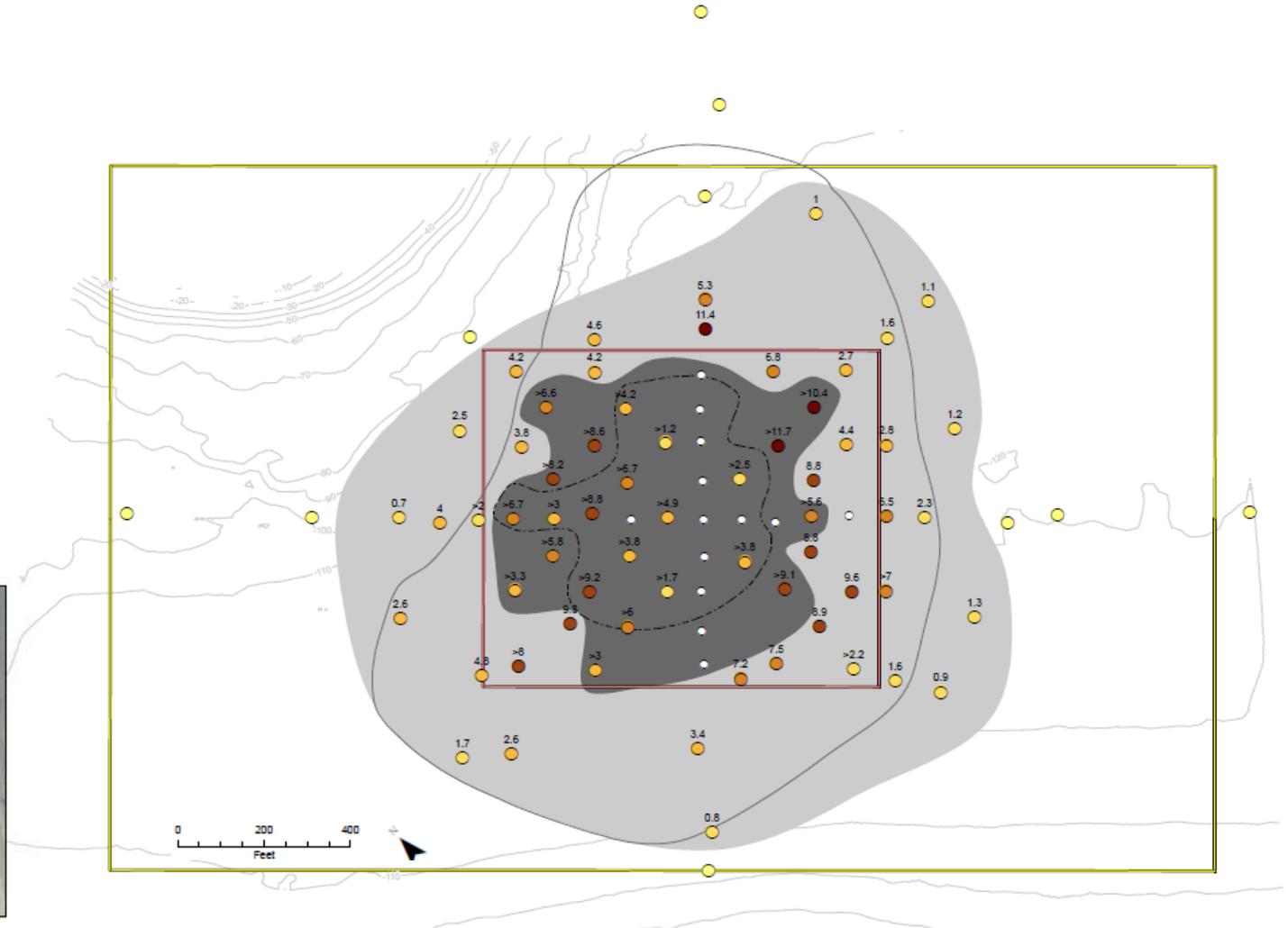


>14 cm Sand Cap

Post Sand Cap Survey—Disposal Site

Sand Cap Thickness (cm)

- 0.0
- 0.1 - 2.5
- 2.6 - 5.0
- 5.1 - 7.5
- 7.6 - 10.0
- 10.1 - 14.1
- No Penetration
- Not Analyzed
- Dredge Material > SPI Prism Penetration
- ▭ Extent of Dredge Material
- Sand Cap > SPI Prism Penetration
- Extent of Sand Cap Material
- Bathymetry (10-Foot Interval)
- Survey Area
- Disposal Site
- Harbor Dredging Area



iSPI...with my little eye...

