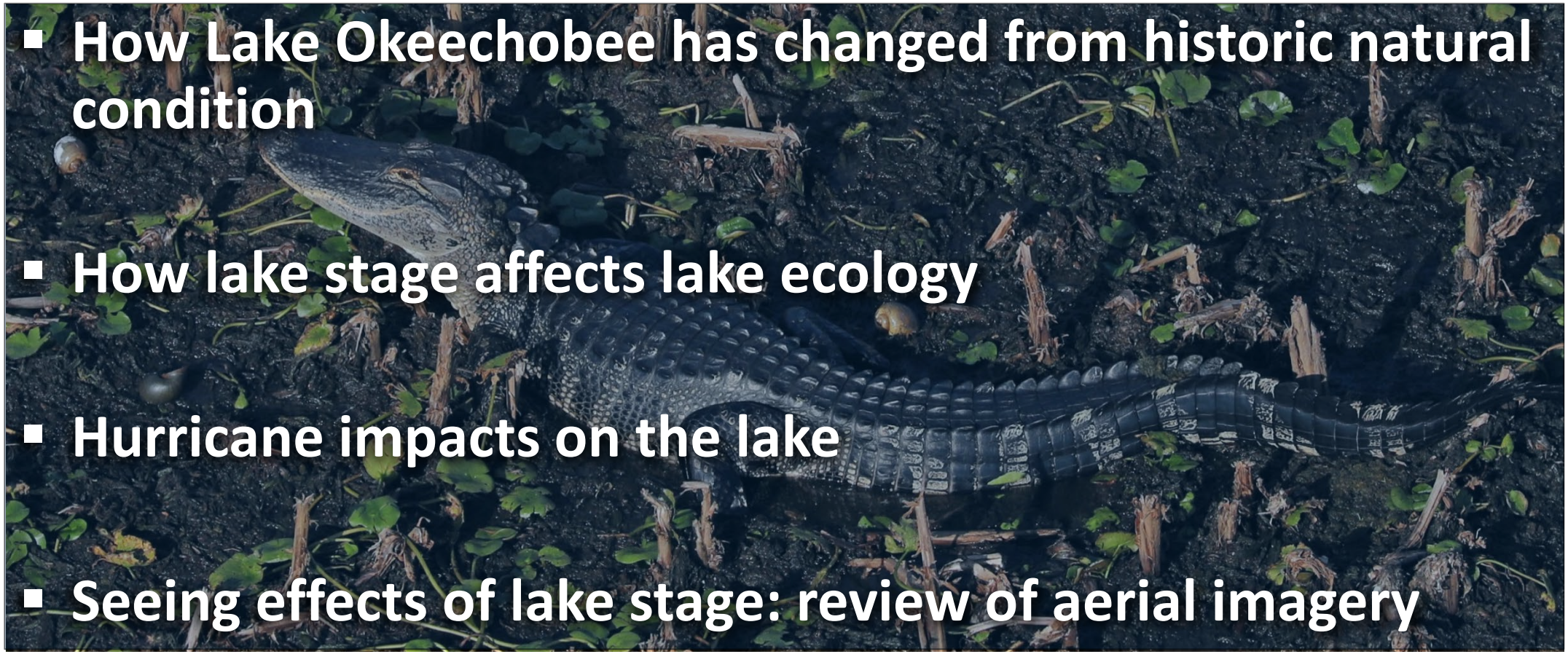
How Lake Okeechobee Water Levels Affect Lake Ecology

Zach Welch, PhD
Applied Sciences Bureau, SFWMD

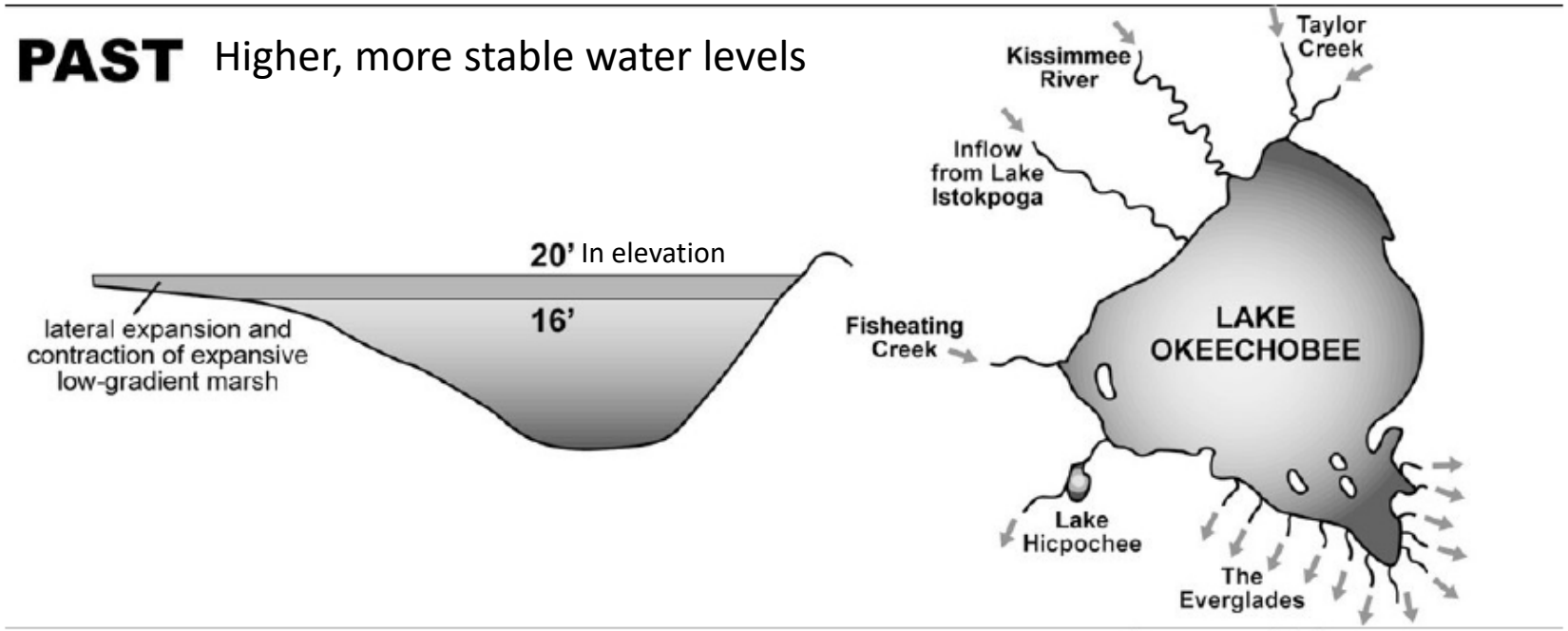
What We Will Cover and What You Will Learn

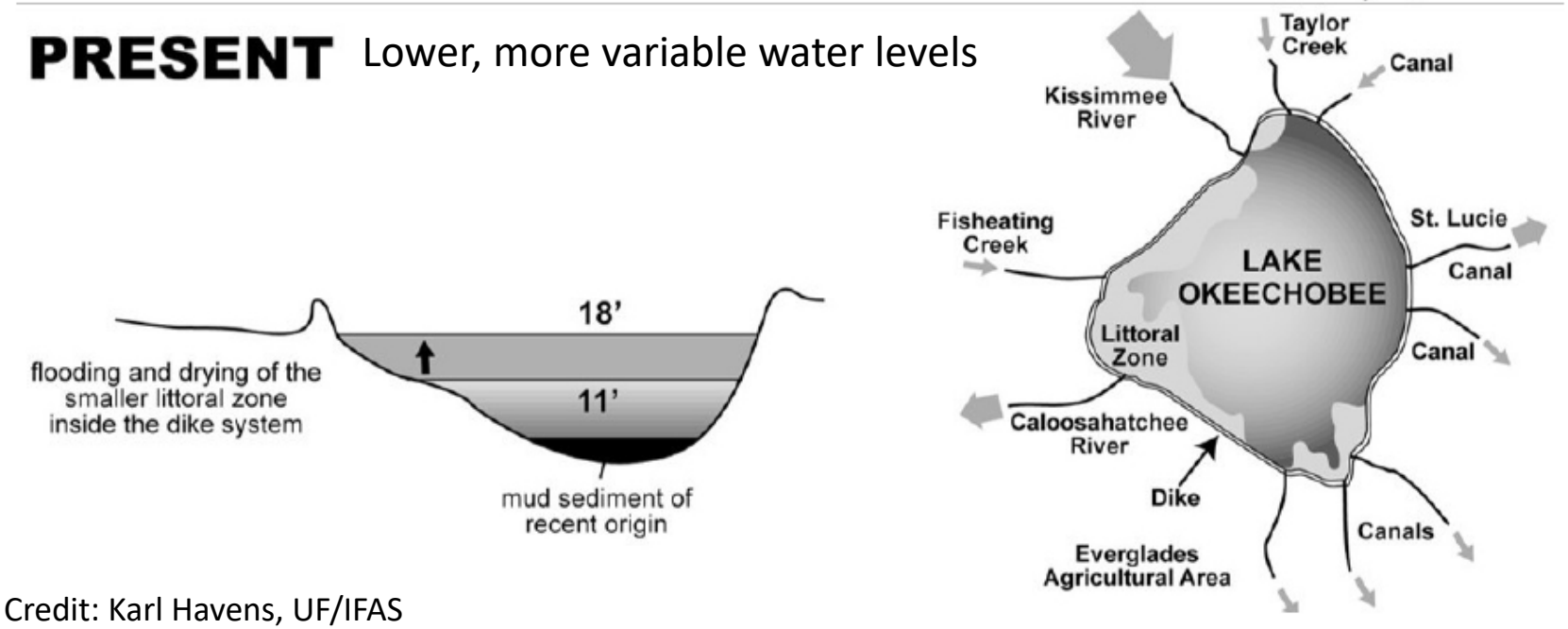


- How Lake Okeechobee has changed from historic natural condition
- How lake stage affects lake ecology
- Hurricane impacts on the lake
- Seeing effects of lake stage: review of aerial imagery

