High Island Rookery Expansion and Resiliency Project Update

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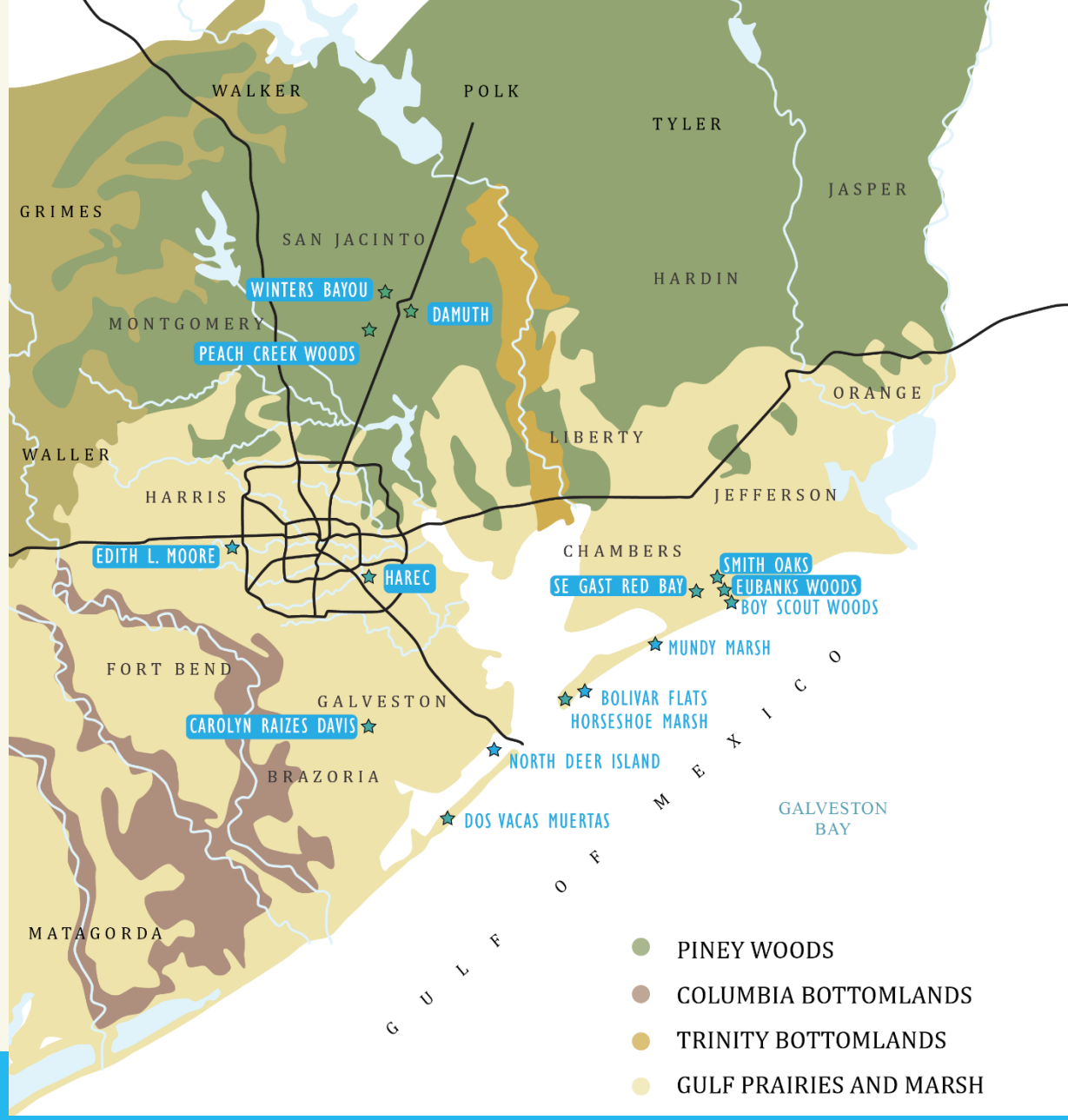
Houston Audubon Sanctuaries

- 18 sanctuaries in 6 counties
- ~4,253 acres
- Forest, prairie, marsh, and beach



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High Island Rookery

- Smith Oaks acquired in 1994
- Active since 1995, surveyed since 1997
- 11 annual/semi-annual breeding species
- Main nesting (and tourist) season Feb – May
- Year-round roost

Management

- Monitor and survey
- Nesting structures
- Mammalian predators removed
- Various plantings
- Invasives removed…and left
- Fire ants treated

Drought:

- Bought water in 2011
- Pumped water (3.5 million gallons in 2014)

1969

2011

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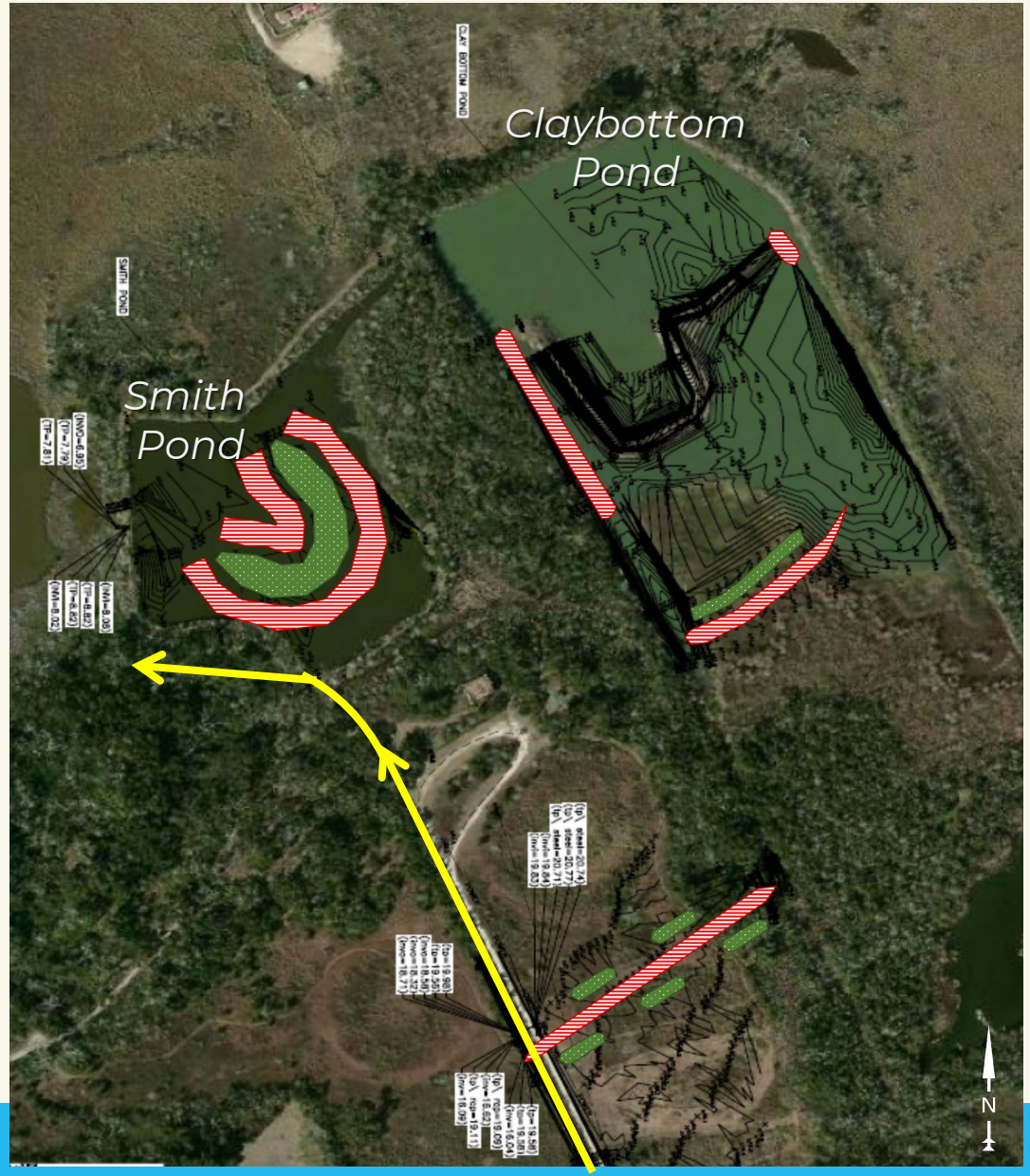
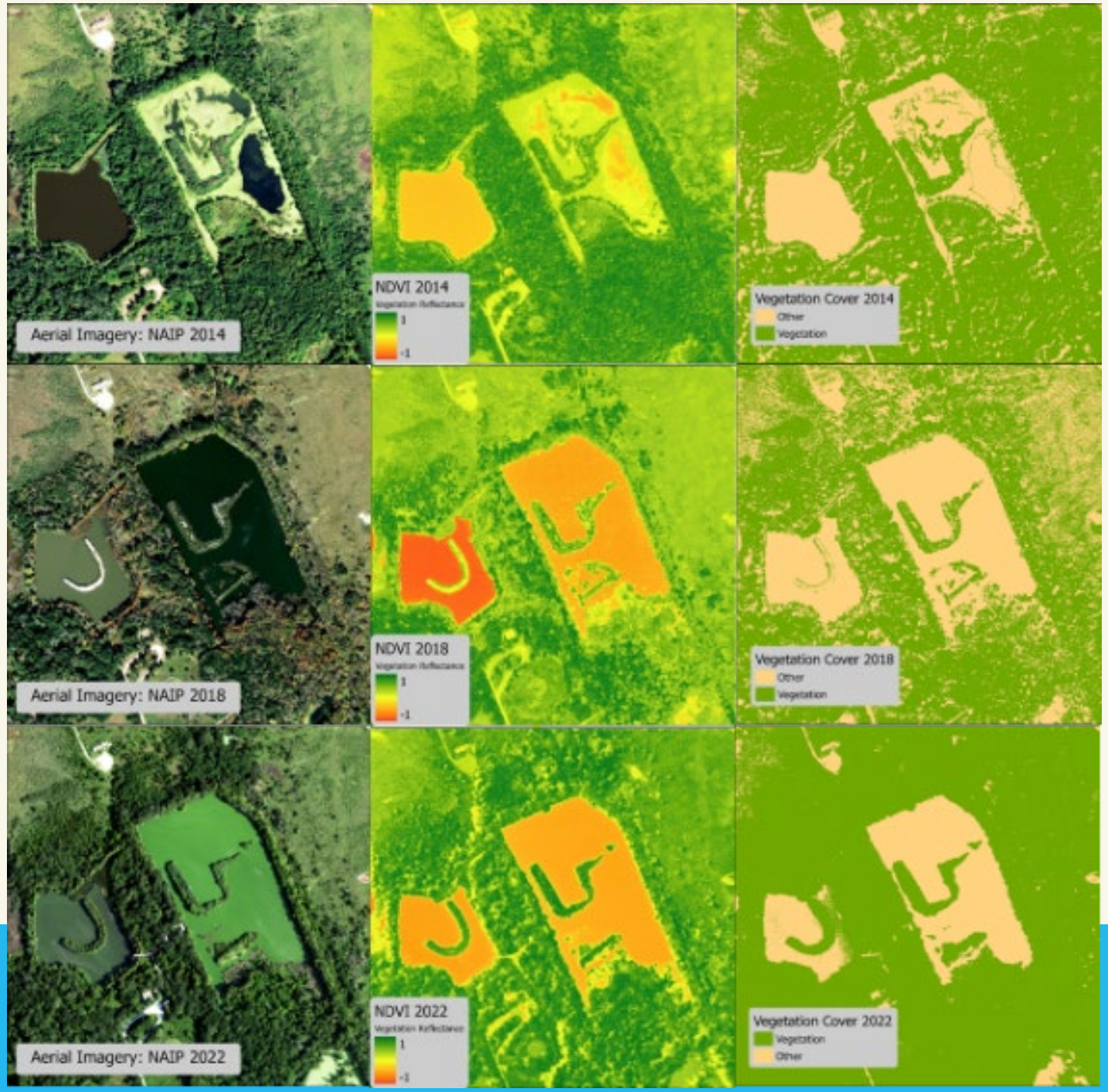
Habitat Expansion and Resiliency with DU

