Deepwater Horizon Oil Spill Salt Marsh Treatment Tests: Monitoring Results

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Initial Oiling Conditions

Bay Jimmy, N. Barataria Bay Louisiana

June 2010

Maximum Marsh Oiling in Louisiana	Current Marsh Oiling (30-September-11)
Total Marsh Shoreline (heavy to trace oiling)	Total Marsh Shoreline (heavy to trace oiling)
729 km (453 mi.) →	256 km (159 mi.)
Heavy Marsh Oiling	Heavy Marsh Oiling
137 km (85 mi.) →	11 km (7 mi.)
Moderate Marsh Oiling	Moderate Marsh Oiling
158 km (98 mi.) →	34 km (21 mi.)



Heavy Persistent Oiling Conditions

September 2010 and beyond

1) Heavily oiled wrack lines
2) Heavily oiled vegetation mats
3) Thick oil trapped on the marsh surface

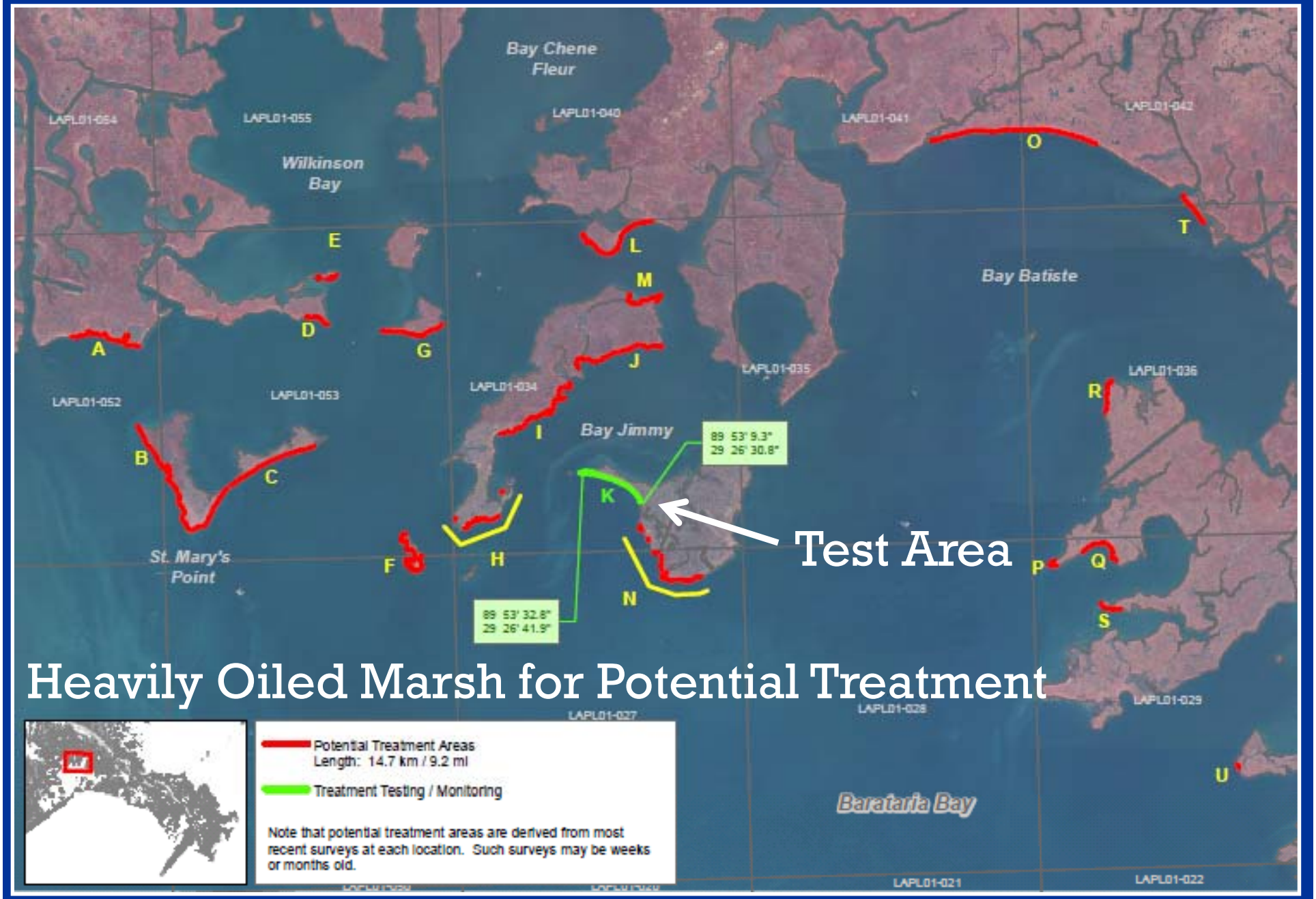
Heavily Oiled Vegetation Mats

Laid Over Vegetation

Thick oil (mousse) trapped under the oiled vegetation mats

Marsh Treatment Tests

- Initiated due to the degree and nature of oiling, potential for delayed marsh recovery, and risk of additional cleanup impacts
- Treatment goal was to improve oil weathering and degradation and enhance habitat recovery, without causing further harm; goal was not to remove all the oil
- Conducted to support cleanup planning, environmental review, and adaptive cleanup operations


Bay Chene Fleur
Wilkinson Bay
Bay Batiste
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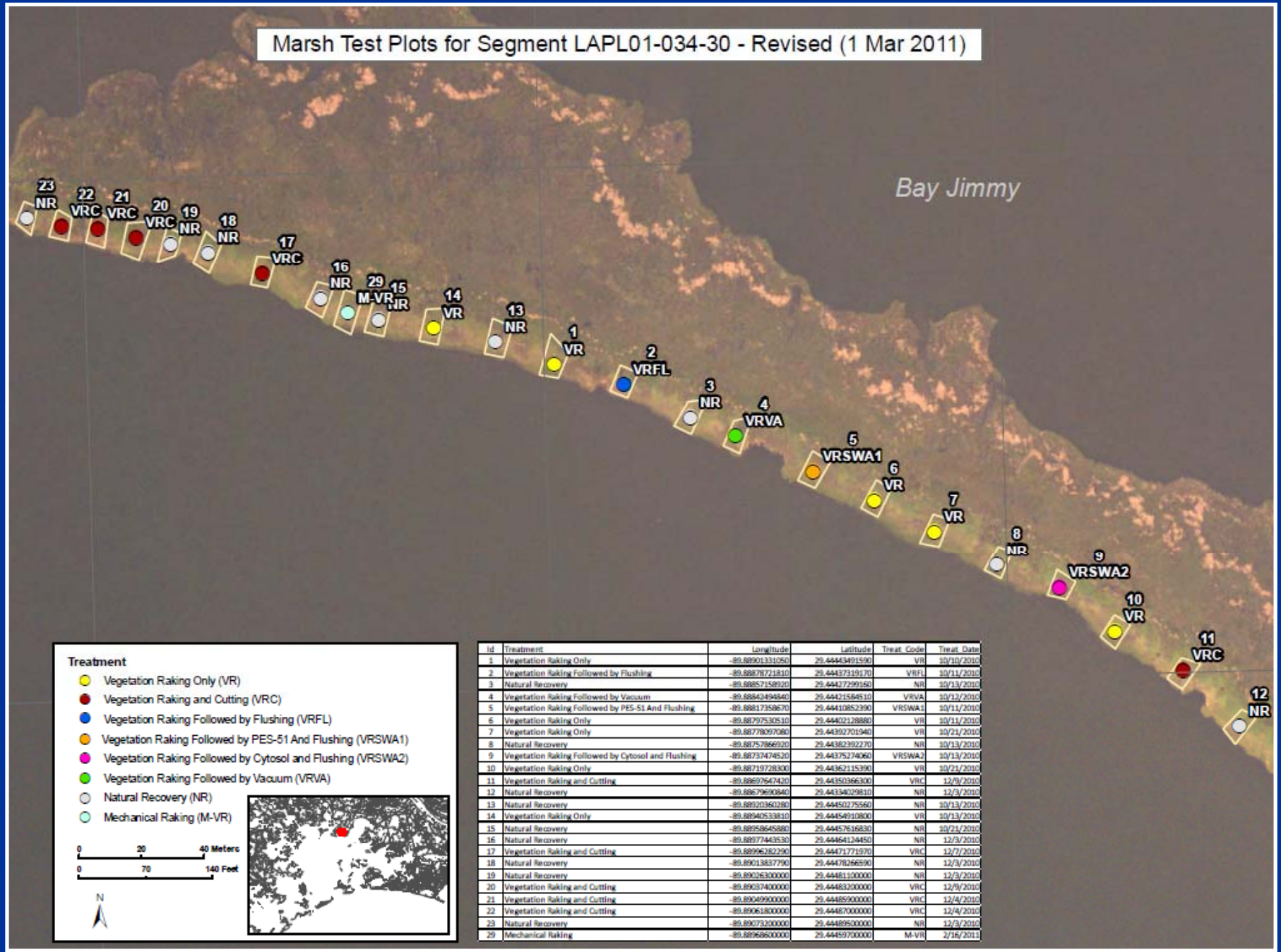
89° 53' 9.3"
29° 26' 30.8"
89° 53' 32.8"
29° 26' 41.9"
Test Area
Heavily Oiled Marsh for Potential Treatment
Potential Treatment Areas
Length: 14.7 km / 9.2 mi
Treatment Testing / Monitoring
Note that potential treatment areas are derived from most recent surveys at each location. Such surveys may be weeks or months old.

