Salt marsh die-back along the Atlantic and Gulf Coasts

David Osgood
Albright College
Reading, PA

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State of the Bay – Past, Present, & Future
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Coastal Die-backs

- Seagrasses
- Coral Reef
- American Lobster
- *Spartina* and *Phragmites* (in Europe)

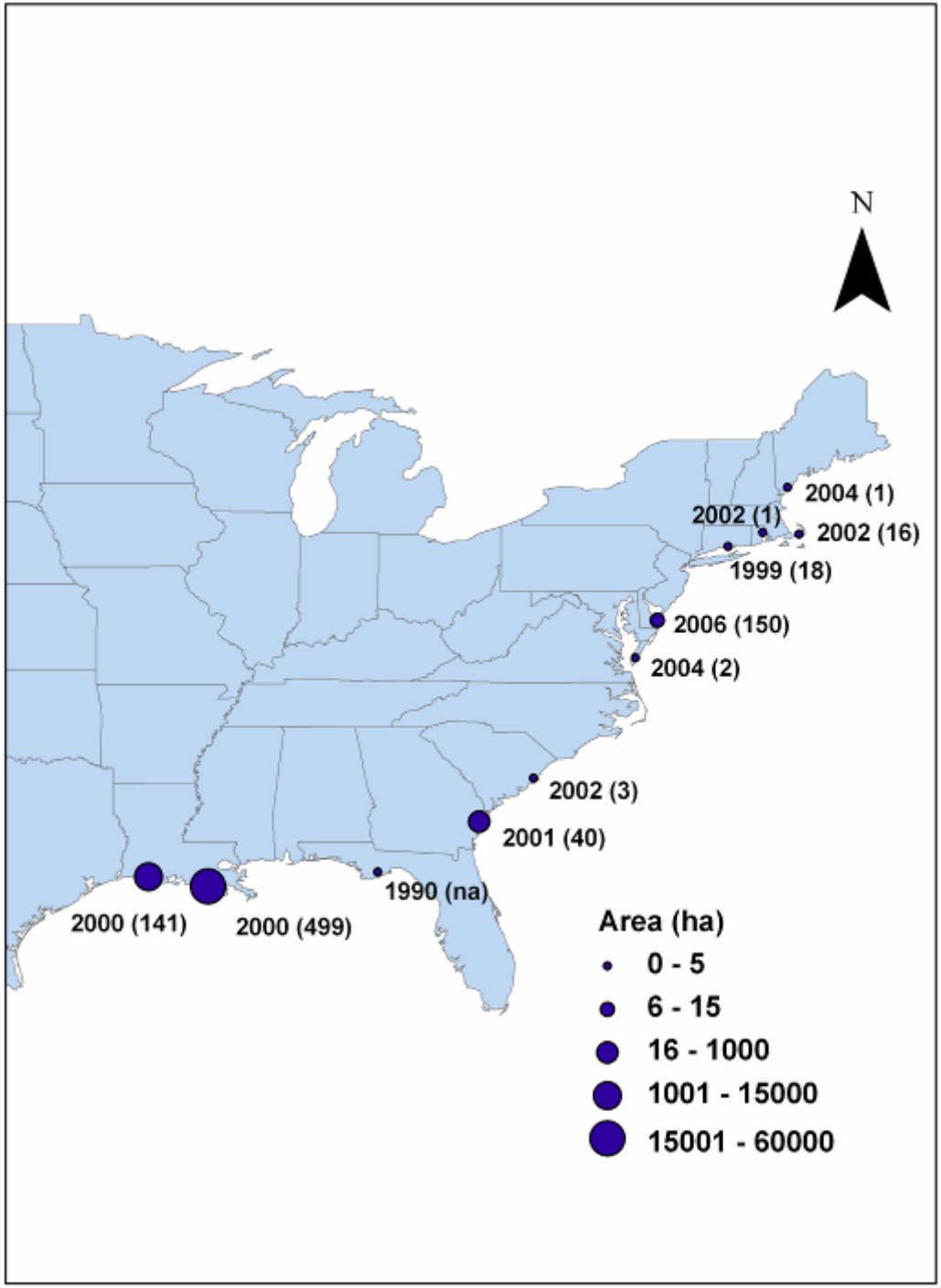
- *Spartina* and other grasses (US Gulf & Atlantic Coasts) (originating 1999)

What is “Die-back”?