- Manage water levels
- Place water control structure on existing drainage ditches to allow for more water
- Add an additional acre of island habitat
- Completed before 2018 nesting season



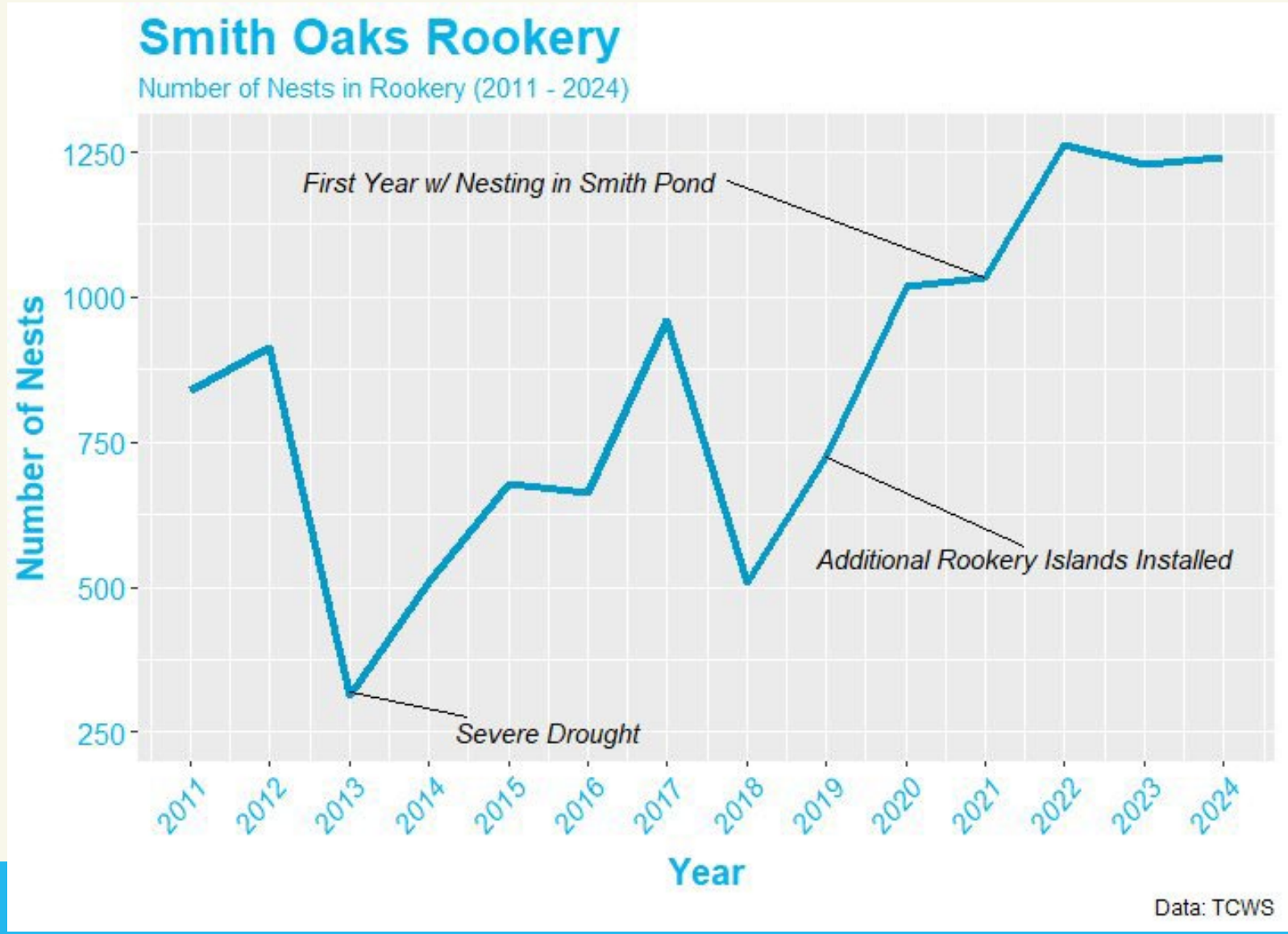
Habitat Expansion and Resiliency with DU

- National Agricultural Imagery Program (NAIP) derived products demonstrate gradual increase in vegetation health (NDVI) and density (Vegetation cover)



