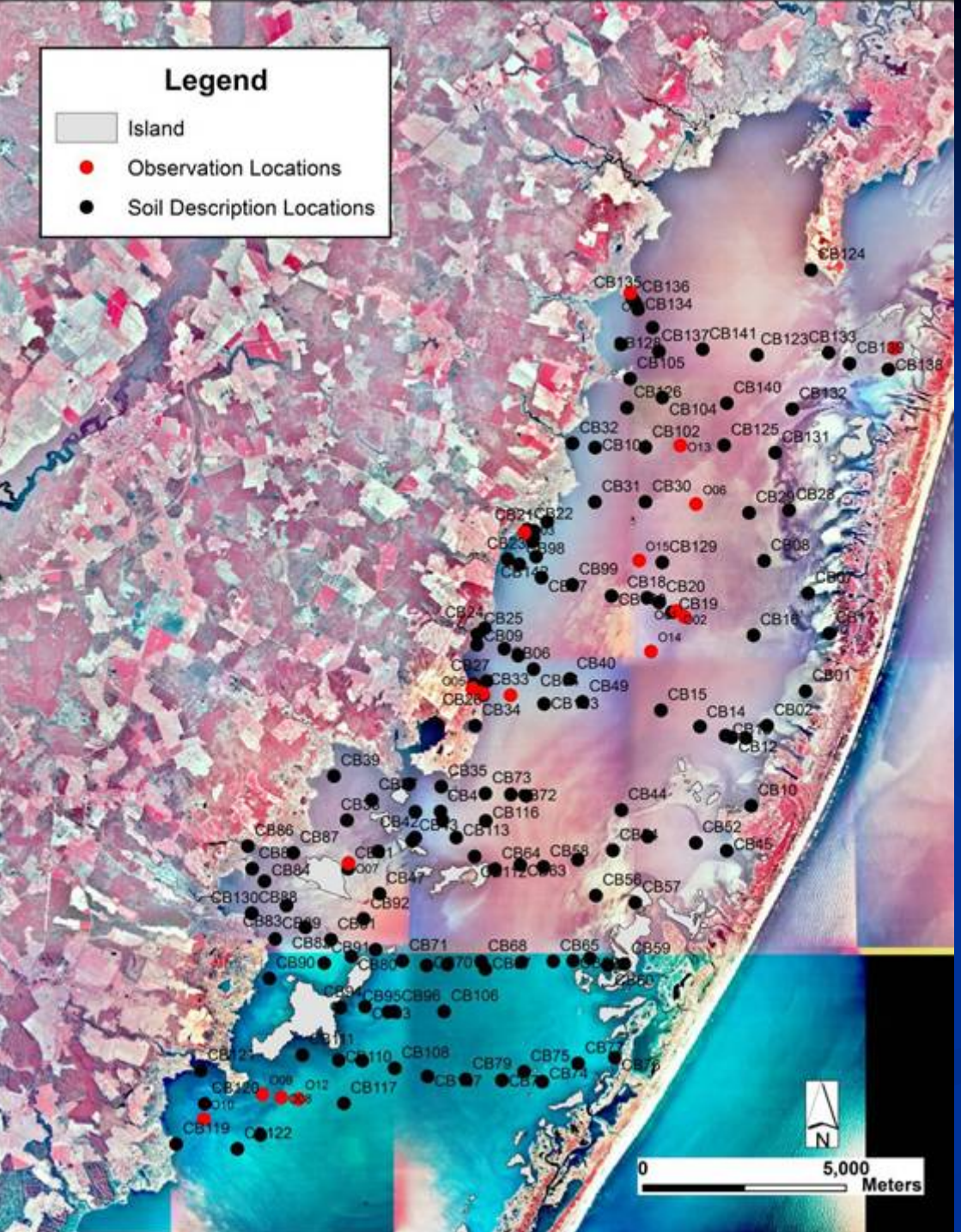
Recent Subaqueous Soils Work in Maryland

Danielle Balduff – PhD 2007
Chincoteague Bay, MD

- Soil-landscape relations in a 18,000 ha coastal lagoon located behind the Assateague barrier island.
- Evaluation of SAV interpretations



146 Full Pedon Descriptions

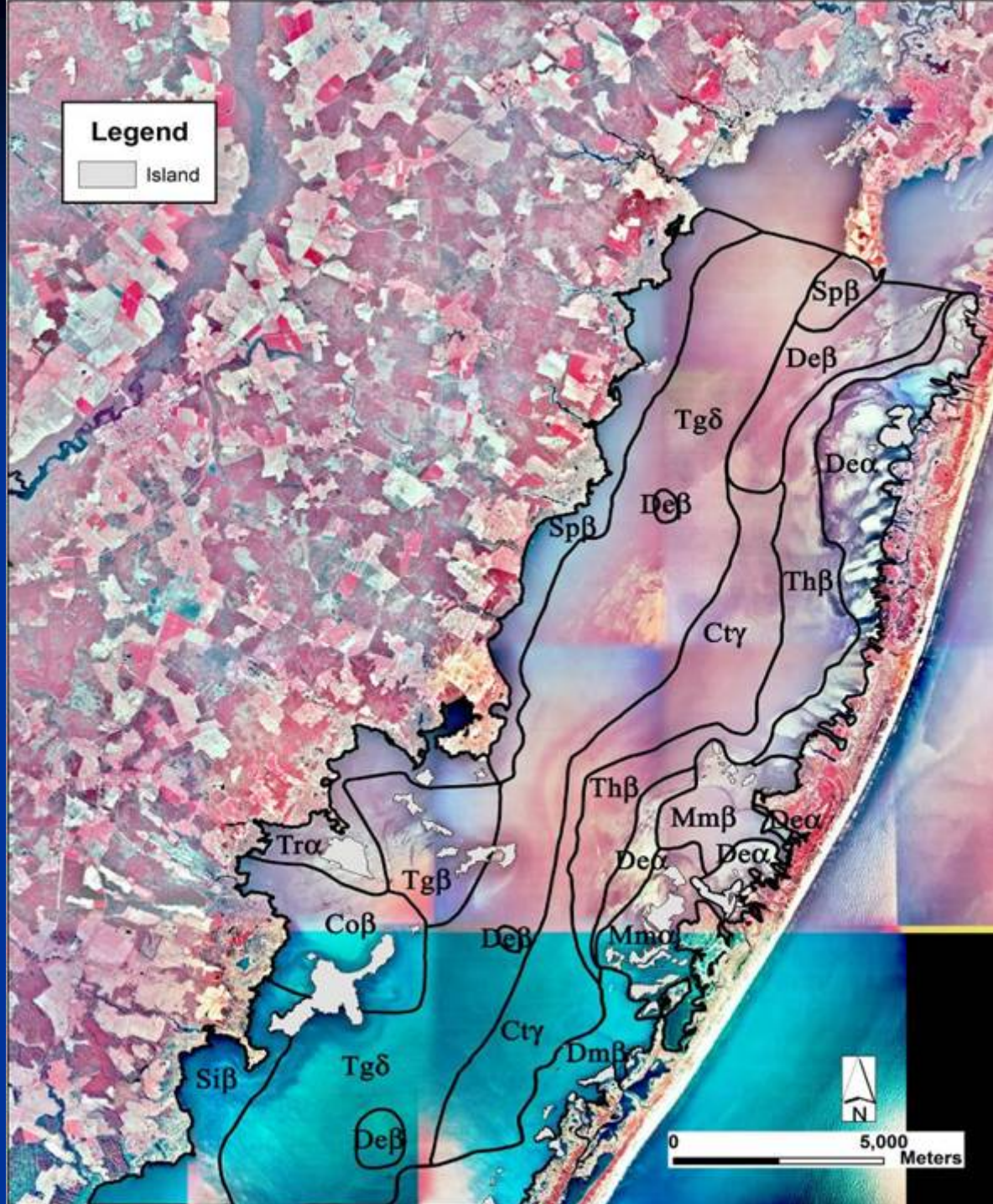
17 Partial Pedon Descriptions or Notes

Soil Series

- Use of Established Subaqueous Soil Series
  - Six established by Demas for Sinepuxent Bay, MD
  - Demas, Sinepuxent, Southpoint, Tizzard, Trappe, and Whittington
  - Only accommodated 25% of the soils in Chincoteague Bay
- Newly Proposed Subaqueous Soil Series
  - Differentiated based on presence of organic horizons, texture in the control section, textural changes with depth, and n values
  - Proposed Series
    - Truitt
    - Tingles
    - Cottman
    - Figgs
    - Tumagan
    - Middlemoor
    - Coards
    - Thorofare

