Fish, Vegetation, and Wildlife as Performance Measures in Gulf Coast Restoration

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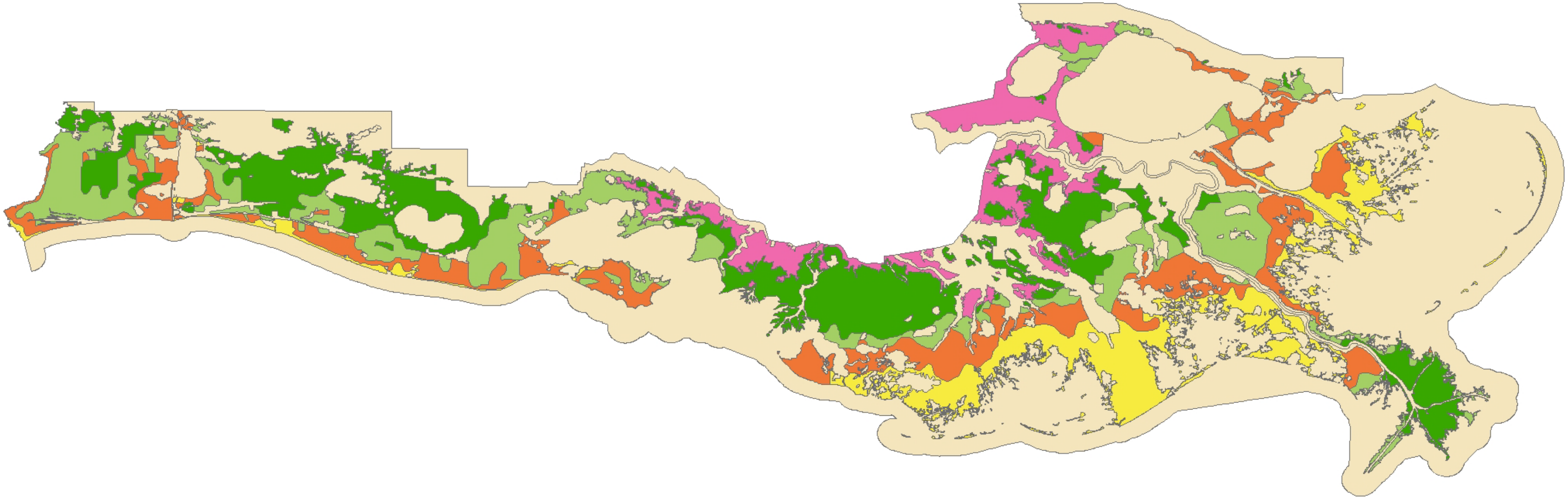
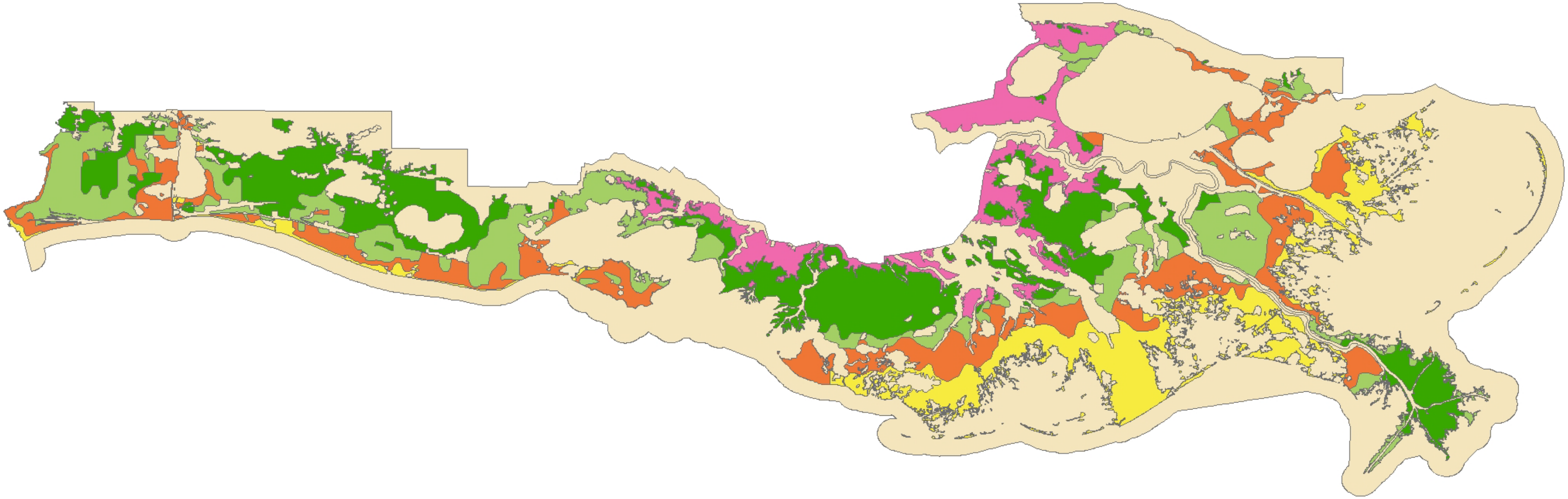


- In the last 50 years, Louisiana lost ~20% of its emergent wetlands and gained extensive areas of shallow, mostly non-fresh water. Couvillion et al. (2011). U.S. Geological Survey Scientific Investigations Map 3164, 12 p. Pamphlet.



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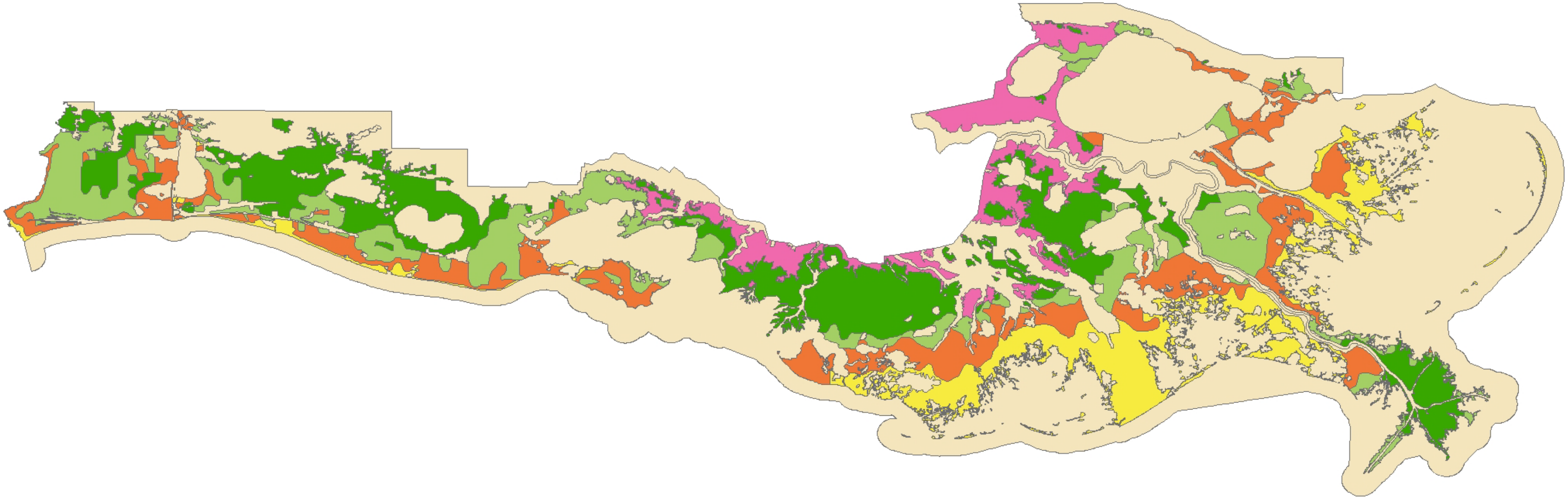

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- In the next 50 years, Louisiana is expected to lose 15% to 32% of its emergent marshes and to gain extensive areas of shallow, mostly non-fresh water. Louisiana's Master Plan for a Sustainable Coast (2012).
- In the next 50 years, Louisiana is expected to lose habitat for fish and wildlife that depend upon low salinity emergent marsh while gaining habitat for fish and wildlife that depend upon shallow non-fresh water. Nyman et al. (2013) Journal of Coastal Research 67:60-74.

Restoring Louisiana’s Coastal Wetlands

1. Slow Loss of Existing Wetlands (dominated prior to 2000)
    a) Manage Water Salinity/Water Level to reduce plant stress
        i. Increase tidal exchange or river inflow
        ii. Draw-down Impoundments
        iii. Weirs, Sills, and Flashboards
    b) Slow Erosion
        i. Planting vegetation
        ii. Establishing oyster reefs
        iii. Rocks, bulkheads, etc.
2. Create New Wetlands (dominates today)
    a) Sediment Diversions; i.e. allowing rivers to create emergent wetlands
    b) Placing Dredged Material in Open Water
        i. Creating edge habitat: Terraces
        ii. Creating emergent wetlands
        iii. Creating barrier islands and back-barrier marshes

Sediment Diversions

Figure 2. Aerial photographs illustrating crevasse splay growth over time for the PAL-1 splay located on Pass-a-Loutre. Note the crevasse channel extension and bifurcation over time.