- Various terminology
  - Die-off
  - Marsh Browning

- Contrast the current die-back with past die-back or marsh loss
  - Die-back events in the U.S. date back to 1970 and in Europe were documented earlier

Die-back Locations
Year of origin (number of sites)



Source: Osgood et al. (in press)
***in* Anthropogenic impacts in**
North American Salt Marshes

Die-back Physiognomy

- Mostly *S. alterniflora*, but *J. roemerianus*, *S. patens,* and *D. spicata* are also impacted at some sites

- Individual areas impacted vary in size (10 to 5 x 10^6 m^2)

In many cases mangrove species and others are un-impacted…

Source:http://www.lacoast.gov

Source: http://www.gcrc.uga.edu/MarshDieback/marsh_photos.htm


Source: http://www.lacoast.gov

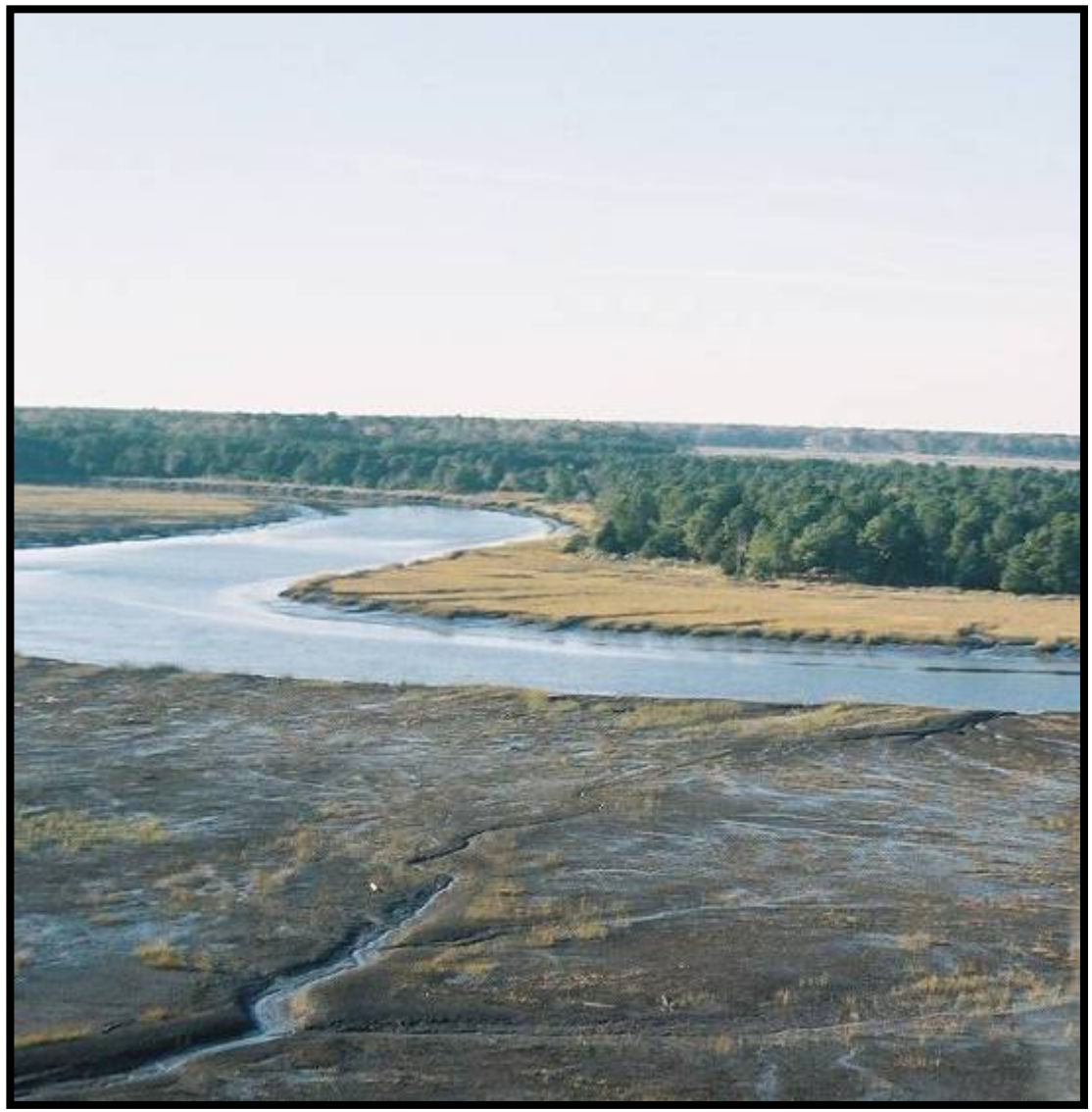
Die-back Physiognomy

- Creekbank and interior locations impacted

Occasionally die-back is isolated to creekbank zones…

Source: http://www.gcrc.uga.edu/MarshDieback/marsh_photos.htm

Other times die-back occurs along creekbanks and within marsh interior…



Source: http://www.gcrc.uga.edu/MarshDieback/marsh_photos.htm

Die-back Physiognomy