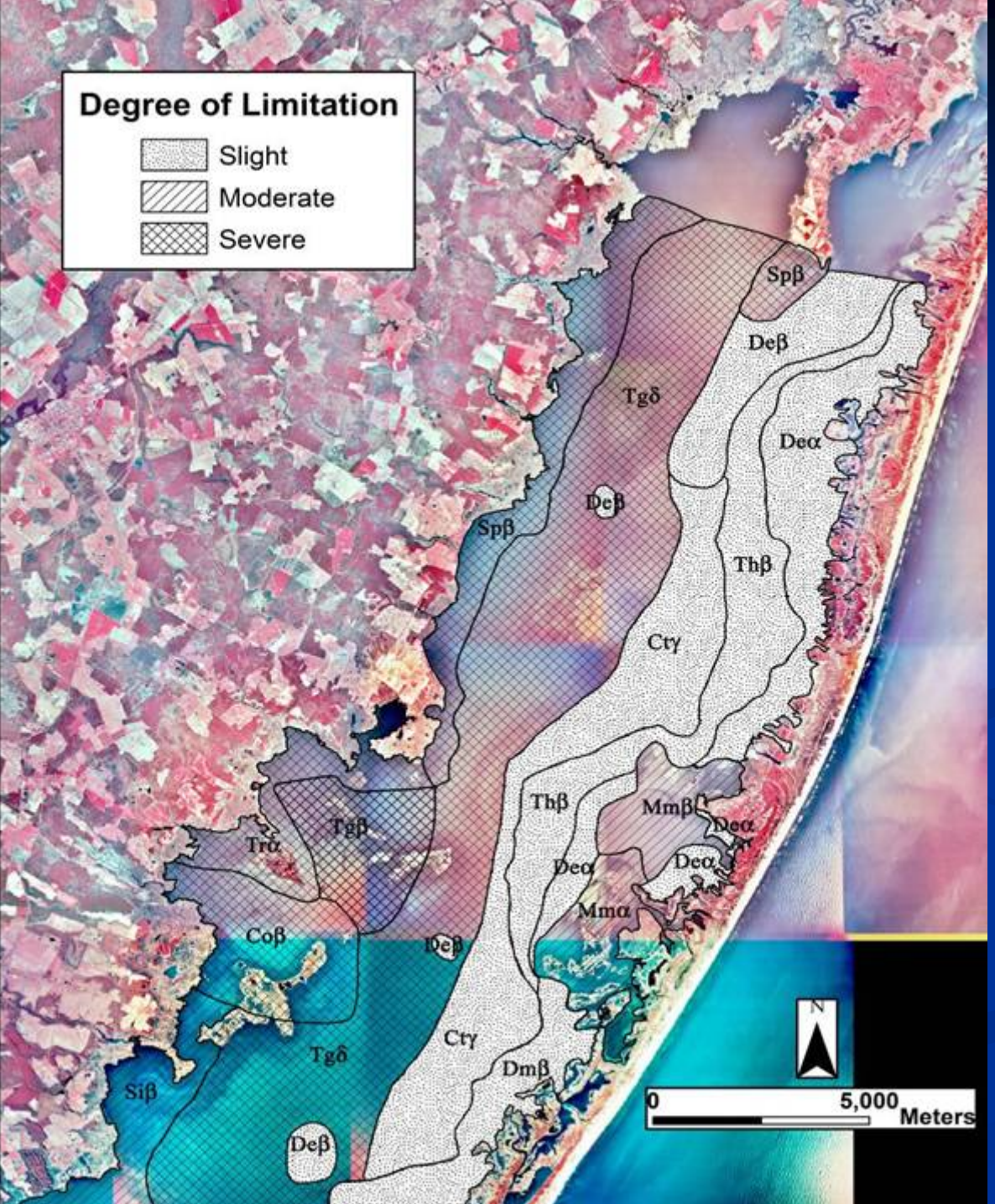
Soil Map

- 13 Soil Map Units
- Map Unit Symbol
  - Series Name
  - Water Depth



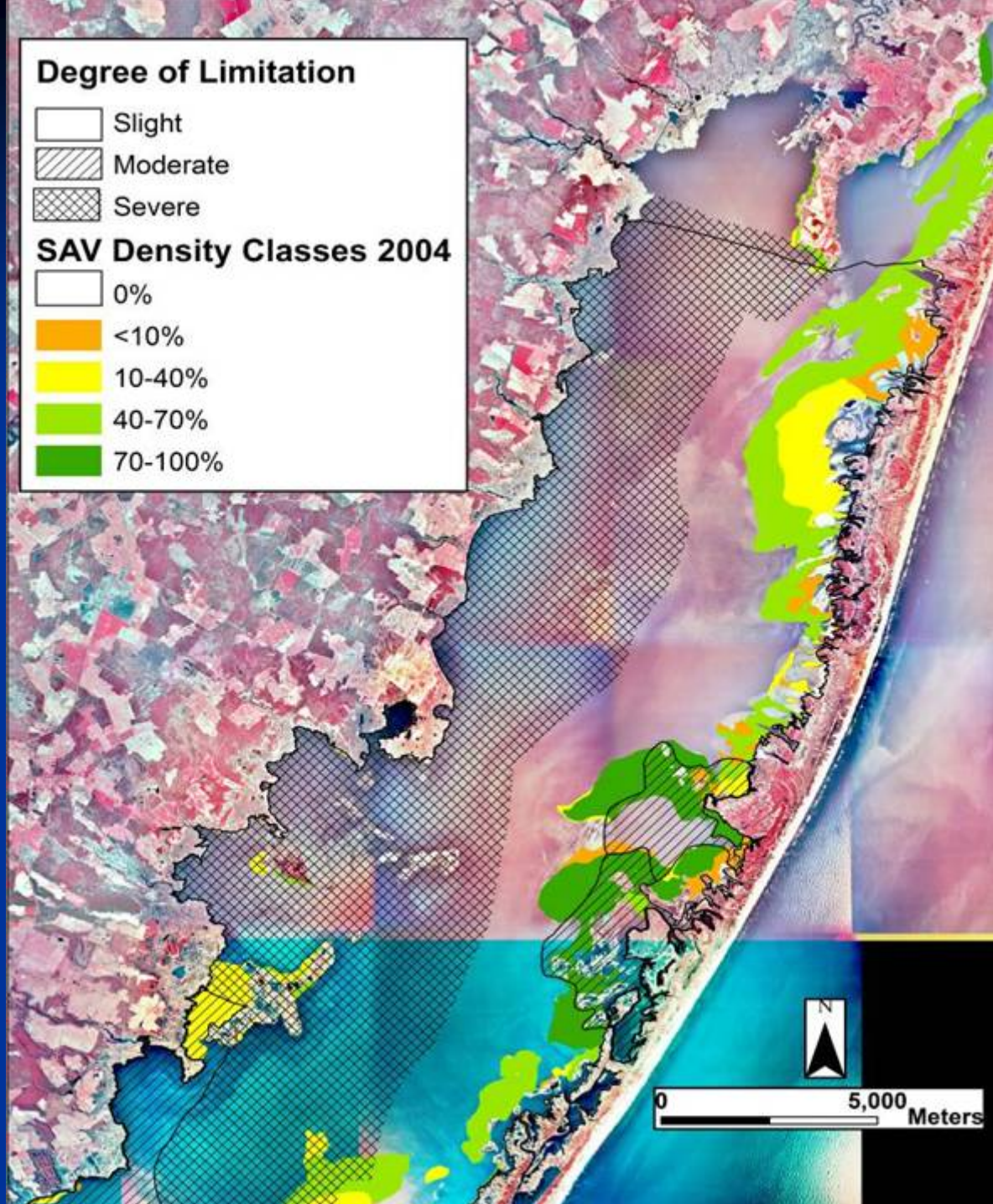
SAV Habitat

- Soil Properties which were used to determine the suitability of the soils
  - Sediment sulfide concentration
    - Favorable – < 5 g kg^{-1}
    - Strongly Detrimental – > 5 g kg^{-1}
  - Organic carbon content
    - Favorable – 30 g kg^{-1}
    - Mildly Detrimental – 30 to 70 g kg^{-1}
    - Strongly Detrimental – > 70 g kg^{-1}
  - Texture
    - Favorable – S or LS (< 20% silt and clay)
    - Mildly Detrimental – SL, SCL, or L (20 to 50% silt and clay)
    - Strongly Detrimental – SiL, SiCL, CL, SiC, C (>50% silt and clay)