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Semi-automatic analysis and interpretation of sediment profile images

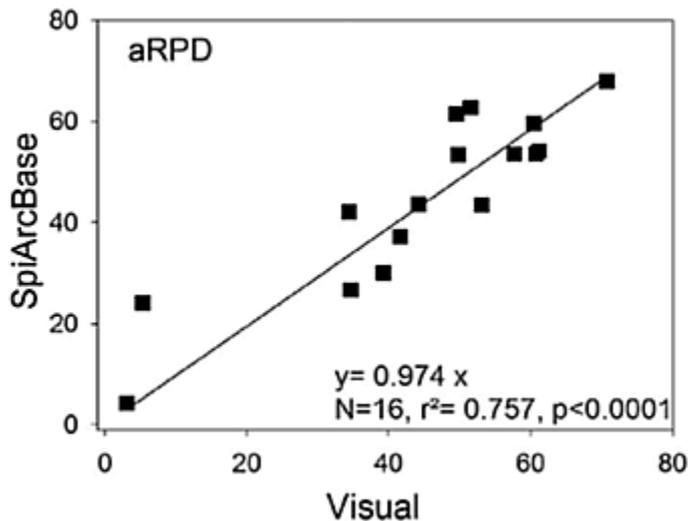


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^c CNRS, EPOC, UMR 5805, F33400 Talence, France



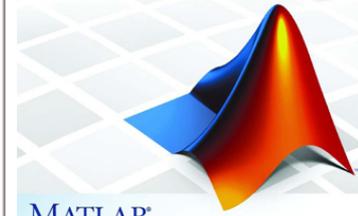
ABSTRACT

Sediment Profile Images (SPIs) are widely used for benthic ecological quality assessment under various environmental stressors. The processing of the information contained in SPIs is slow and its interpretation is largely operator dependent. We report here on a new software: SpiArcBase, which allows for a semi-automatic analysis of SPIs and facilitates the interpretation of observed features. SpiArcBase enhances the objectivity of the information extracted from SPIs, especially for the assessment of the apparent Redox Potential Discontinuity (aRPD). This new software also allows the user to create and manage a database containing original SPIs and corresponding derived pieces of information. Examples of the use of SpiArcBase for SPIs collected during a case study carried out within the Rhône River Prodelt are provided. Correlations between: (1) visually and automatically assessed aRPD and Benthic Habitat Quality Index (BHQ), and (2) automatically assessed aRPD and BHQ and surface sediment organic carbon support the use of this new software.

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Comparison of the mean depths of aRPD assessed automatically (SpiArcBase) and visually, by two independent operators (Romero-Ramirez et al. 2013)

iSPI Platform Architecture



MATLAB®



OpenCV



ImageJ

Image Processing & Analysis in Java



iSPI v0.1a
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iSPI_v0.1a

Project Overlay Processing Setup Reporting Reference Images

Grid = 5 cm x 5 cm

Project Information
File: iSPI_Douglas Harbor_Event 1.xlsx
Path: C:\Code_Share\ISPMAC1459_DHDP_TBD\iSPI Douglas
Analyst: Stupakoff, Ian

Subset: Harbor Area
ImageID: DH-01_A, DH-01_B, DH-01_C, DH-02_A, DH-02_B, DH-02_C, DH-03_A, DH-03_B, DH-03_C, DH-04_A, DH-04_B, DH-04_C, DH-04_C, DH-05_A

ISPI Batch Processing
Process Single PV/SP Pair Process Subset

Plan-View Processing
Laser Calibration [A] [A] [A] [A]
Feature Identification [A] [A] [A] [A]
Analyst Observations [A] [A] [A] [A]

Sediment Profile Processing
Sed/Water Interface [A] [A] [A] [A]
RPD Depth [A] [A] [A] [A]
Feature Identification [A] [A] [A] [A]
Grain Size [A] [A] [A] [A]
Analyst Observations [A] [A] [A] [A]