- Recovery often occurs within 1-2 years

Postulated Causes

- Drought as a trigger factor
  - Desiccated soils
  - Reduced freshwater inflow

Drought indicator	Georgia		Louisiana*	
	Drought	Predrought/ nondrought	Drought	Predrought
Yearly rainfall (cm)	93 ± 7.5	131 ± 21	102 ± 76	132 ± 74
PDSI	−2.71 ± 0.57	0.18 ± 1.56	−2.85 ± 1.27†	0.11 ± 2.02†
Estuarine salinities (ppt)	30.5 ± 1.41	20.8 ± 3.54	25.5 ± 0.6	20.6 ± 5.6
Marsh soil salinities (ppt)	48.6 ± 4.27	27.3 ± 2.58	†	†

*Data modified from (22). †Grand Terre, LA. Although interstitial salinities before and after the drought are not available for Louisiana, interstitial salinities collected in June 2000 at a dieback site at Bay Junop ranged from 27 to 32 ppt; salinity was 23 ppt in an adjacent nondieback site (8).

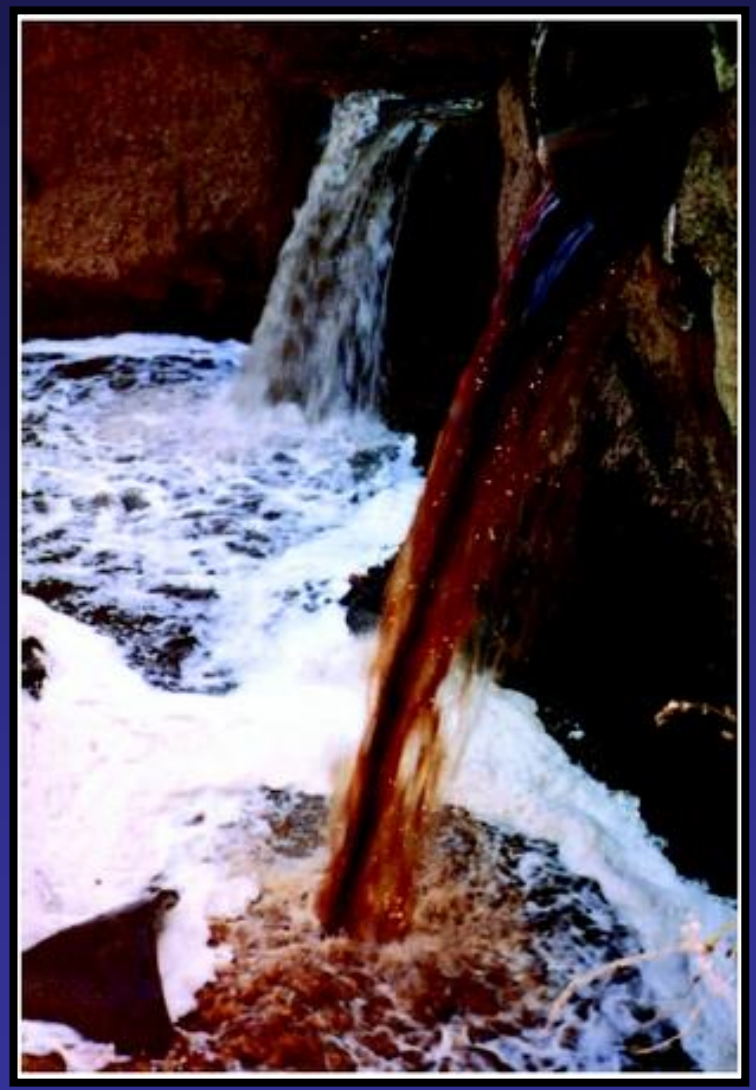
Source: Silliman et al. (2005) Science 310:1803

Postulated Causes

- Pollution

For: Pollution (e.g. oil spills) can cause acute die-back of marsh grasses

Against: Die-back occurrences have not coincided with acute pollution events. Chronic sources of pollution (e.g. eutrophication) have impacted marshes over a long time period.