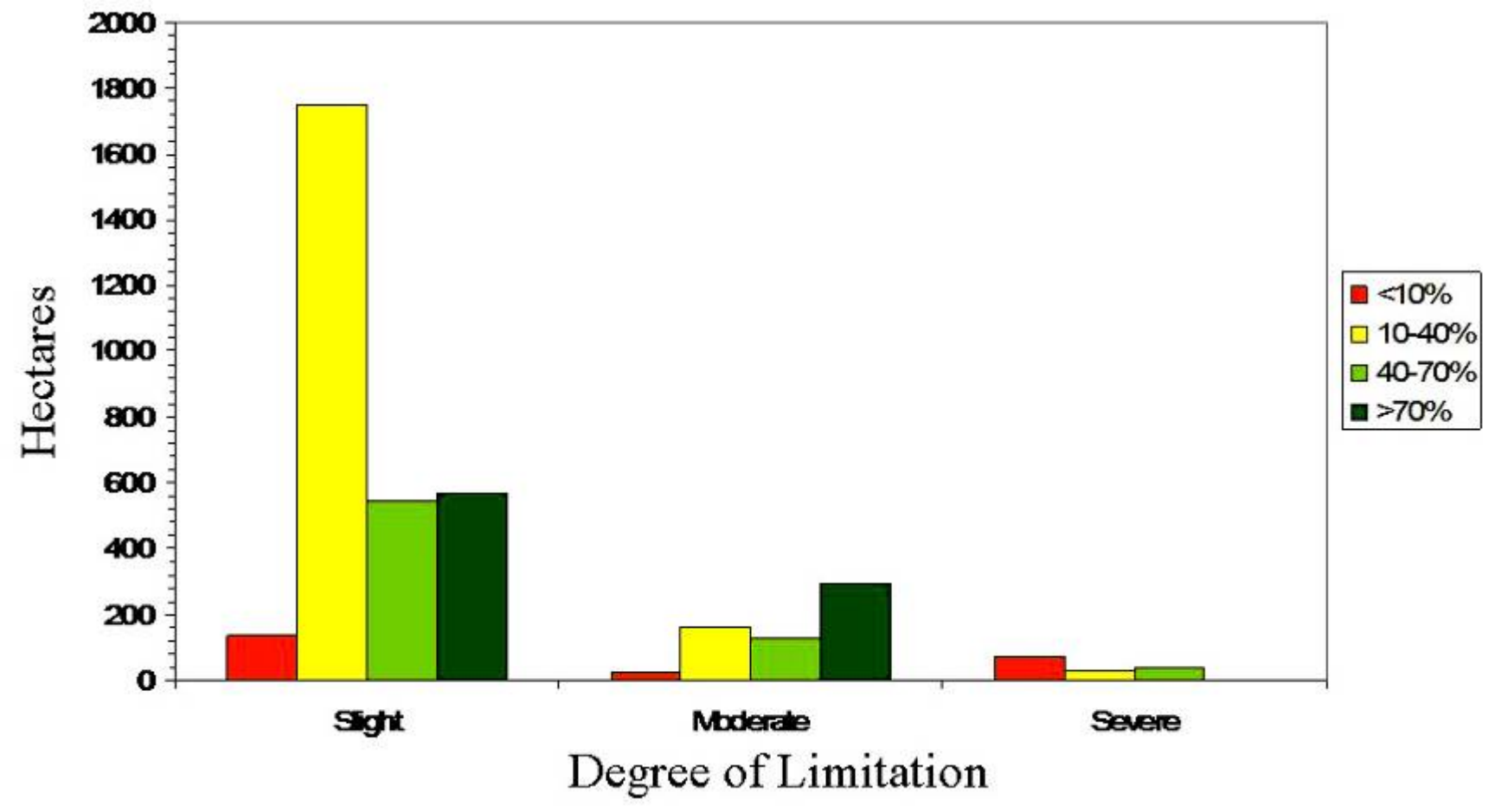

Degree of Limitation
Slight
Moderate
Severe
Spβ
Deβ
Tgδ
Deα
Deβ
Spβ
Thβ
Ctγ
Thβ
Mmβ
Deα
Tgβ
Trα
Deα
Deα
Mmα
Coβ
Deβ
Ctγ
Tgδ
Dmβ
Siβ
Deβ
N
0
5,000
Meters

Suitability Map

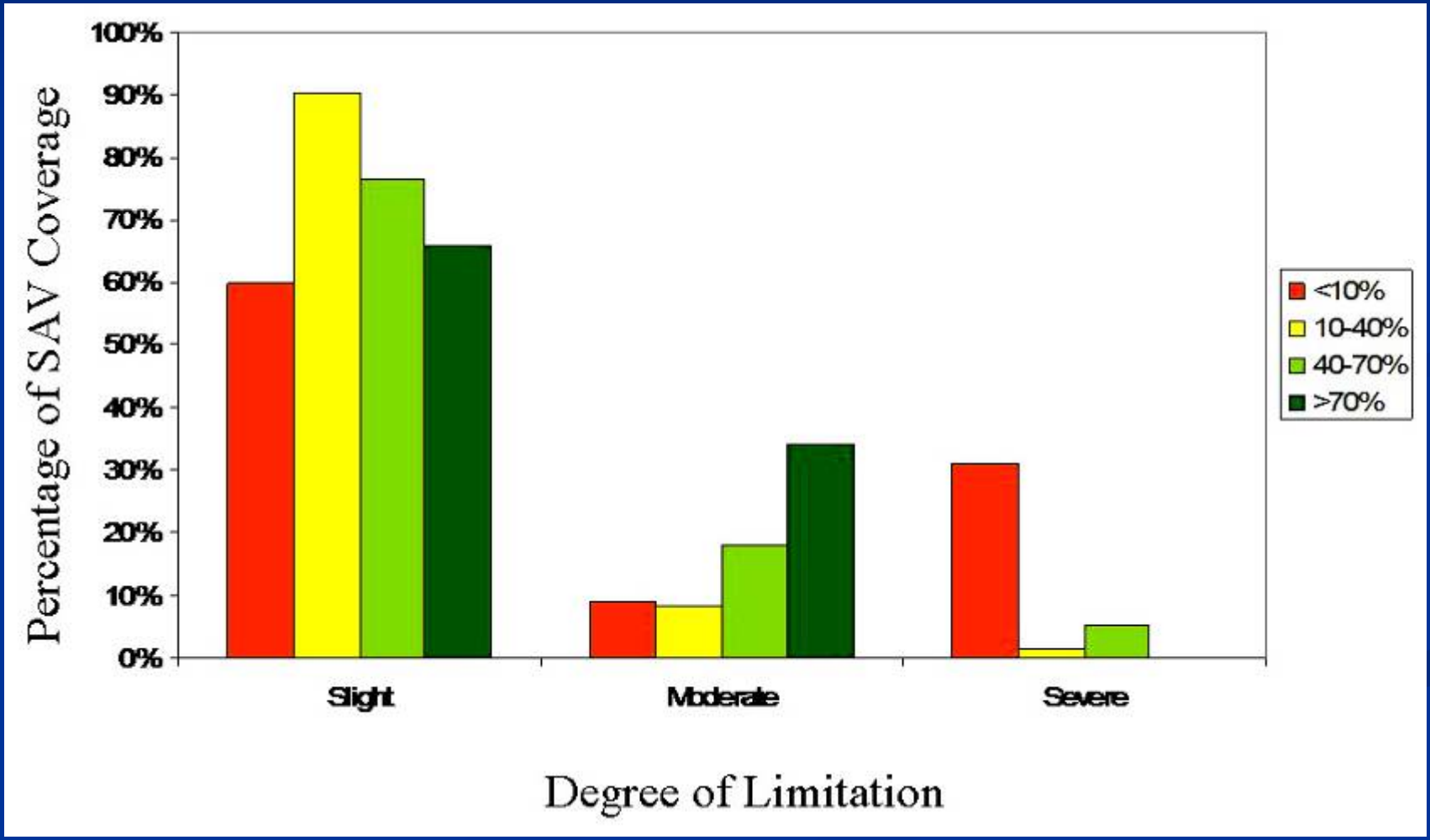
- Tested based on past and present SAV growth patterns in Chincoteague Bay based on data sets provided by VIMS
- Used 2004 VIMS data and compared it to our suitability map



Total Hectares of SAV within Suitability Classes



Percentage of SAV for each Suitability Class



Methodology Issues

- Calculating organic carbon and calcium carbonate carbon values
- Determination of sulfidic materials
- Calculated n values

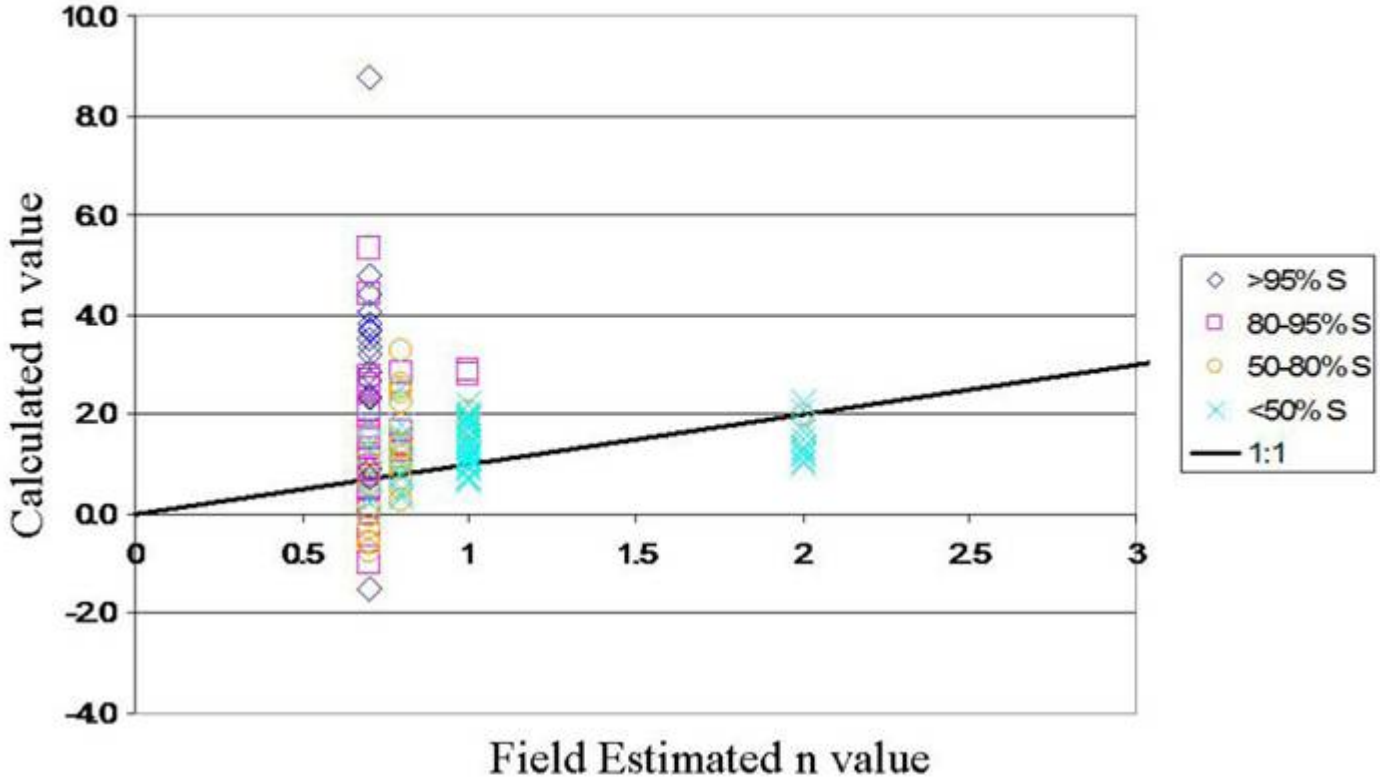


Figure 4-21. Comparison of the field estimated n values and the calculated n values for 163 samples collected in Chincoteague Bay. The field estimated n values for the sandier soils (>50% S) did not correlate well with the calculated n values, but the finer textured soils (<50% S) were better correlated. The field estimated n value provided a more accurate description of the fluidity and bearing capacity of the soils.

Using IRIS Tubes for Measuring Porewater Sulfide in Subaqueous Soils

IRIS (Indicator of Reduction in Soils) Tubes

- Fe Oxide paint is applied to ½ inch schedule 40 PVC tubing while the tube is on a lathe device to ensure an even distribution of the paint.