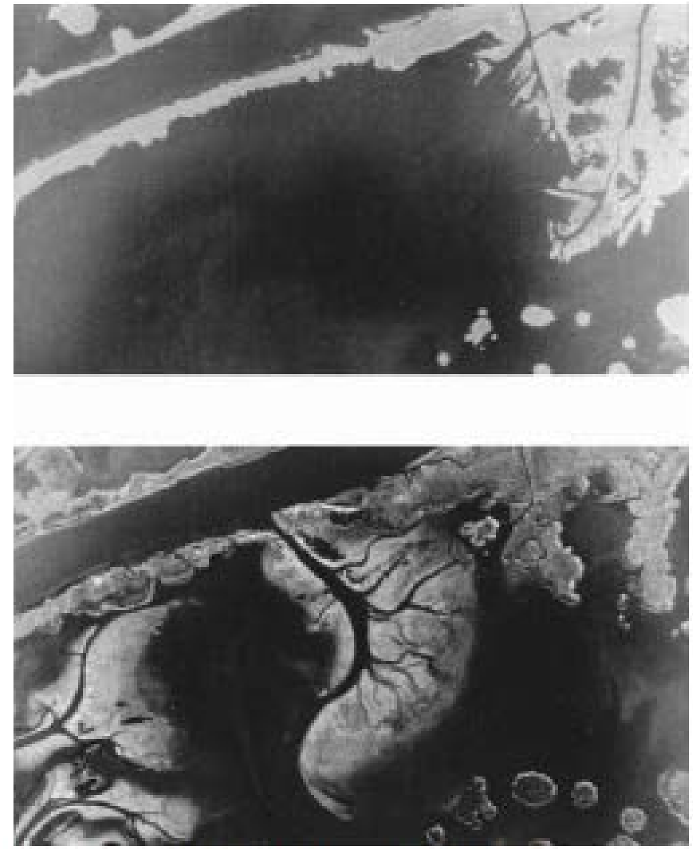
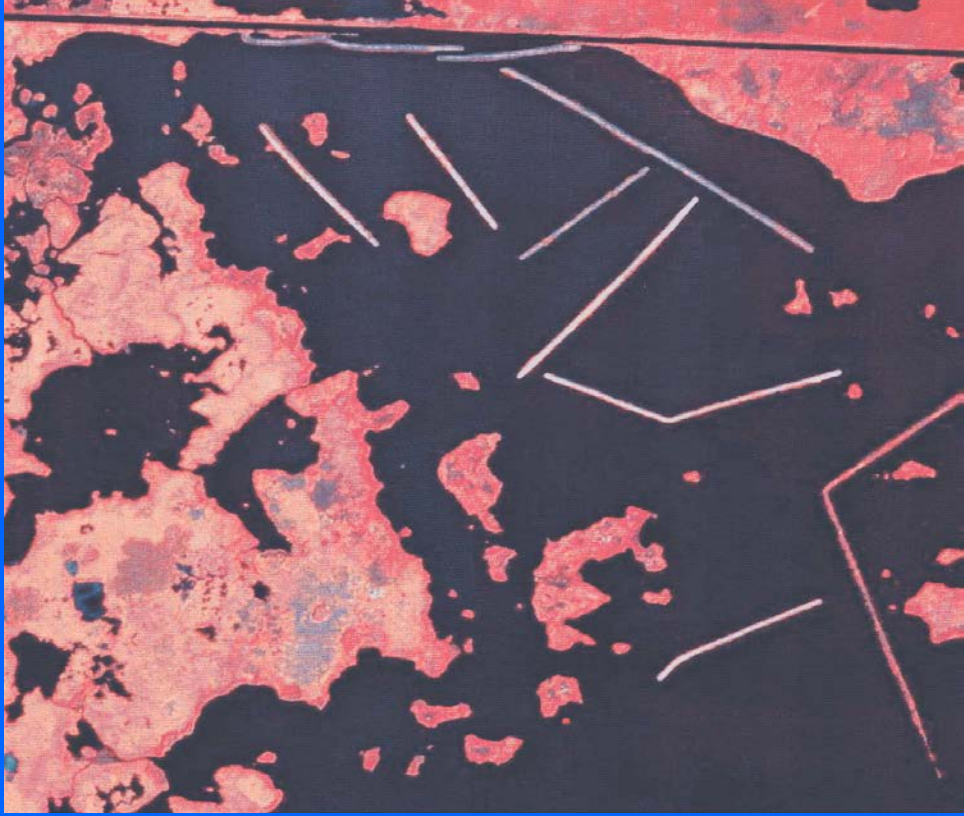


Figure 1. One of the Delta National Wildlife Refuge crevasse sites before (above) and after (below) construction. The crevasse (83–1) in 1986 (1 year before construction) and in 1995. The width of the main channel immediately opposite the crevasse is 266 m.

Kelley, S. 1996. Small sediment diversions (MR-01) MR-01-MSPR-0696-2. Progress Report No. 2. La. Dept. Natural Resources.

Boyer et al. 1997. Restoration Ecology 5:85-92

Terraces

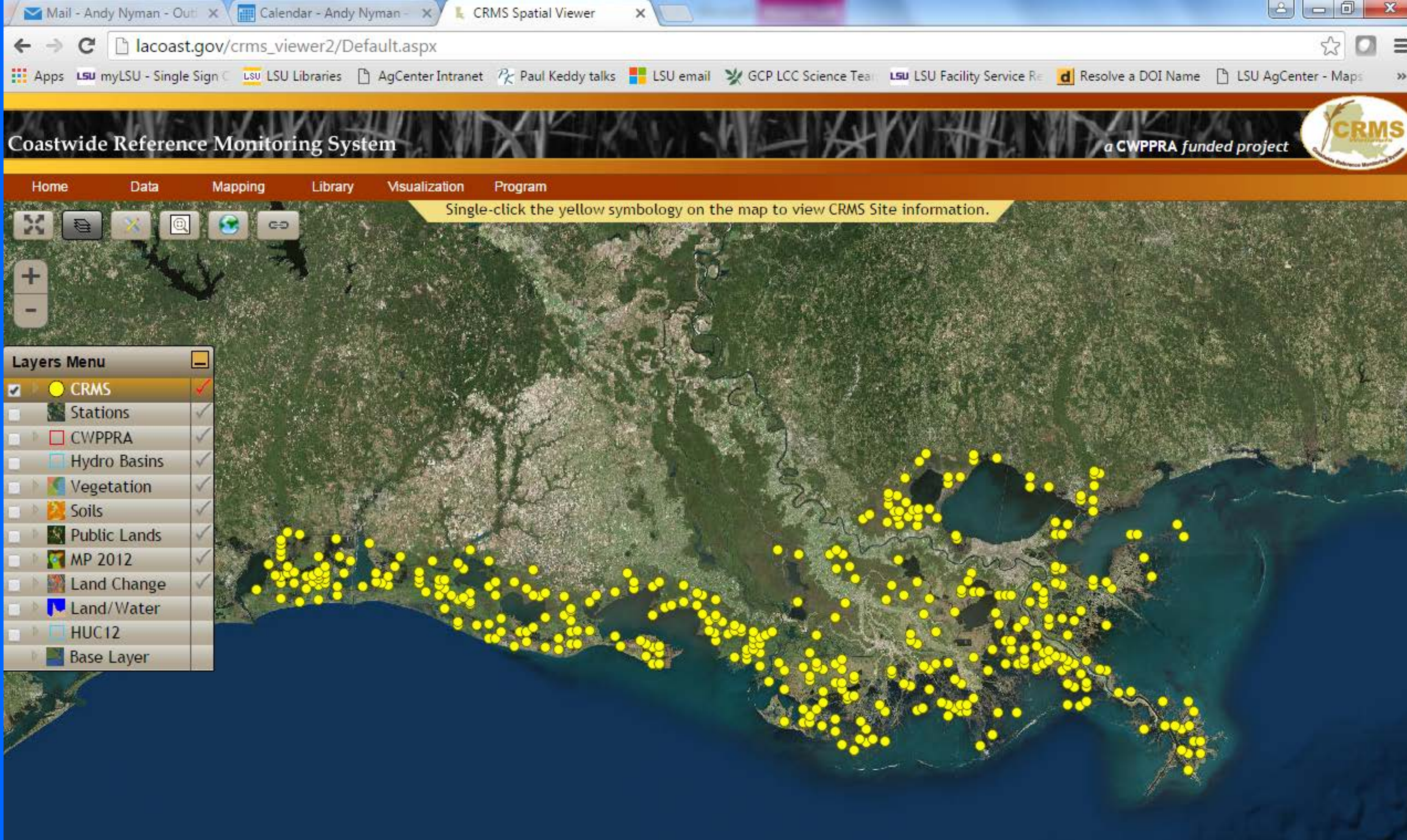
Dredged Material Wetlands

Emergent Vegetation as a Measure of Performance

- Vegetation
  - reduces storm surge speed
  - reduces wave height
  - creates fish and wildlife food and habitat
  - creates elevation (marsh vertical accretion via vegetative growth)