Alligator on Lake Okeechobee, Chuck Hanlon

Changes in Hydrology

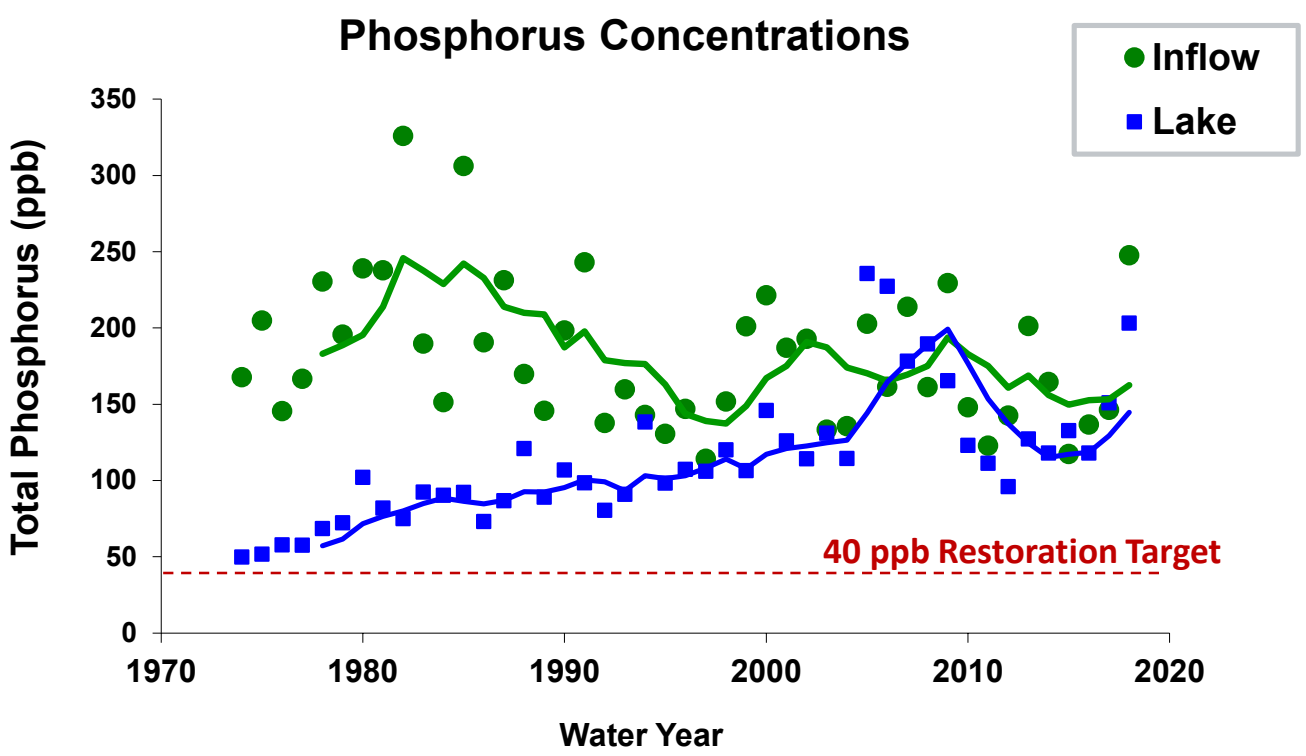




Credit: Karl Havens, UF/IFAS

West Lake Okeechobee 2008

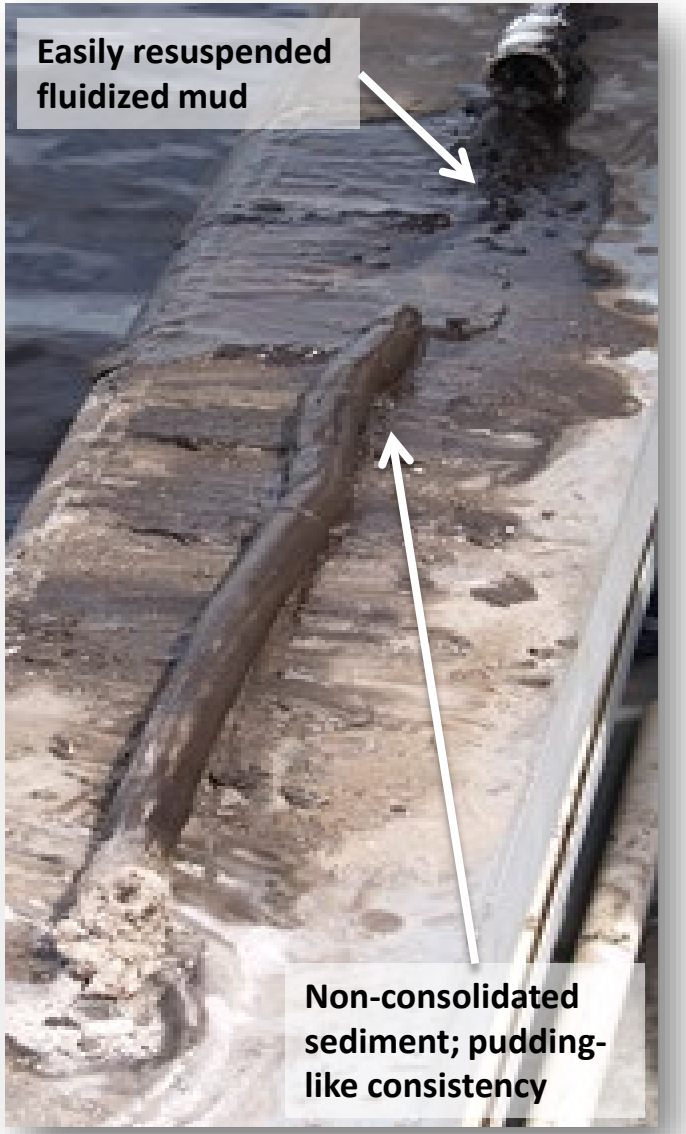
Changes in Nutrients



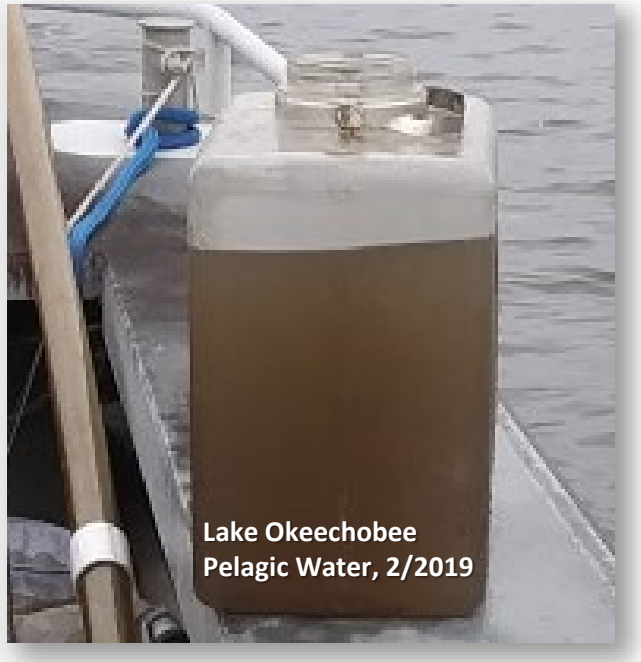
Jones, P – 2019 SFER, Ch 8B

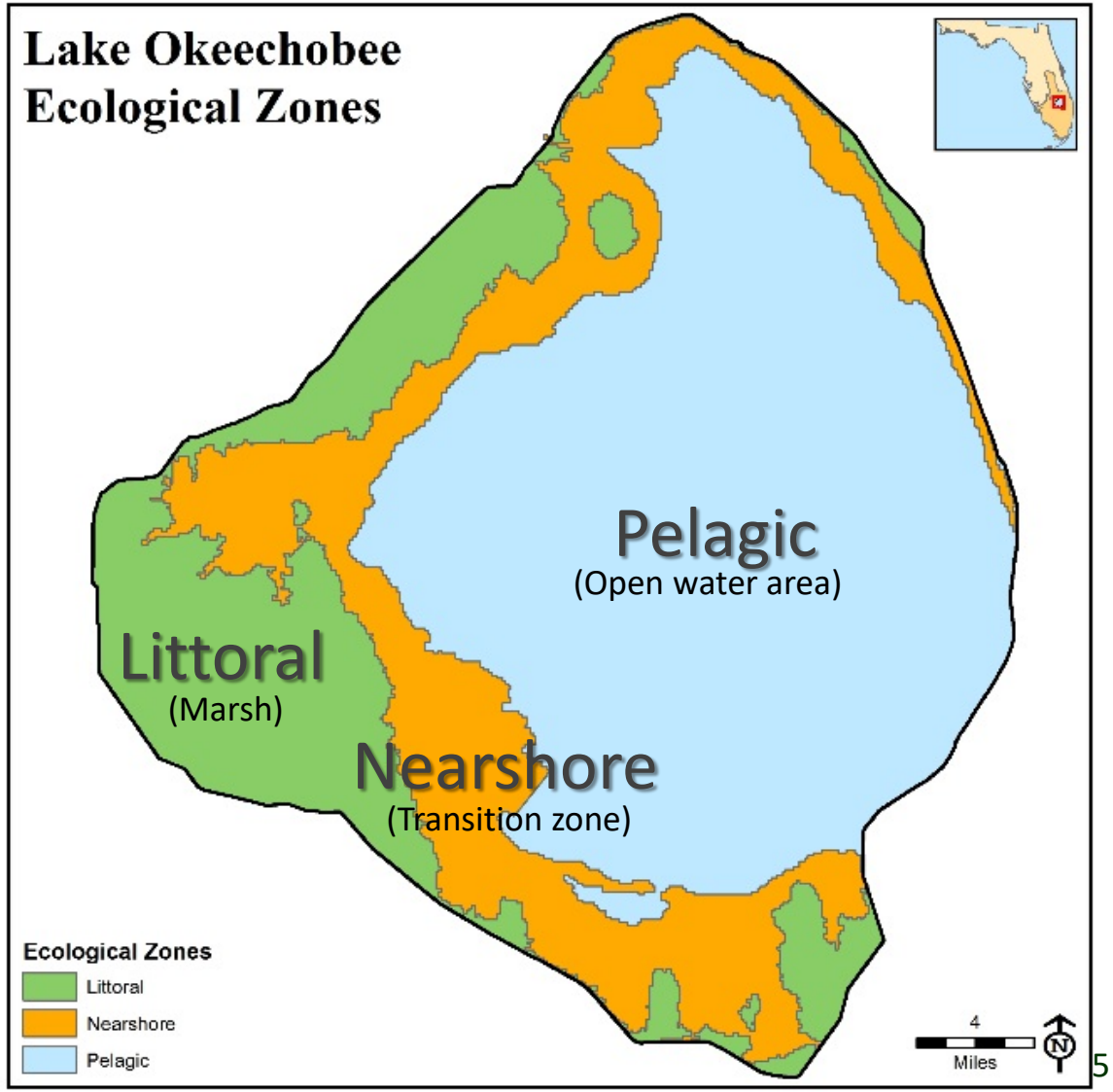
- Nutrient levels have been increasing since the 1950s
- Ability of lake to absorb excess phosphorus is dwindling
- Improvements to inflows and in-lake phosphorus will be on very long-term time scale

Changes in Sediments

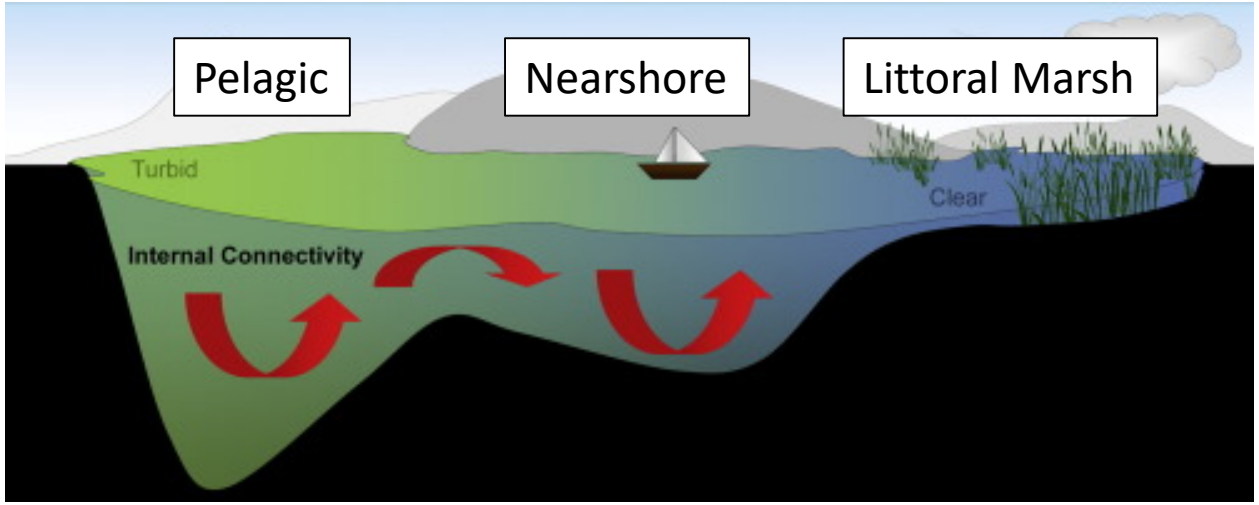


- Resuspension of sediment and phosphorus during storm events
- Potential for very low light penetration, algal blooms





Higher Stages = Higher Connectivity

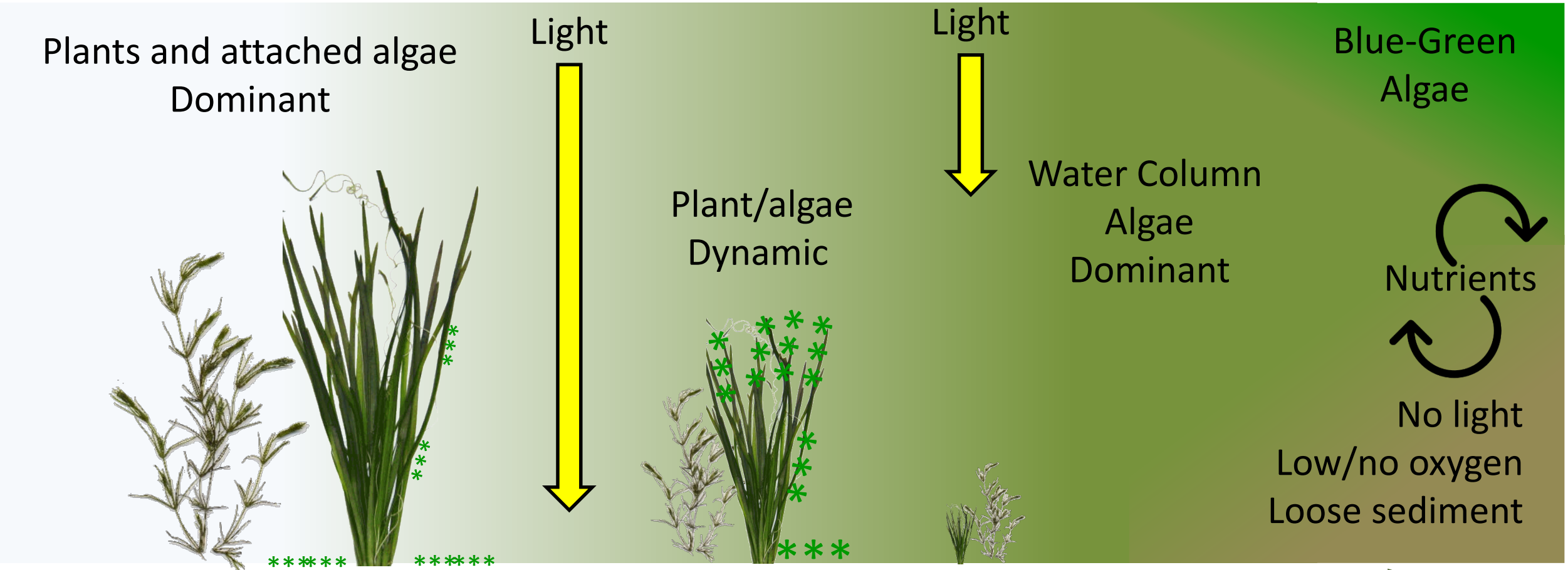


Graphic modified from: Janssen, ABG, S Teurlincx, S An, JH Janse, HW Paerl, and WM Mooij. 2014. Alternative stable stages in large shallow lakes? Great Lakes Research 40(4)L813-826

- **Nearshore Zone:** Distinct water quality and soil types
  - Transition between marsh and deep water areas
  - Depth, wave energy, water clarity: determine whether plants or algae dominate
  - Primary zone for **S**ubmerged **A**quatic **V**egetation (SAV)