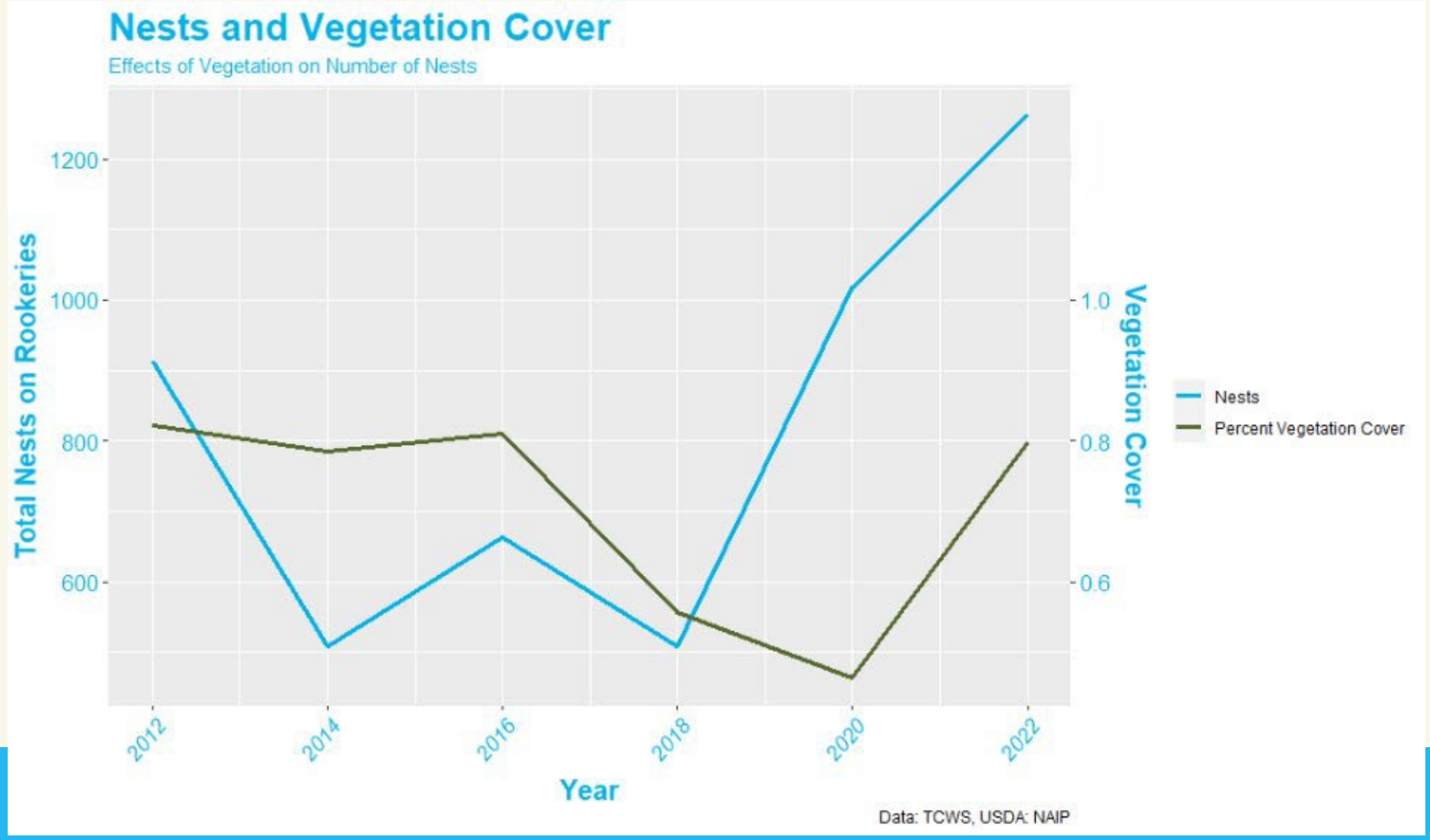
Habitat Expansion and Resiliency with DU

- General upward trend of bird nests between 2012 and 2022.
- Disruptions from Drought, Hurricanes
- Temporal Lag

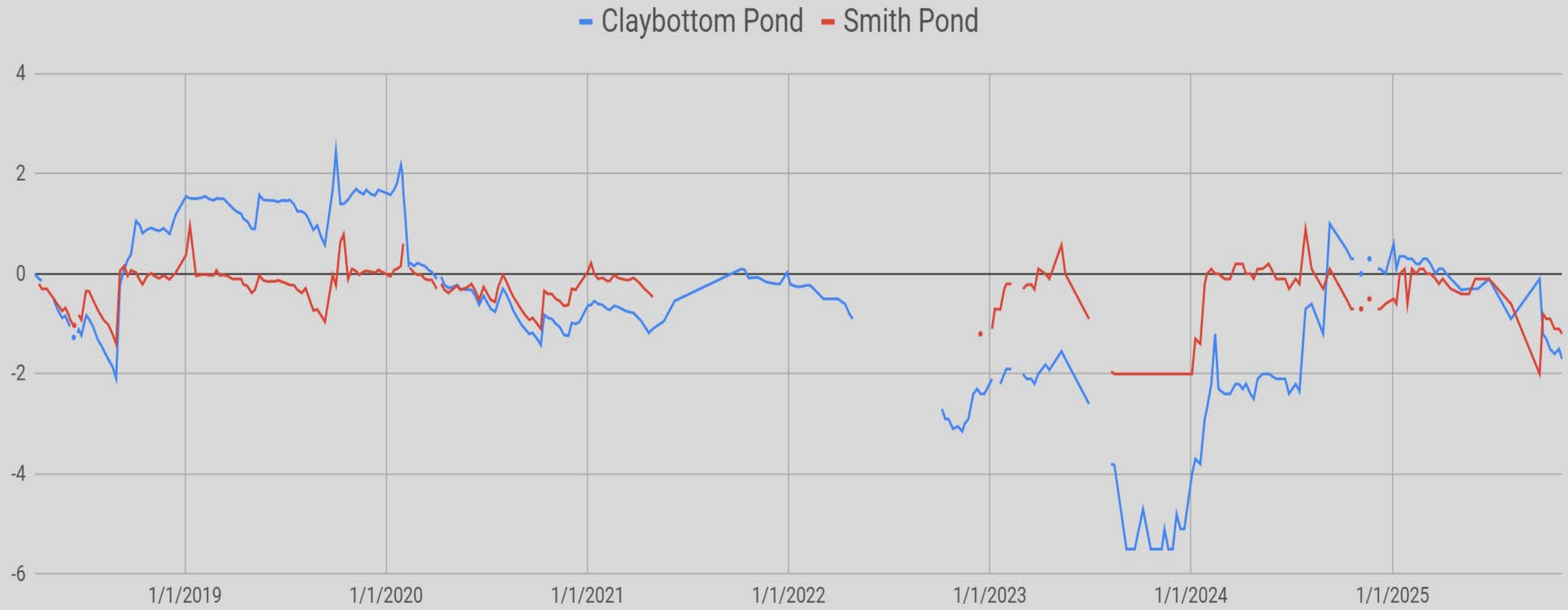


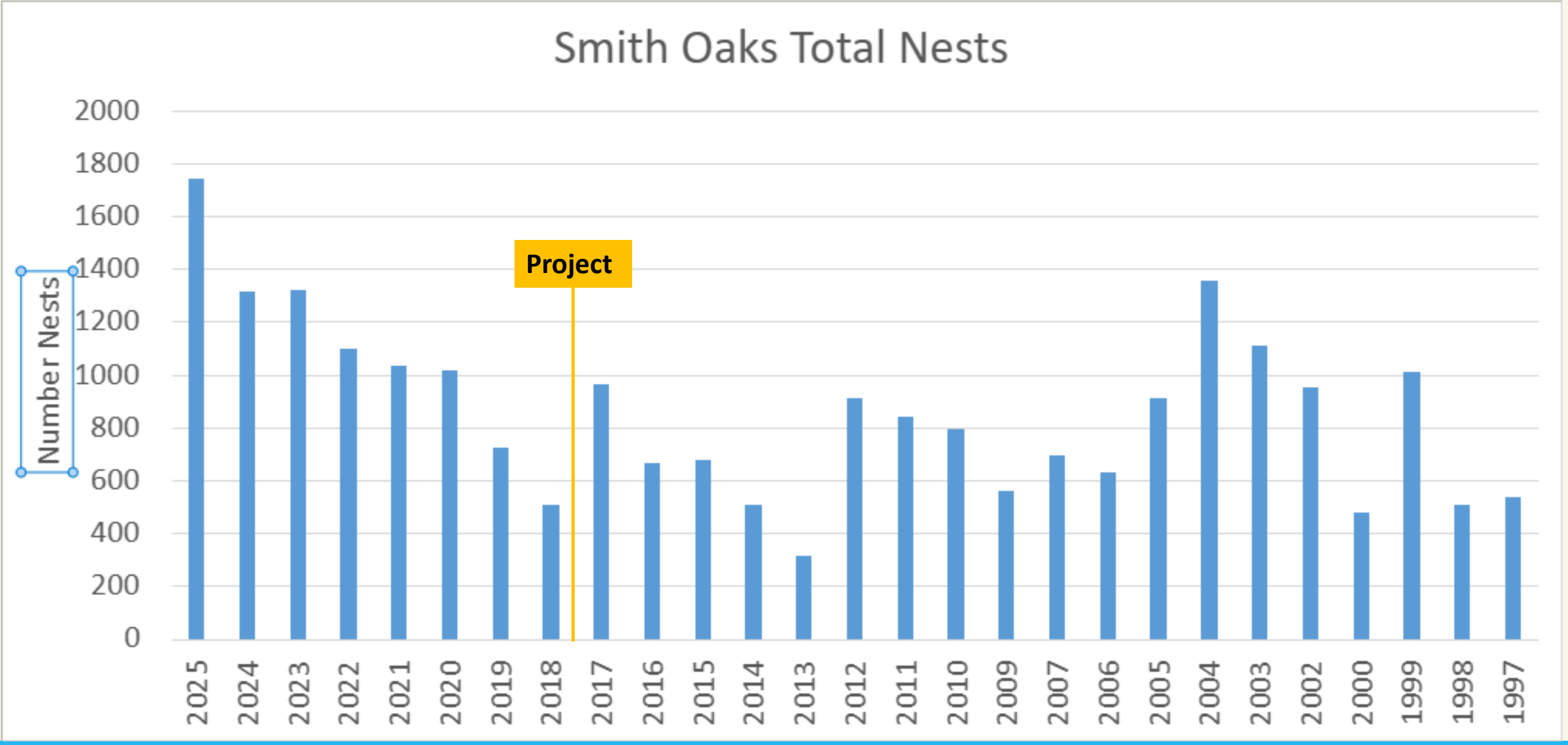
Habitat Expansion and Resiliency with DU

- When vegetation drops, bird nests drop as well.