Marsh Test Plots for Segment LAPL01-034-30 - Revised (1 Mar 2011)



Id	Treatment	Longitude	Latitude	Treat_Code	Treat_Date
1	Vegetation Raking Only	-89.88901331050	29.44443491590	VR	10/10/2010
2	Vegetation Raking Followed by Flushing	-89.88878721810	29.44437319170	VRFL	10/11/2010
3	Natural Recovery	-89.88857158920	29.44427299160	NR	10/13/2010
4	Vegetation Raking Followed by Vacuum	-89.88842494840	29.44421584510	VRVA	10/12/2010
5	Vegetation Raking Followed by PES-51 And Flushing	-89.88817358670	29.44410852390	VRSWA1	10/11/2010
6	Vegetation Raking Only	-89.88797530510	29.44402128880	VR	10/11/2010
7	Vegetation Raking Only	-89.88778097080	29.44392701940	VR	10/21/2010
8	Natural Recovery	-89.88757866920	29.44382392270	NR	10/13/2010
9	Vegetation Raking Followed by Cytosol and Flushing	-89.88737474520	29.44375274060	VRSWA2	10/13/2010
10	Vegetation Raking Only	-89.88719728300	29.44362115390	VR	10/21/2010
11	Vegetation Raking and Cutting	-89.88697647420	29.44350366300	VRC	12/9/2010
12	Natural Recovery	-89.88679690840	29.44334029810	NR	12/3/2010
13	Natural Recovery	-89.88920360280	29.44450275560	NR	10/13/2010
14	Vegetation Raking Only	-89.88940533810	29.44454910800	VR	10/13/2010
15	Natural Recovery	-89.88958645880	29.44457616830	NR	10/21/2010
16	Natural Recovery	-89.88977443530	29.44464124450	NR	12/3/2010
17	Vegetation Raking and Cutting	-89.88996282290	29.44471771970	VRC	12/7/2010
18	Natural Recovery	-89.89013837790	29.44478266590	NR	12/3/2010
19	Natural Recovery	-89.89026300000	29.44481100000	NR	12/3/2010
20	Vegetation Raking and Cutting	-89.89037400000	29.44483200000	VRC	12/9/2010
21	Vegetation Raking and Cutting	-89.89049900000	29.44485900000	VRC	12/4/2010
22	Vegetation Raking and Cutting	-89.89061800000	29.44487000000	VRC	12/4/2010
23	Natural Recovery	-89.89073200000	29.44489500000	NR	12/3/2010
29	Mechanical Raking	-89.88968600000	29.44459700000	M-VR	2/16/2011

Test Plot Set-Up

Test Plot Layout

Plot size 6 m x 8-10 m

Treatment Options Tested

- Low pressure flushing
- Vegetation mat cutting (weed trimmers)
- Marsh burning (small-scale)
- Manual raking
- Raking & low pressure flushing
- Raking, surface washing agents, & flushing
- Raking & vacuum treatments
- Raking & power cutting
- Natural recovery (no treatment)

Raking & Cutting, Dec. 2010

Immediate Post-Treatment

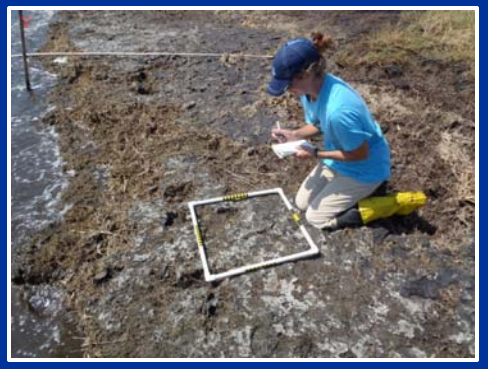
Total removal of the oiled vegetation mats and wrack

Post-Raking & Cutting
1-month

Removed or reduced thick mousse layer

Residual oil weathering and breaking up

Monitoring Results

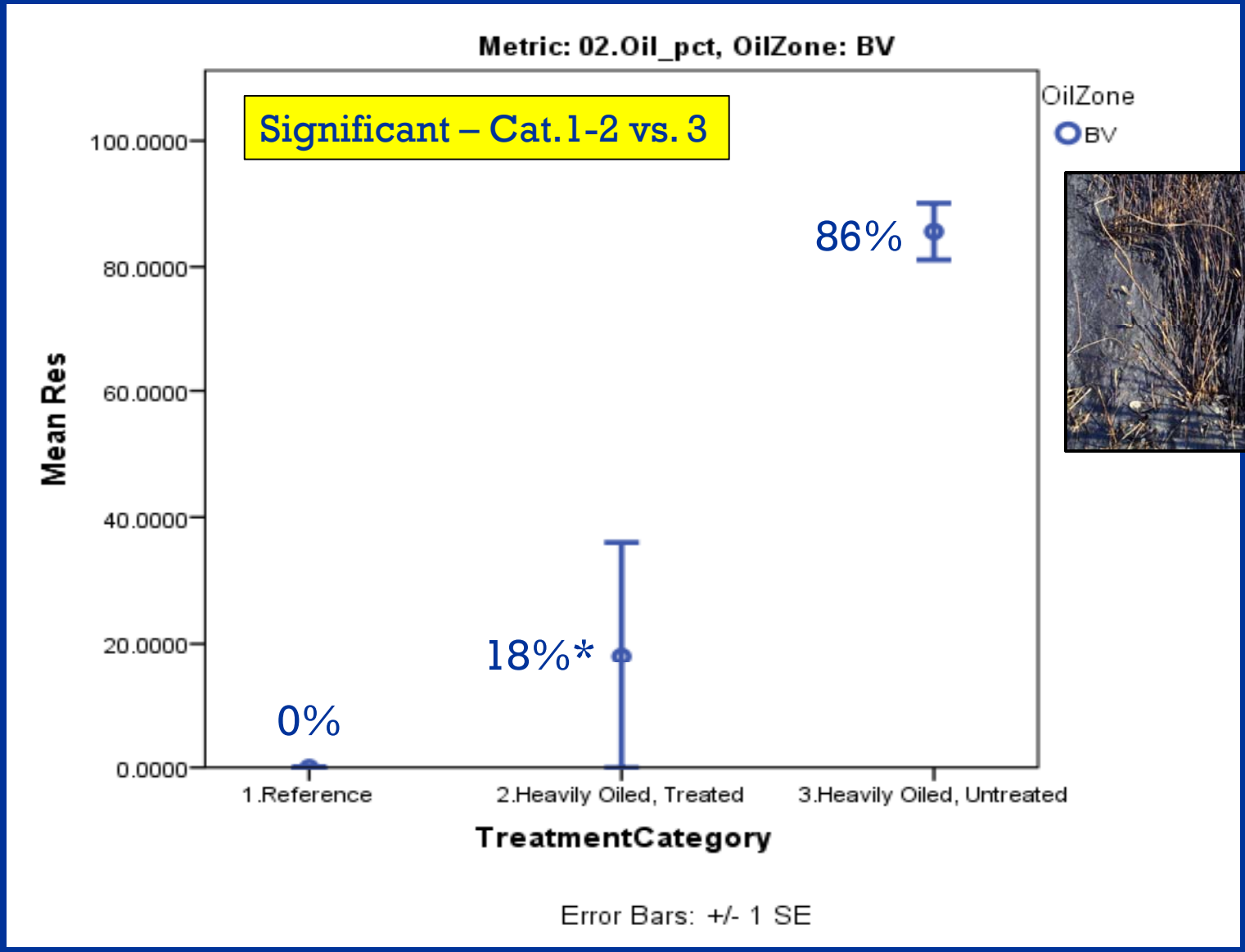


- Preliminary results
- Basic statistical analysis
- Data presented mainly from September 2011, 1+ year after initial impact, 9 months post-treatment, and after Tropical Storm Lee
- Comparison categories
  - 1) Reference - no to minimal oiling, vegetation intact
  - 2) Heavily Oiled, Treated - raking and cutting
  - 3) Heavily Oiled, Untreated - natural recovery only