Postulated Causes

- Elevated Salinity

For: Elevated salinity has been observed at most sites coincident with die-back events. In certain cases surviving plants are more salt-tolerance variety.

Against: Observed hypersalinity does not exceed known tolerance within affected species.

Source: http://www.gcrc.uga.edu/MarshDieback/marsh_photos.htm

Postulated Causes

- Acidity/Metal Toxicity

For: Experimental evidence exists in support of argument. Acute metal toxicity has been documented for marsh grasses and matches die-back symptoms. Surviving species more tolerant of low pH and metals.

Against: Die-back occurrences have not always coincided with soil dessication events.

Drought

Desiccation/ Oxidation

Re-watering

Reduced pH

Mobilization of Metals

Mortality

Postulated Causes

- Elevated Sulfides & Waterlogging

For: Elevated sulfide has been observed coincident with die-back events and is known to cause die-back in historic events.

Against: Unclear if low oxygen/high sulfide conditions precede die-back or result from grass die-back. Surviving species are not necessarily more sulfide-tolerant. Some locations outside of die-back zones also had equally high sulfide concentrations.

Postulated Causes

- Herbivore Grazing

For: High densities of snails found at several sites. Experimental evidence shows mortality is possible from grazing fronts.

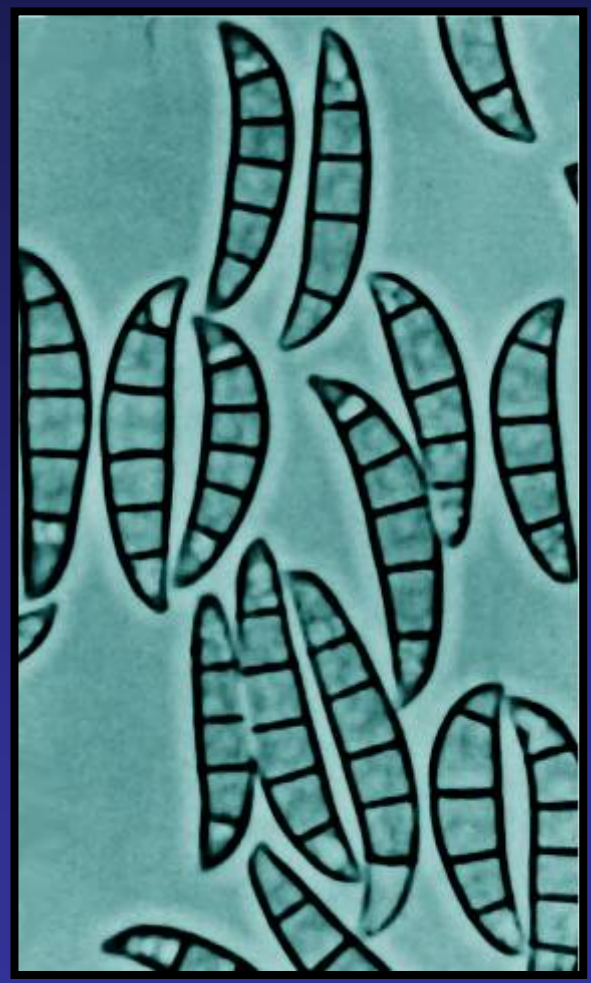
Against: Unclear if grazing is antecedent to die-back, snails not always present at high densities.

Postulated Causes

- Pathogens

For: *Fusarium* and *Rhizoctionia* found with belowground tissue of die-back plants.

Against: Unclear if fungal infection is opportunistic or the cause of die-back. Fungal bodies not found at all sites.