Water Levels




Smith Oaks Total Nests
Number Nests
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Project
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2023
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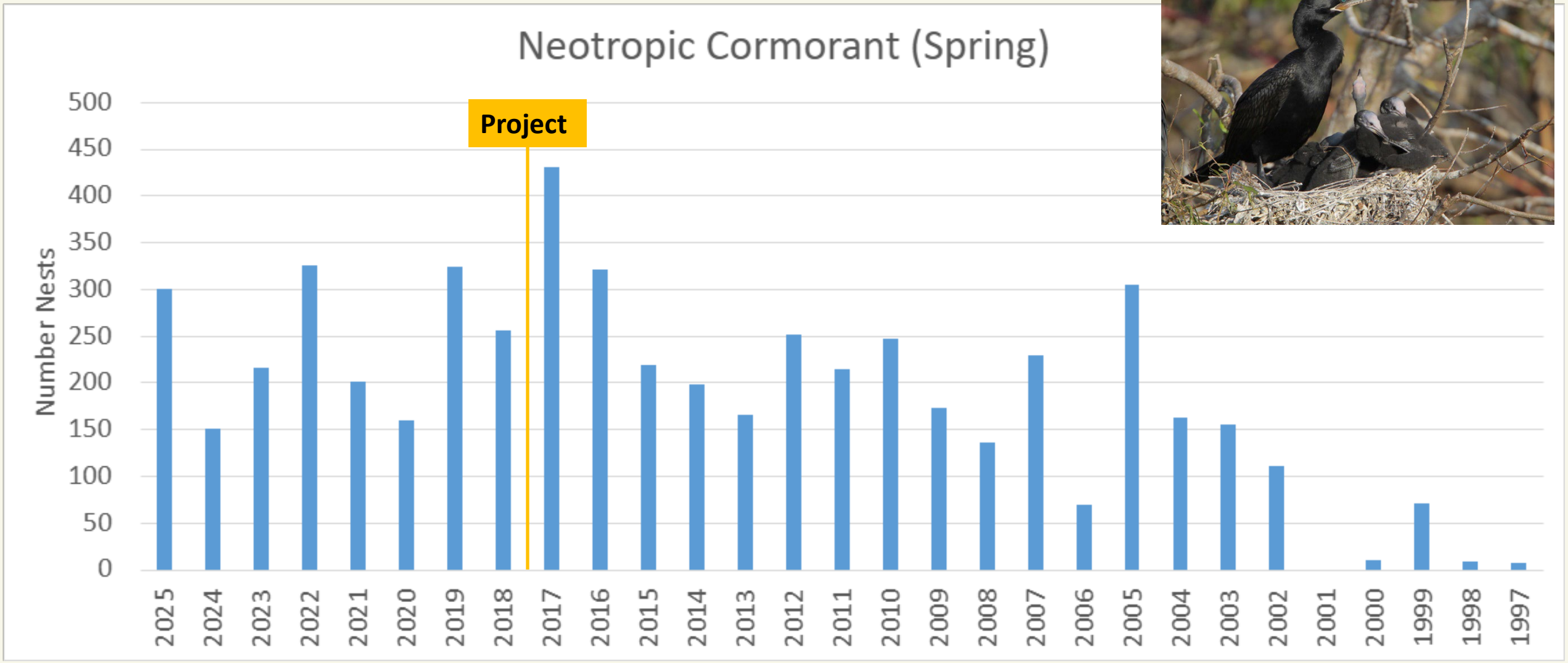
Neotropic Cormorant (Spring)
Project
Number Nests
500
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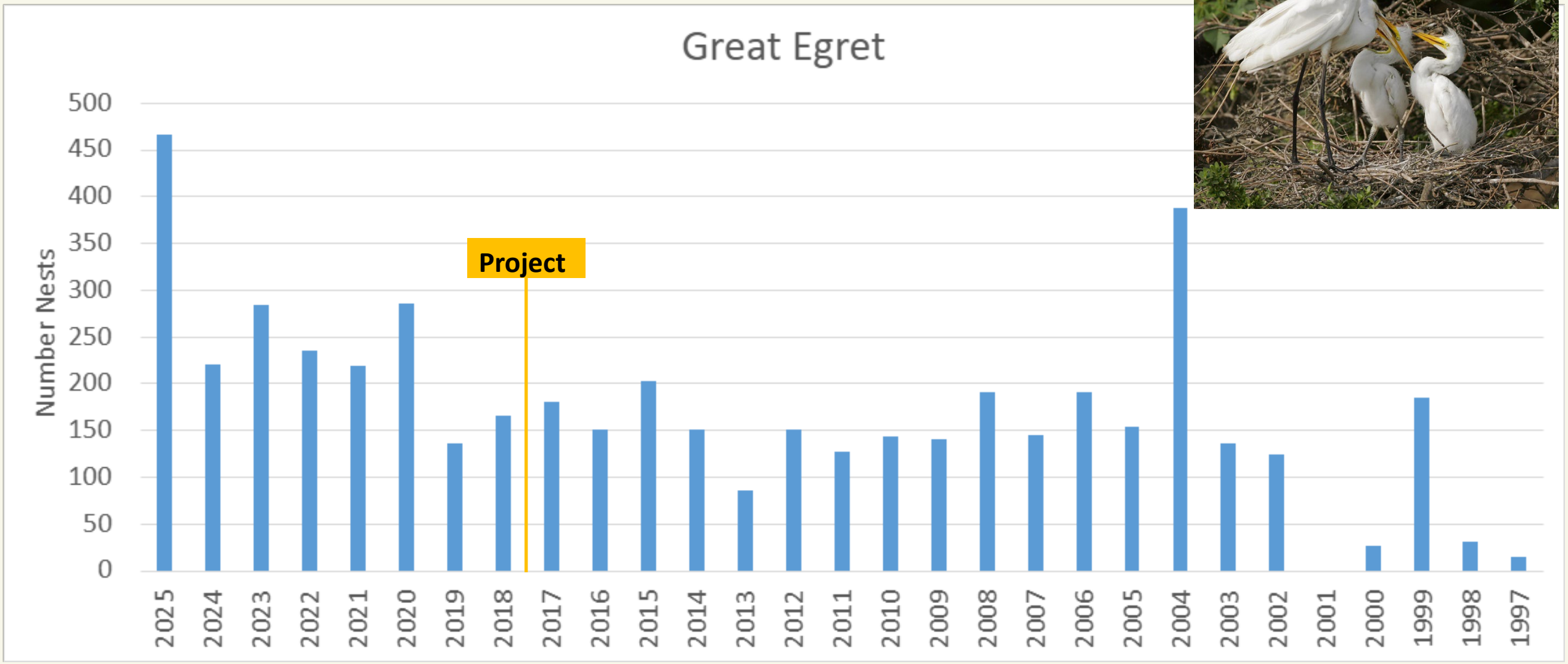
Great Egret
Number Nests
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Project
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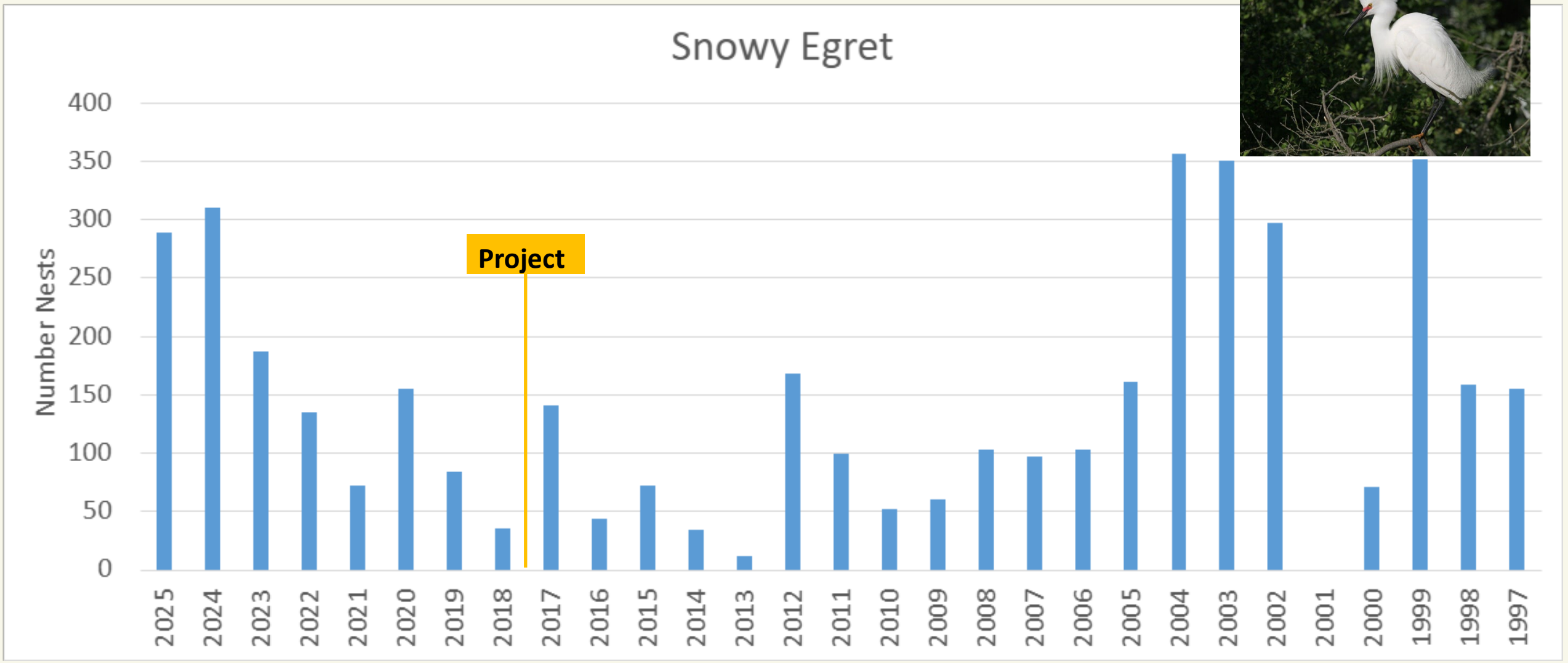
Snowy Egret