Jenkinson, B. 2002. Indicators of Reduction in Soils (IRIS): A visual method for the identification of hydric soils. Ph.D. Diss. Purdue Univ., West Lafayette, IN

Rabenhorst, M. C., and K. L. Castenson. 2005. Temperature Effects on Iron Reduction in a Hydric Soil. Soil Sci. 170:734-742.

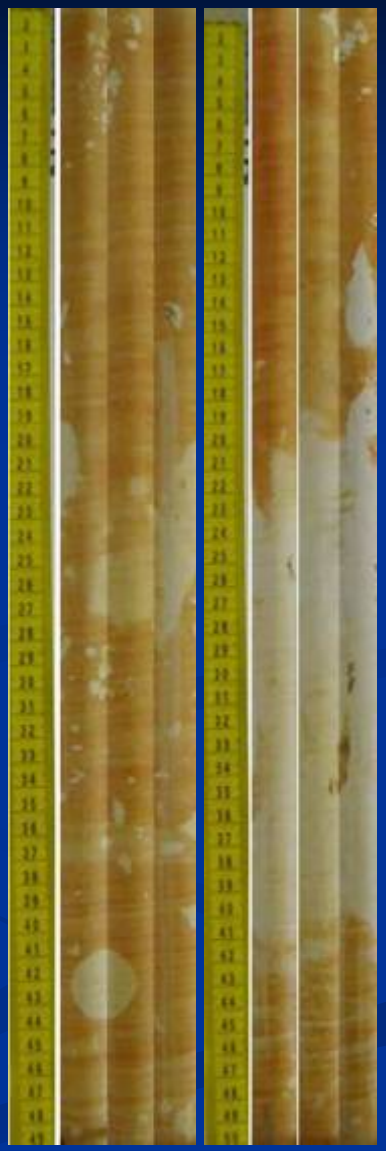
Jenkinson, B.J., and D.P. Franzmeier. 2006. Development and evaluation of Fe-coated tubes that indicate reduction in soils. Soil Sci. Soc. Am. J. 70: 183-191.

Castenson, K. L., and M. C. Rabenhorst. 2006. Indicator of Reduction in Soil (IRIS): Evaluation of a New Approach for Assessing Reduced Conditions in Soil. Soil Sci. Soc. Am. J. 70: 1222-1226.

Rabenhorst, M. C., and S. N. Burch. 2006. Synthetic Iron Oxides as an Indicator of Reduction in Soils (IRIS). Soil Sci. Soc. Am. J. 70: 1227-1236.

- Pilot hole made for each IRIS tube
- IRIS Tubes inserted into the soil
- Under anaerobic conditions, microbes oxidize OM utilize Fe oxides on IRIS tubes as e^- acceptors
- As Fe(III) in paint is reduced to Fe(II), it dissolves
- Zones where Fe paint has been removed is visible and can be documented (quantified)

- Composite photos of tubes (three 120° rotations)
- Scans on modified scanner
- Paint removal estimated
  - Visually
  - Using image analysis



IRIS Technology in Estuarine Systems

Reaction of Iron "oxides" with Sulfide

$$\xrightarrow{+2e^-}$$

(+3) (+2) (+2)

$$3H_2S + 2FeOOH \text{ ---> } FeS + FeS_2 + 4H_2O$$

(-2) (-2) (-1)

$$\xrightarrow{-2e^-}$$

Reaction with e- transfers

Proceeds fast without need for microbial mediation

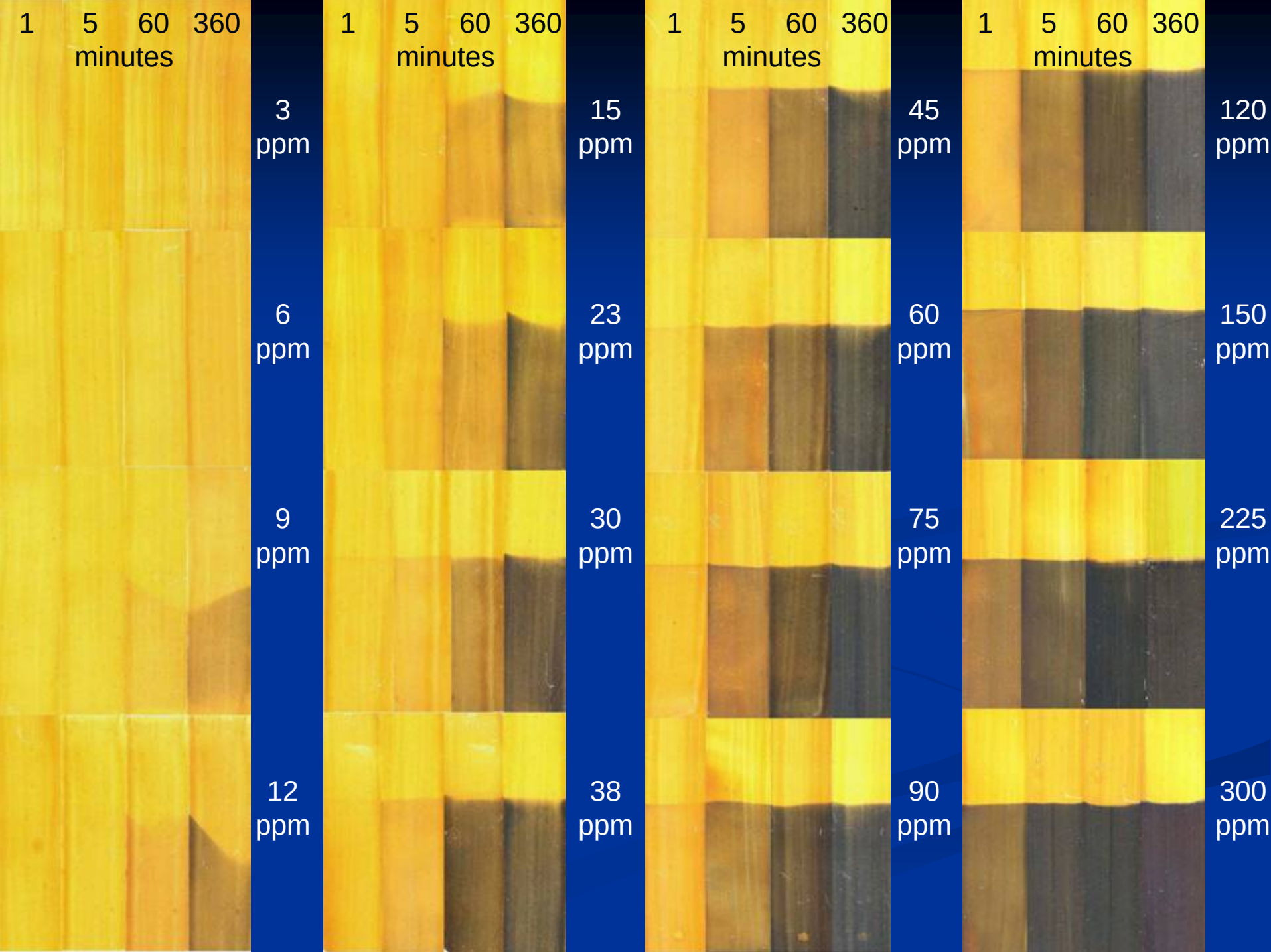
IRIS tubes in Na_2S solutions (pH 7.5) for 1 hr