Emergent Vegetation as a Measure of Performance

- area of emergent vegetation (routinely monitored)
- cover (%) within emergent vegetation (routinely monitored)
- species richness within emergent vegetation (routinely monitored)
- net production (rarely used as a performance measure but for an exception see Flynn et al. 1999. Wetlands Ecology and Management 7:193-218)
- Understanding effects of restoration on emergent vegetation requires understanding effects of restoration on
  i. marsh elevation
  ii. water elevation
  iii. water salinity



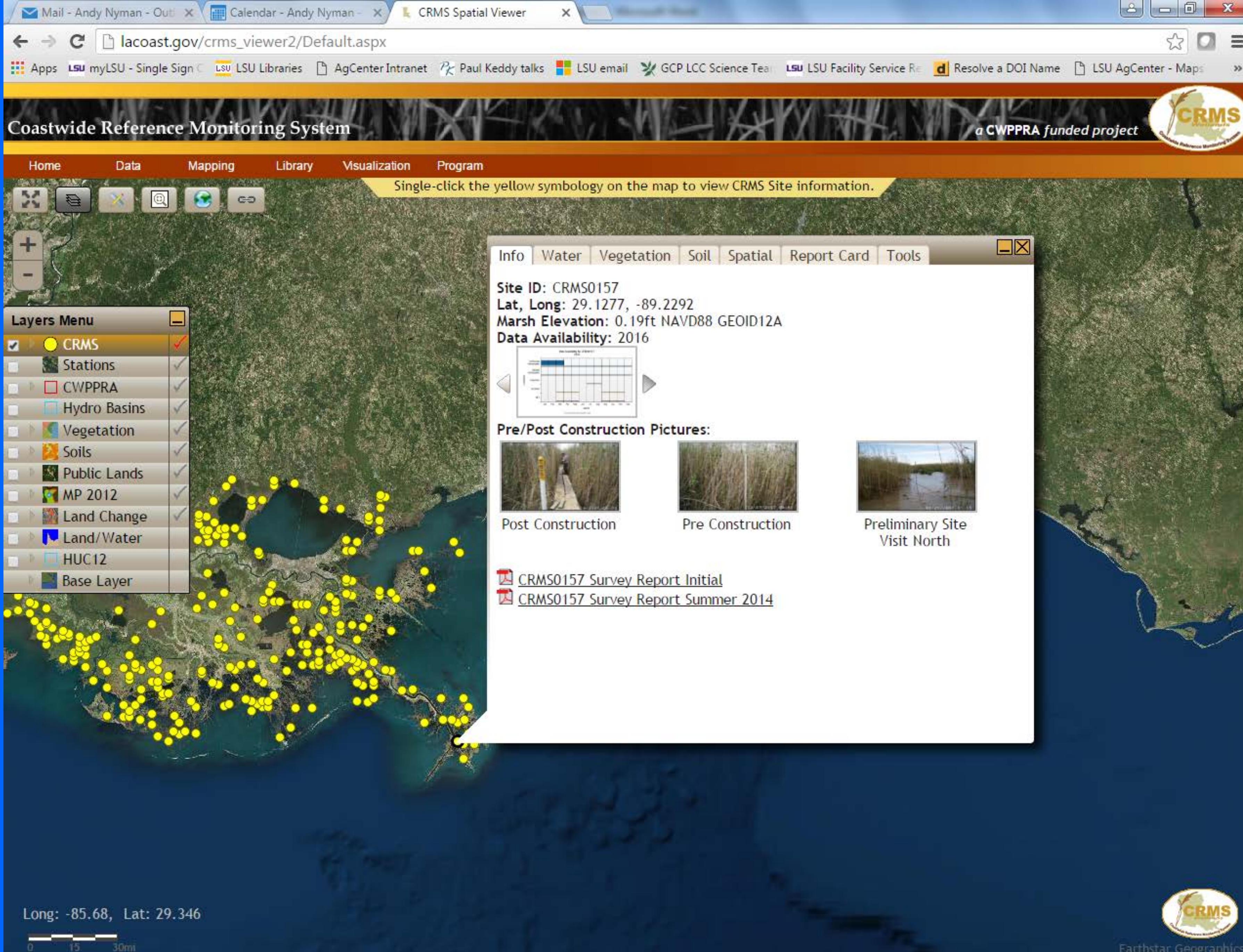
http://lacoast.gov/crms_viewer2/Default.aspx

Steyer et al. (2003). Journal of Environmental Monitoring and Assessment 81:107-117

Long: -89.322, Lat: 30.895

0 15 30mi

Earthstar Geographics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Land Change
Land/Water
HUC12
Base Layer
Info
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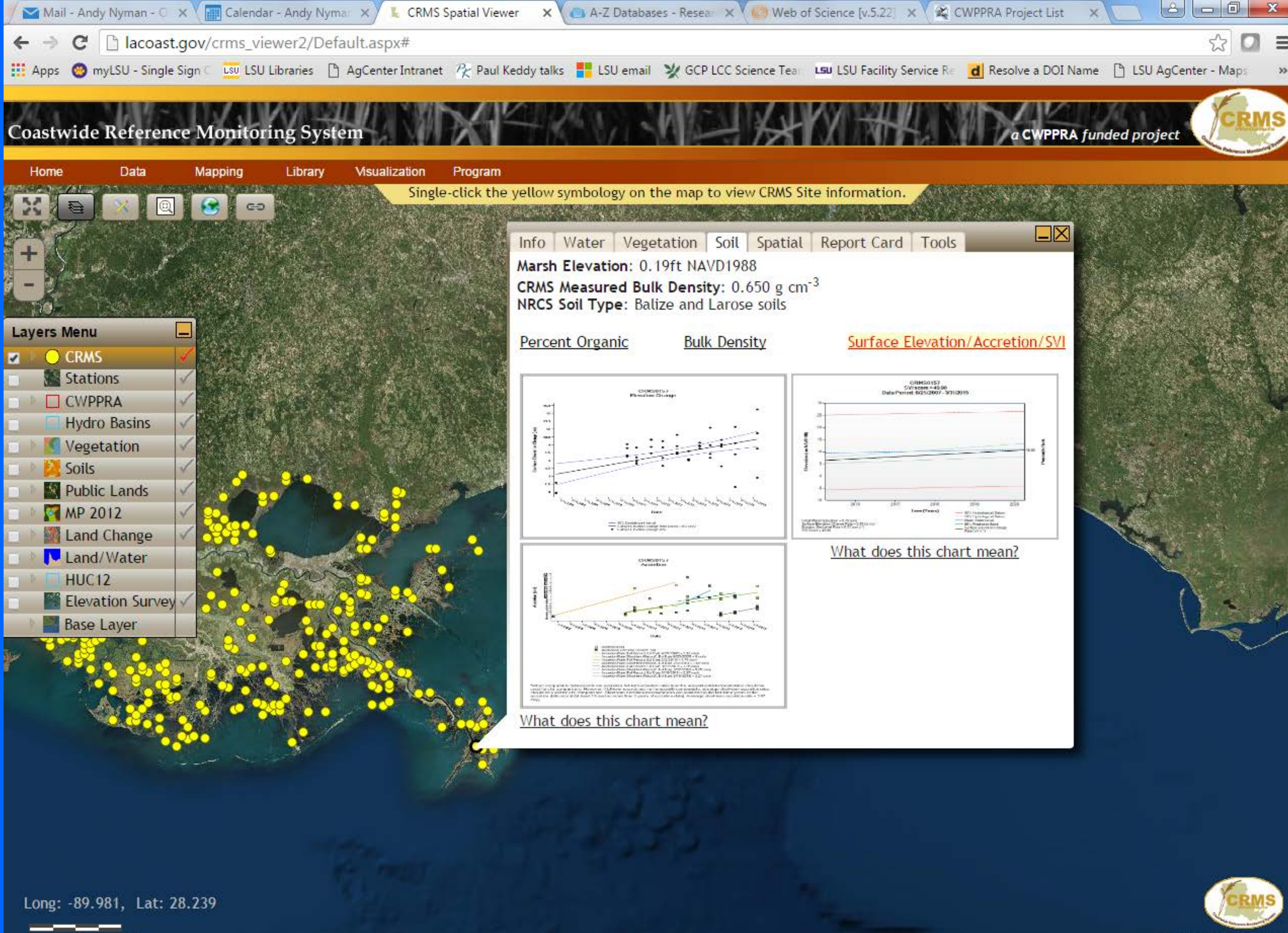
Vegetation
Soil
Spatial
Report Card
Tools
Site ID: CRMS0157
Lat, Long: 29.1277, -89.2292
Marsh Elevation: 0.19ft NAVD88 GEOID12A
Data Availability: 2016
Pre/Post Construction Pictures:
Post Construction
Pre Construction
Preliminary Site Visit North
CRMS0157 Survey Report Initial
CRMS0157 Survey Report Summer 2014
Long: -85.68, Lat: 29.346
0
15
30mi
CRMS
Earthstar Geographics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MP 2012
Land Change
Land/Water
HUC12
Elevation Survey
Base Layer
Info
Water
Vegetation
Soil
Spatial
Report Card
Tools
Marsh Elevation: 0.19ft NAVD1988
CRMS Measured Bulk Density: 0.650 g cm-3
NRCS Soil Type: Balize and Larose soils
Percent Organic
Bulk Density
Surface Elevation/Accretion/SVI
What does this chart mean?
What does this chart mean?
Long: -89.981, Lat: 28.239
CRMS

Emergent Vegetation as a Measure of Performance

- Assessing restoration designed to slow loss of existing wetlands
  - is complicated because of uncertainty in vegetation without restoration.