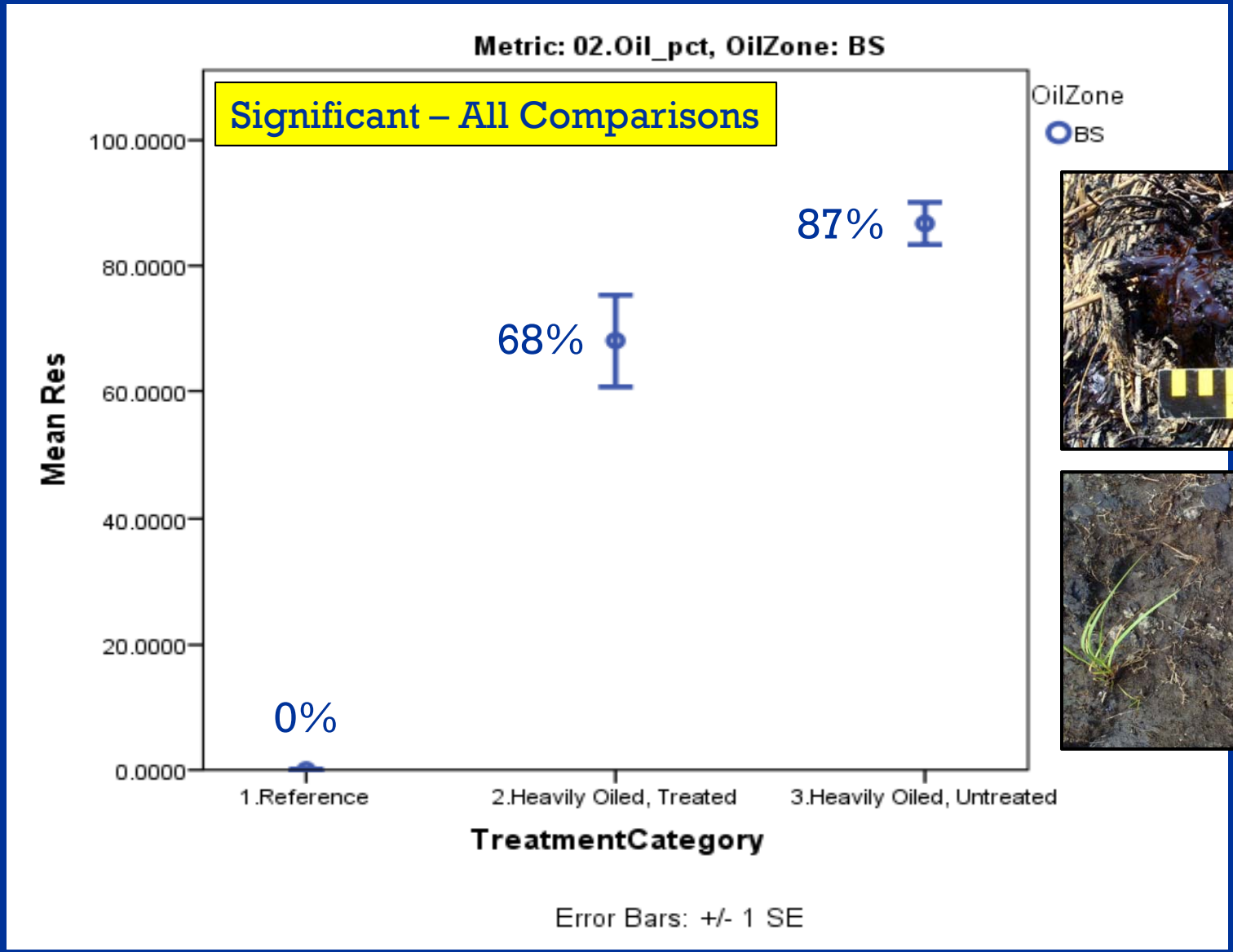
Monitoring Parameters

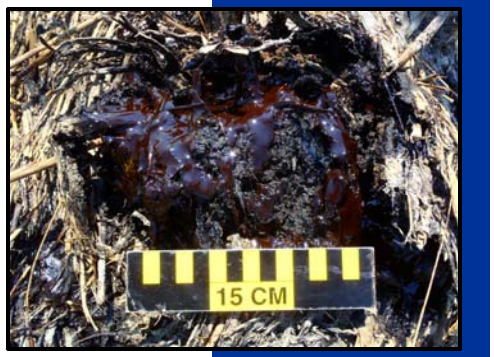
- Oil cover per oiling zone (%)
- Oil thickness (cm) and character
- Oil in subsurface sediments
  - TPH, Total PAH (mg/kg)
- Vegetation cover and composition
- Benthic faunal densities (#/m^2)
  - Fiddler crab burrows (*Uca* spp.)
  - Marsh periwinkles (*Littoraria irrorata*)
- Erosion
  - Shoreline change (m/yr)
  - Soil shear strength (kPA)