Nearshore Zone, West Lake Okeechobee, 11.7 ft Lake Stage

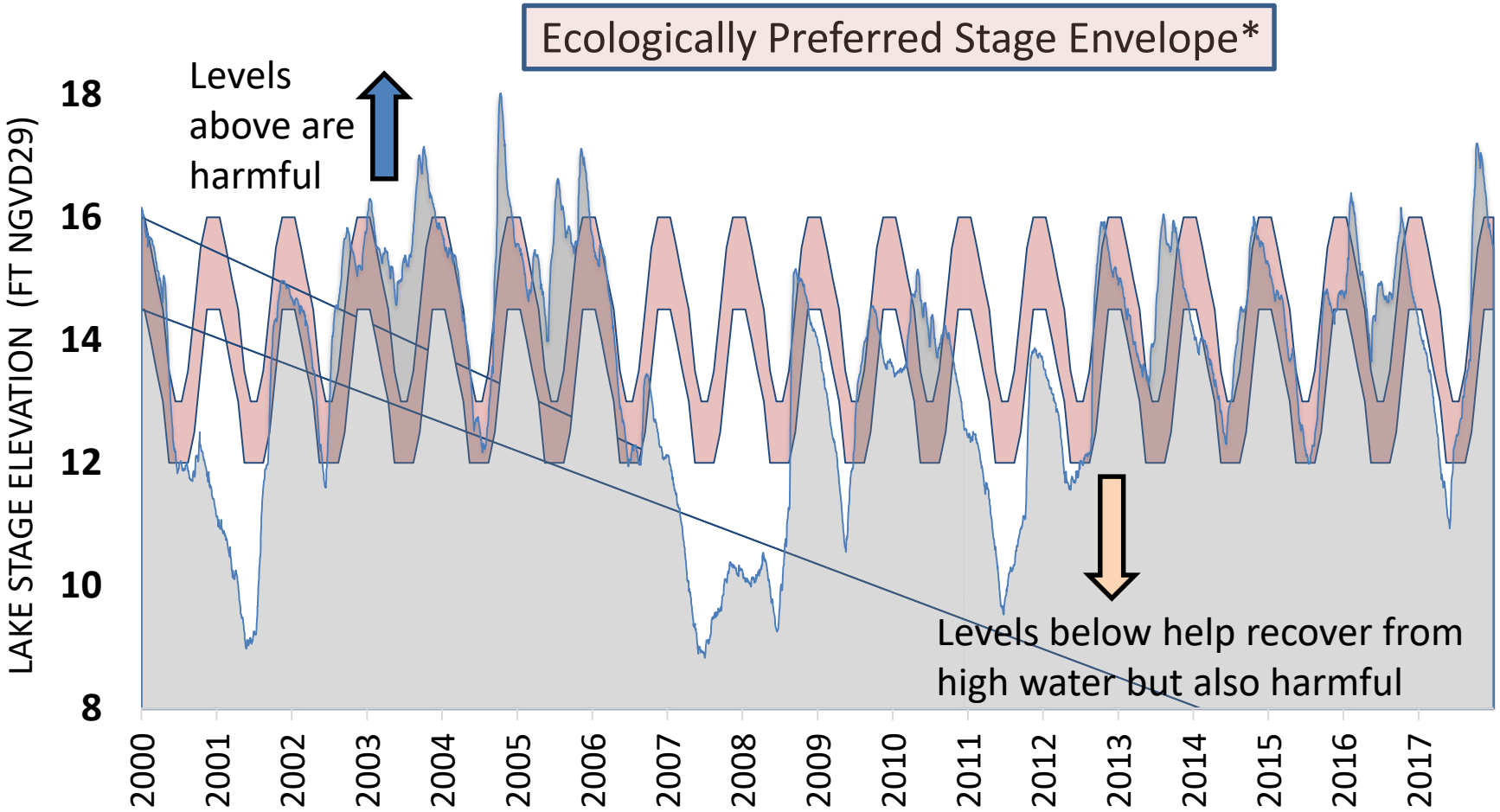
Plant/Algae Competition in Nearshore Zone



Increasing Nutrient Levels

High and Low Stages Affect Lake Ecology

- Levee at 15 ft elevation
  - Stages too high, reduce marsh
  - Stages too low, create uplands
- Ideal stages for lake health = 12 -15.5 ft NGVD

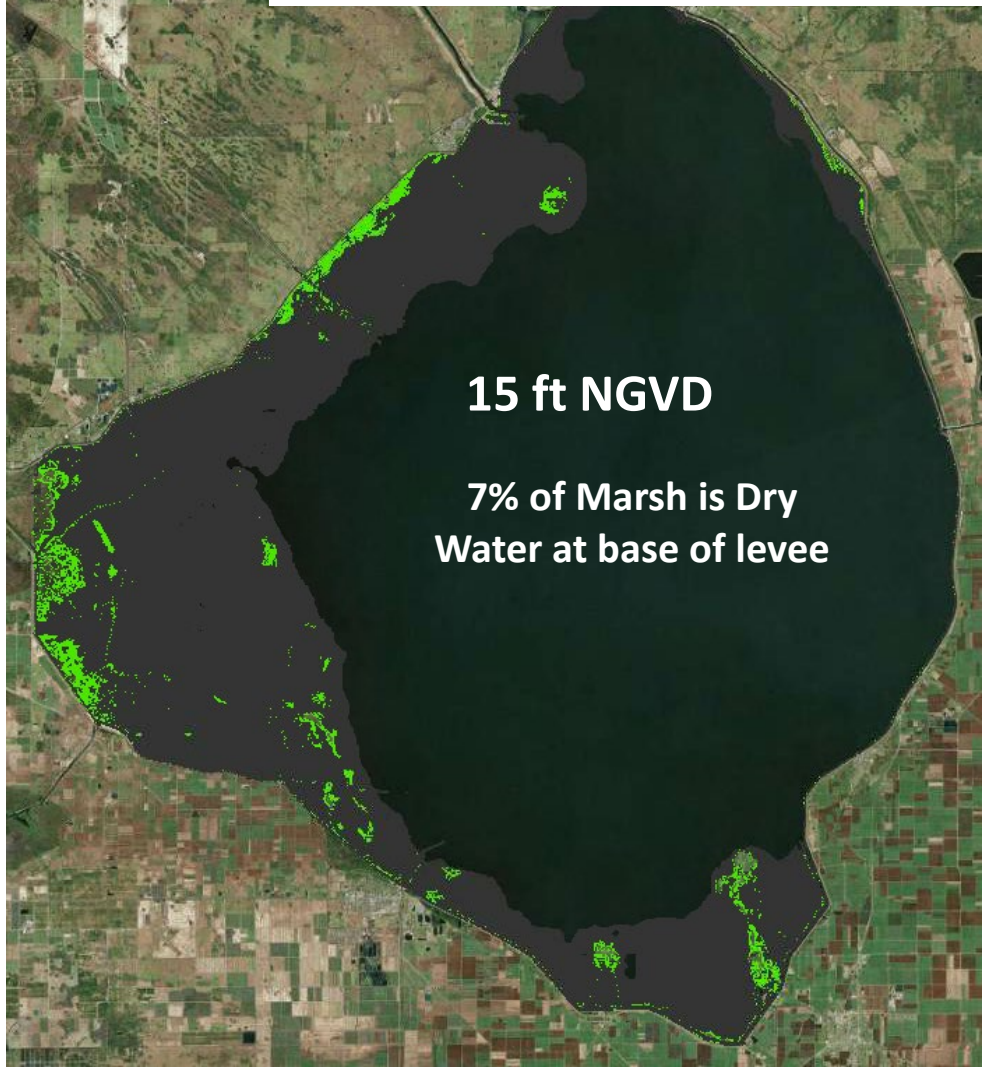


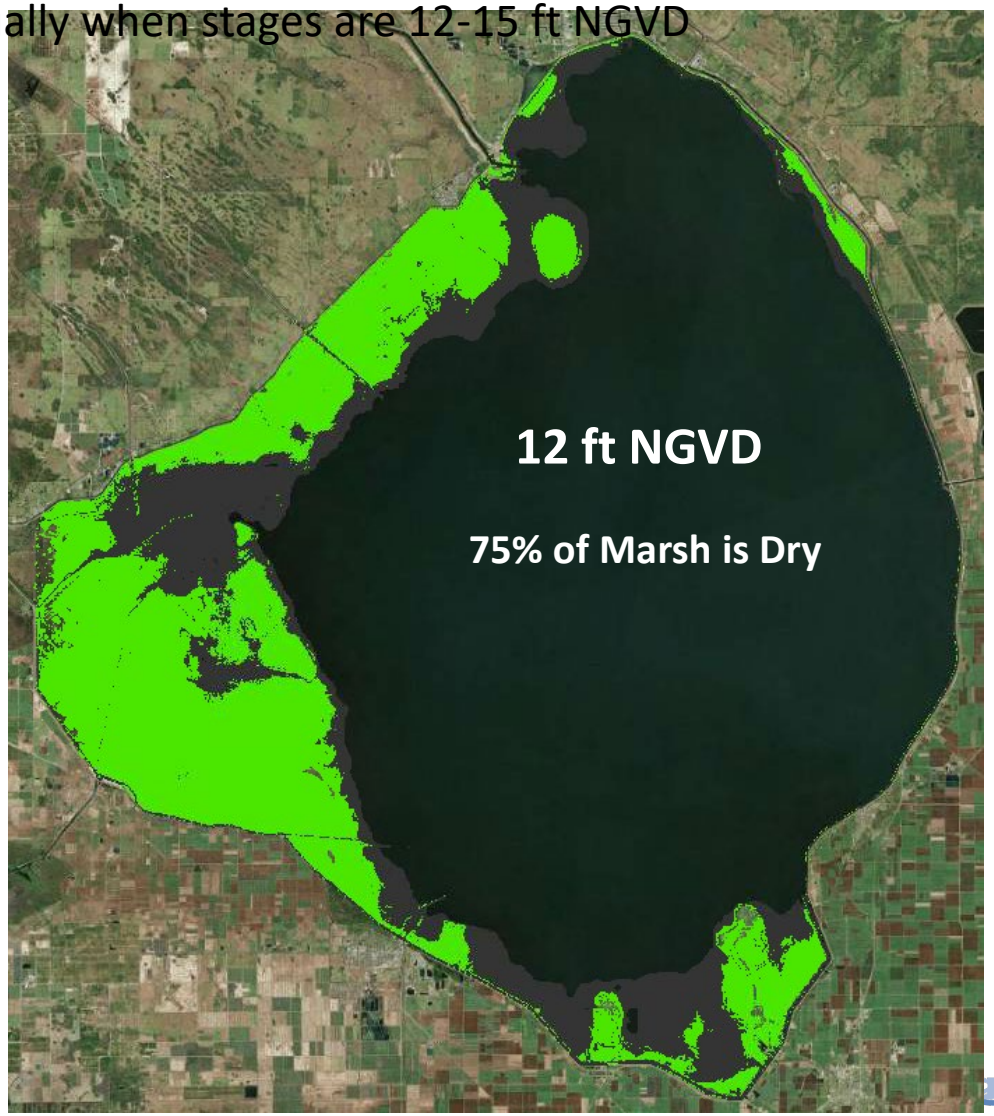
*Havens, K.E. 2002. Development and Application of Hydrologic Restoration Goals for a Large Subtropical Lake. Lake and Reservoir Management. 18(4):285-292.

*USACE. 2007. Lake Okeechobee Stage Performance Measure. Comprehensive Everglades Restoration Plan, Restoration Coordination and Verification. http://141.232.10.32/pm/recover/recover_docs/et/lo_pm_stage_081409.pdf