Emergent Vegetation as a Measure of Performance

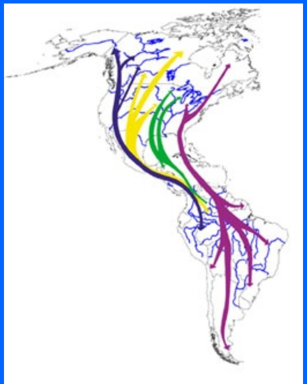
- Assessing restoration designed to slow loss of existing wetlands
  - is complicated because of uncertainty in vegetation without restoration.
- Assessing restoration designed to create new wetlands
  - shows that restoration increases vegetation.

Fish and Wildlife as Measures of Performance

- For over 50 years, almost every presentation and document addressing Louisiana's wetland loss problem mentions fish and wildlife.
- Public Law creating the Coastal Wetland Planning, Protection and Restoration Act (101st Congress, 1989-1990) has 5 references to wetlands and "the fish wildlife dependent thereon" or similar wording.
- Almost all restoration controversy involves fish and/or wildlife.

Fish and Wildlife as Measures of Performance

- Bad news
  - Migratory wildlife cause seasonal changes in wildlife abundance that are greater than many effects of restoration
  - Transient fish cause seasonal changes in fish abundance that are greater than many effects of restoration.
  - Even resident fish and wildlife are more expensive to sample than vegetation.



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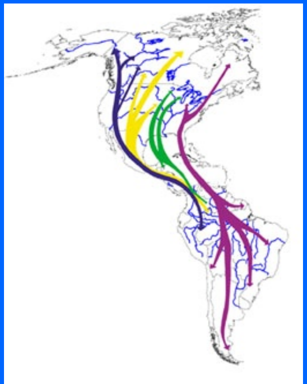
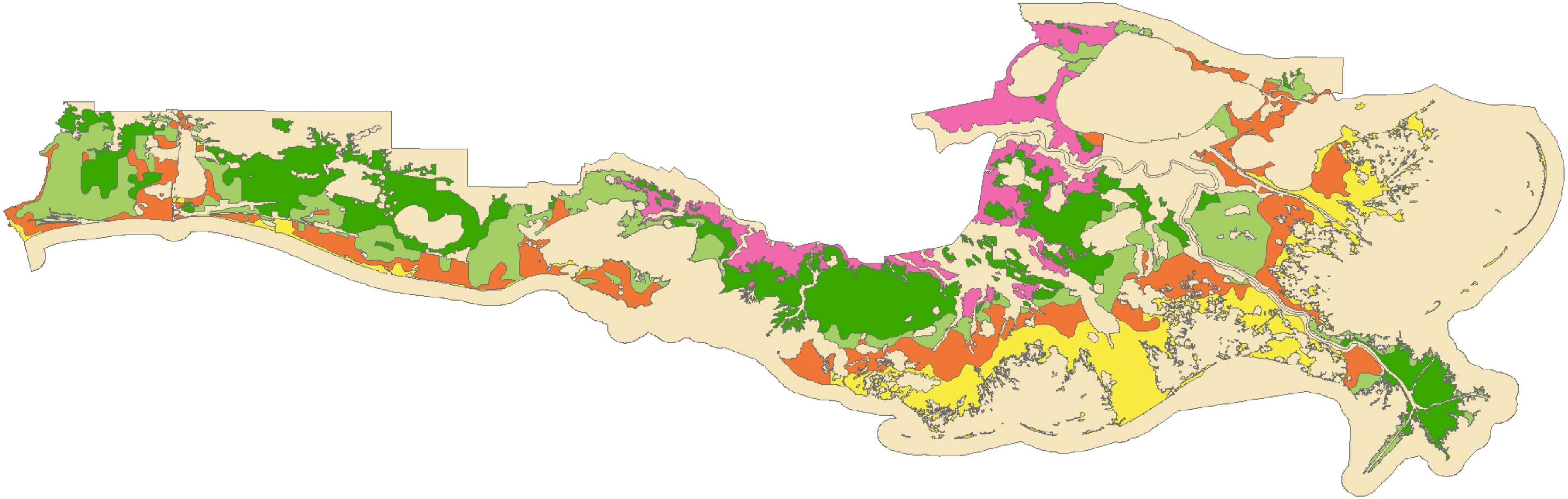
  - Transient fish cause seasonal changes in fish abundance that are greater than many effects of restoration.
  - Even resident fish and wildlife are more expensive to sample than vegetation.
- Good news
  - Broad patterns in vegetation coincide with broad patterns in wildlife abundance





- this map shows coastal forests and the most common marsh classification system in coastal Louisiana
  - swamp (*Taxodium distichum*)
  - fresh marsh (*Panicum hemitomon*, *Sagittaria lancifolia*, or *Typha* sp.)
  - intermediate marsh (*Spartina patens* and many species)
  - brackish marsh (*Spartina patens* and few species)
  - saline marsh (*Spartina alterniflora*)
- different types of marshes support different types of fish and wildlife

Fish and Wildlife as Measures of Performance

- species richness (a few studies)
- abundance (a few studies)
- net production has not been measured
  - but see trophic diversity/breadth work by Llewellyn and La Peyre (2011) Estuaries and Coasts 34:172-184.
- Understanding the response of fish and wildlife to restoration efforts requires understanding the response of vegetation, edge habitat, other animals, marsh elevation, water elevation, and water salinity to restoration.

Performance of created wetlands at supporting fish and wildlife

1. Sediment Diversions

- Fish: Castellanos and Rozas 2001 Estuaries 24:184-197.
- Wildlife: Sullivan 2015. M.S. Thesis

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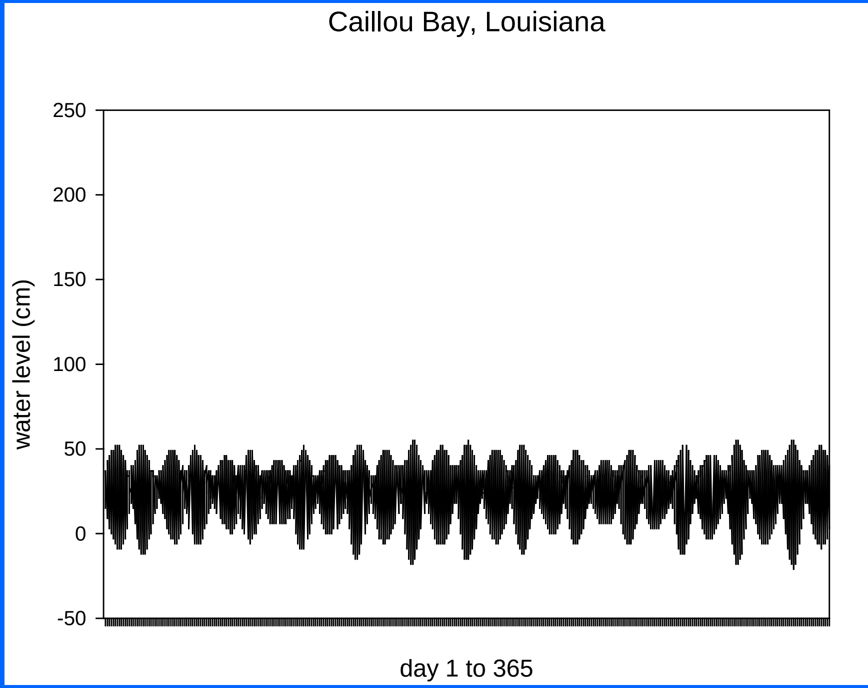
      - Wildlife: Sullivan 2015. M.S. Thesis
   3. Creating Barrier Islands and Back Barrier Marshes
      - Fish: Bilodeau and Bourgeois (2004) Journal of Coastal Research 20:931-936.
      - Wildlife: Raynor et al. (2012) Auk 129:763-772.