Oil Cover, Vegetation Mats & Wrack, Sept. 2011

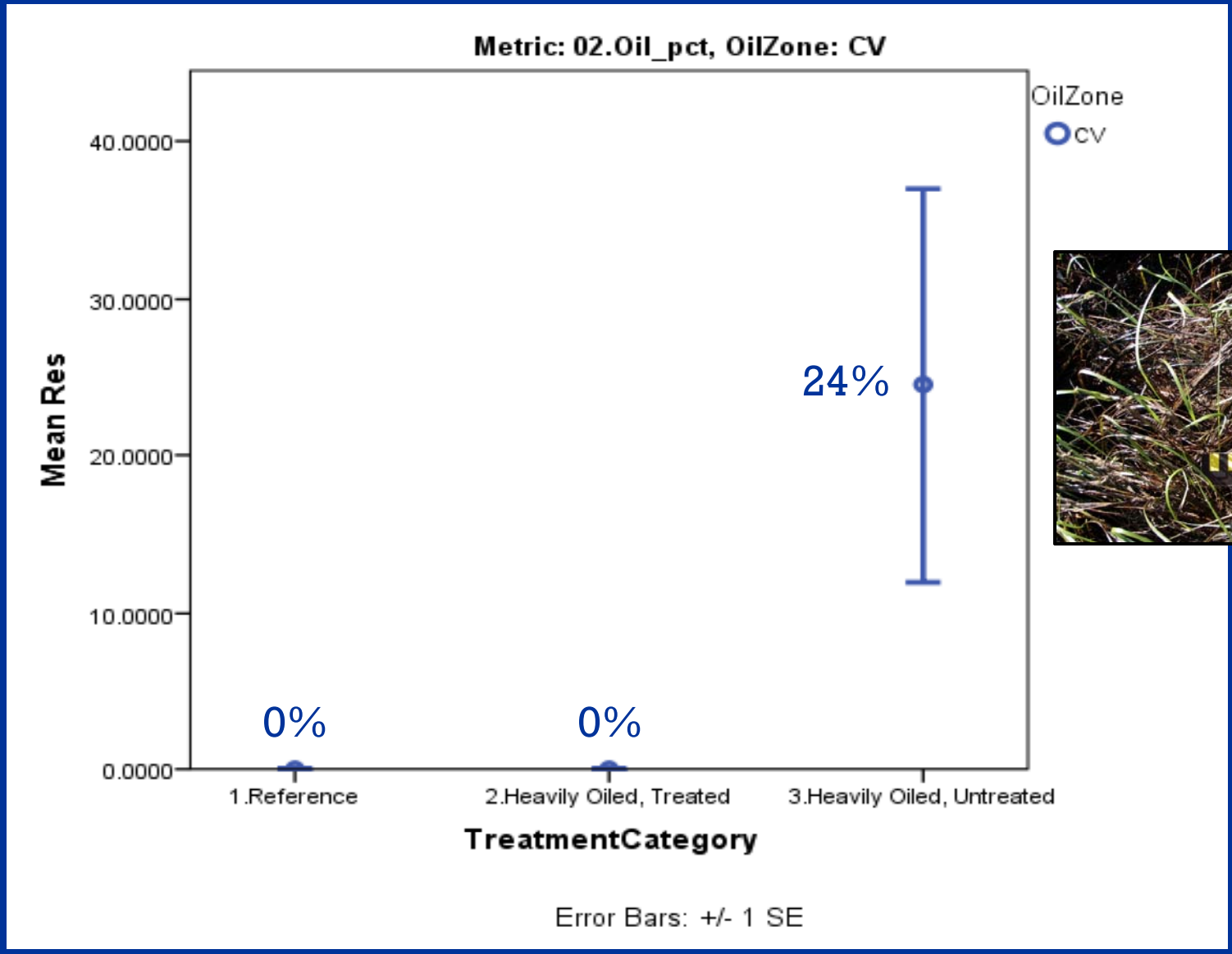


Oil Cover, Sediment Surface, Sept. 2011

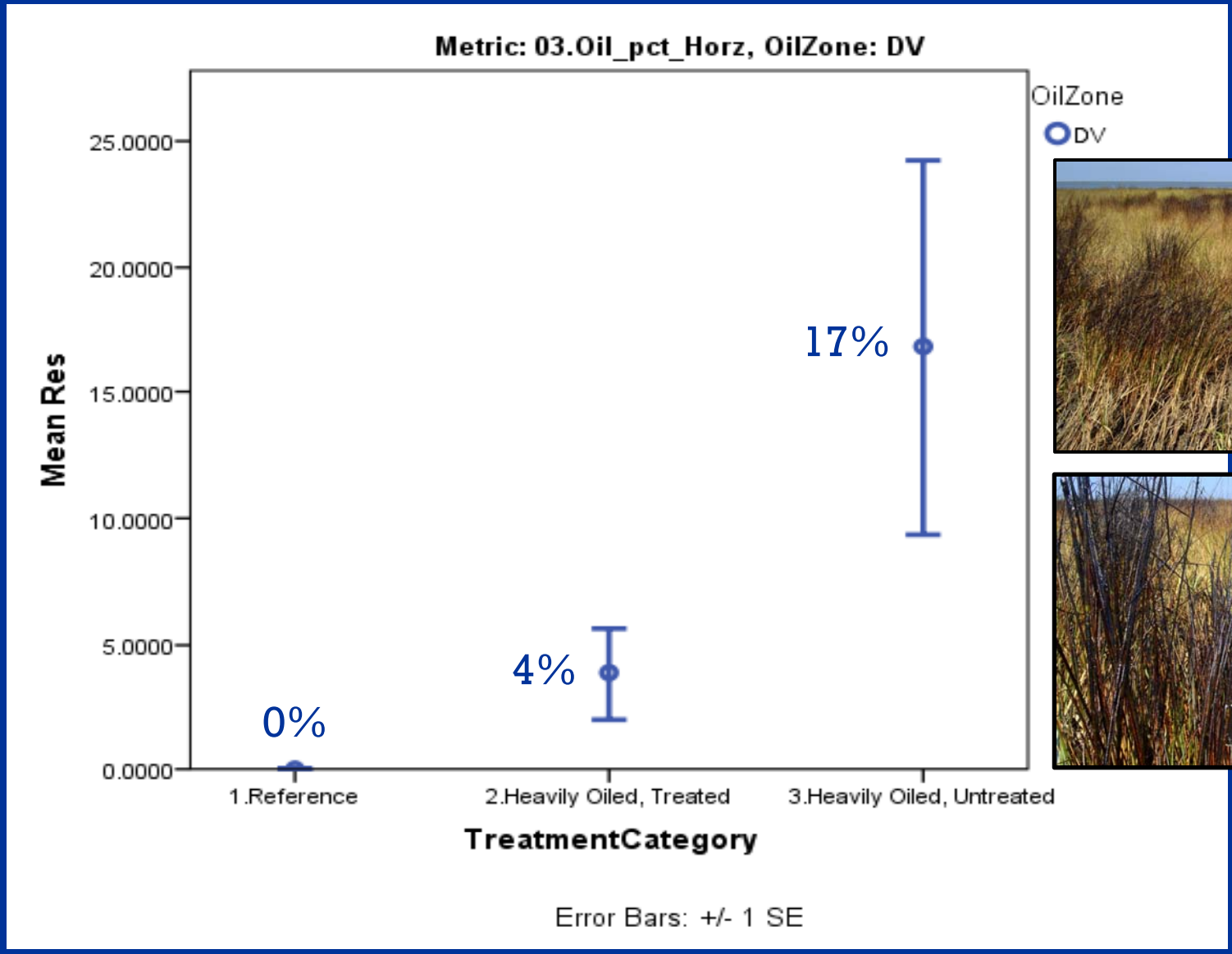




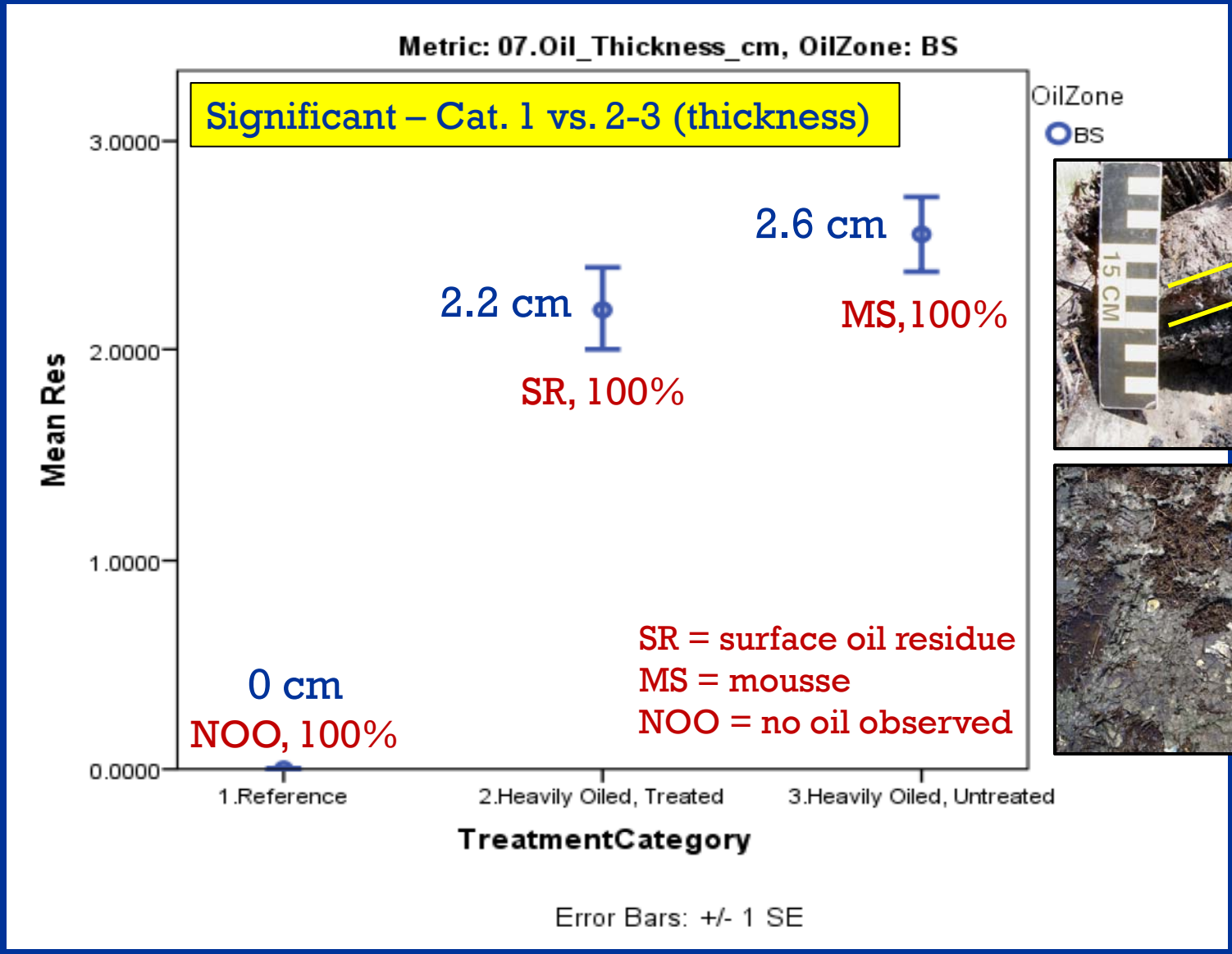
Oil Remobilization on New Vegetation, Sept. 2011