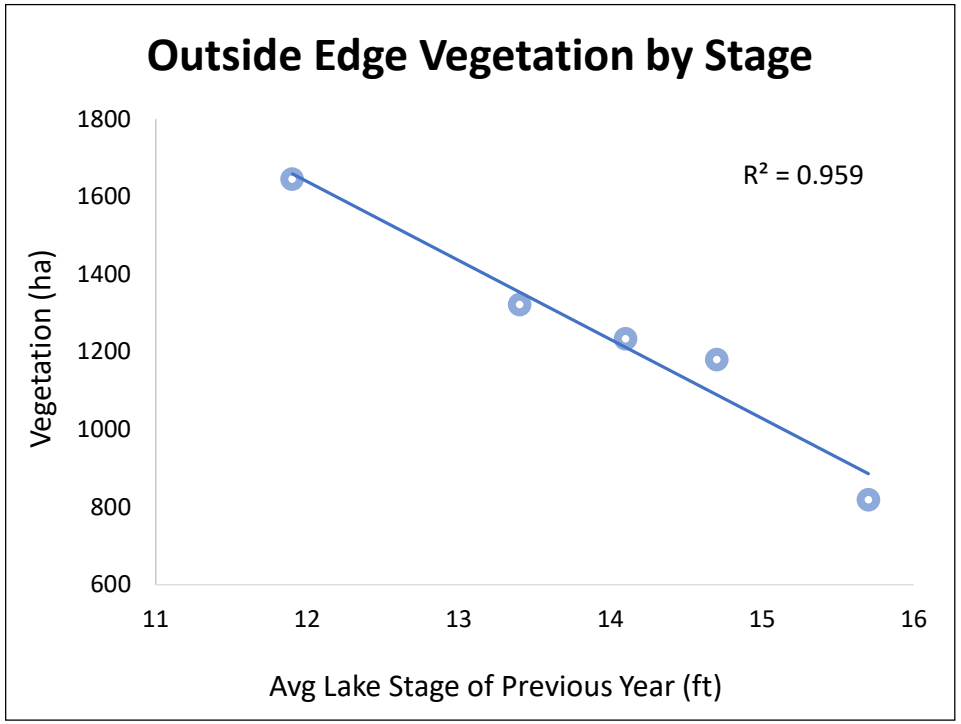
Marsh Water Depths and Lake Stage

Most of marsh is flooded and dried out annually when stages are 12-15 ft NGVD





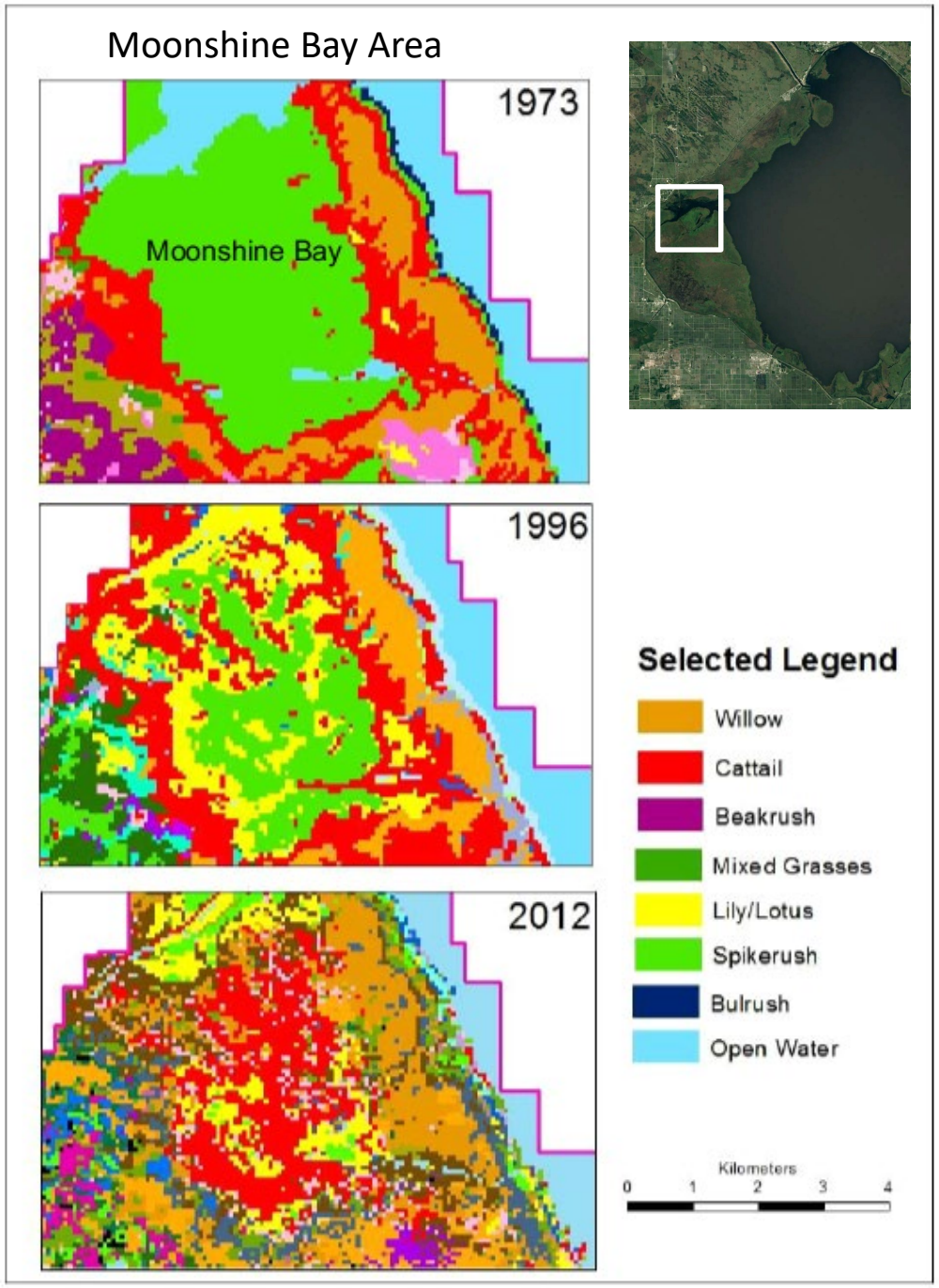
Lake Stage Effects on Marsh Vegetation



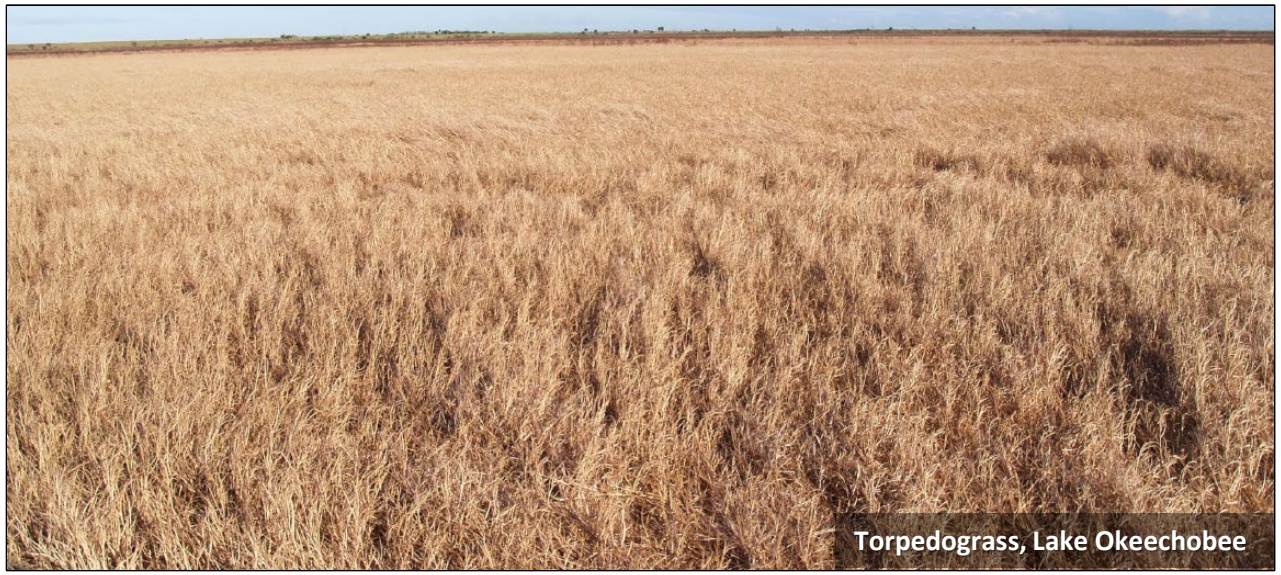
SFWMD, Hanlon – data from 2003, 2006, 2010, 2012, 2016 aerial imagery

- Higher water increases wave damage, reduces size of marsh, creates muck barrier to fish where plants are piled up

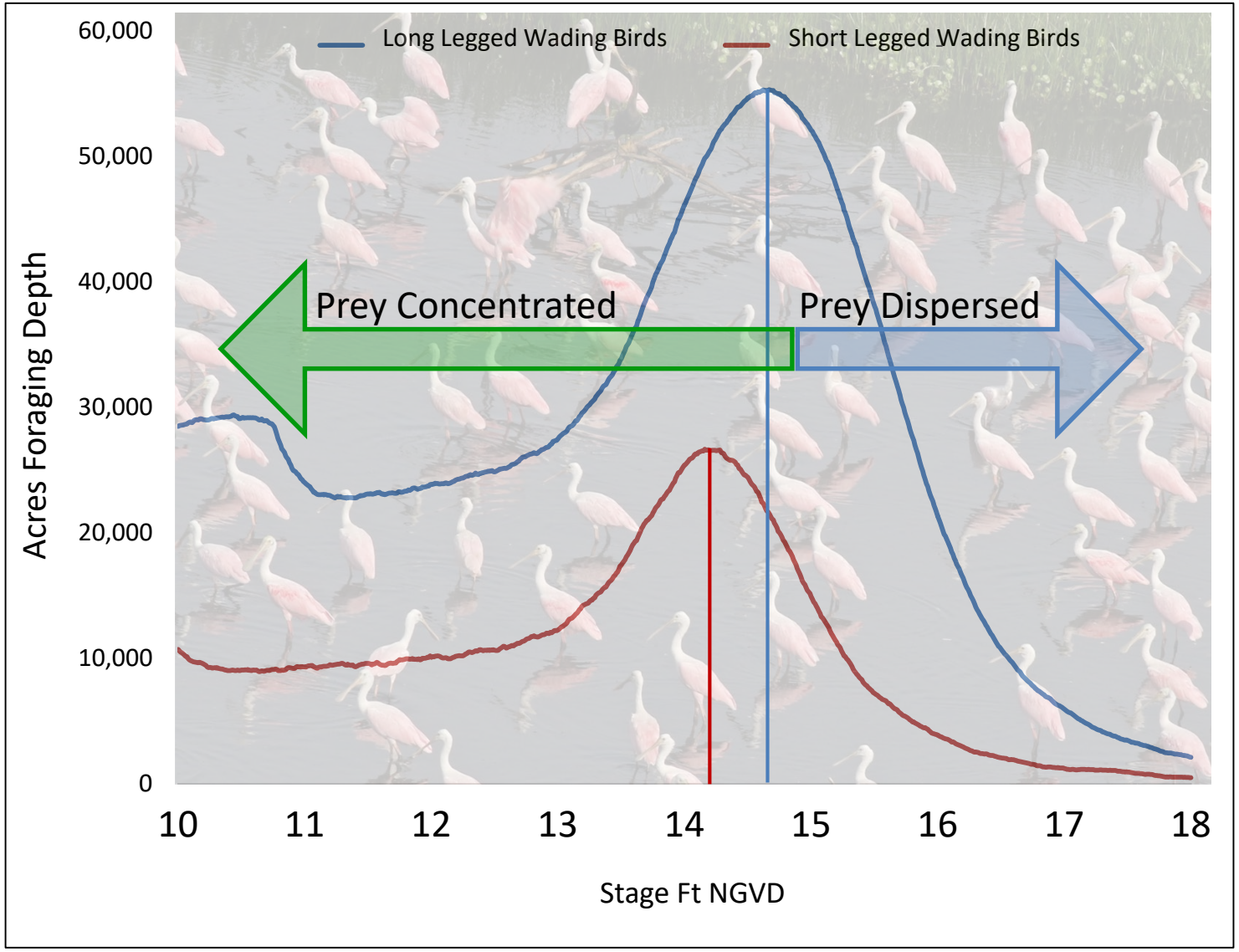
Lake Stage Effects on Marsh Vegetation

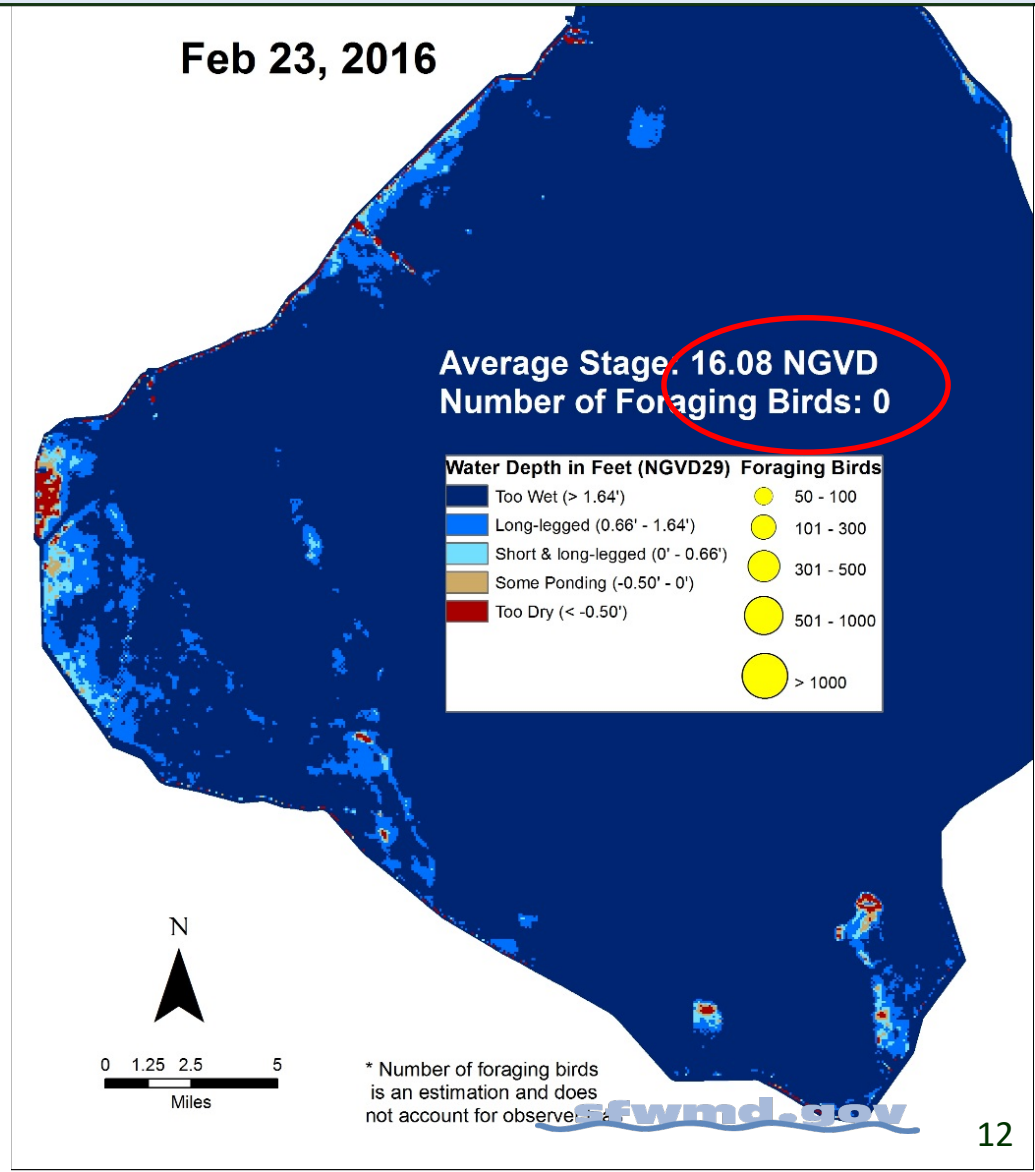


- Stages within ecological range maintain desired distribution of shallow and deep marshes
- Too High stages or durations:
  - Increase nutrient transport to interior, increases cattail
  - Reduce woody species coverage
- Too low stages or durations:
  - Upland species invade, exotics species expand (torpedograss)
  - SAV replaced with marsh vegetation in nearshore zone