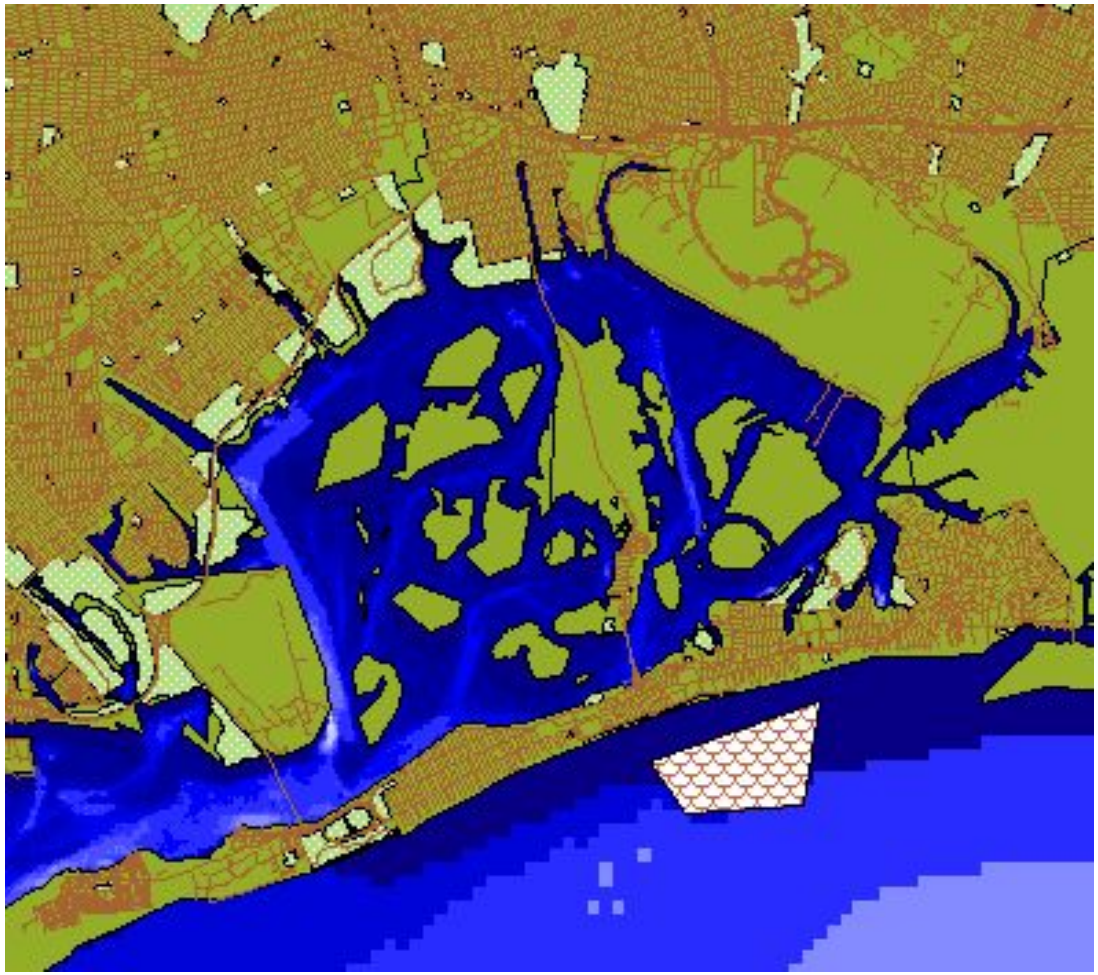


Source: www.mycotox-society.org

Factor Interaction

Culmination of anthropogenic stressors?