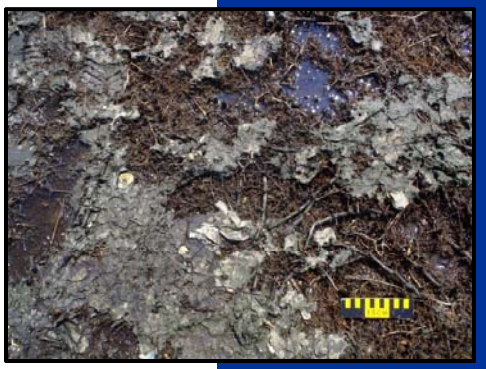


Oil Remobilization to Interior Vegetation, Sept. 2011

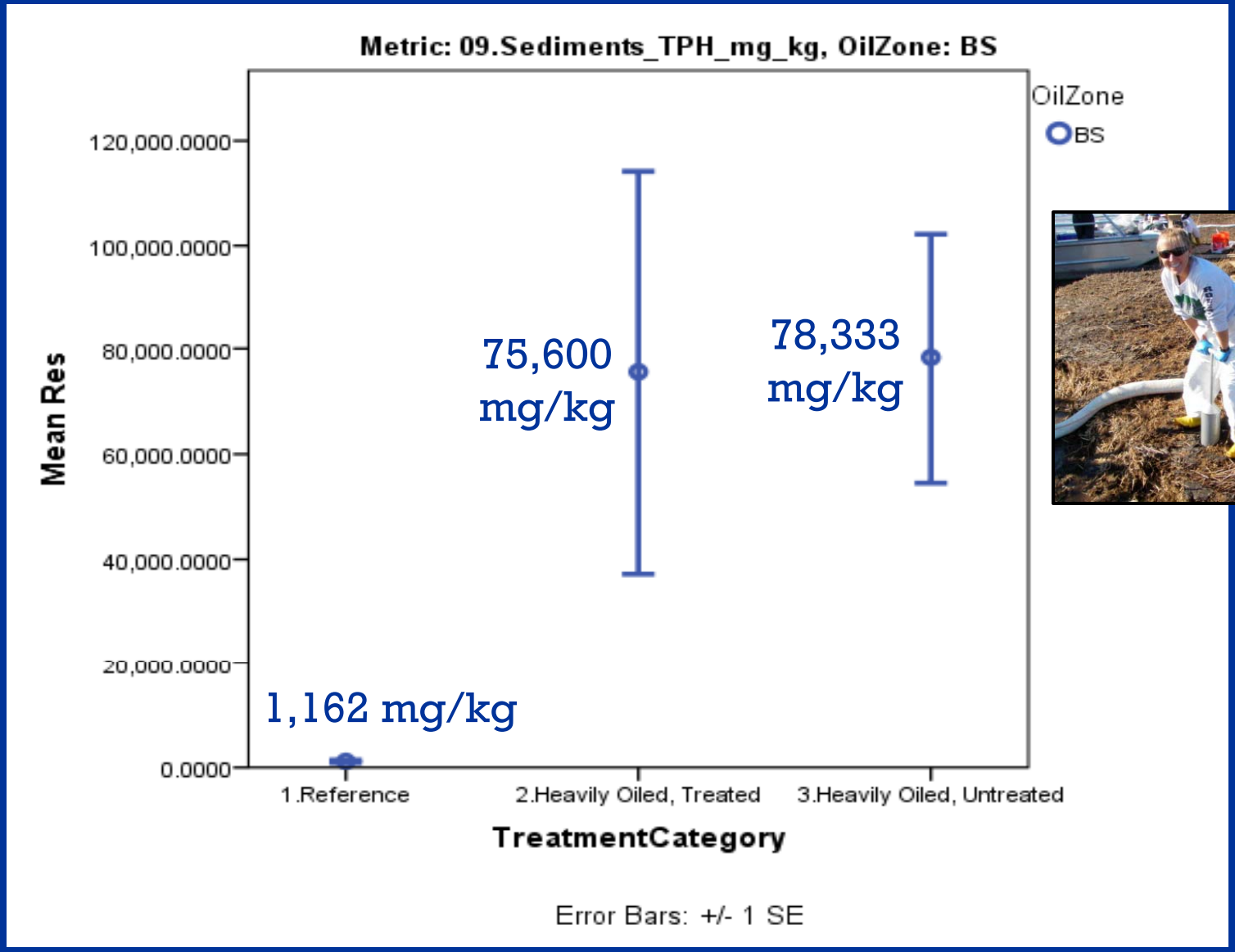


Oil Thickness (cm) & Oil Character, Sept. 2011