Number Nests
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Project
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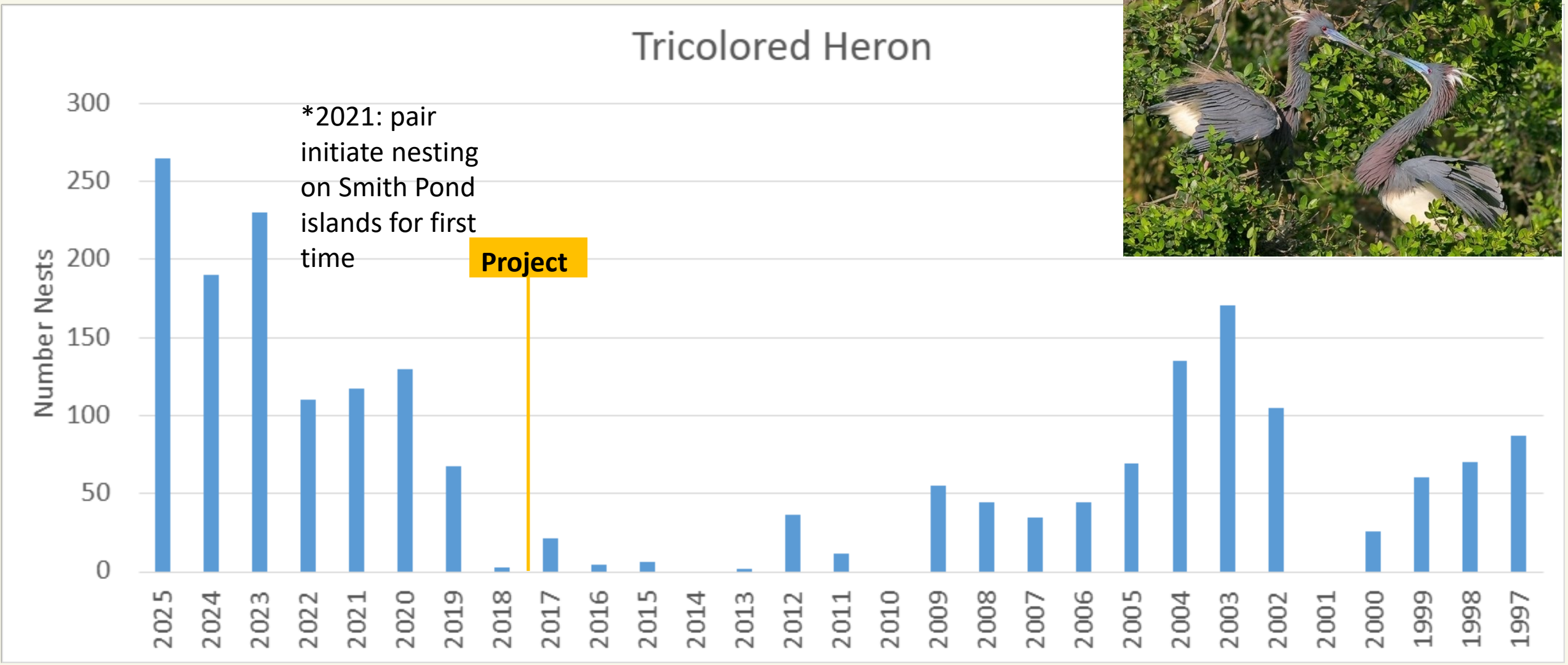
Tricolored Heron
*2021: pair initiate nesting on Smith Pond islands for first time
Project
Number Nests
300
250
200
150
100
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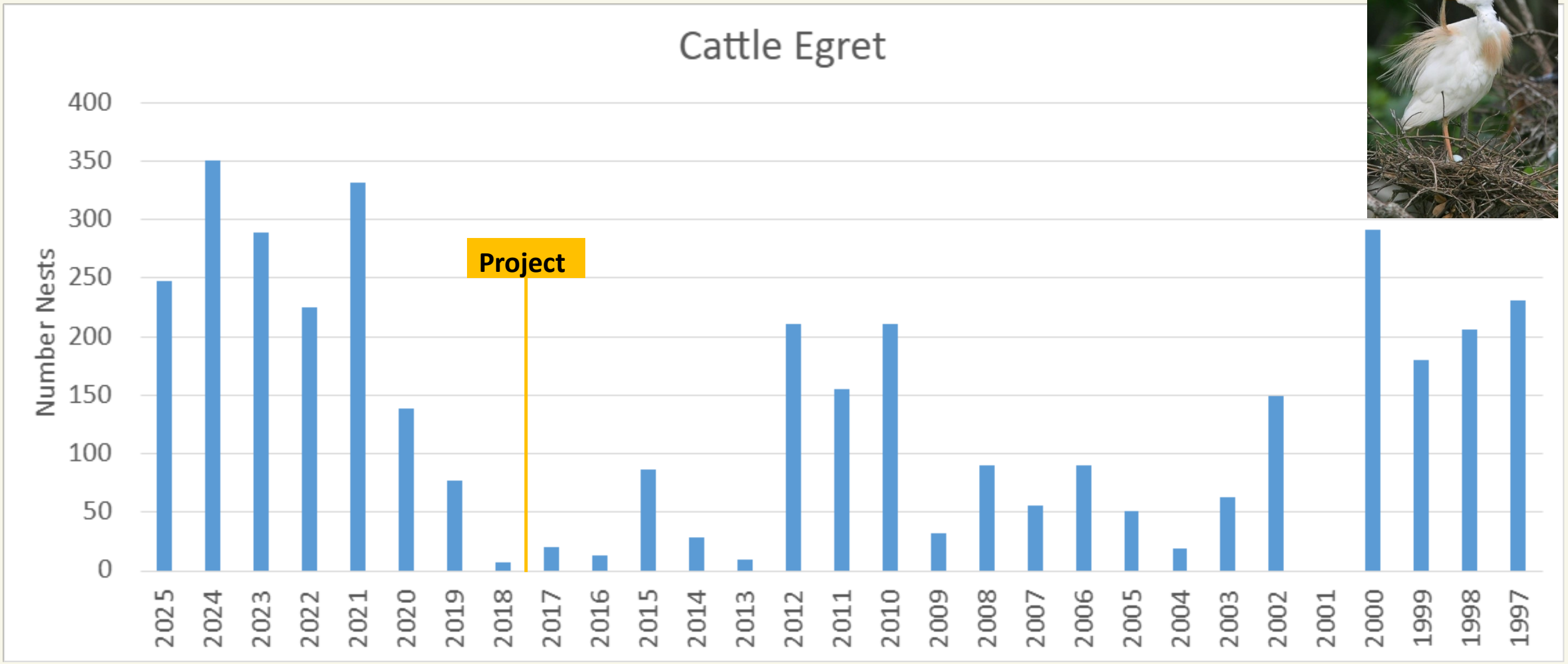
Cattle Egret
Number Nests
400
350
300
250
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Project
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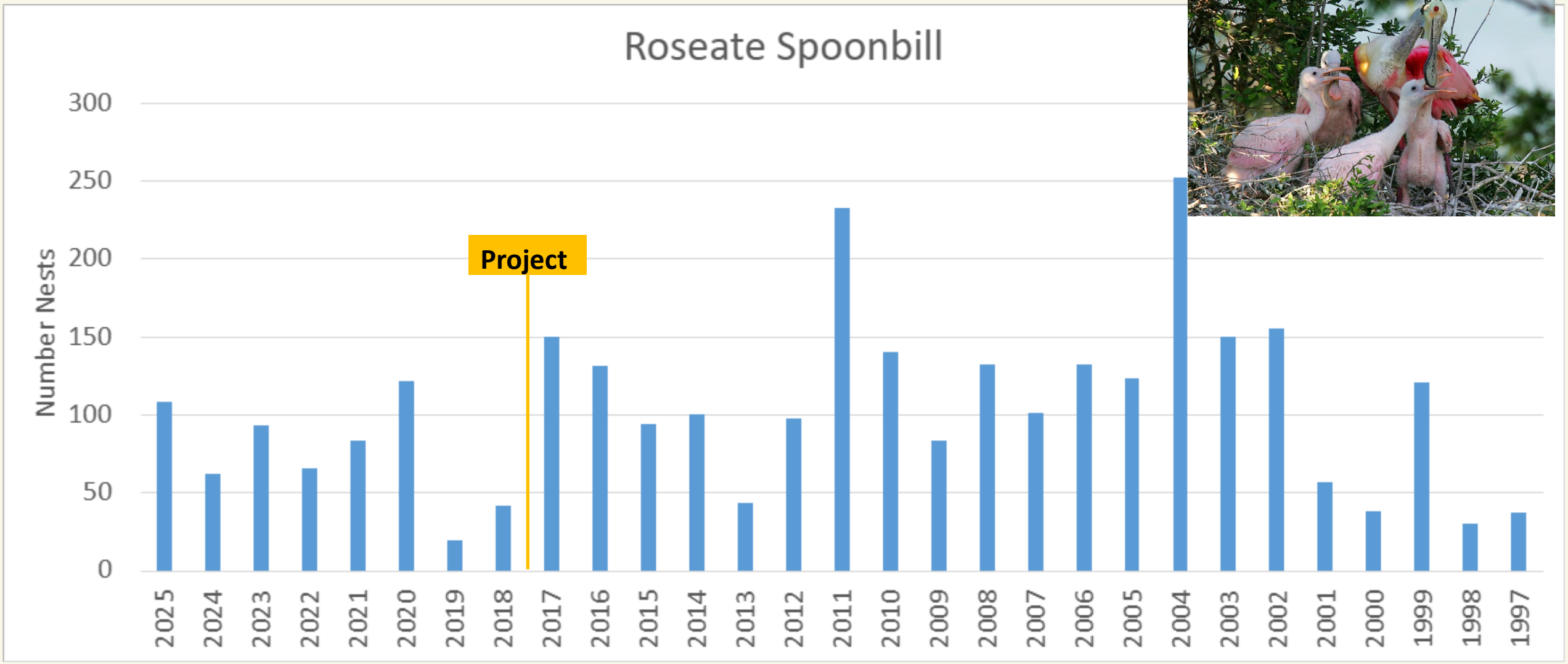
Roseate Spoonbill
Number Nests
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Summary & Notes