1.2 3 6 12 30 60 120 300

ppm S^{-2}

1 mM

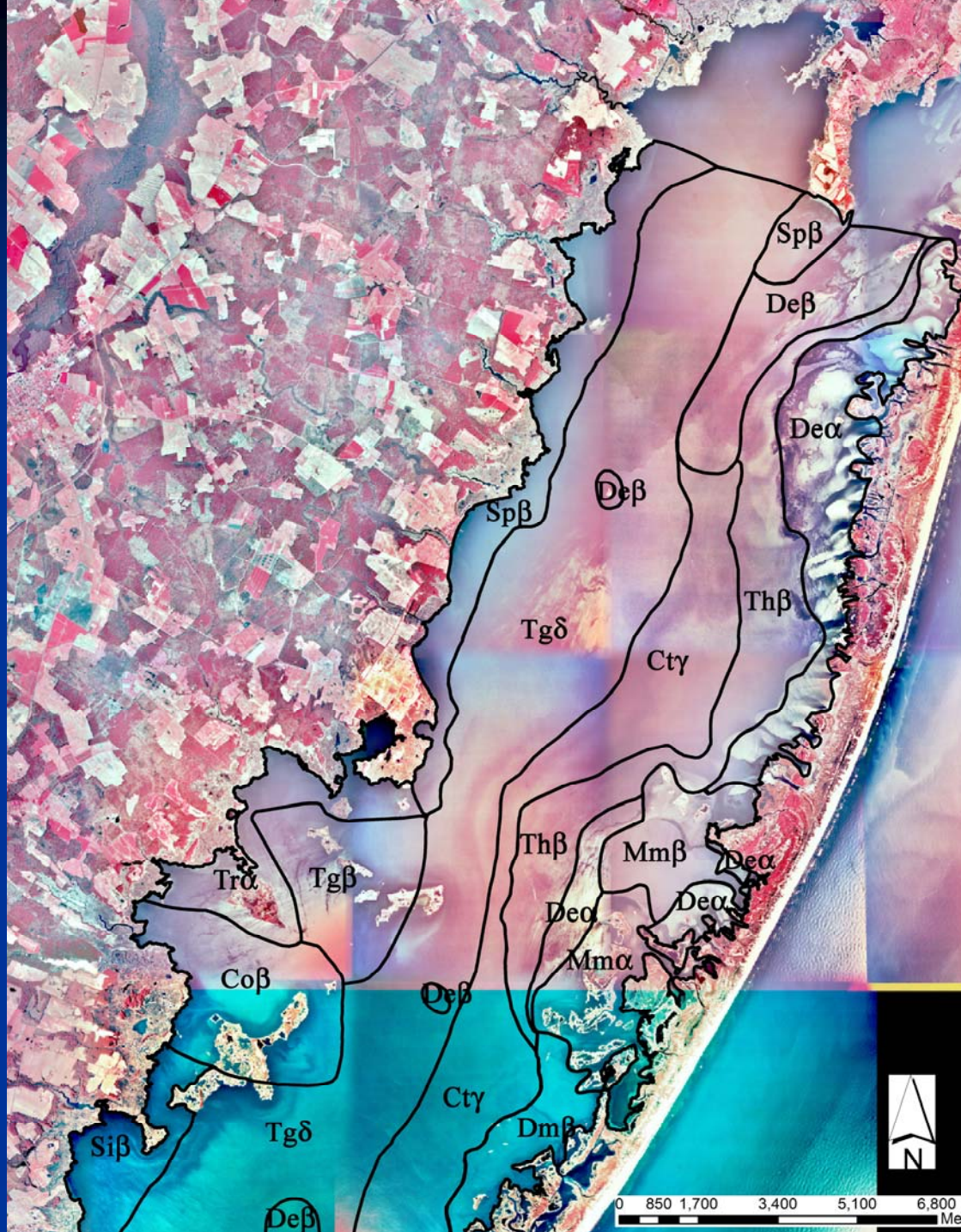
10 mM


1 5 60 360
minutes
3 ppm
6 ppm
9 ppm
12 ppm
1 5 60 360
minutes
15 ppm
23 ppm
30 ppm
38 ppm
1 5 60 360
minutes
45 ppm
60 ppm
75 ppm
90 ppm
1 5 60 360
minutes
120 ppm
150 ppm
225 ppm
300 ppm

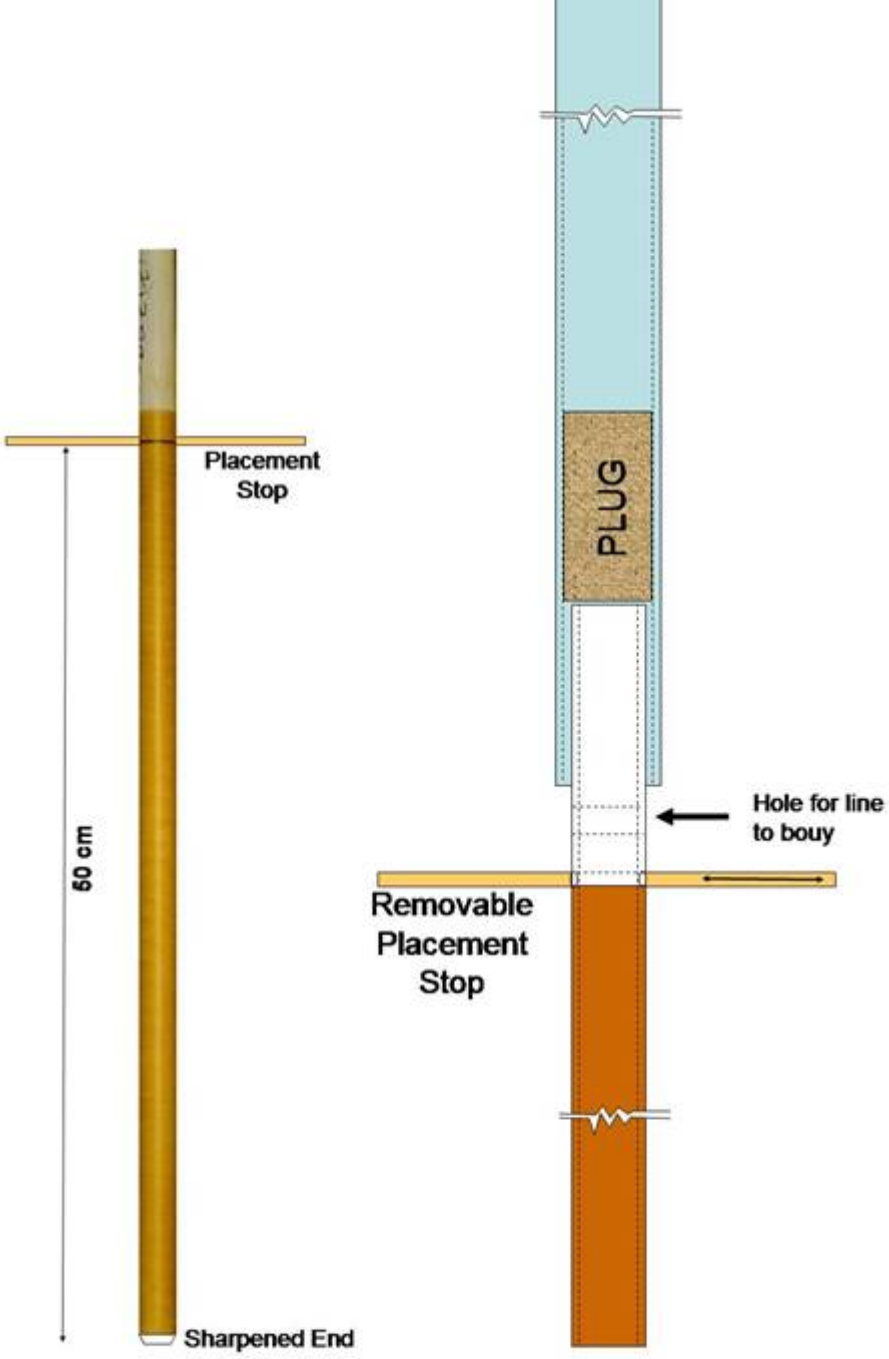
Sulfide in Benthic Ecosystems

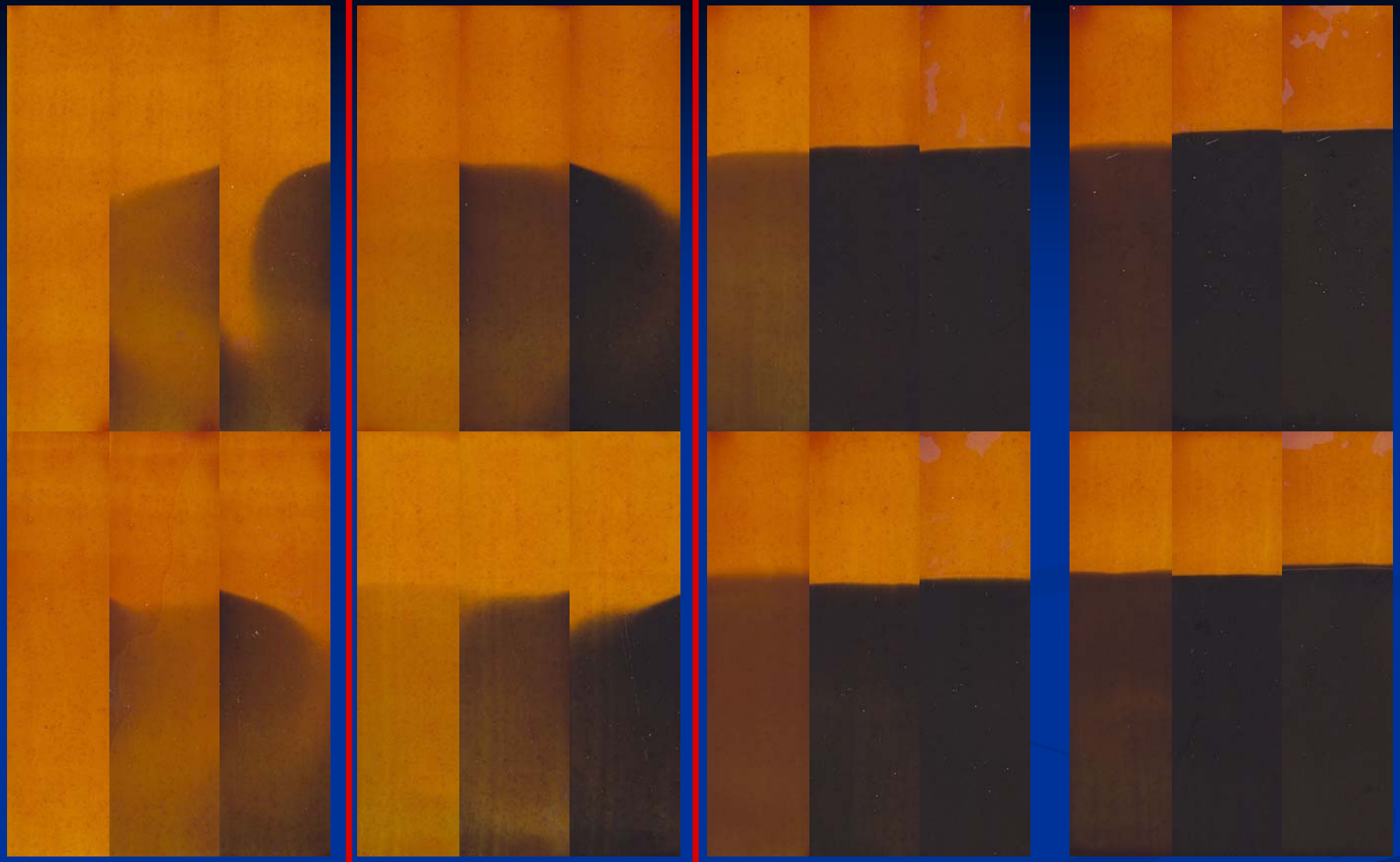
- H_2S forms in anaerobic subaqueous soils
- H_2S can be toxic to SAV (Koch, 2001) or benthic organisms including hard clam *M. mercenaria* (Wang and Chapman, 1999; Bergquist et al., 2003).
- Soil properties affecting the production of H_2S
  - H_2S enhanced by higher levels of oxidizable OM and low redox potentials
  - Coarse textured soils (sands) permit greater diffusion of oxygen
  - finer textured soils become reducing more easily.
  - Reactive Fe in the soils can lower the levels of dissolved H_2S by forming low solubility Fe sulfide phases.