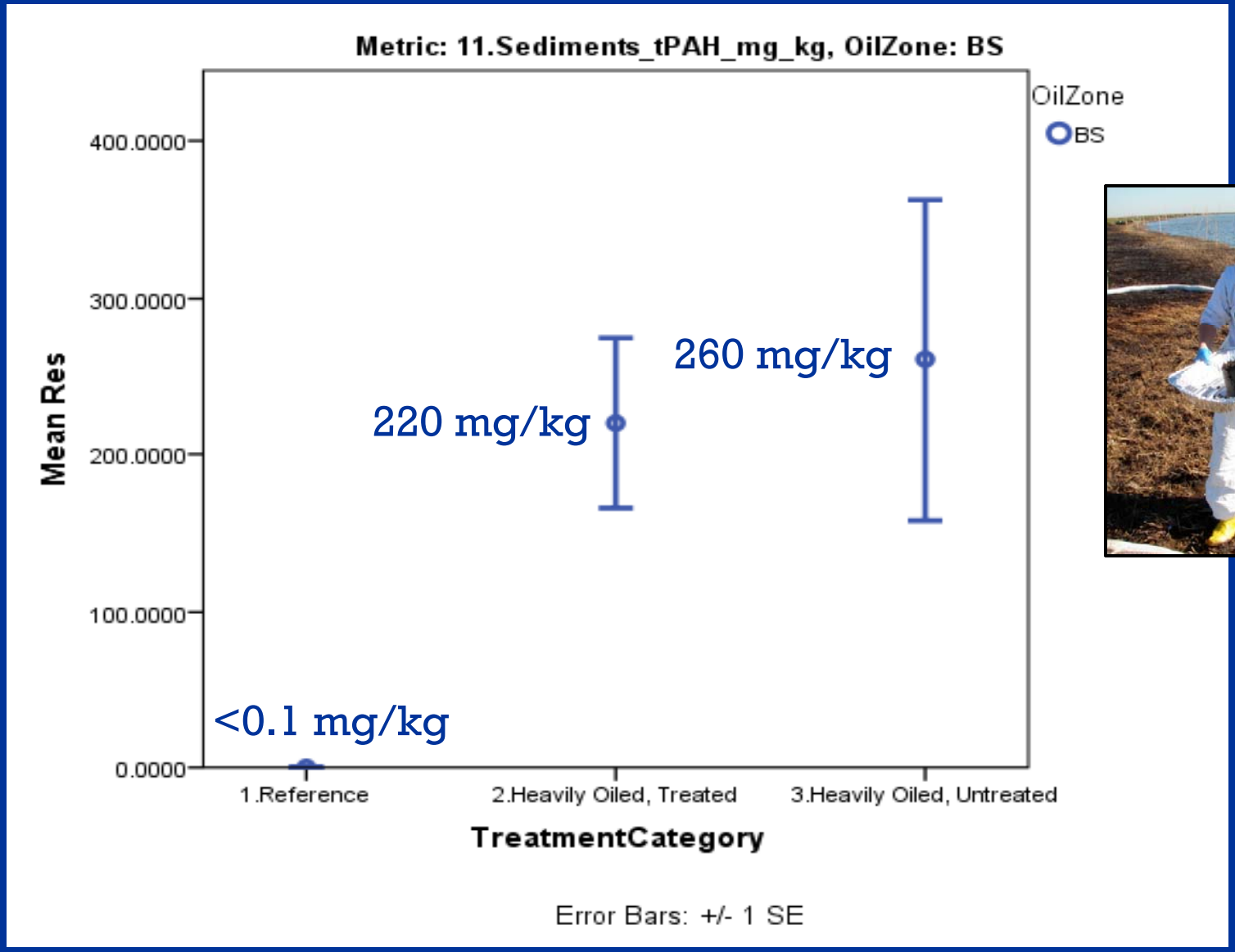




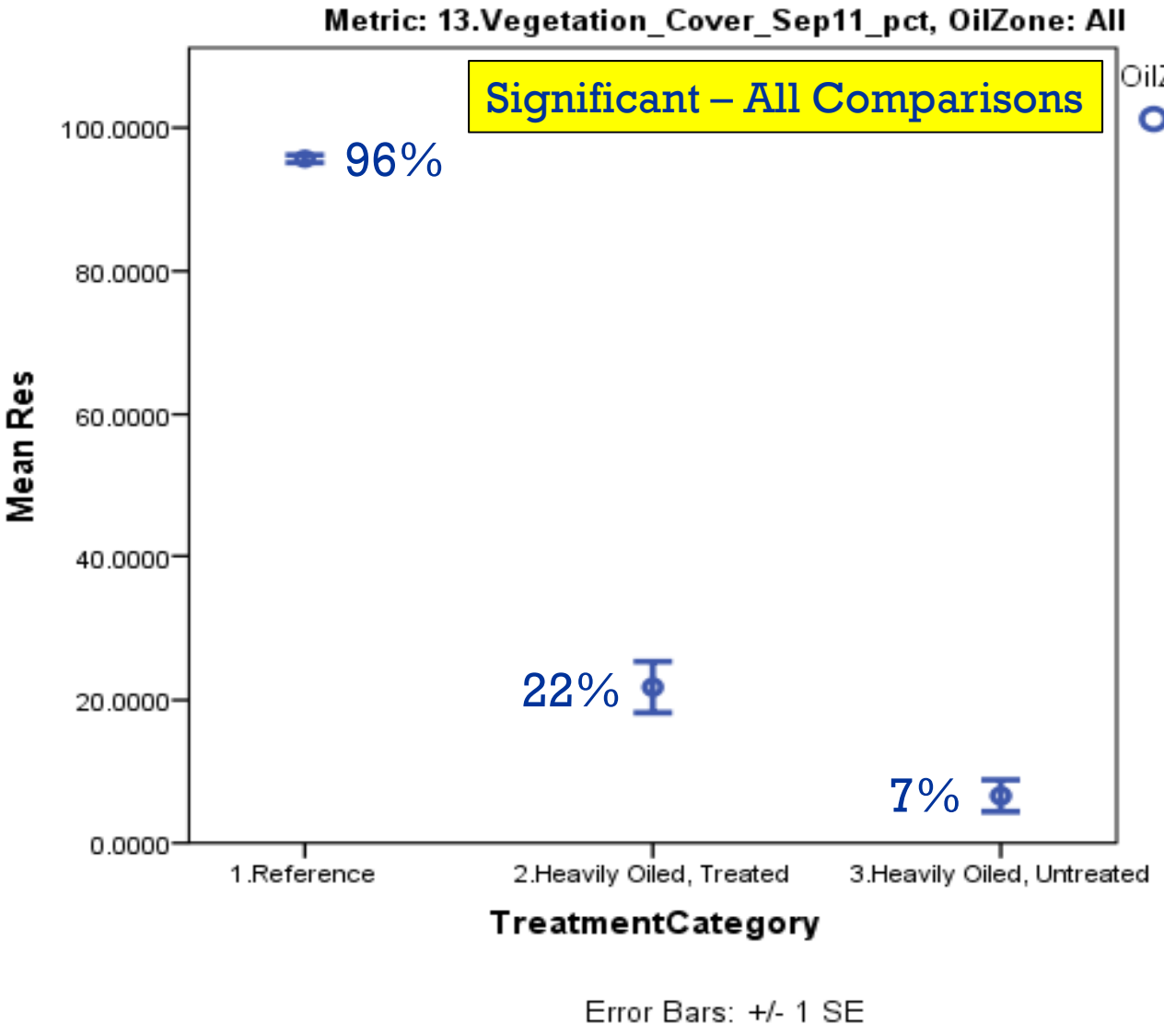
Oil in Subsurface Sediments (TPH), July-Aug 2011



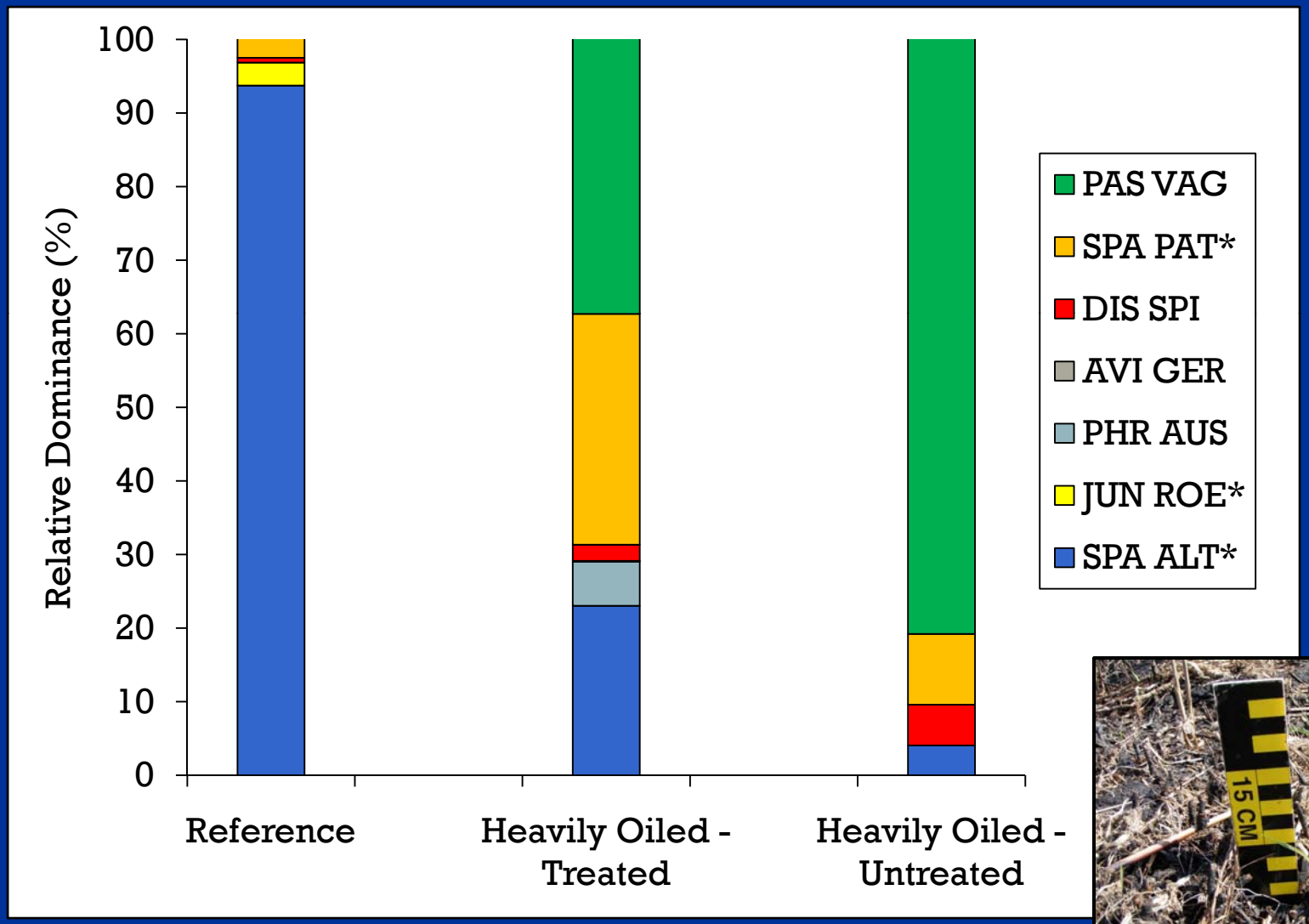
Oil in Subsurface Sediments (tPAH), July-Aug 2011