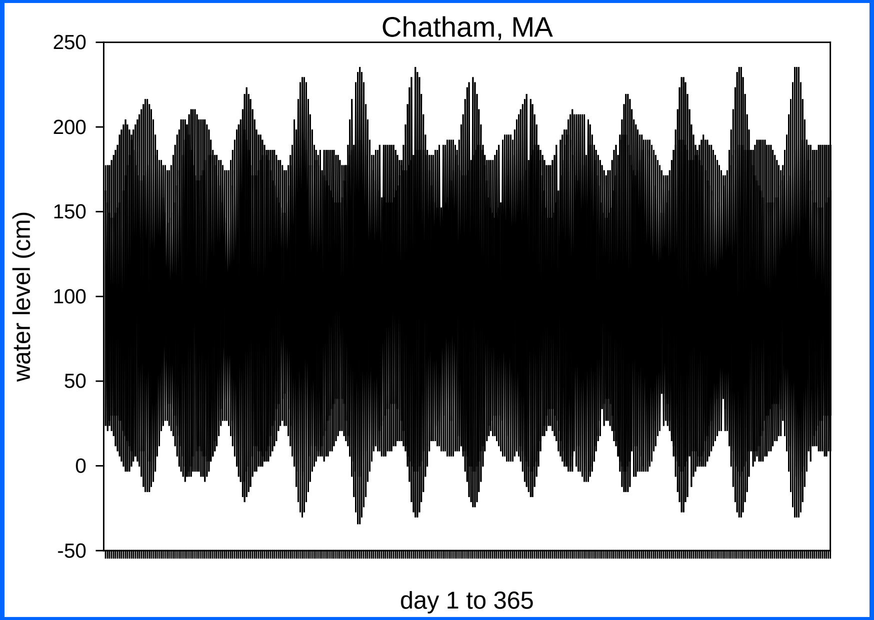
Pre-existing marsh

Marsh created with dredged material

Pre-existing marsh

Marsh created with dredged material


Caillou Bay, Louisiana
250
200
150
100
50
0
-50
water level (cm)
day 1 to 365


Chatham, MA
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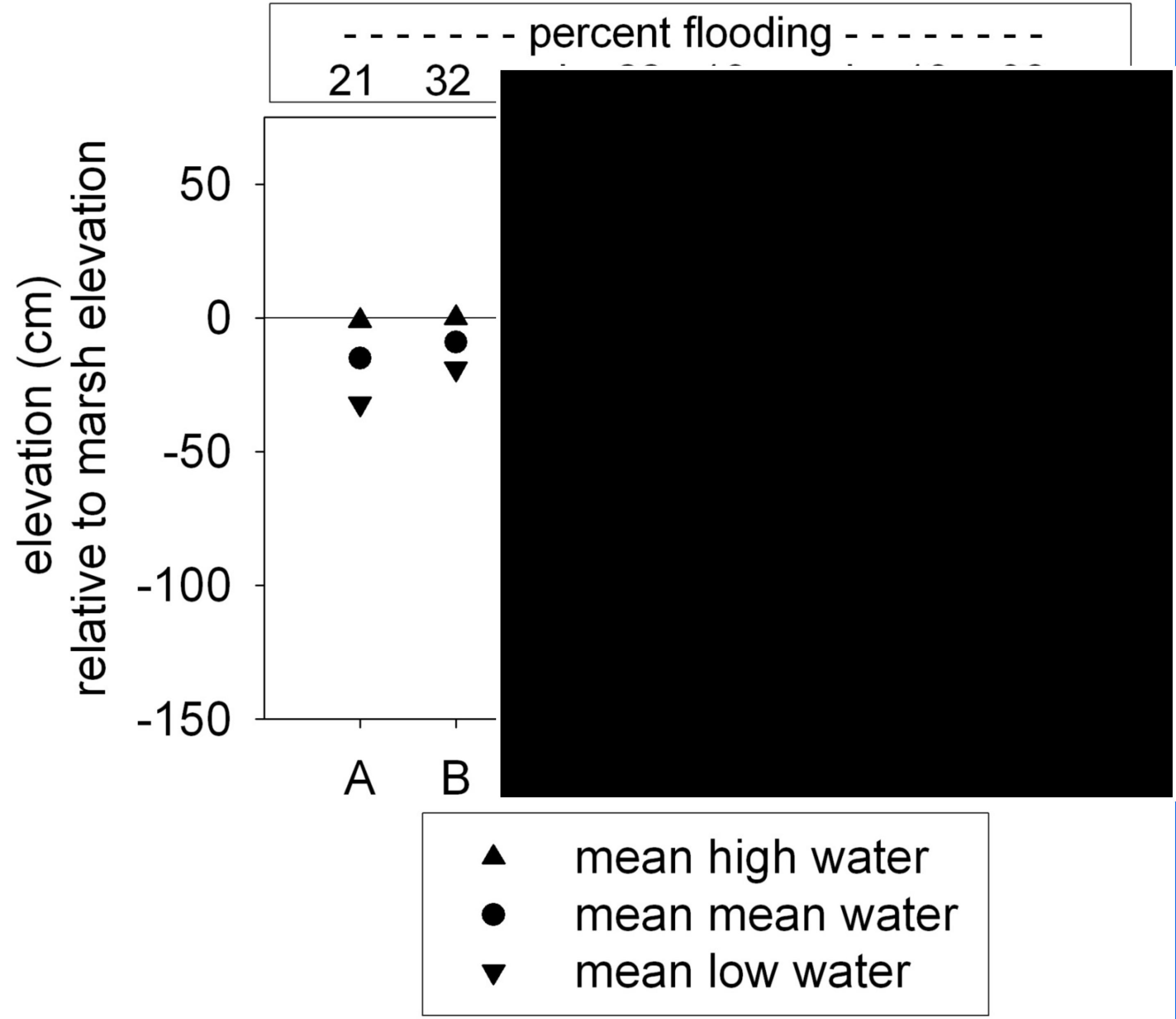
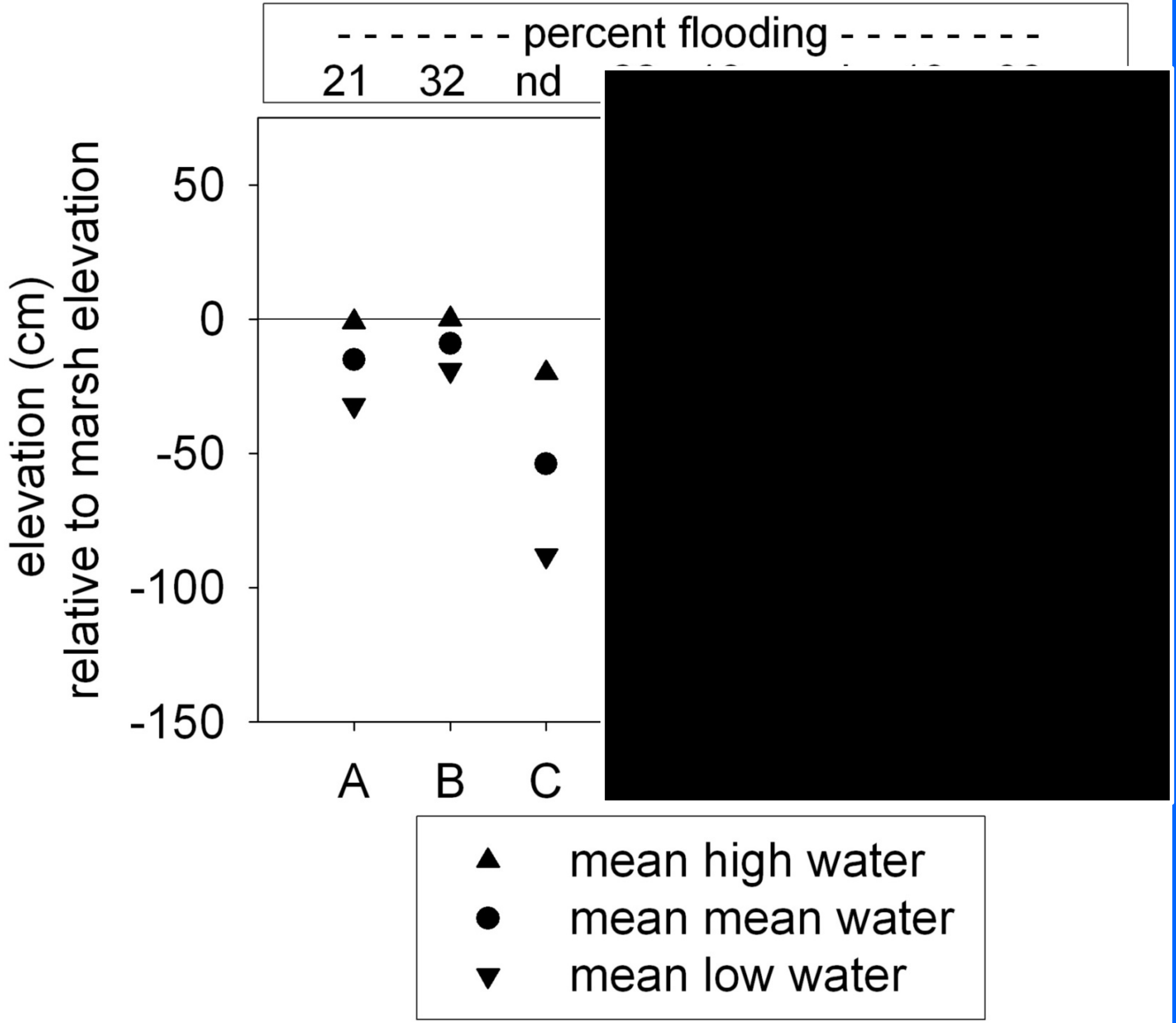
water level (cm)
day 1 to 365