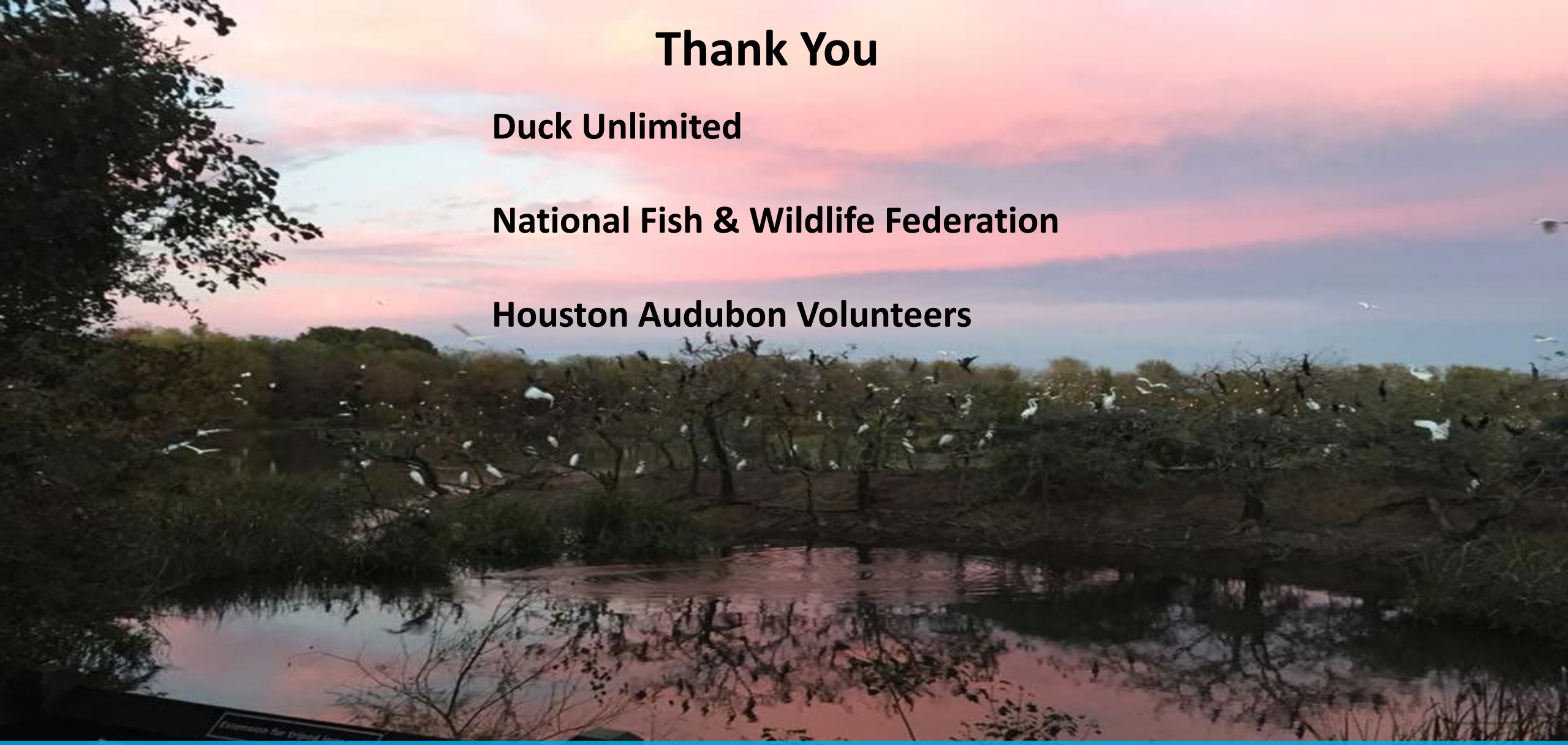
- Successfully created/enhanced rookery habitat within both ponds at Smith Oaks Sanctuary
- Managed water levels (reducing variability during periods of drought)
- Growth and apparent stabilizing of number of nesting pairs since project for each species
- Continued expansion in occupancy at Smith Pond rookery since pioneering TRHE pair in 2021
- Nest initiation timing between species stable (except fall 2022-24 NECO)
- Diversification of overall rookery species assemblage on property (ANHI, LBHE, YCNH, BCNH, GRHE)