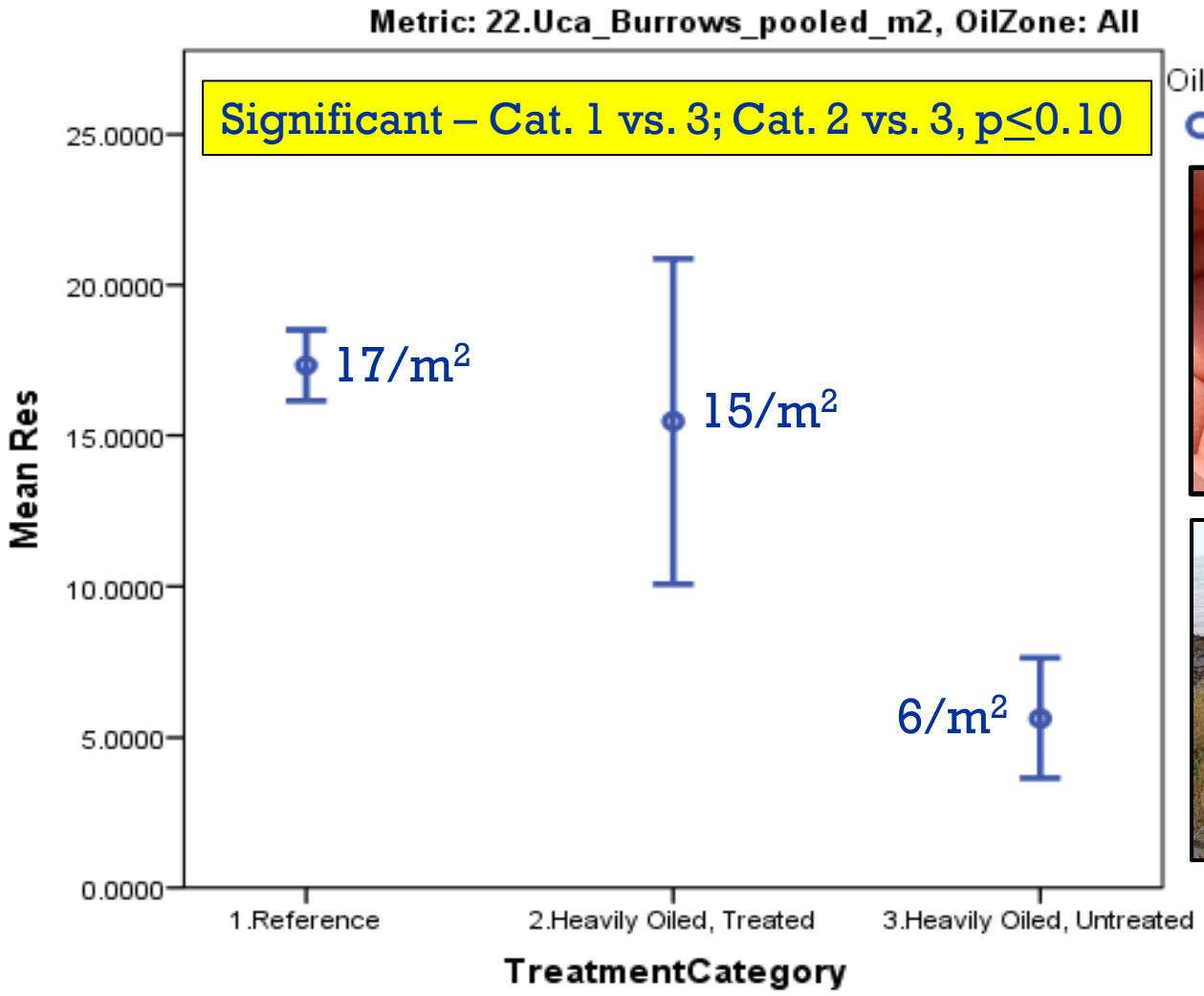
Total Vegetation Cover, Sept. 2011



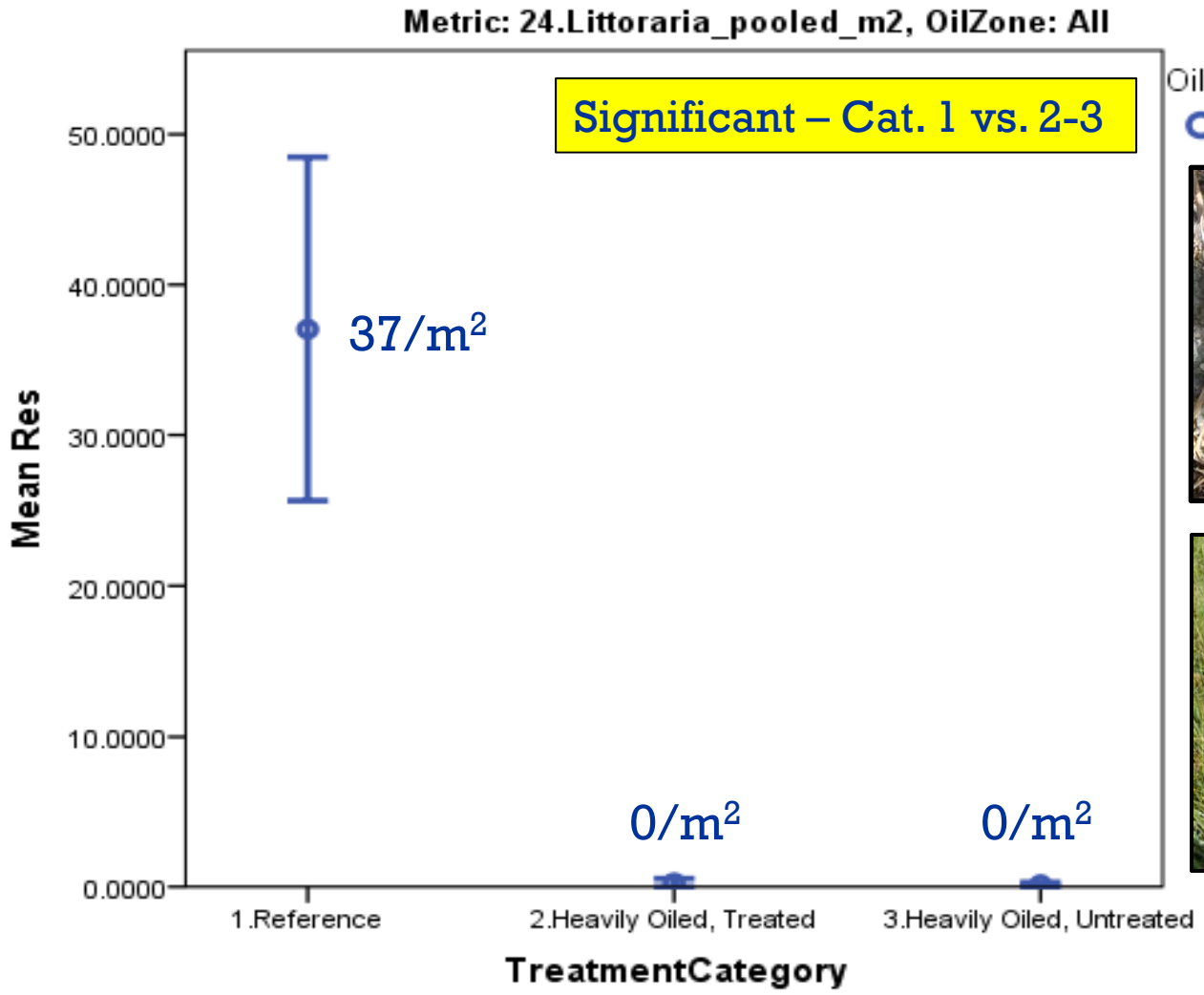
Vegetation Species Composition, Sept. 2011