Measurement Tools
Distance Area
PV SP

Full-Resolution Image Viewer
Plan-View Sediment Profile

Mapping
Webmap Static-Map KML Export

Plan-View Attributes
Image Info:
Filename: L:\C1459_DHDP_TBD\Working_Files\iSPI A
FileModDate: 01-Apr-2016 14:49:34
FileSize: 15807034
Format: jpg
FormatVersion:
Width: 6000
Height: 4000
BitDepth: 24
ColorType: truecolor
FormatSignature:

Sediment Profile Attributes
Image Stats:
Penetration Depth: 7.8 cm
Boundary Roughness: 0.3 cm
RPD Depth: 2.2 cm
Image Info:
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FileModDate: 11-Jan-2016 16:07:59
FileSize: 11452827
Format: jpg
FormatVersion:
Width: 4000
Height: 6000
BitDepth: 24
ColorType: truecolor
FormatSignature:
NumberOfSamples: 3
CodingMethod: Huffman
CodingProcess: Sequential
Make: NIKON CORPORATION
Model: NIKON D7100
Orientation: 1
XResolution: 300
YResolution: 300
ResolutionUnit: Inch

Plan-View Results Sediment Profile Results

* iSPI Automated Processing
^ Manual Processing



iSPI_v0_1a

Project Overlay Processing Setup Reporting Reference Imag

Project Information

File: iSPI_Douglas Harbor_Event 1.xlsx
Path: C:\Code_Share\ISPM\1459_DHDP_TBD\iSPI Douglas
Analyst: Stupakoff, Ian

Subset	ImageID
All	DH-01_A
Disposal area	DH-01_B
Harbor Area	DH-01_C
	DH-02_A
	DH-02_B
	DH-02_C
	DH-03_A
	DH-03_B
	DH-03_C
	DH-04_A
	DH-04_B
	DH-04_C
	DH-05_A

iSPI Batch Processing

Process Single PV/SP Pair Process Subset

Plan-View Processing	Proc. Selection	QA
TBD	*	N Y
<input checked="" type="checkbox"/> Laser Calibration	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>
<input checked="" type="checkbox"/> Feature Identification	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>
Analyst Observations	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>

Sediment Profile Processing

Proc. Selection	QA	
TBD	*	N Y
<input checked="" type="checkbox"/> Sed/Water Interface	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>
<input checked="" type="checkbox"/> RPD Depth	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>
<input checked="" type="checkbox"/> Feature Identification	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>
<input checked="" type="checkbox"/> Grain Size	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>
Analyst Observations	<input checked="" type="radio"/> <input type="radio"/> <input type="radio"/>	<input type="radio"/> <input checked="" type="radio"/>