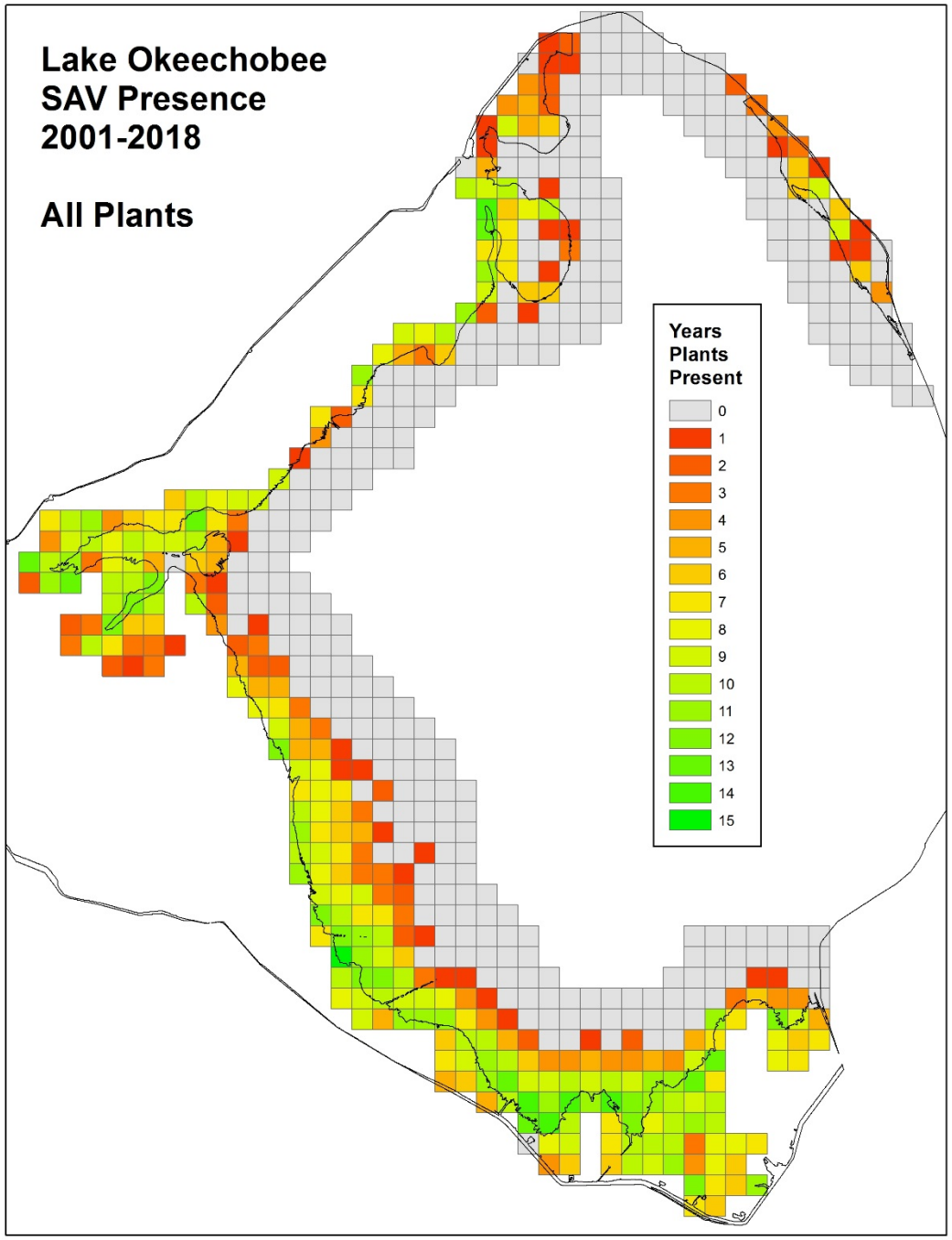

Torpedograss, Lake Okeechobee

Lake Stage Effects on Wading Bird Habitat



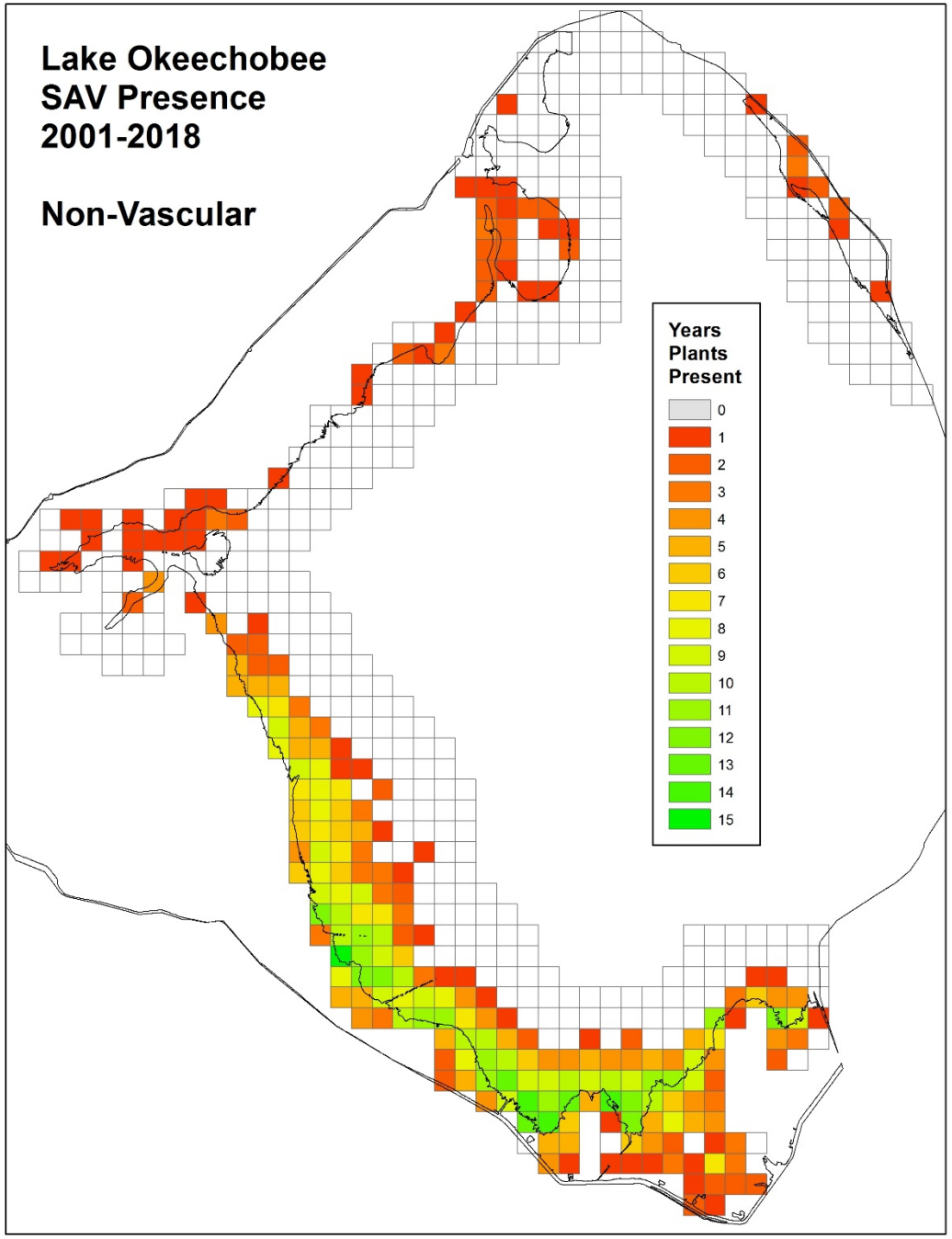


All SAV 2001-2018



Eelgrass and hydrilla, Fisheating Bay 2009

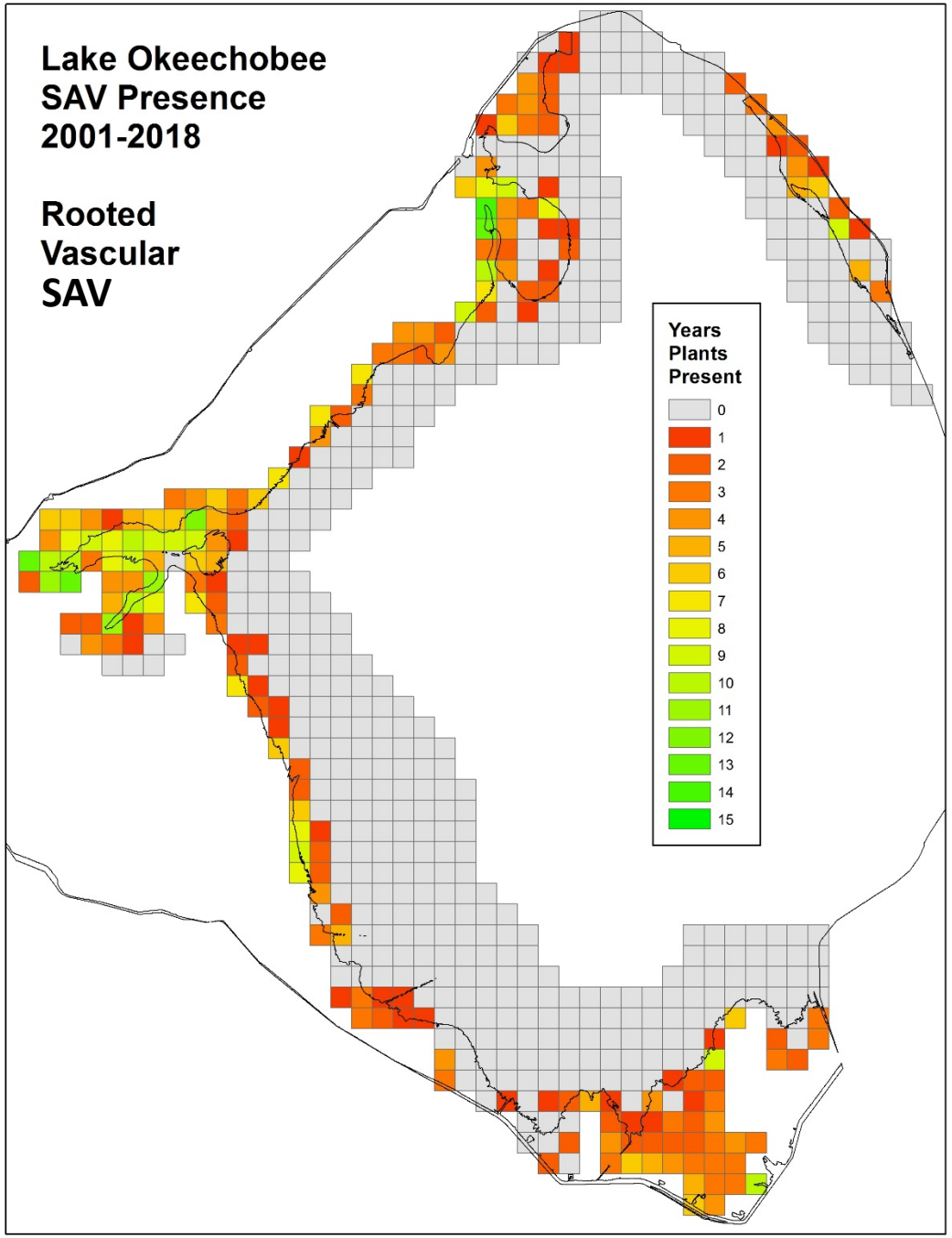
Non-vascular SAV 2001-2018



- Macroalgae (large algae with plant-like growth form)
  - *Chara* - Also known as shrimp grass or muskgrass
  - Recovers quickly during clear or low water levels
  - Prefers peat soils in south end

Chara, Shrimp grass, Muskgrass

Rooted Vascular SAV 2001-2018



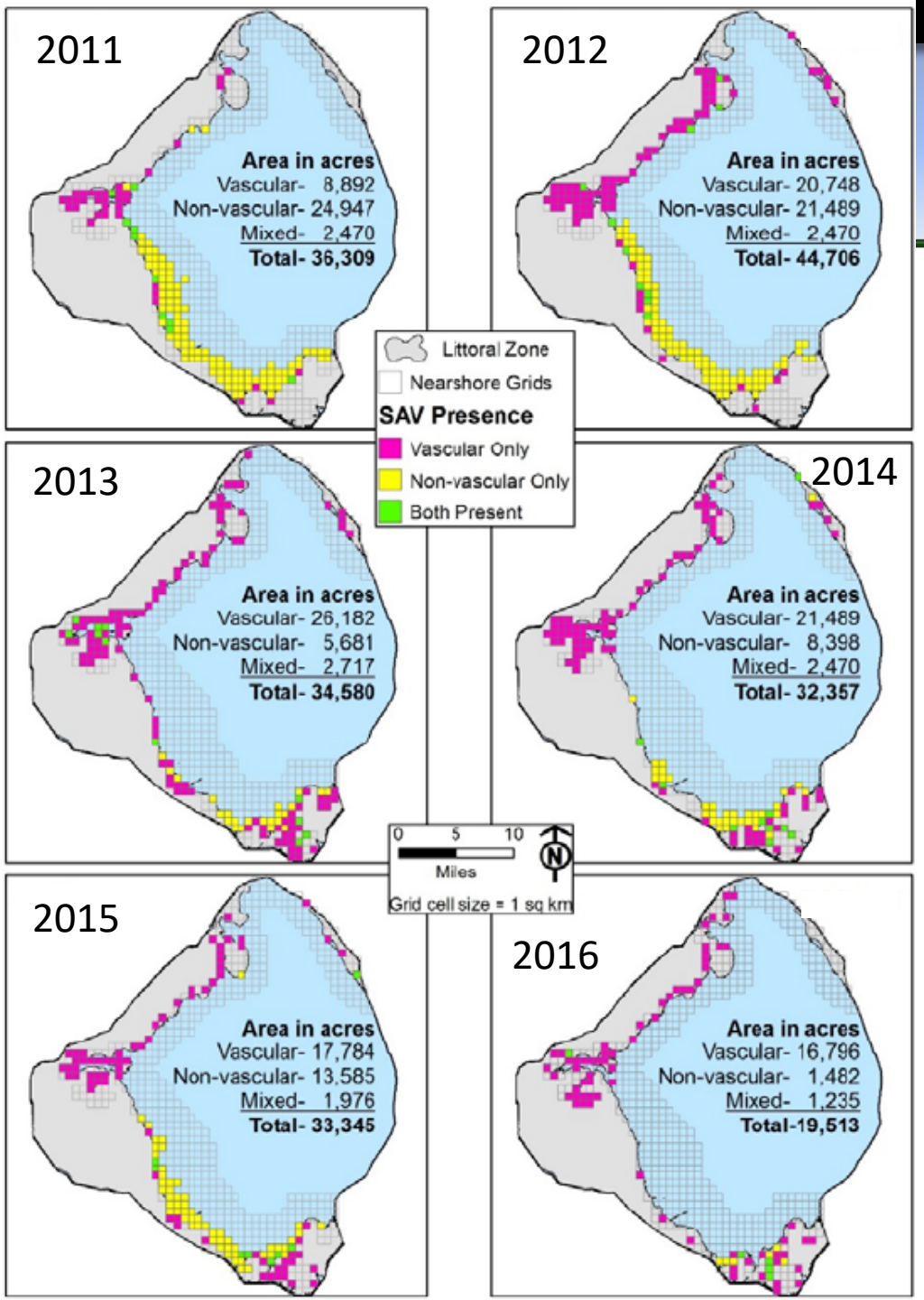
- Rooted Vascular SAV (No macroalgae)
  - Eelgrass, tapegrass, hydrilla, pondweed
  - Take 1-2 years to recover after high-water impacts
  - Primarily occurs within grass line or in protected bays