Soils Map of Chincoteague Bay



- Objective: To evaluate the use of IRIS technology to assess soluble sulfide levels in the porewater of subaqueous soils.
  - Different soils in Chincoteague Bay
  - Seasonal variations


Placement
Stop
50 cm
Sharpened End
PLUG
Hole for line
to bouy
Removable
Placement
Stop



5m 1hr 6hr

15 mg/L
0.5 mmol

5m 1hr 6hr

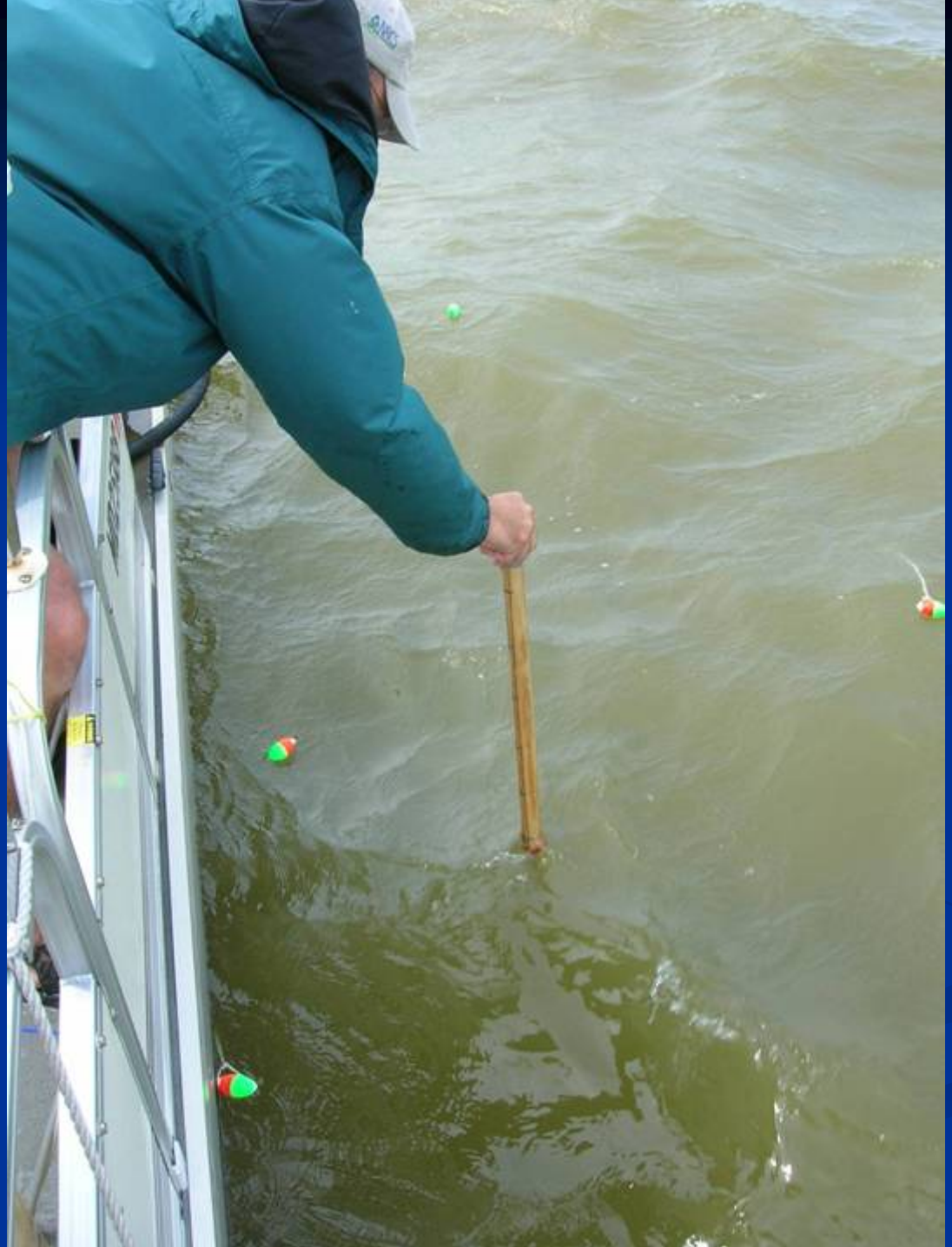
30 mg/L
1 mmol

5m 1hr 6hr

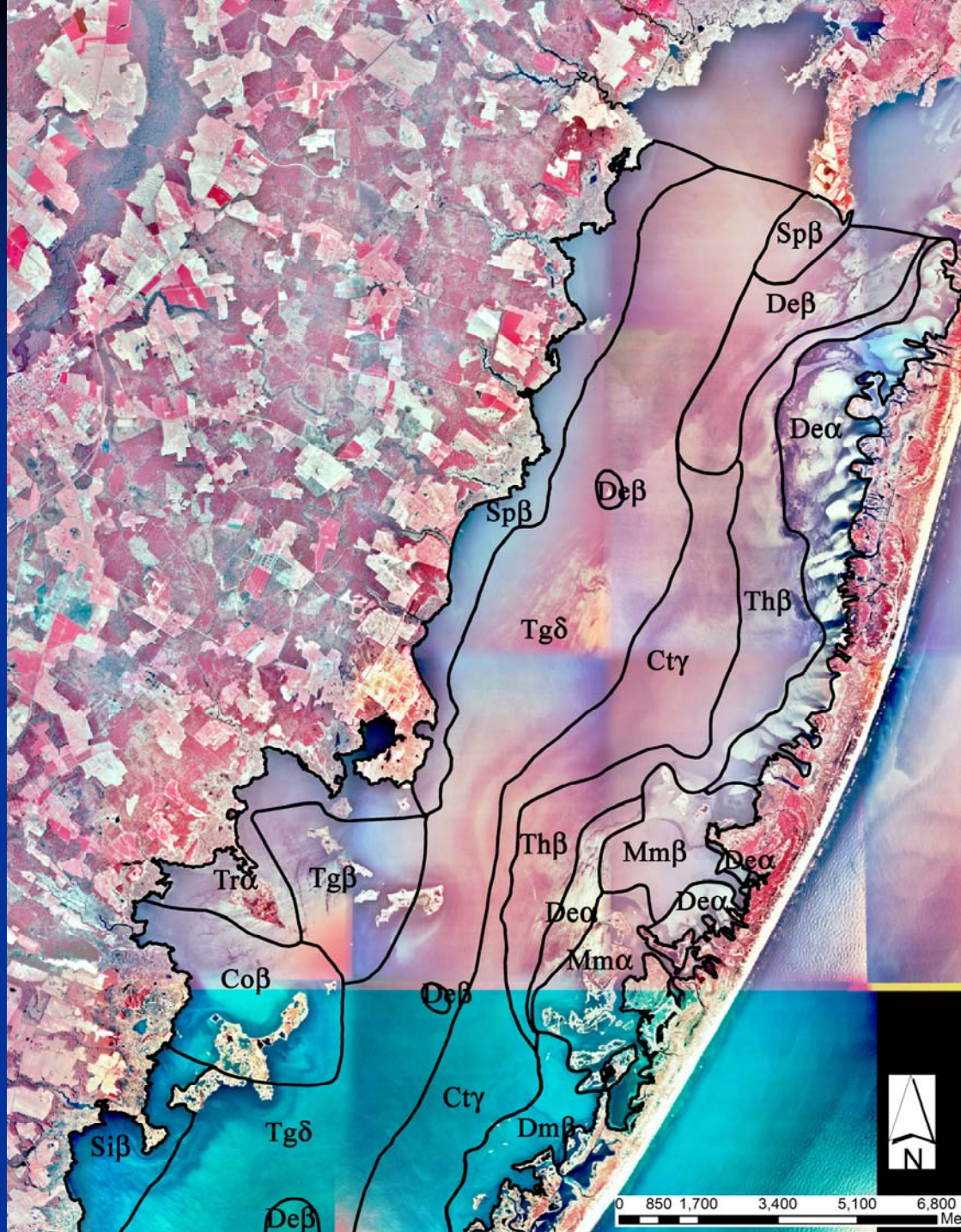
74 mg/L
2.5 mmol

5m 1hr 6hr

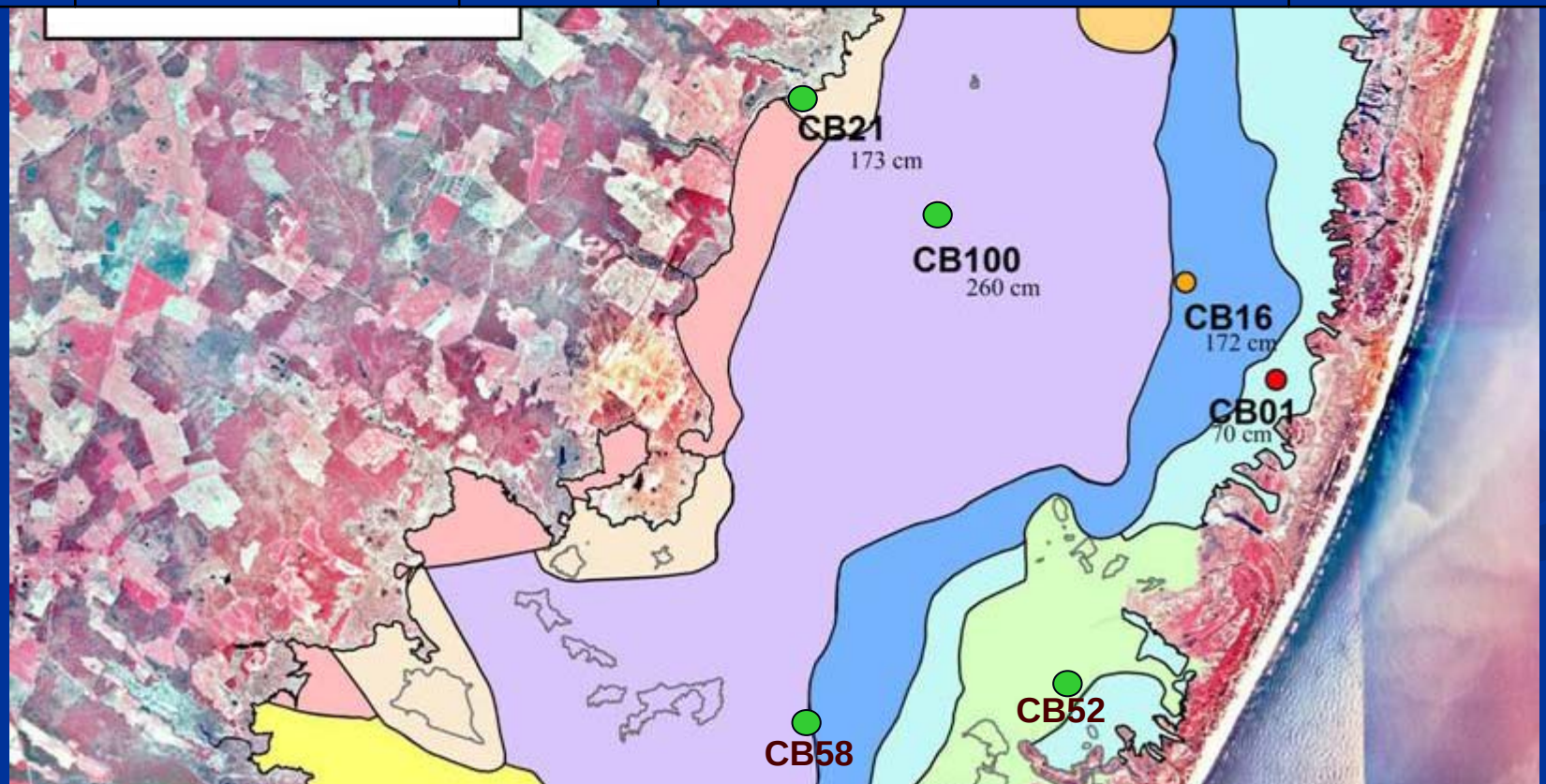
148 mg/L
5 mmol



Soils Map of Chincoteague Bay



Pedon		Landform	Soil Map Unit	Current Soil Classification (Proposed Soil Classification)	Series
CB21	A	Submerged wave-cut headland	Spβ	Fine-loamy, Thapto-Histic Sulfaquents (Fine-loamy, Thapto-Histic Sulfiwassents)	Southpoint Tax.
CB52	D	Barrier cove	Mmβ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Middlemoor
CB58	C	Lagoon bottom (barrier side)	Ctγ	Coarse-loamy, Typic Sulfaquents (Coarse-loamy, Fluvic Sulfiwassents	Sinepuxent
CB100	B	Lagoon bottom (central)	Tgδ	Fine-silty, Typic Sulfaquents (Fine-silty, Fluvic Sulfiwassents)	Tingles