Thank You

Duck Unlimited

National Fish & Wildlife Federation

Houston Audubon Volunteers



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TETRA TECH

Wulfert Bayous

Bird Nesting Habitat Design

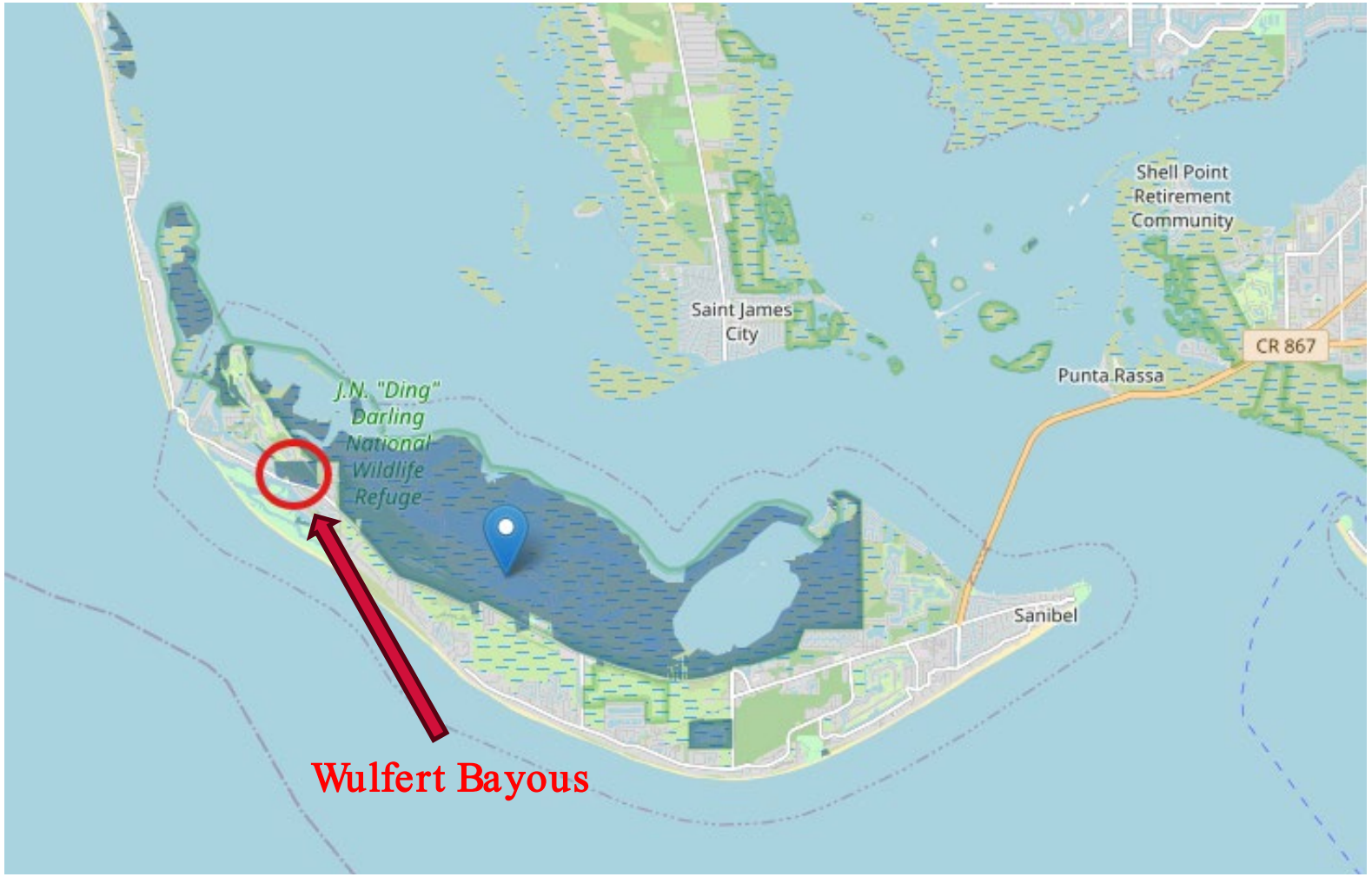
Marijke Maxwell, M.S.

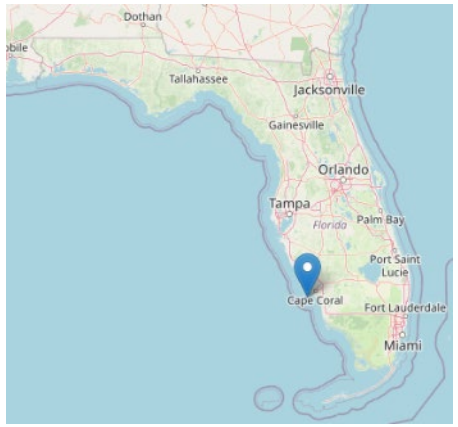
Élise Cormier, PLA

State of the Bay Symposium (Galveston TX)

February 24, 2026

J.N. "Ding" Darling National Wildlife Refuge





TETRA TECH

MHZ JV

J.N. "Ding" Darling
National Wildlife Refuge

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

"DING" DARLING WILDLIFE SOCIETY
SANIBEL FLORIDA
Friends of the Refuge

Lee County
Southwest Florida

NATIONAL FISH AND WILDLIFE FOUNDATION

Overview

Wulfert Bayous Bird Nesting Habitat – project goals:

1. **Enhance** 16 acres of existing mangrove wetlands and **restore** 23 acres of filled wetlands, for a **total treatment area of 39 acres.**

2. **Preserve native plants** and **control invasive** and exotic **species** such as Australian pine and Brazilian pepper.

3. **Design** a mangrove **bird nesting island habitat** with **crocodile basking** areas. Use hydrodynamic and water quality modeling to test and inform the design.

Aerial view of the project site (2019)

Source: www.publiclandsalliance.org/blogs/janine-doyle/2019/10/14/wulfert-bayous-acquisition-protects-key-wildlife-h

Comparative Similarities: Sanibel Island (FL) and Galveston (TX)

TETRA TECH

Gulf Coast barrier/nearshore systems: low-lying, sandy beaches and dune complexes vulnerable to shoreline change.

Climate &hazard profile: subtropical influence with seasonal hurricane/tropical-storm risk, storm surge, and coastal flooding.

Ecosystems &services: beaches and nearshore/estuarine habitats that support shorebirds, sea turtles, fisheries, and provide natural storm buffering.

Economy &community reliance: tourism and recreation–based economies with seasonal visitor peaks; high socio-economic exposure to storm impacts.

Common management responses: dune restoration and beach nourishment, elevated/ resilient construction, and combined nature-based and engineered resilience measures.

Site Investigations

1. Water quality monitoring
2. Subsurface investigations
3. Hydrographic and topographic survey
4. Wetland delineation and vegetation characterization
5. Ornithology review (Audubon Bird Migration Explorer)

At least 12 species:

- ✓ Reddish Egret
- ✓ White Ibis
- ✓ Great Egret
- ✓ Snowy Egret
- ✓ Wood Stork
- ✓ Black-Crowned Night Heron
- ✓ Brown Pelican
- ✓ Great Blue Heron
- ✓ Little Blue Heron
- ✓ Roseate Spoonbill
- ✓ Tricolored Heron
- ✓ Yellow-Crowned Night Heron

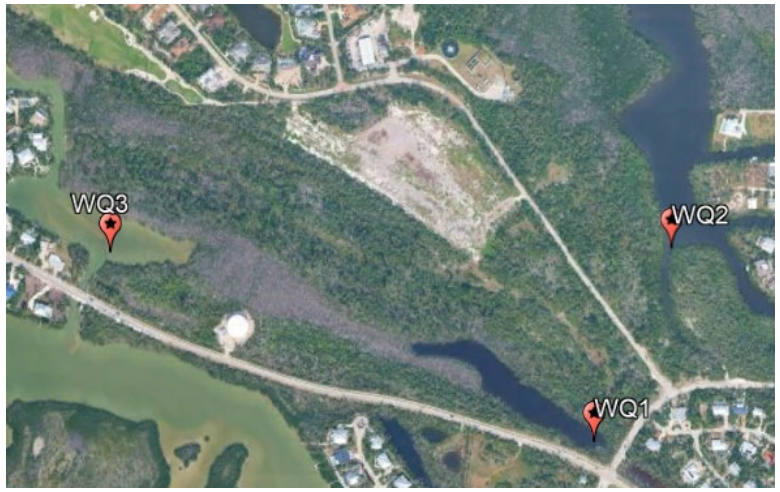
TETRA TECH

Roseate Spoonbills and Mangroves at Ding Darling NWR

Source: U.S. Fish and Wildlife Service Headquarters, Public domain, via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Roseate_Spoonbills,_J.N._%22Ding%22_Darling_NWR_(5613060762).jpg

Site Investigations

Water Quality Monitoring

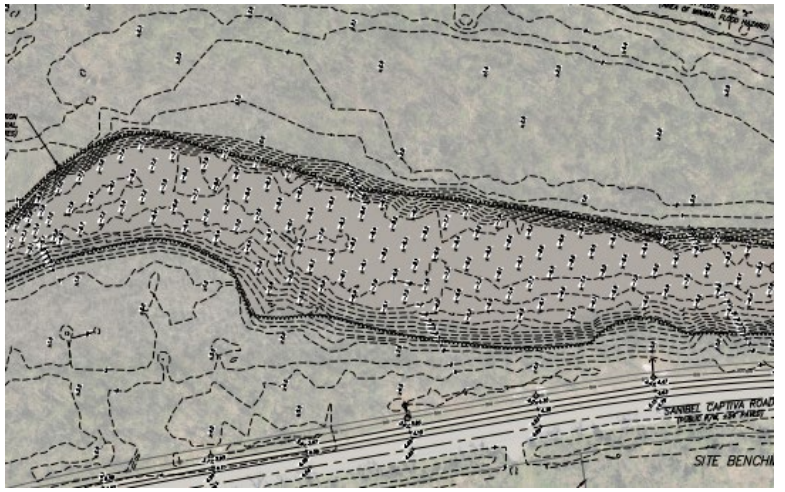


- Three YSI EXO2 sondes recording water level, conductivity, temperature, DO, pH/ORP from 9 Dec 2024–14 Mar 2025 (2,270 sonde observations).
- WQ1 has distinctly lower DO, lower salinity, and lower turbidity than WQ2/WQ3, and much greater salinity variability due to partial isolation and stormwater input from nearby residential development.
- Formed a robust time-series baseline; dominant drivers are seasonal change, intermittent rainfall, and WQ1's stormwater influence.