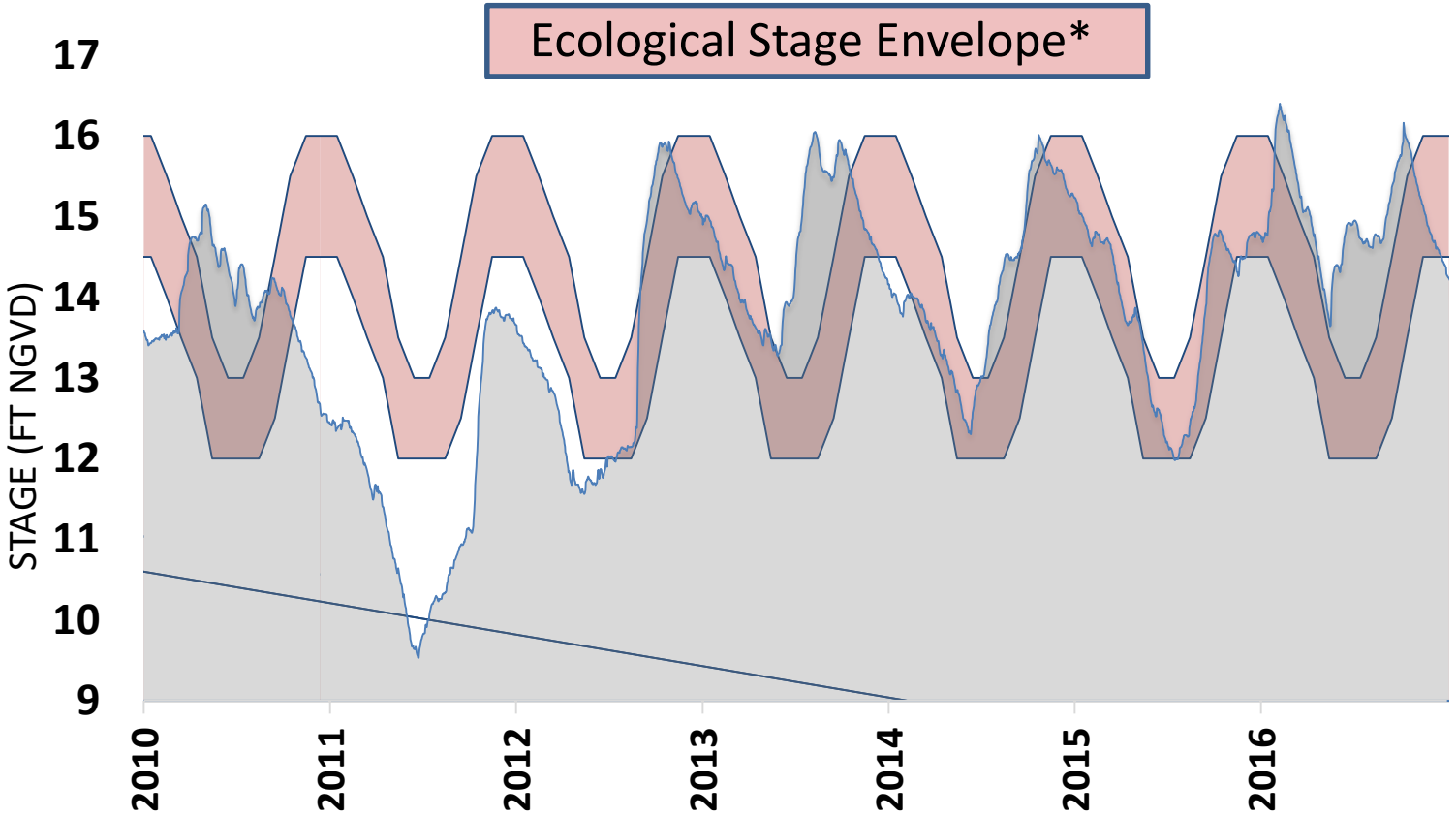
Eelgrass

Hydrilla

Pondweed

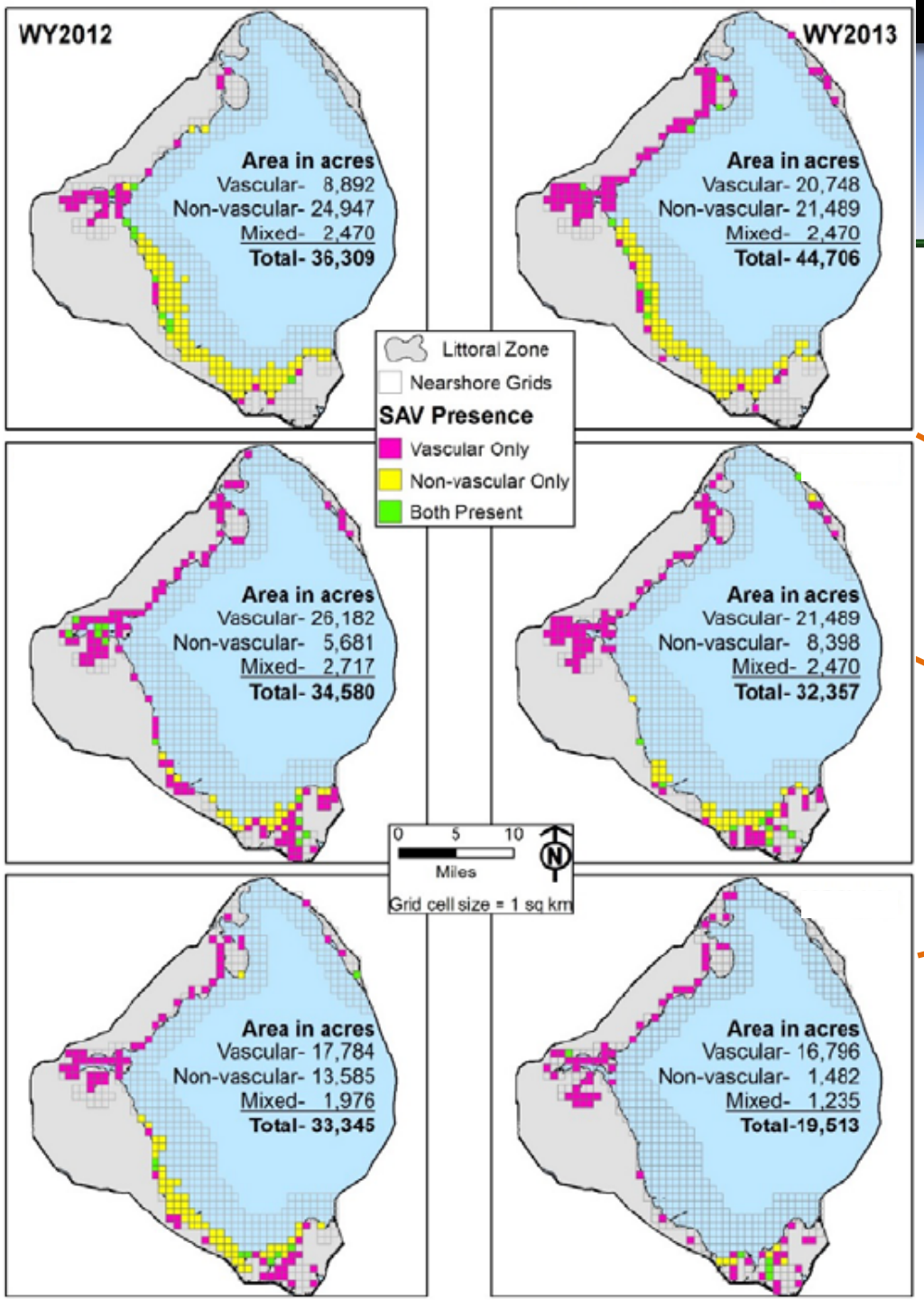
Lake Stage Effects on SAV

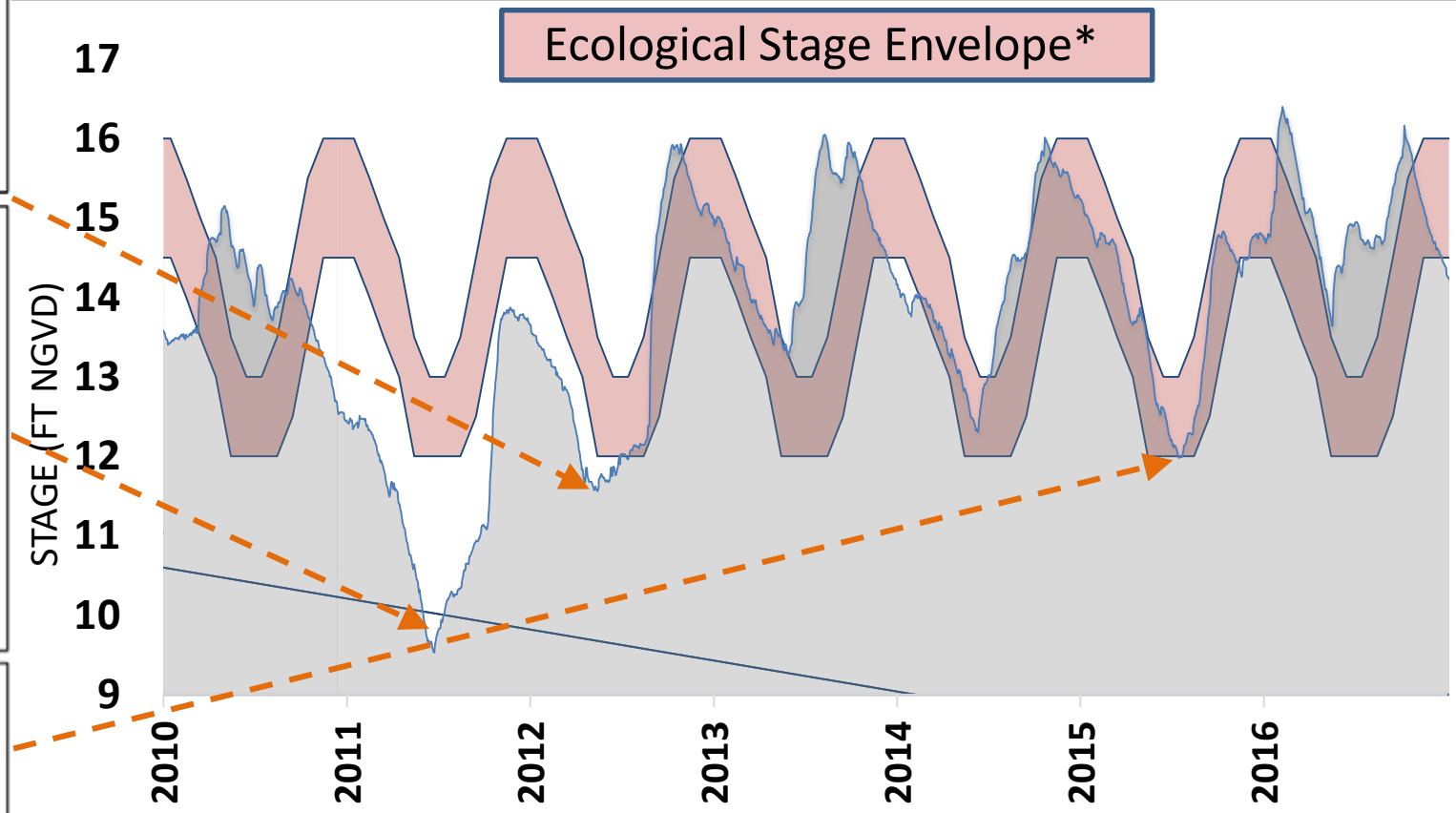




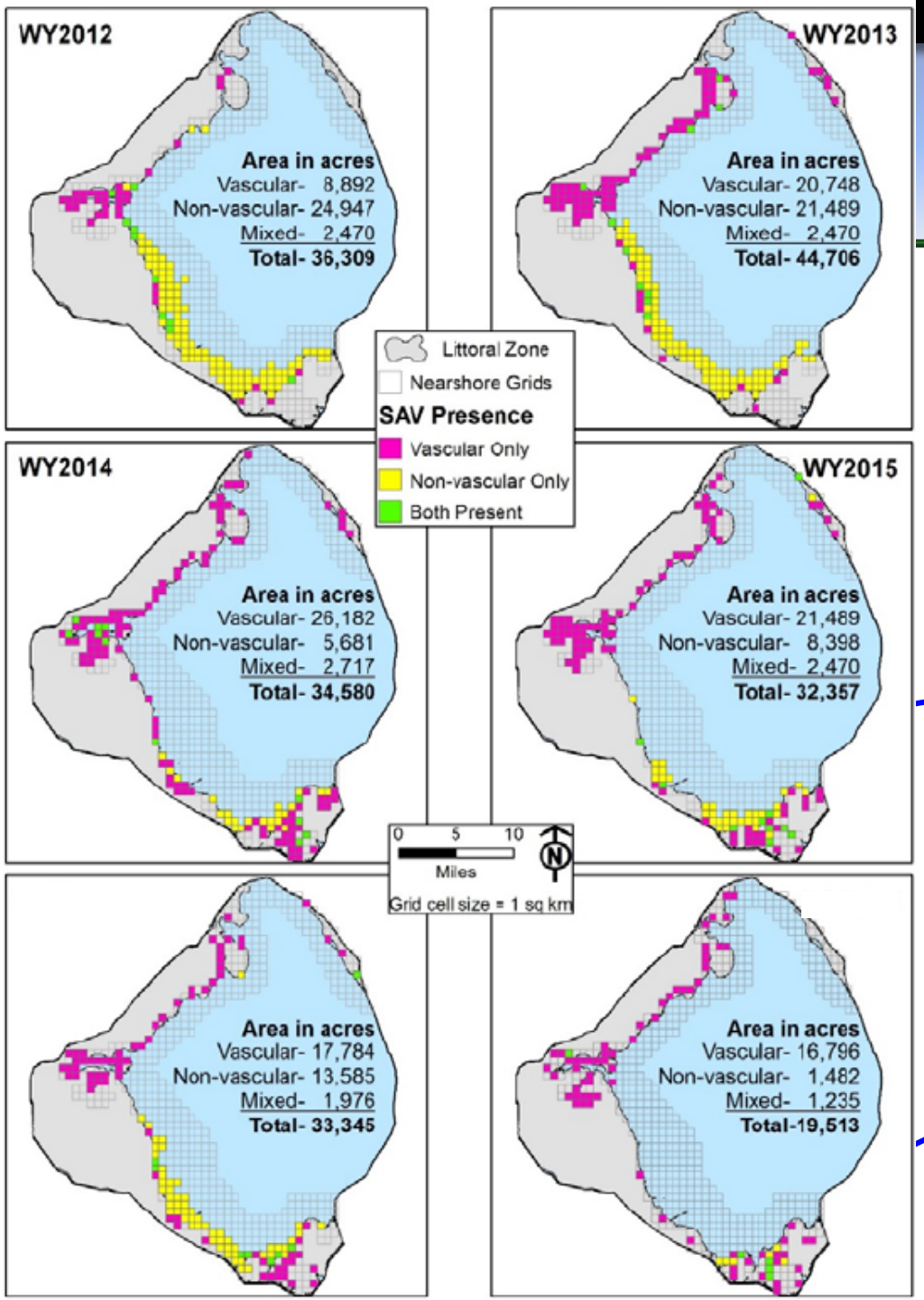
- Coverage of SAV varies by year
- Macroalgae (yellow) respond faster than vascular (pink)
- Low total in 2016 from consecutive highs and too few lows

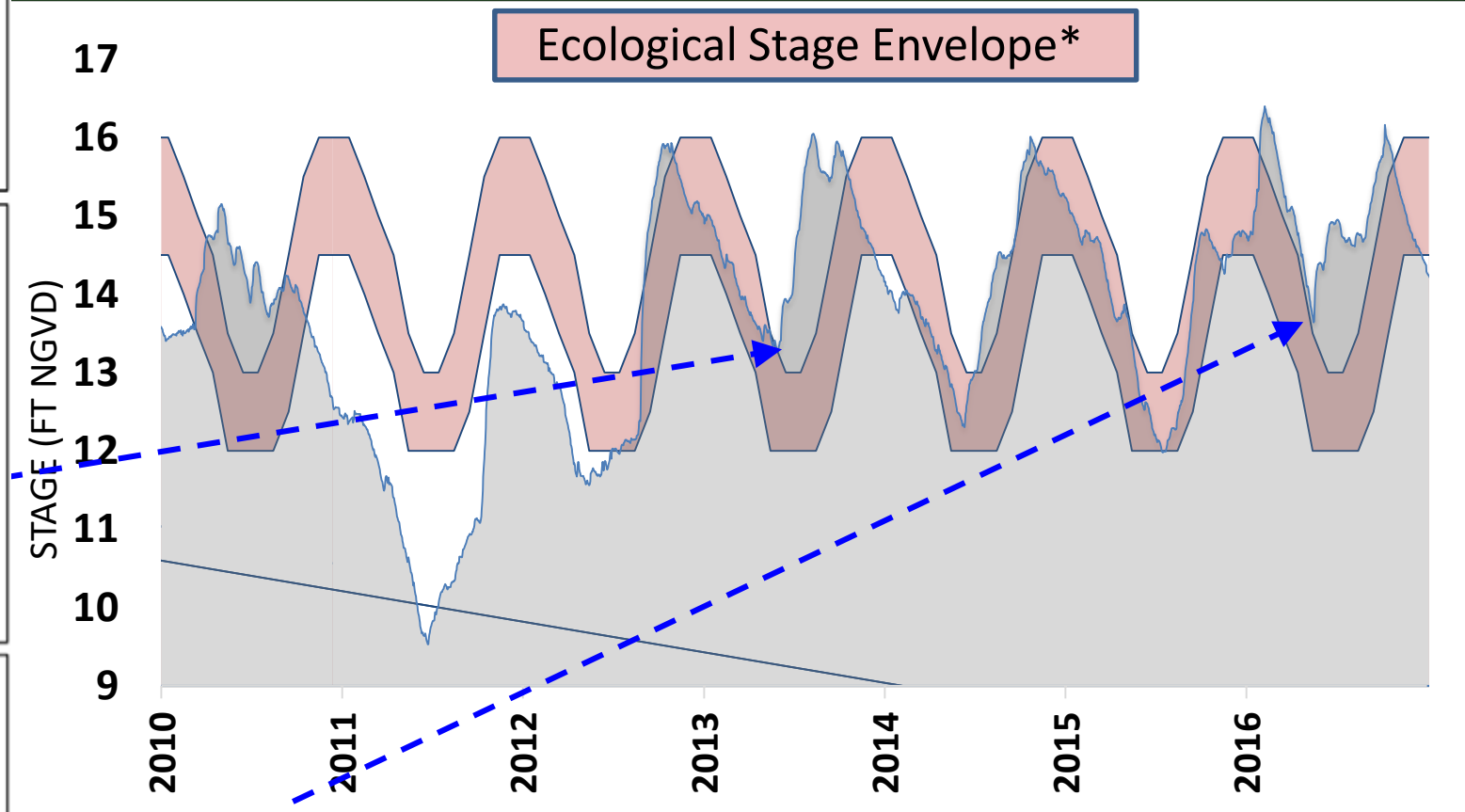
Lake Stage Effects on SAV





Lake Stage Effects on SAV





How to Offset Impacts of High/Low Stages

- Vegetation control
  - Spray/burn
  - Prescribed fires
  - Plantings
- Harvesting muck barriers
- Muck soil removal
- Reduce spraying when stages are high