Measurement Tools

Distance Area

PV SP

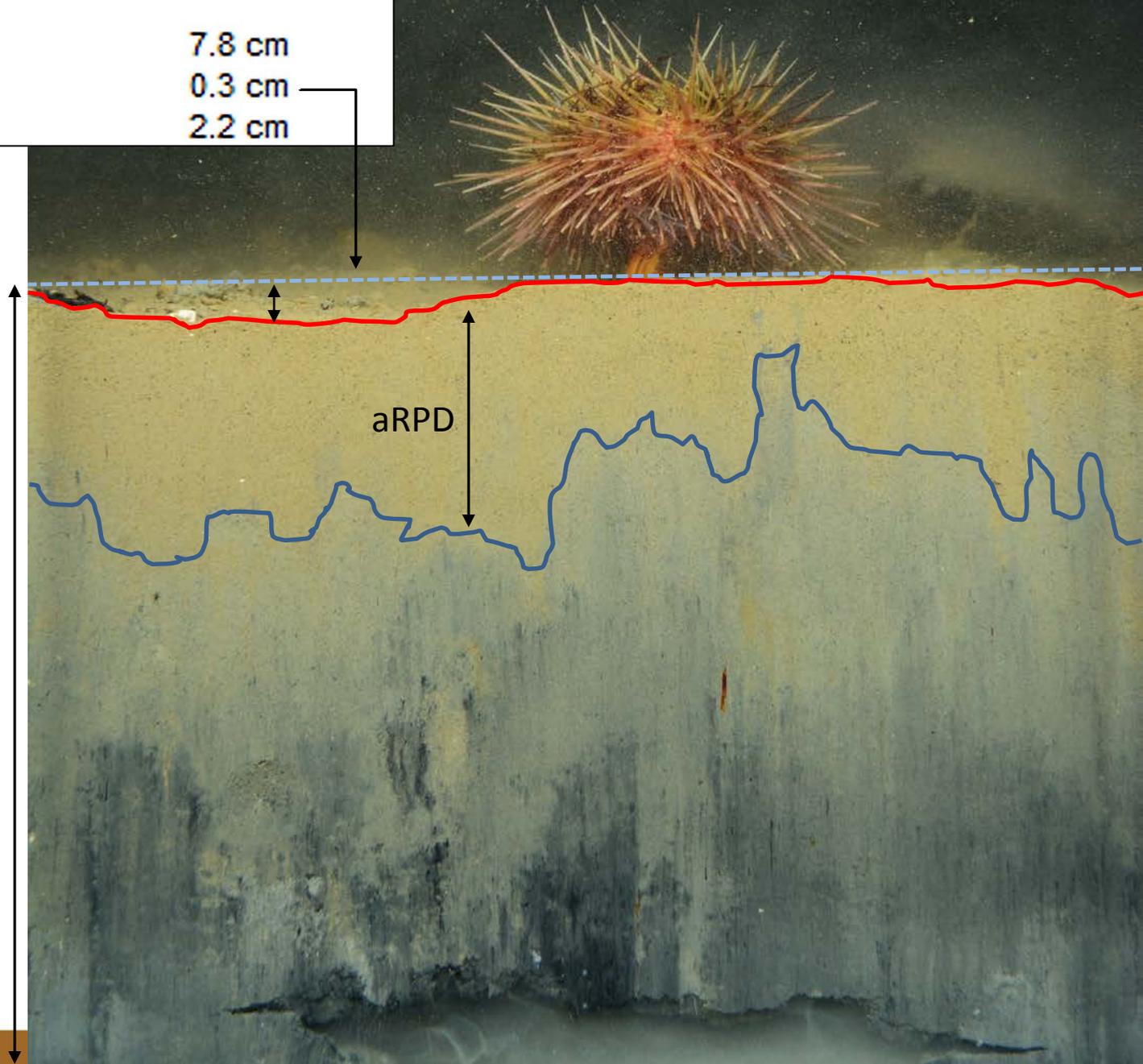
* iSPI Automated Processing
^ Manual Processing