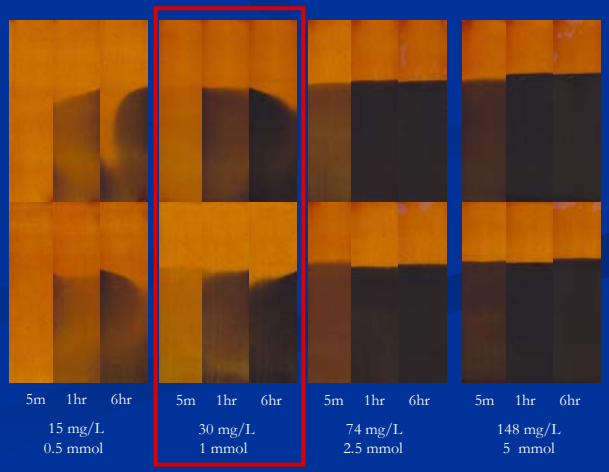


1hr

6hrs

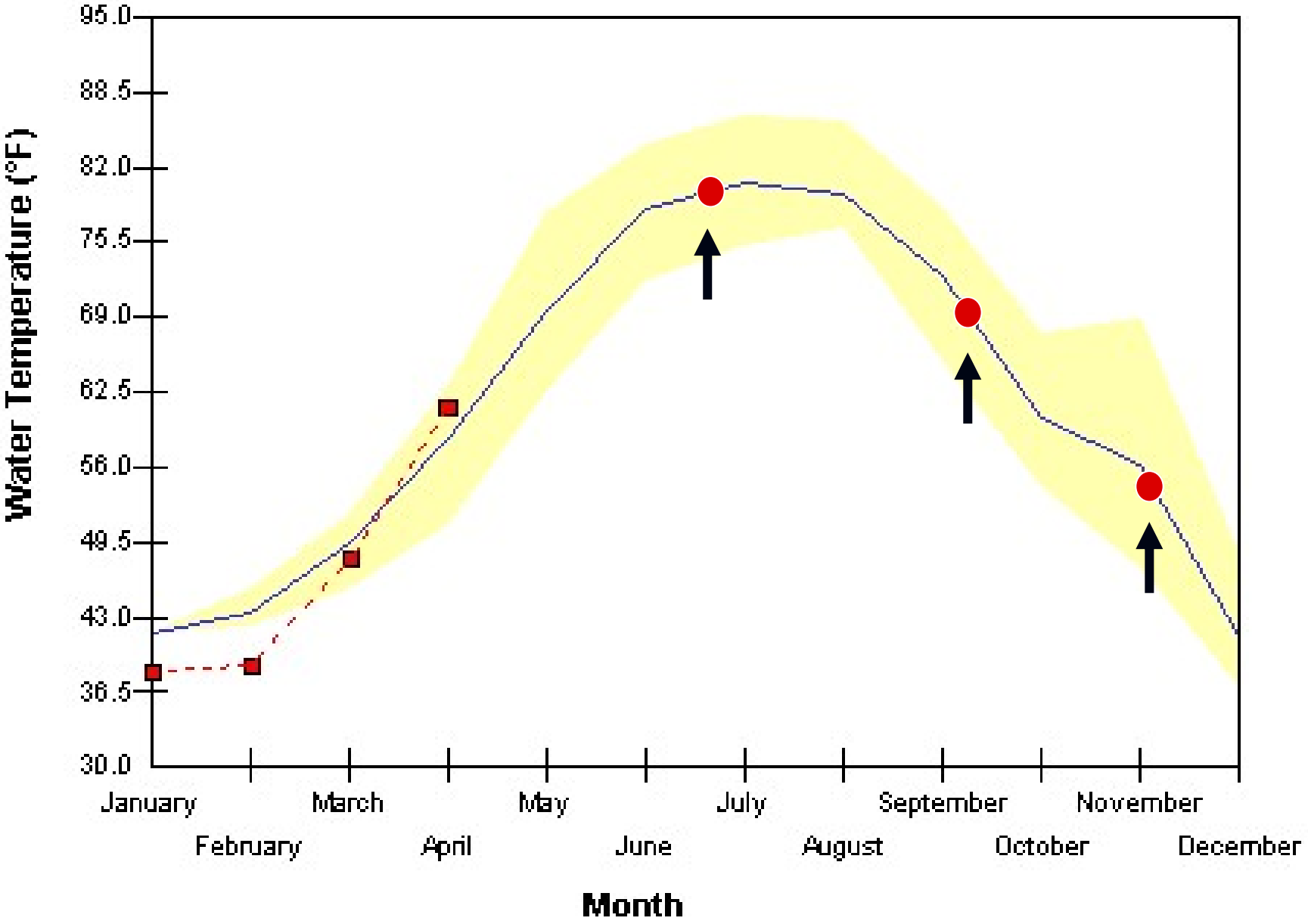
A

24hrs

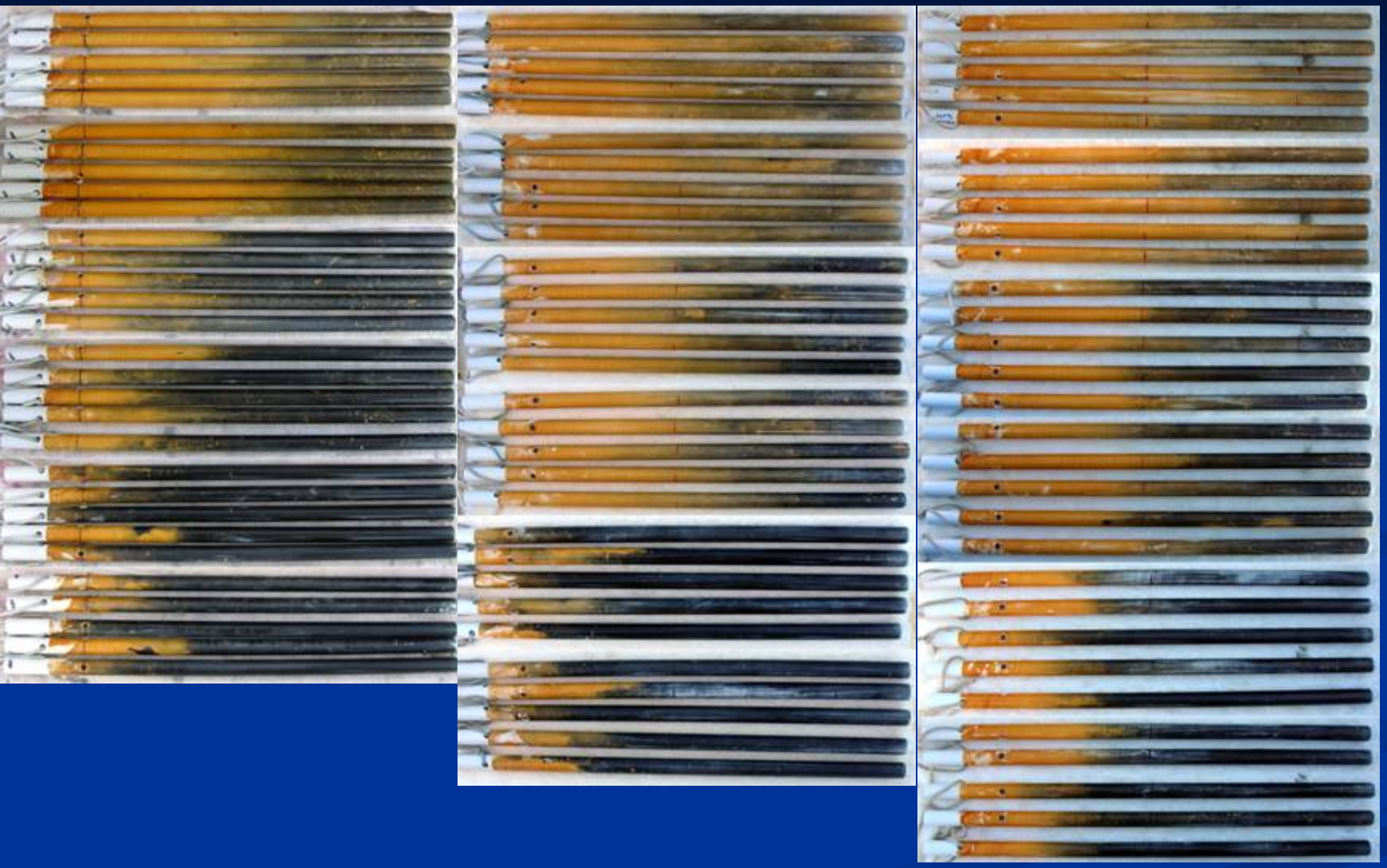


A B C D

June 24-25, 2007

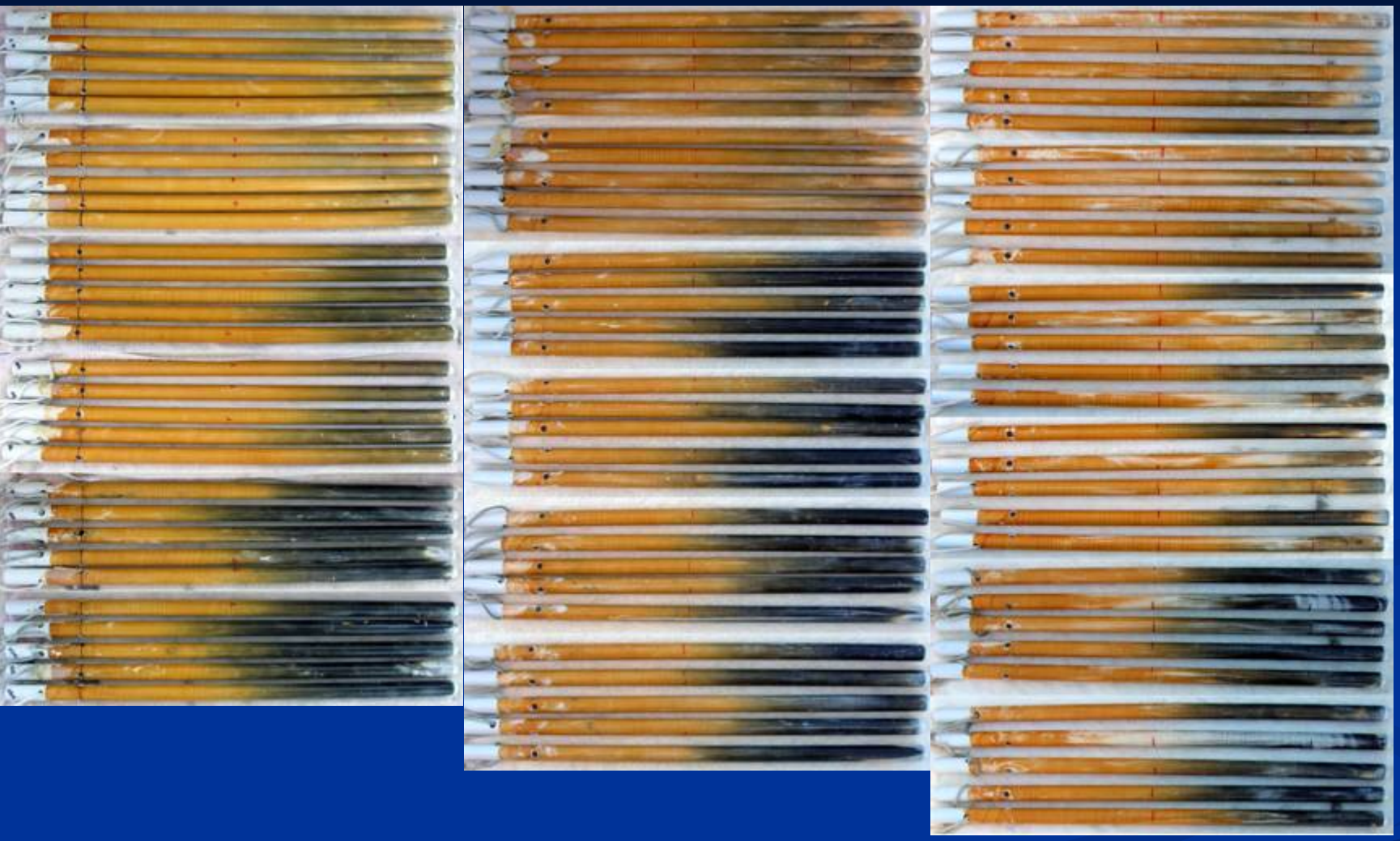

Water Temperature (°F)
95.0
88.5
82.0
75.5
69.0
62.5