An argument for compounding anthropogenic stressors…



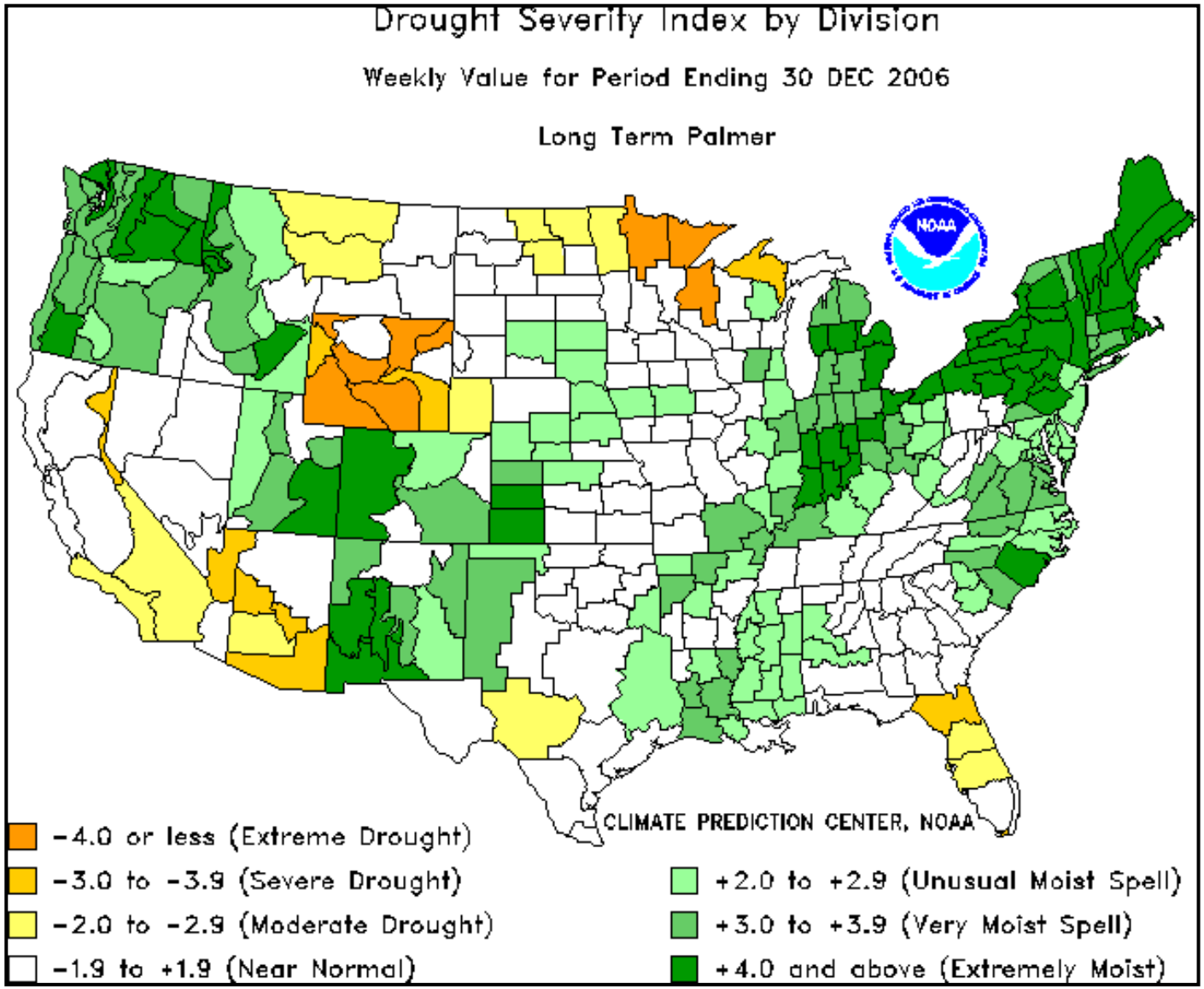
Source: www.njnycoast.org

Jamaica Bay

- Die-back in J. Bay has a longer history than current die-back phenomenon
- Good case for compounding anthropogenic stressors
- Impacts of drought on die-back?