Nyman, J.A. and R.H. Chabreck. 2012. pages 133-156 In N.J. Silvy (editor) The Wildlife Techniques Manual. 7th edition, volume 2. ISBN-13: 978-4214-0159-1



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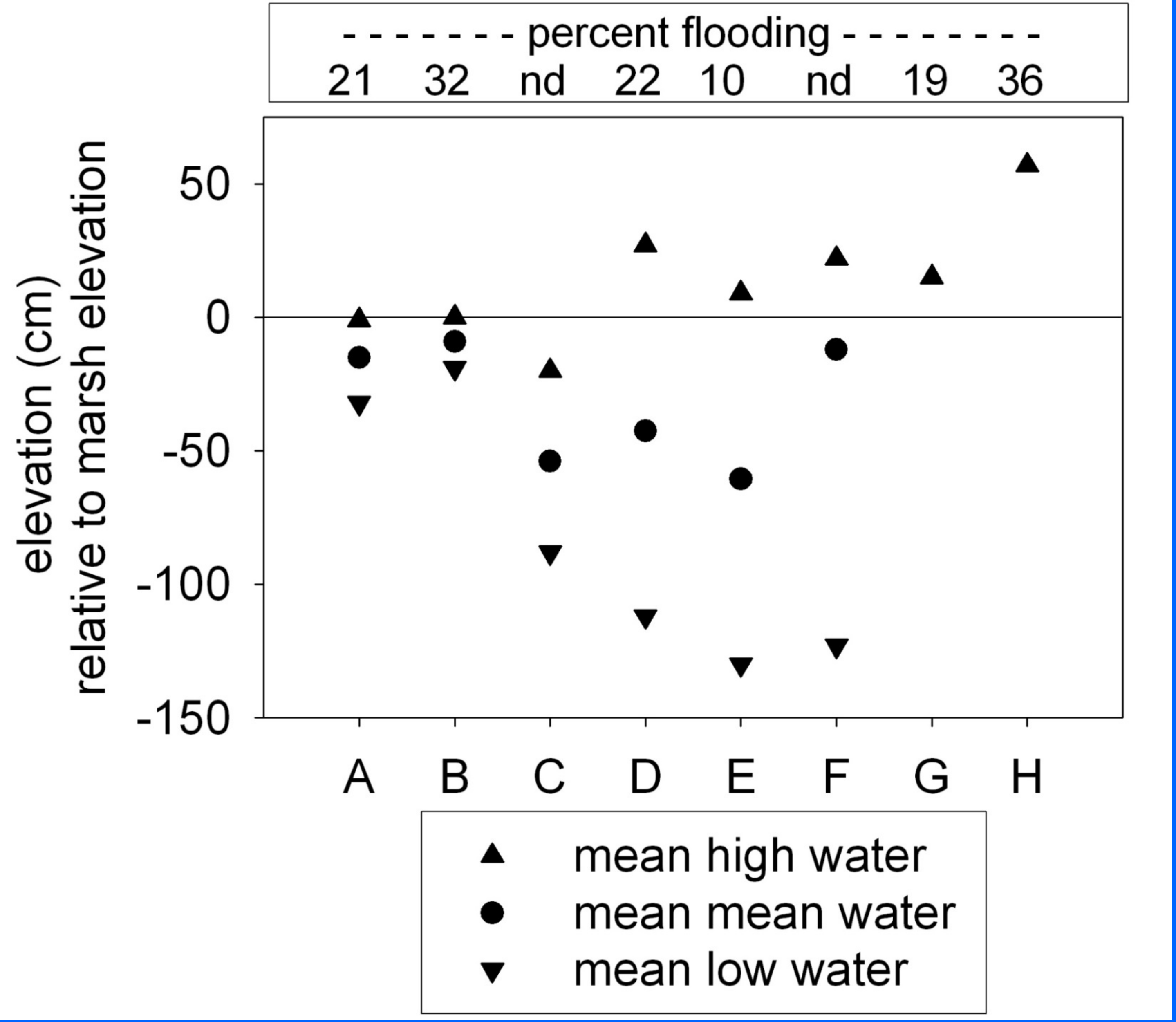

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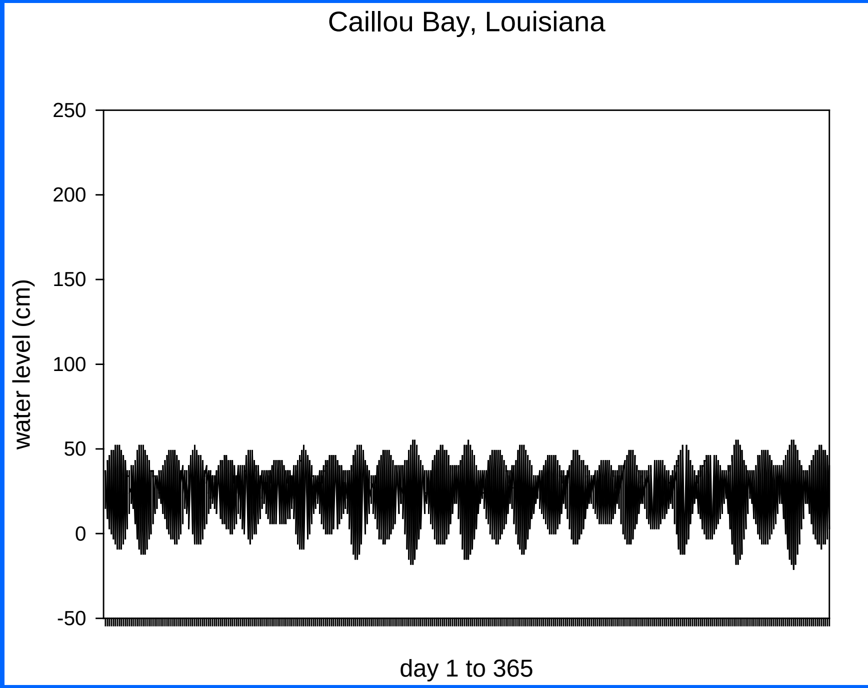
Caillou Bay, Louisiana
water level (cm)
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200
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100
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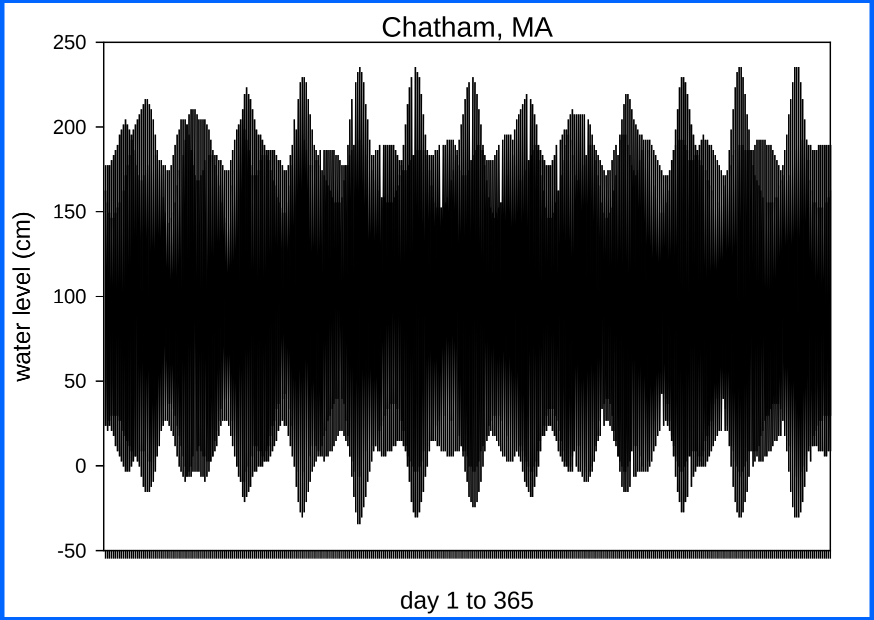
-50
day 1 to 365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water level (cm)
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www.lacoast.gov/intChart/Default.aspx?stat=CRMS0157-H01

Coastwide Reference Monitoring System

a CWPPRA funded project

Home Data Mapping Library Visualization Program

CRMS0157-H01 | Salinity | Red
CRMS0157-H01 | Water Level | Blue
CRMS0157-H01 | Salinity | Red