56.0
49.5
43.0
36.5
30.0
January
February
March
April
May
June
July
August
September
October
November
December
Month

A



June September November

B

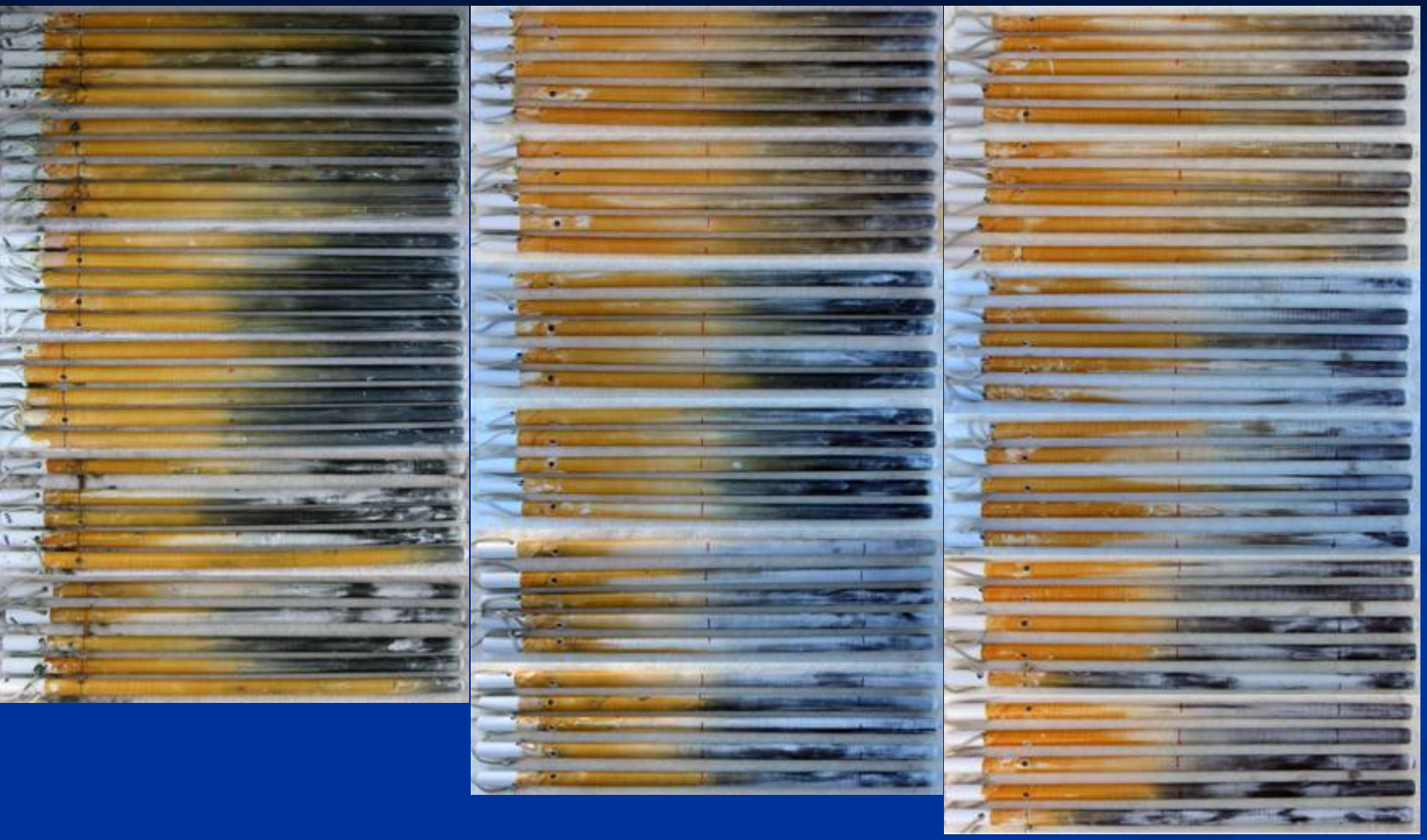


June September November

C

June September November

D



June September November