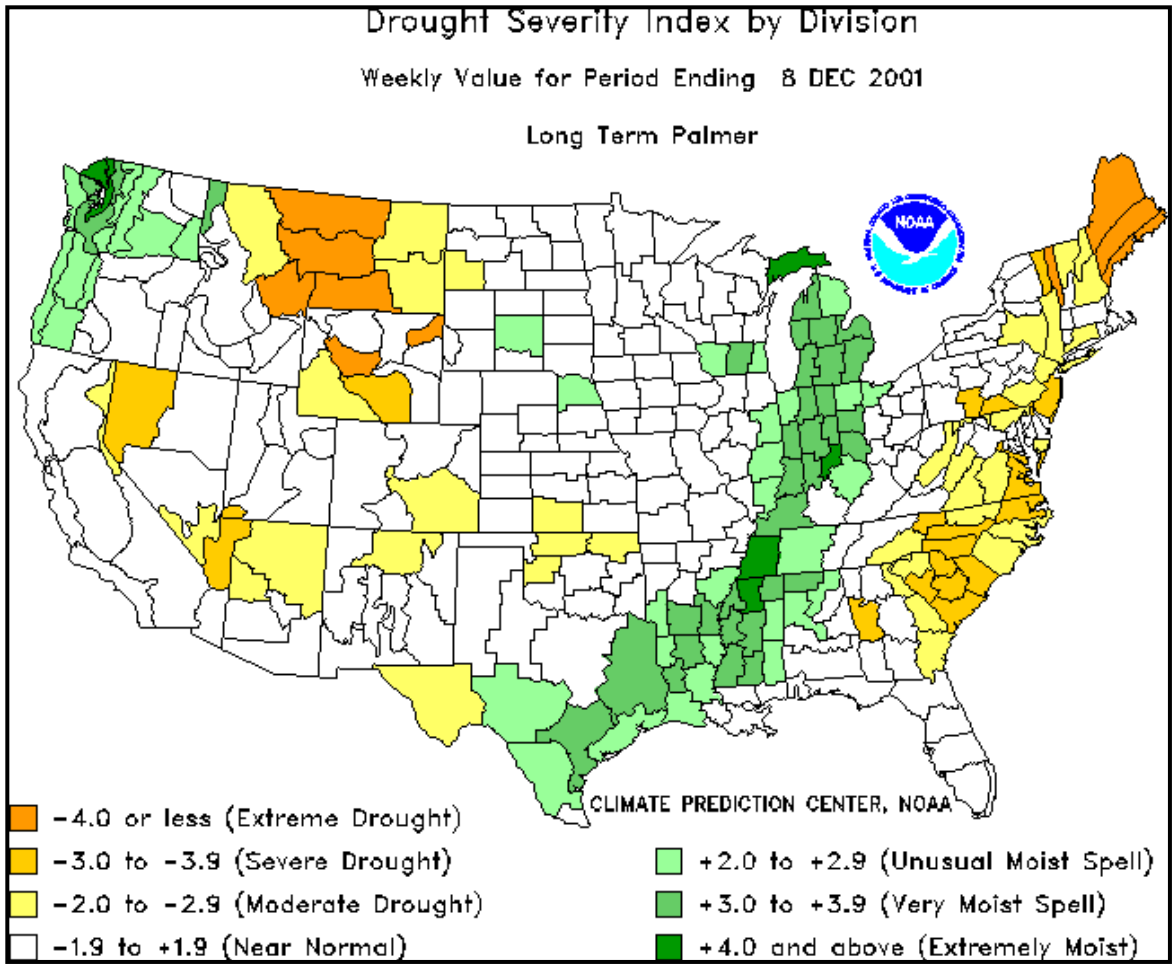
Drought within N.E. US

Most times the NE US looks like this….



Source: www.cpc.ncep.noaa.gov

Drought within N.E. US



Source: www.cpc.ncep.noaa.gov

Year	Month	Locations	PDSI	Ranking
1998	Sept Nov-Dec	NJ, Long Island, Upstate NY, CT	-2.0 to -3.9	Moderate-Severe
1999	May-Aug	NJ, Upstate NY, New England, Eastern PA	-2.0 to -3.9	Moderate- Severe
2001	May Aug-Dec	NJ, Long Island, Upstate NY, Western MA, Eastern PA	-2.0 to -3.9	Moderate-Severe
2002	Jan-April July-Aug	NJ, Long Island, Upstate NY, CT, Western MA	-2.0 to 4+	Moderate-Extreme
2005	Aug-Sept	NJ, Long Island, CT	-2.0 to -3.9	Moderate-Severe
2006	May	S. NJ	-2.0 to -3.9	Moderate
2007	Sept-Oct	S. NJ, CT	-2.0 to 3.9	Moderate-Severe
2008	Aug	S. NJ	-2.0 to -2.9	Moderate

Source: www.cpc.ncep.noaa.gov

Wrap-up

- **Drought is very likely a trigger factor in current die-back**
- **Causes may be site-specific**
- **Synergistic Factors – have we reached a threshold in environmental stress?**
- **Not always a silver bullet**

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http://www.gcrc.uga.edu/MarshDieback/marsh_photos.htm