- Manage for low lake stages after high water damage so SAV can recover

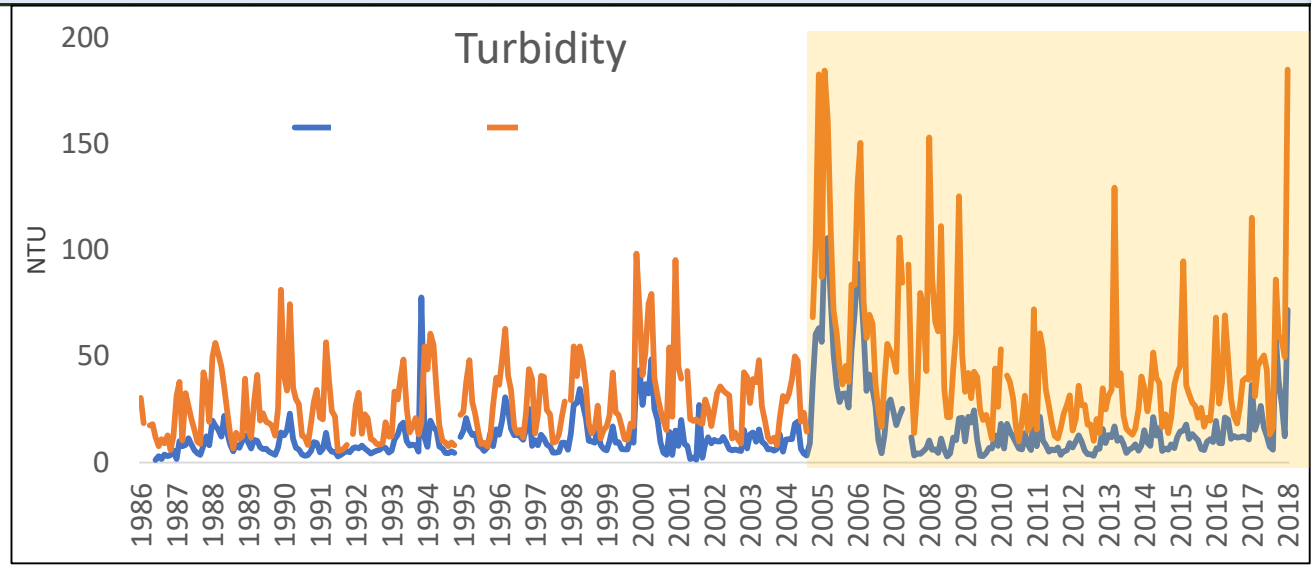
Chuck Hanlon, SFWMD

Managing torpedograss with herbicides

Chuck Hanlon, SFWMD

Lasting Hurricane Impacts

- Higher turbidities since 2004-05 hurricanes, at least in pelagic area
- 4 hurricanes in 14 months: loosened mud bed, lowest water clarity in history
- Shallower water needed for light to reach plants



South Lake Okeechobee on 9/22/2017

North Lake Okeechobee on 9/22/2017

White outline shows extent of marsh at low lake stages

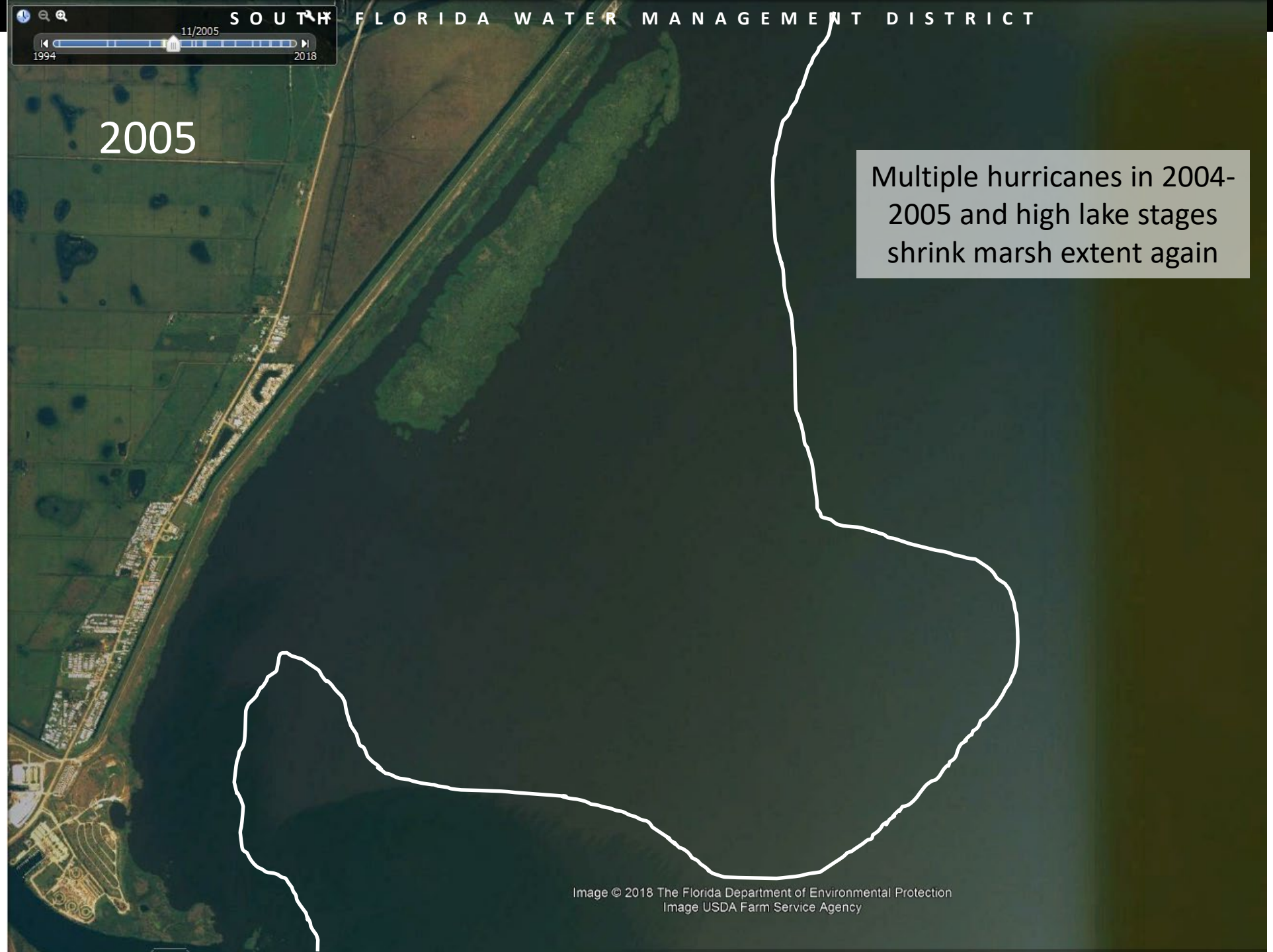
(note shifts in position through next slides from high vs low water levels)