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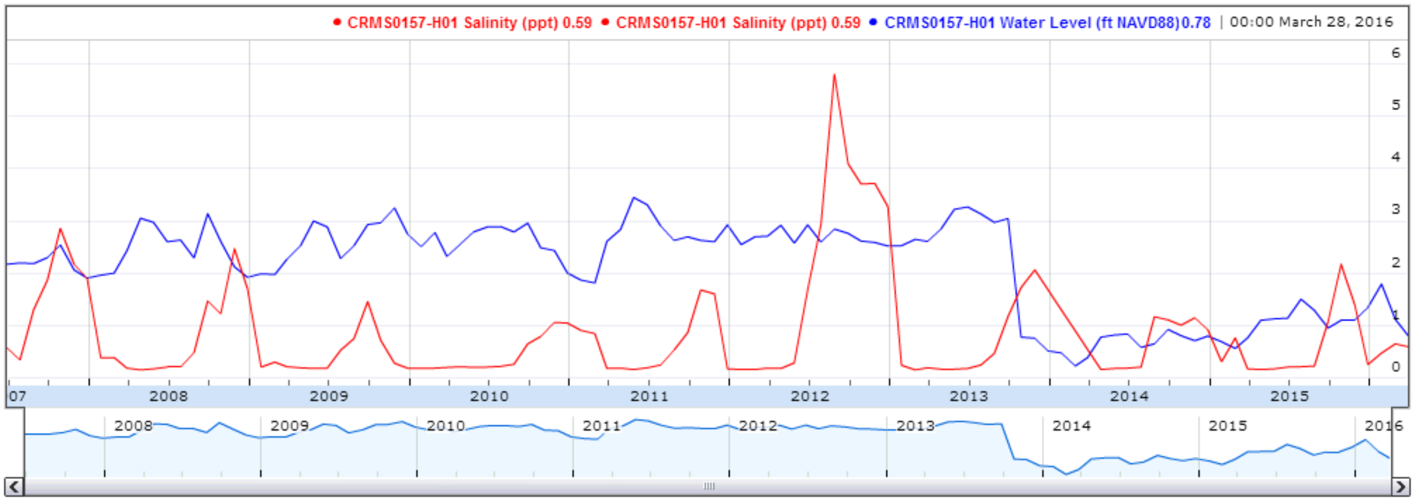
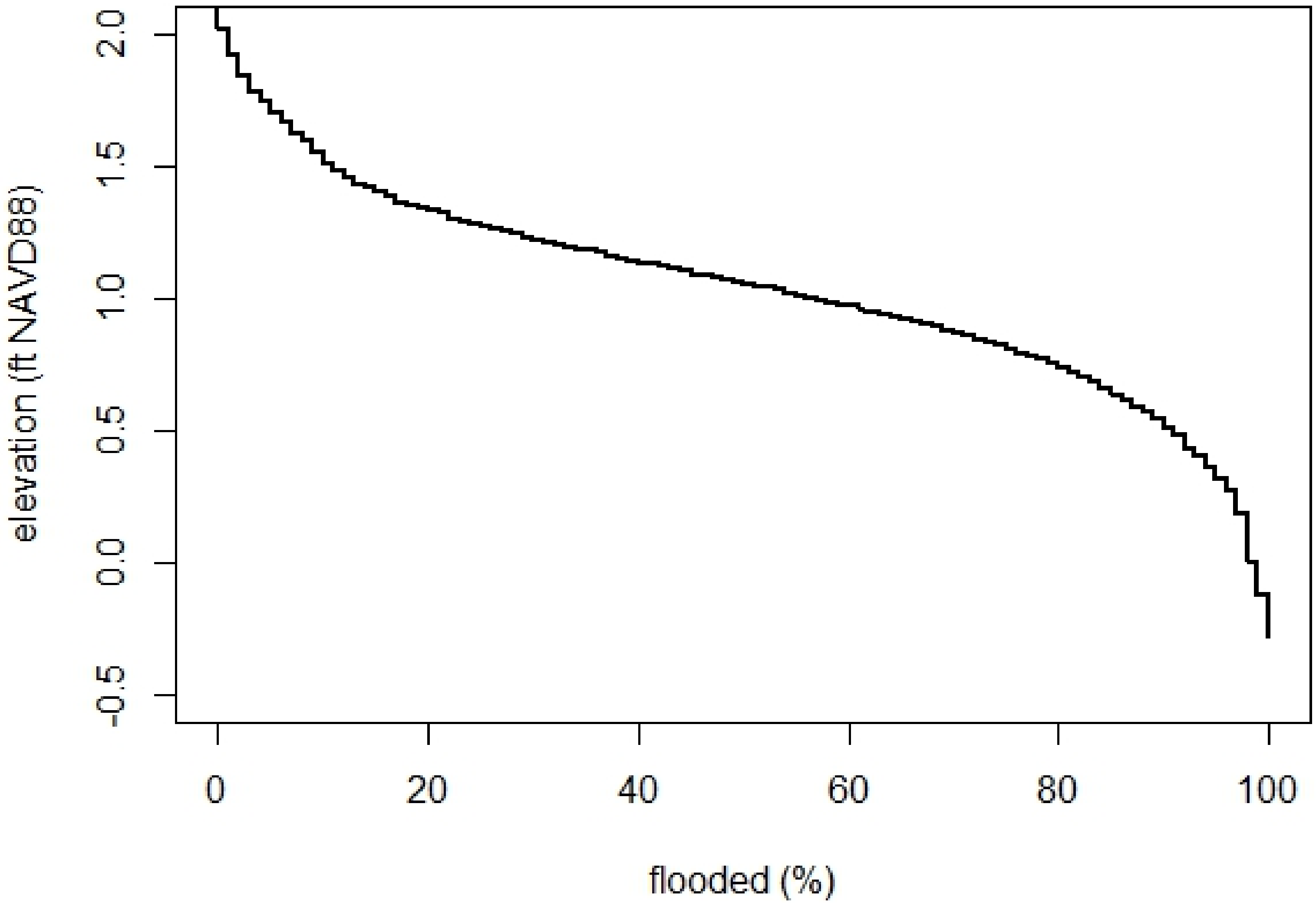
Download type for .csv: Hourly

Download Chart | Download CSV



NOTE: Water elevations prior to Oct. 1, 2013 are GEOID99 and GEOID12a thereafter



elevation (ft NAVD88)
2.0
1.5
1.0
0.5
0.0
-0.5
0
20
40
60
80
100
flooded (%)

Table 7

Mean values (range in parentheses) for average annual salinity, percent time flooded, and tidal amplitude for each of the nine community types identified.

Community type	Average annual salinity	Percent time flooded	Tidal amplitude (cm)
Paus	1.5 (0.8–3.5)	68.6 (46.1–95.5)	24.3 (20.7–26.8)
Ppun	1.2 (0.2–3.6)	57.3 (1.4–100.0)	10.4 (0.3–29.9)
Humb	1.0 (0.2–3.3)	61.7 (9.6–98.5)	1.8 (0.1–6.1)
Same	4.0 (0.2–8.8)	44.9 (8.6–90.4)	11.3 (0.3–27.7)
Spat	4.3 (1.9–7.8)	55.4 (4.3–100.0)	2.2 (0.0–10.1)
Srob	7.8 (2.1–14.9)	55.2 (12.2–98.5)	7.0 (0.1–27.4)
Sten	8.2 (2.3–16.4)	44.8 (16.1–81.7)	16.4 (6.7–28.9)
Jroe	12.8 (3.5–18.5)	50.8 (29.1–72.0)	26.5 (19.8–31.7)
Salt	18.3 (13.7–20.9)	49.7 (37.1–61.5)	25.9 (15.2–32.9)

Table 2

Mean % relative cover of the seven most abundant species for each community type. Bold indicates species was a significant indicator ($\alpha = 0.01$) for the group in question. Asterisk indicates species' highest indicator value was for group in question.

Paus		Ppun		Humb		Same		Spat	
Phragmites australis*	**66**	*Sagittaria lancifolia*	9	***Panicum hemitomon****	**16**	*Spartina patens*	45	***Spartina patens****	**70**
A. philoxeroides*	**8**	***Vigna luteola****	**9**	***Sagittaria lancifolia****	**13**	***Schoen. americanus****	**13**	***Typha latifolia****	**7**
Vigna luteola	5	*Spartina patens*	9	***Eleocharis****	**10**	*Vigna luteola*	9	*Leptichloa fusca**	4
Panicum repens*	**4**	***Polygonum punctatum****	**8**	***Leersia hexandra****	**8**	*Distichlis spicata*	7	*Paspalum vaginatum**	4
Colocasia esculenta	4	*A. philoxeroides*	6	***Thelypteris palustris****	**7**	***Lythrum lineare****	**6**	*Bacopa monnieri**	3
Spartina patens	3	*Colocasia esculenta**	4	***Hydrocotyle umbellata****	**7**	*Juncus roemerianus*	3	*Schoen. californicus*	2
Spartina alterniflora	2	*Leersia hexandra*	3	***Morella cerifera***	**4**	*Baccharis halimfolia**	2	*Typha domingensis*	2