Sediment Profile Attributes

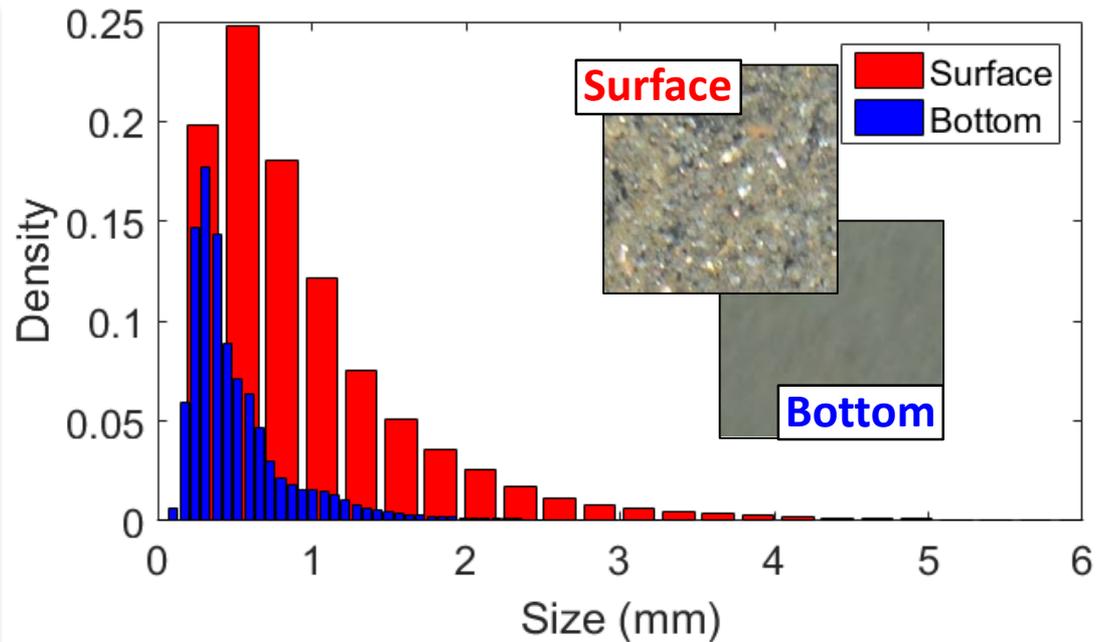
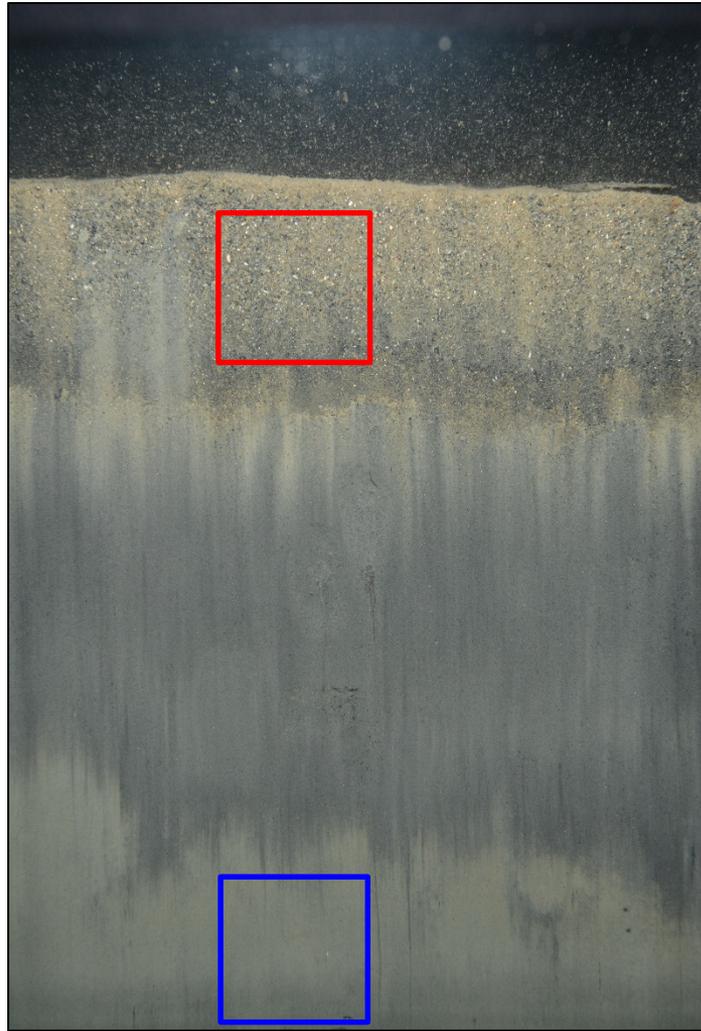
Image Stats:

Penetration Depth:	7.8 cm
Boundary Roughness:	0.3 cm
RPD Depth:	2.2 cm

Penetration Depth

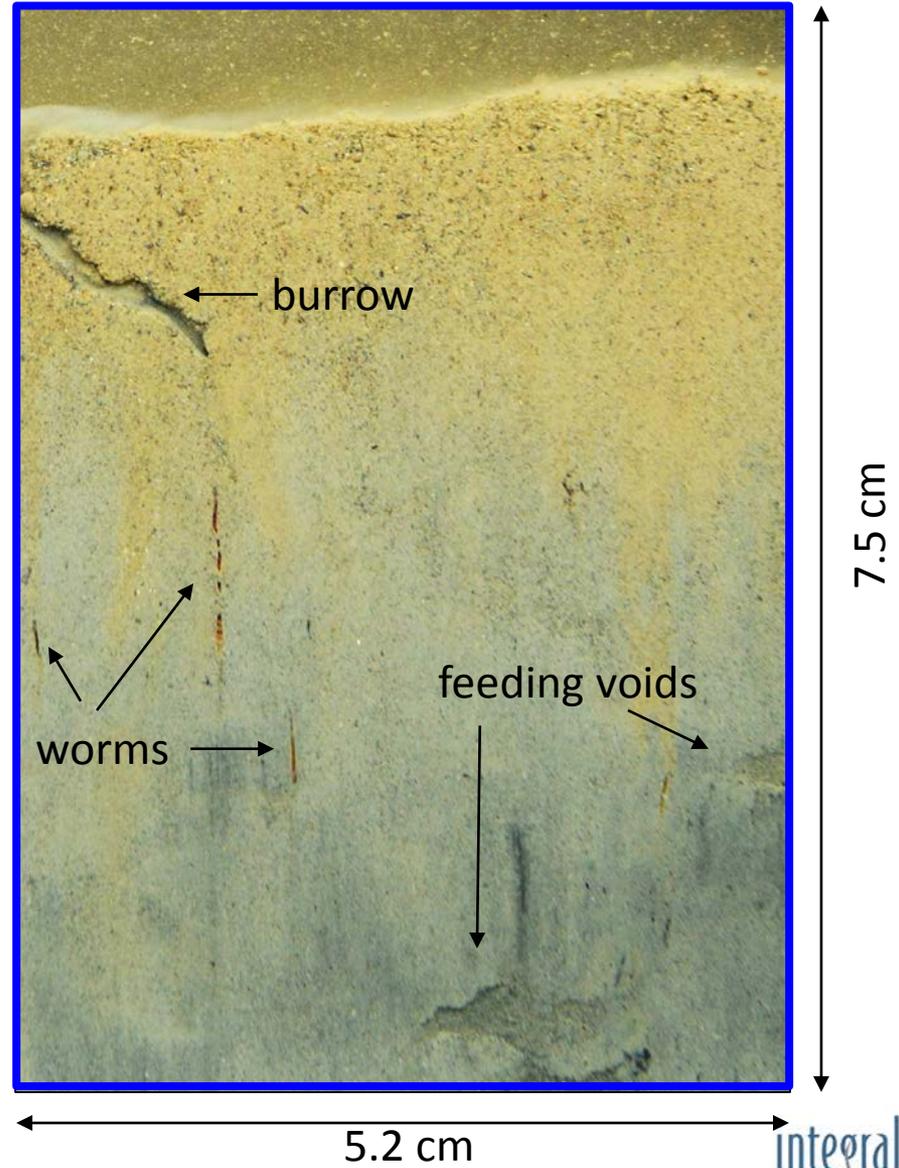
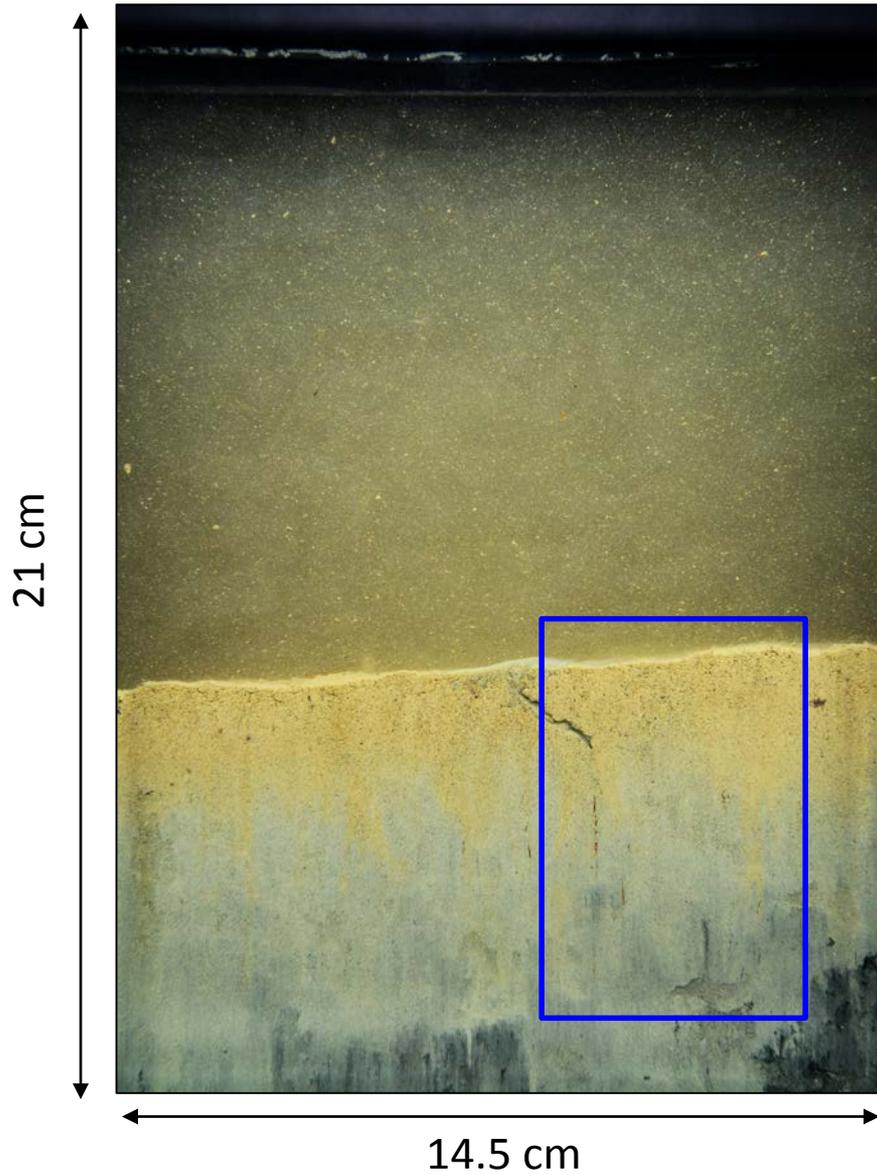