Lake Stage and Marsh Response

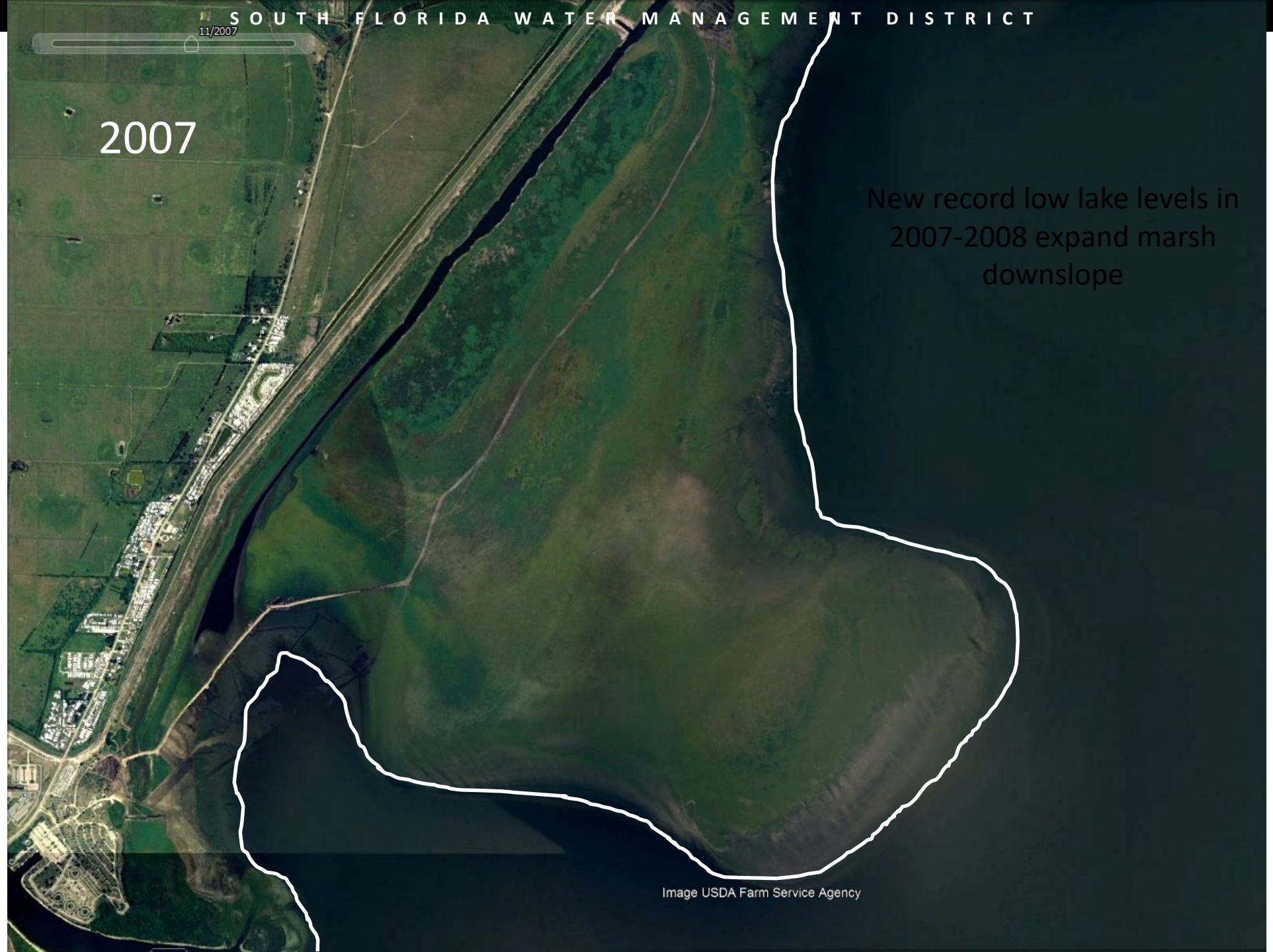
Imagery:
Google Earth
Time Slider

Record low lake stage (at the time) in 2001 aided marsh recovery and expansion after high water in late 1990s

Imagery:
Google Earth
Time Slider



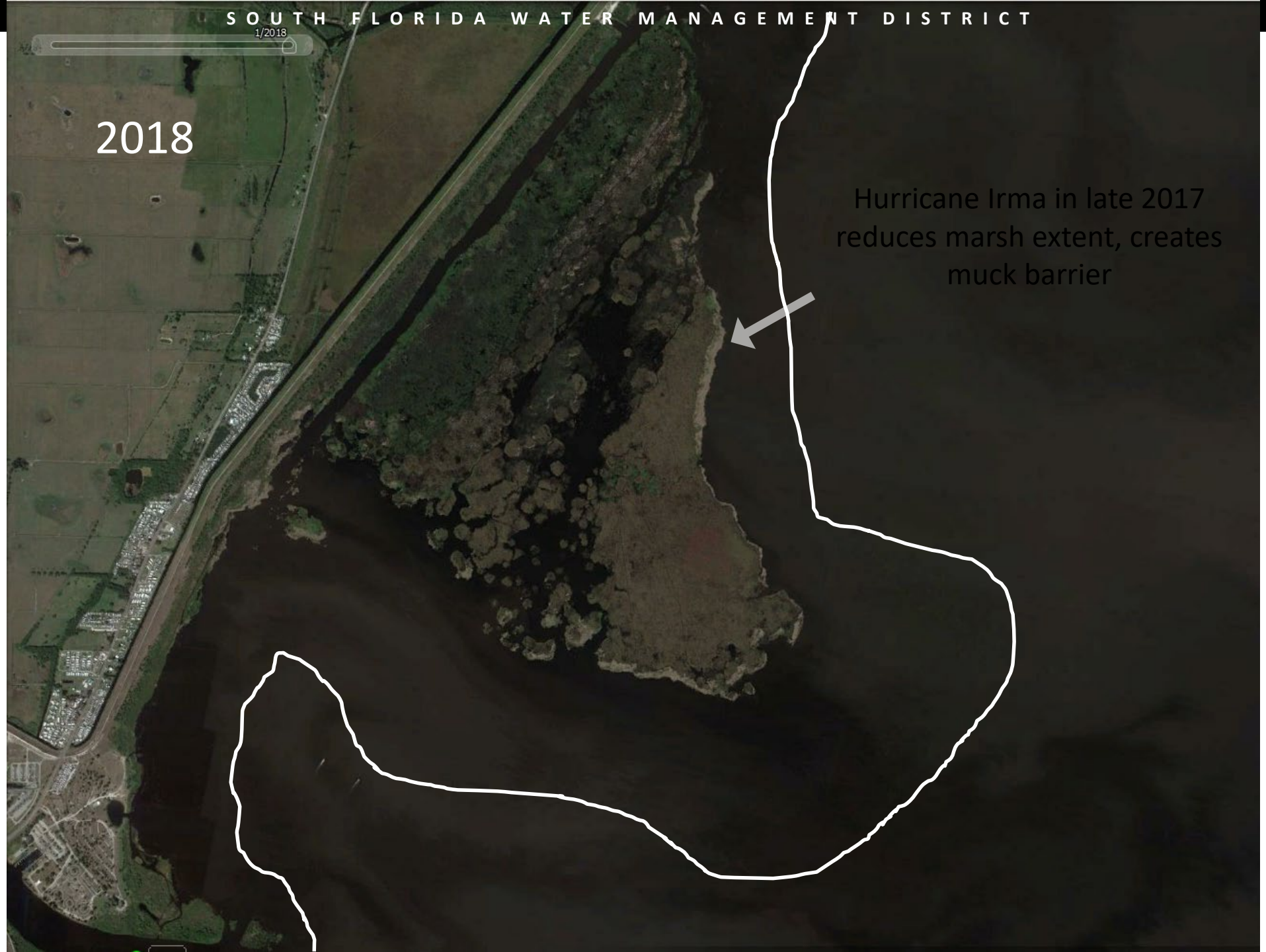
Imagery:
Google Earth
Time Slider



Imagery:
Google Earth
Time Slider

Imagery:
Google Earth
Time Slider

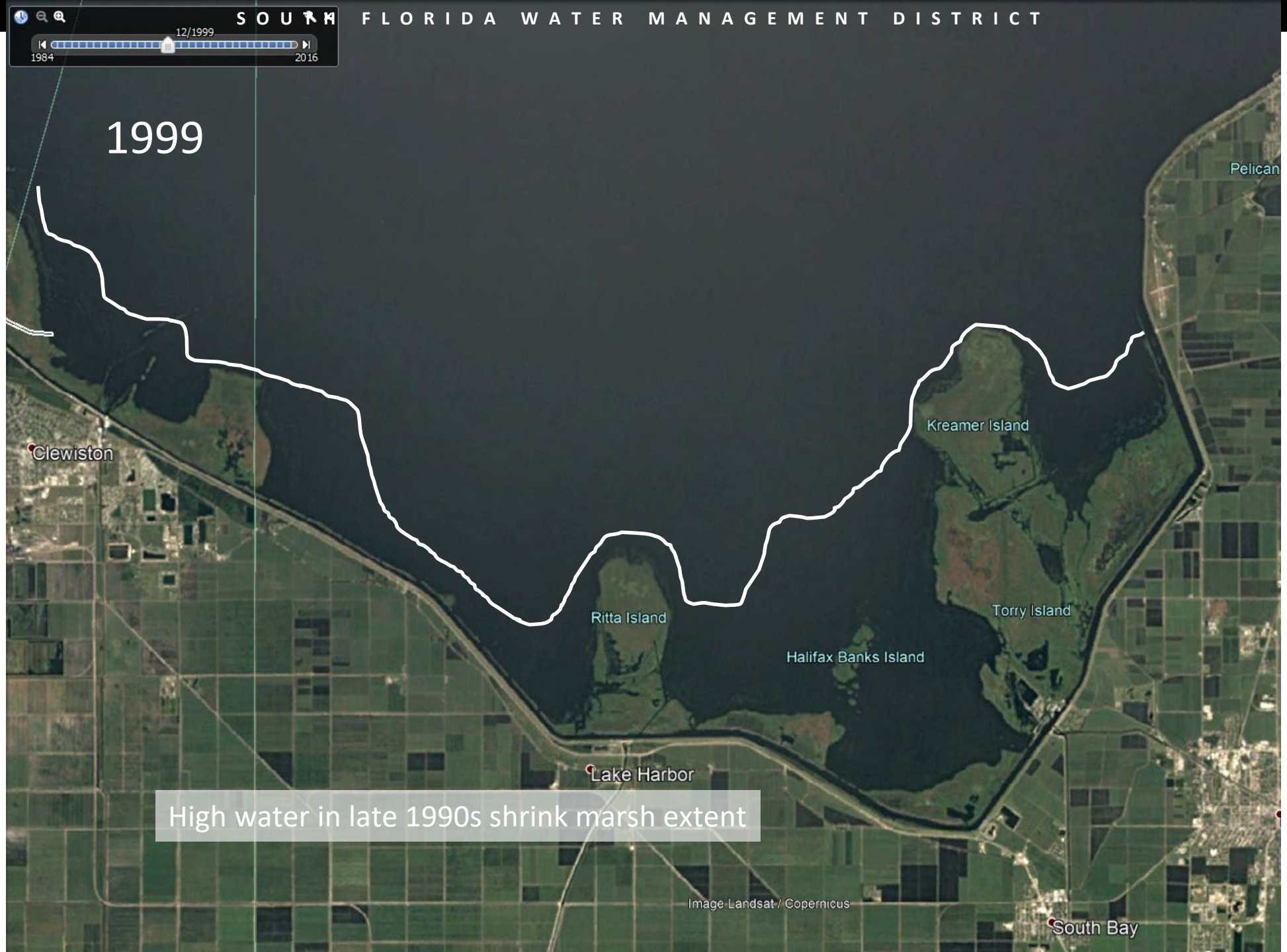
Imagery:
Google Earth
Time Slider



Imagery:
Google Earth
Time Slider

Imagery:
Google Earth
Time Slider

Imagery:
Google Earth
Time Slider



High water in late 1990s shrink marsh extent

Imagery:
Google Earth
Time Slider

Record low lake stage in 2001 (at the time) aided marsh recovery and expansion

Imagery:
Google Earth
Time Slider

Multiple hurricanes in 2004-2005 and high lake stages shrink marsh extent again

Imagery:
Google Earth
Time Slider

Imagery:
Google Earth
Time Slider

Marsh remains where open water occurred prior to droughts in 2007-2008

Herbicide treatments to reduce plant density, restore fish habitat

Imagery:
Google Earth
Time Slider

Key Takeaways

- Mud pool in center of lake affects light penetration and nutrients in water column
- Multiple hurricanes loosened mud, made it easier to resuspend
- Lake stage affects mixing rate of clear (marsh) and turbid (middle) water portions of the lake
- Lake stage affects health of SAV and marsh vegetation, which compete with algae and provide fish and wildlife habitat

QUESTIONS

UNTIL 1:00 PM
TYPE A QUESTION INTO THE WEBINAR CHAT
OR EMAIL LAKEOCOMMENTS@USACE.ARMY.MIL

LOSOM Website: www.saj.usace.army.mil/LOSOM

LOSOM Email for comments: LakeOComments@usace.army.mil

USACE Water Management Page: www.saj.usace.army.mil//WaterManagement/

Bay Bottom, Lake Okeechobee