Srob		Sten		Jroe		Salt	
Spartina patens	43	*Spartina alterniflora*	36	*Spartina alterniflora*	79	***Spartina alterniflora****	**92**
Distichlis spicata*	**24**	*Spartina patens*	34	***Juncus roemerianus****	**19**	*Avicennia germinans**	3
Schoen robustus*	**9**	*Distichlis spicata*	15	*Spartina patens*	1	*Salicornia depressa**	2
Spartina alterniflora	4	*Juncus roemerianus*	7	*Batis maritime*	<1	*Distichlis spicata*	1
Schoen. americanus	4	*Spartina cynosuroides**	2	*Avicennia germinans*	<1	*Batis maritime*	1
Vgina luteola	2	*Symphyotrichum ten.**	2	*Distichlis spicata*	<1	*Spartina patens*	<1
Phragmites australis	2	*Lythrum lineare*	1	*Eleocharis parvula*	<1		

Snedden and Steyer (2013) Estuarine, Coastal & Shelf Science 118:11-123

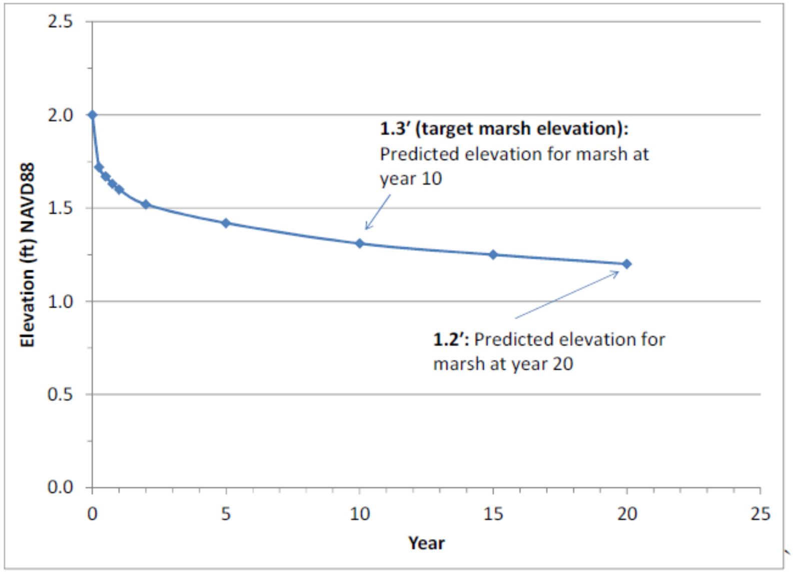
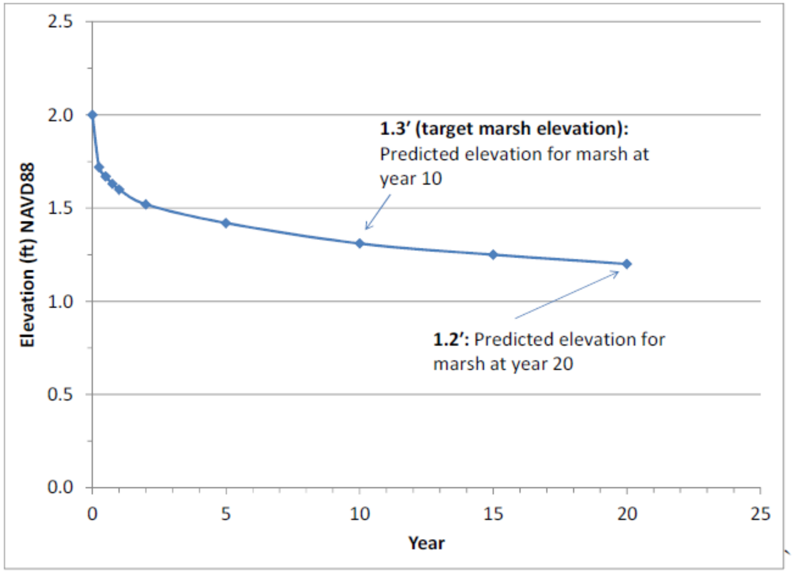


Figure 7. Predicted twenty-year settlement curve for BA-39 based on a constructed marsh fill elevation of +2.0′ NAVD88.



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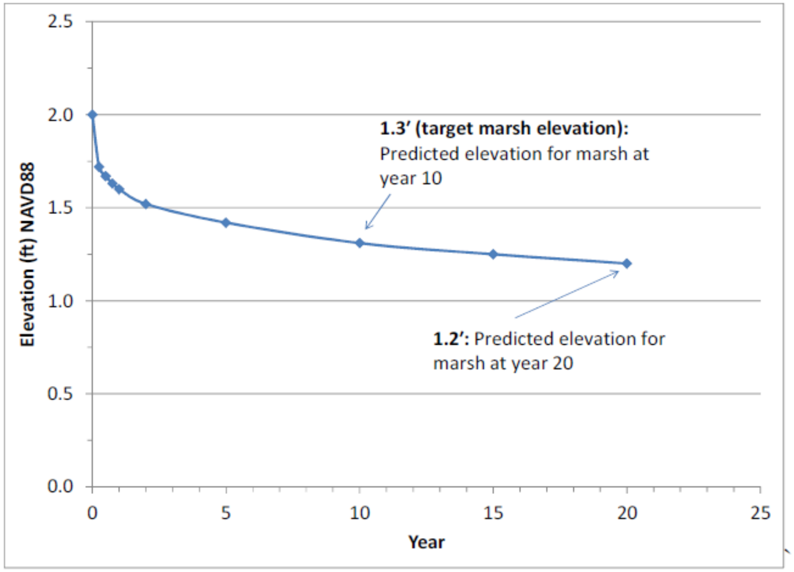
Ignoring marsh vertical accretion leads to initial elevations that are too high to perform as a natural wetland with regards to fish and wildlife habitat.



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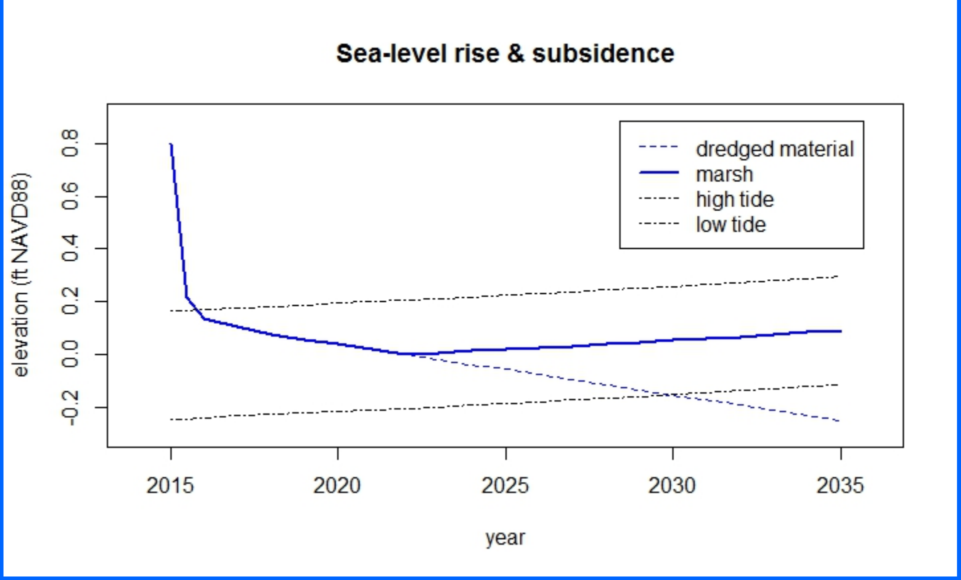

Acknowledging marsh vertical accretion leads to initial elevations that can perform as a natural wetland with regards to fish and wildlife habitat.

Conclusions

- Whether restoration seeks to slow the loss of existing wetlands or to create new wetlands
  - emergent vegetation is an excellent but incomplete measure of performance for restored Gulf Coast Wetlands
    - area (commonly measured)
    - cover (commonly measured)
    - species composition (commonly measured)
    - net production (few measurements)
  - Understanding the response of emergent vegetation to restoration efforts requires understanding the response of marsh elevation, water elevation, and water salinity to restoration. (commonly measured)

Conclusions

- After the 2005 hurricanes, storm protection has become an increasing important justification for restoring Gulf Coast Wetlands
  – Woody vegetation is better than non-woody
  – Closer to levees is better than farther from levees
  – This is outside my area of expertise, but the performance of restored wetlands at reducing storm surge is probably judged best with widespread simulations and opportunistic studies/validations.
  – I assume such simulations and studies/validations are important parts of restoration planning and assessment.

Conclusions

Fish and wildlife motivated restoration of Gulf Coast wetlands long before the 2005 hurricanes.

- The performance of restored wetlands at supporting fish and wildlife is probably judged best with widespread simulations and opportunistic studies/validations.
  - Such studies/validations appear to me to be unimportant parts of restoration planning and assessment.
- Percent vegetative cover, marsh-type, and water quality parameters are insufficient to simulate fish and wildlife habitat value.
  - Edge habitat: area of open water within 10-m of emergent vegetation (m^{-2})/project area (ha)
  - Flooding statistics (percent time flooded, duration of flood events)