Grain Size Analysis*



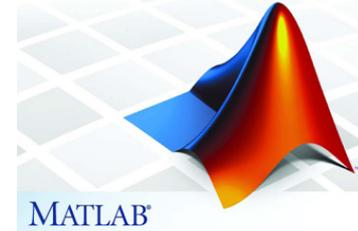
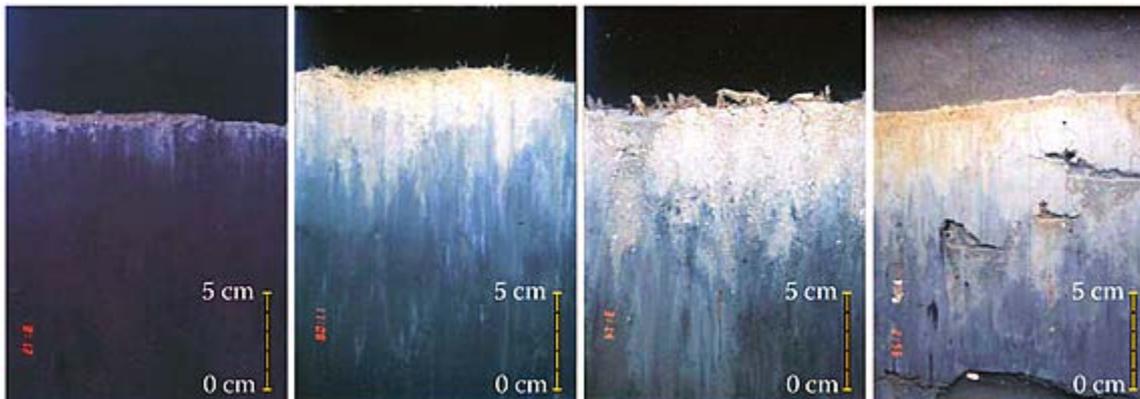
*Buscombe, D. 2013. Transferable wavelet method for grain-size distribution from images of sediment surface and thin sections, and other natural granular patterns. *Sedimentology* 60:1709–1732. http://dbuscombe-usgs.github.io/DGS_Project/

Biological Parameters



iSPI Image Analysis Goals

- Semi-Automate Measurement of basic features in SPI and PV images
- Standardize Data Quality
- Improve Data Management and Analytical Capabilities
- Minimize Subjectivity/BPJ in Image Interpretation



Questions?