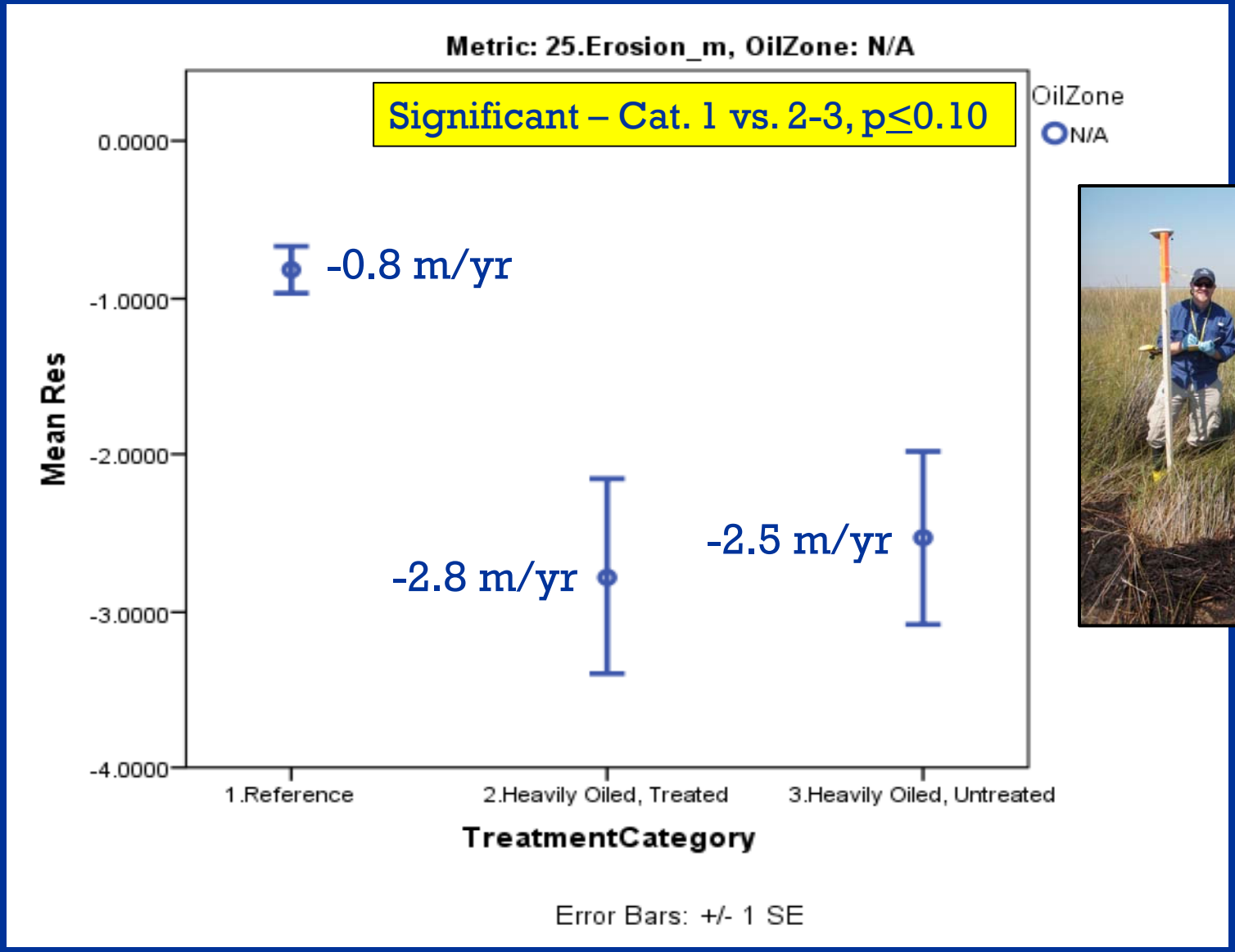
Fiddler Crab Burrow Density, Sept. 2011



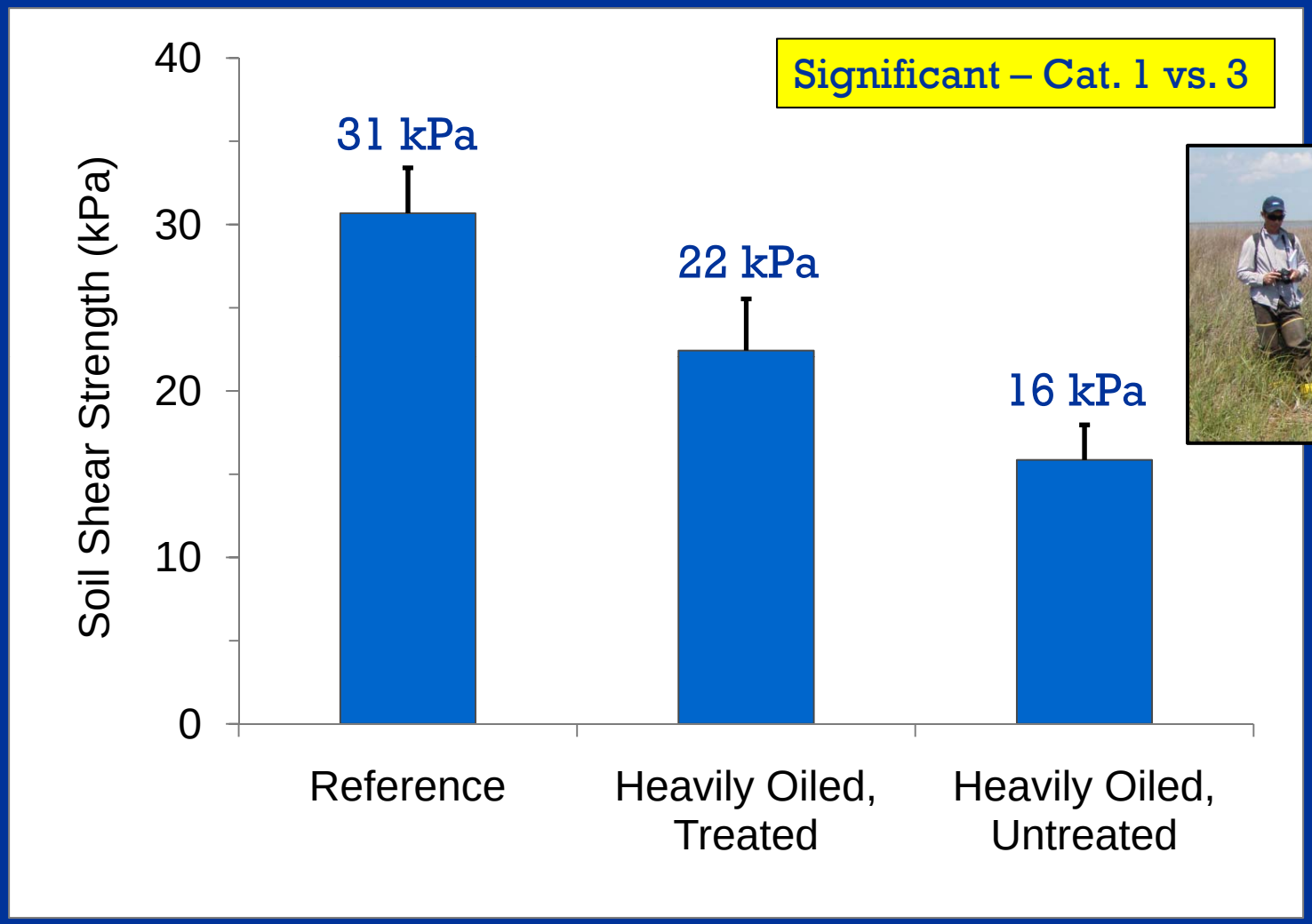
Marsh Periwinkle Density, Sept. 2011



Shoreline Change, Oct/Dec. 2010-Nov. 2011



Marsh Soil Shear Strength, 0-6 cm depth, Feb. 2012



(from Lin and Mendelssohn, unpublished data)

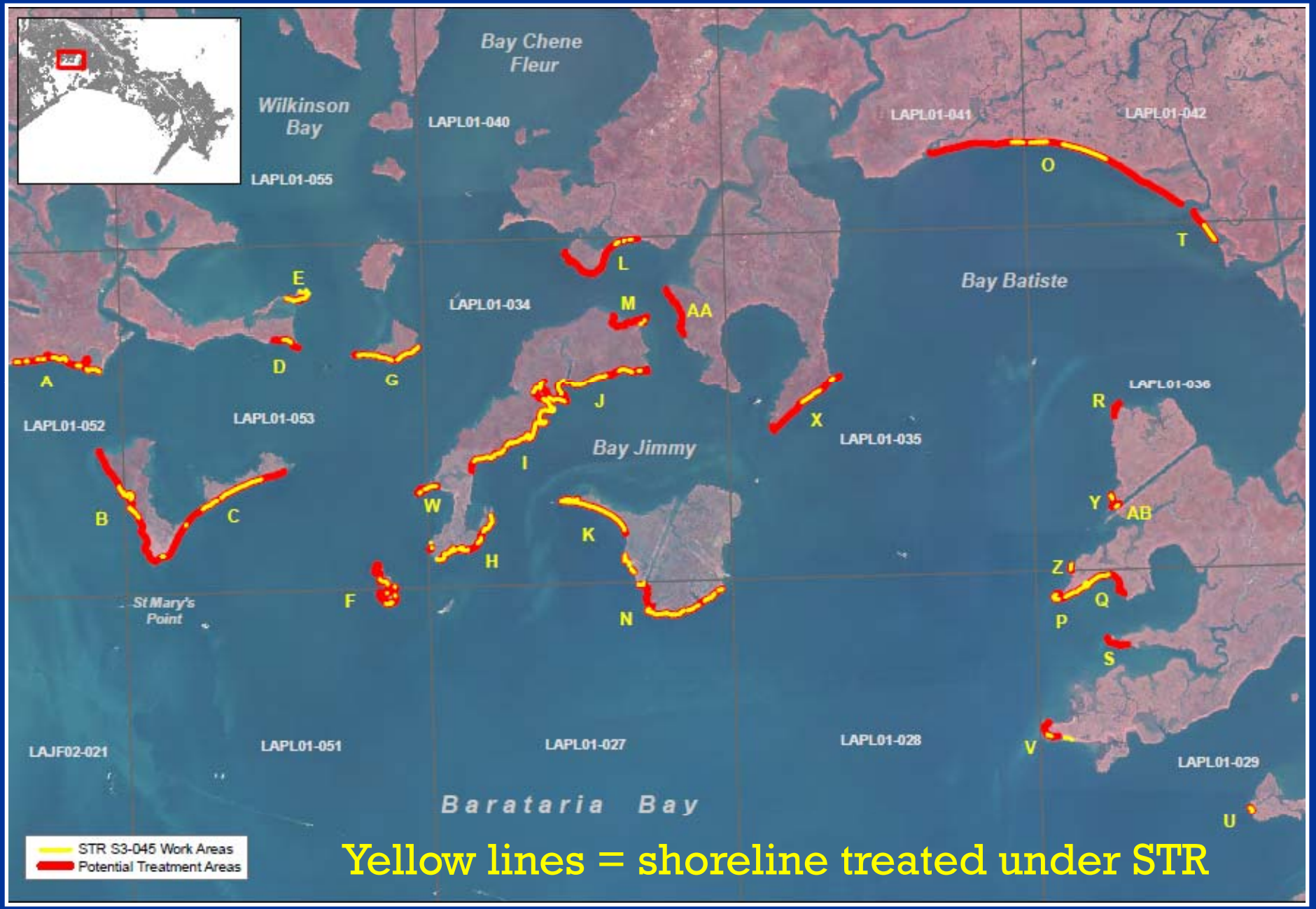
Monitoring Conclusions

- Persistent oiling and continuing ecological effects observed in heavily oiled marsh more than 1 year after oiling
- Signs of enhanced initial habitat recovery observed with treatment at 9 months post-treatment (first growing season)
- No additional impacts from treatment observed (9 months post-treatment)



Operational Application

- Initial test results used to development an operational Shoreline Treatment Recommendation (STR) in January 2011
- STR S3-045 was applied from February to September 2011
- A total of 11 km (7 mi.) of shoreline were treated (~1% of oiled marshes Gulf-wide)
- 4,915 m^3 (6,429 CY) & 486 tons (metric) of oil and oiled debris removed
- Caution – these treatments were only applicable for the most heavily oiled shorelines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STR S3-045 Work Areas
Potential Treatment Areas
Yellow lines = shoreline treated under STR

Acknowledgements