Subsurface Exploration

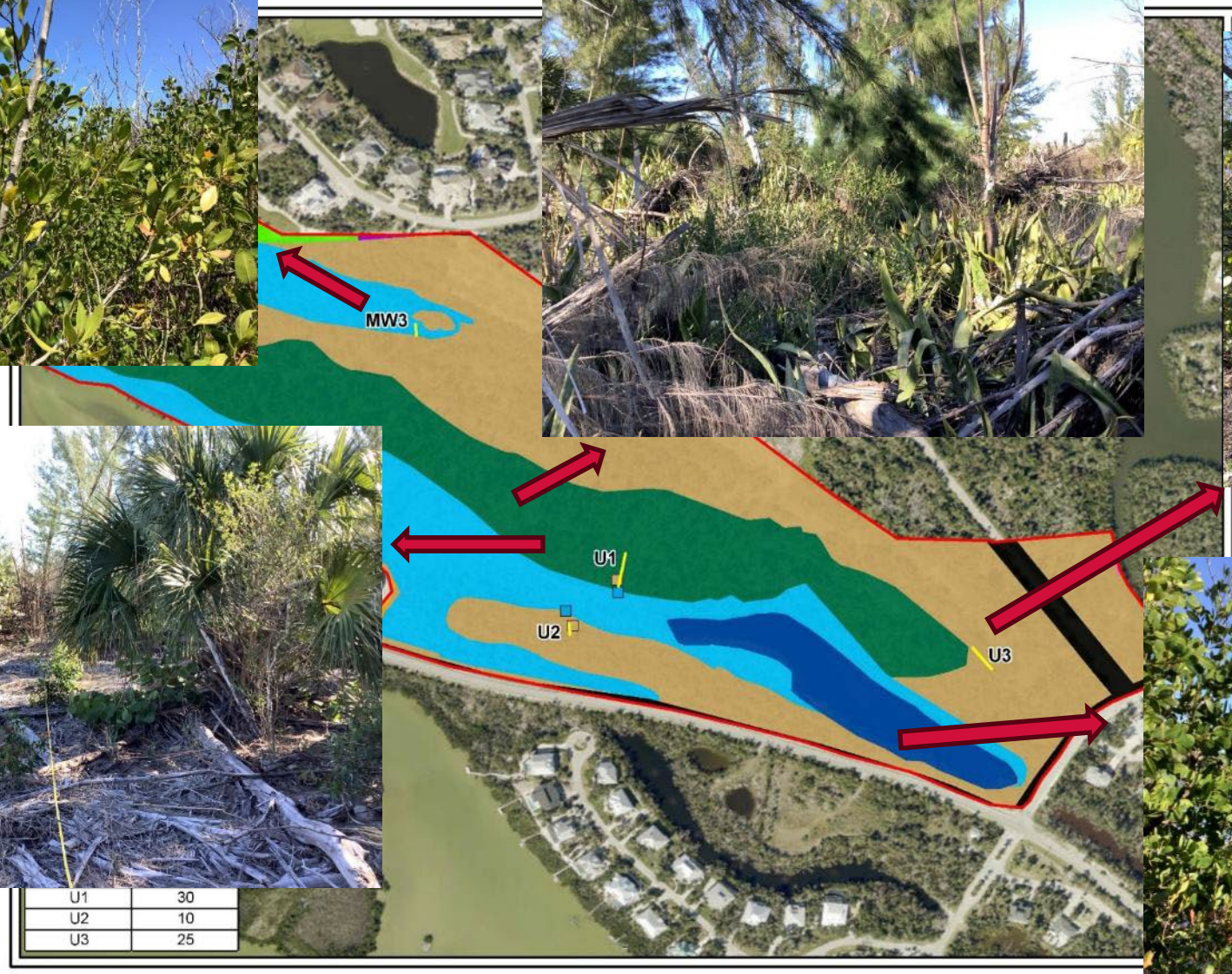
- Two 2-inch diameter piezometers, each screened at ~5 to 15 feet below ground surface.
- Outfitted to support long-term monitoring of the water table.
- Five auger borings to 5 to 15 feet below the existing ground surface.
- Soil samples were visually classified in the field and representative portions of the samples were sent to a lab.
- Groundwater levels measured during boring activities ranged from 2-1/2 to 4-1/3 feet below existing ground surface.

Hydrographic & Topographic Surveys



- Topographic survey at 100-foot intervals.
- Hydrographic survey at 25-foot intervals.
- Included mean high-water.

Vegetation Characterization



U1	30
U2	10
U3	25

Wetland Delineation

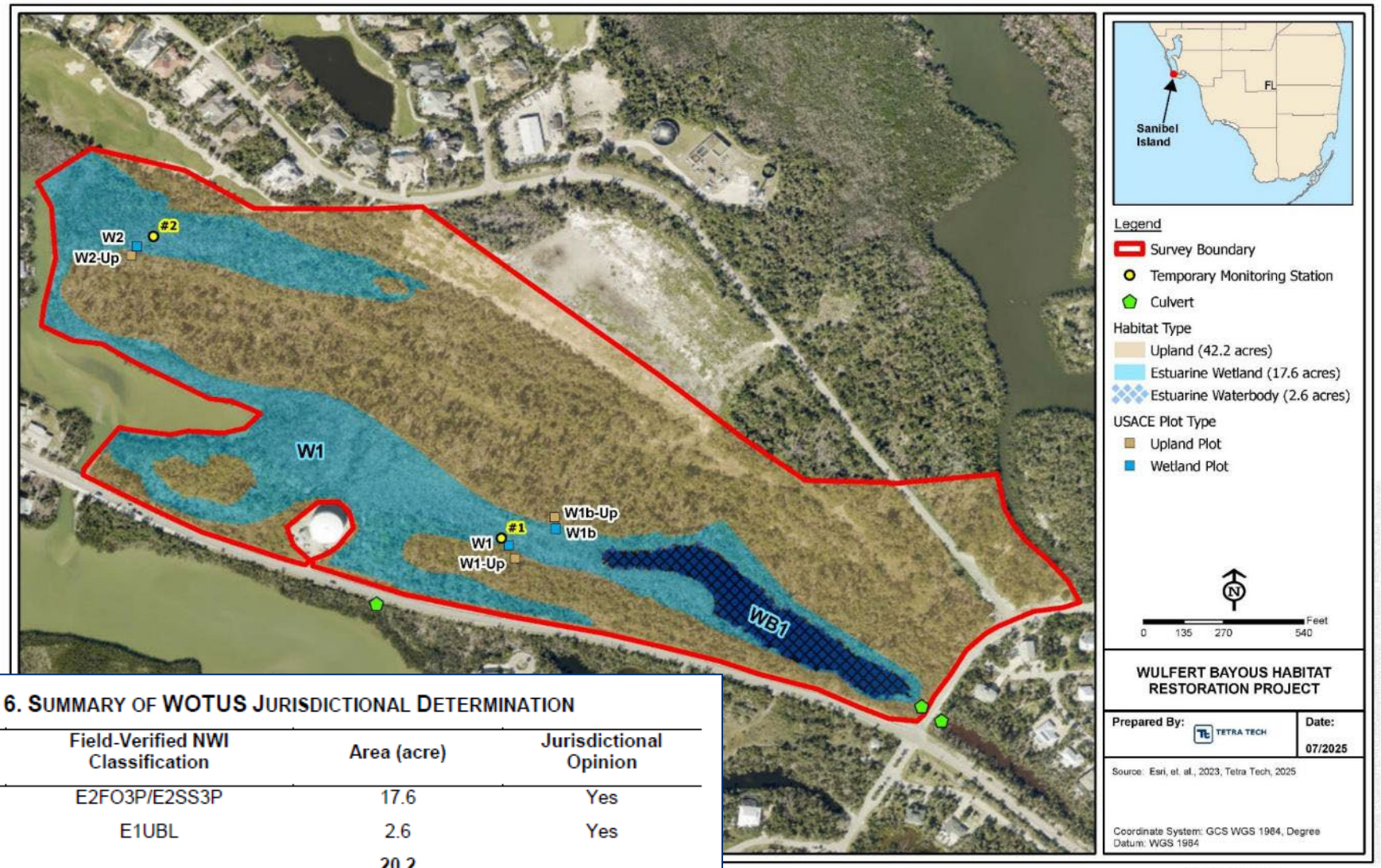
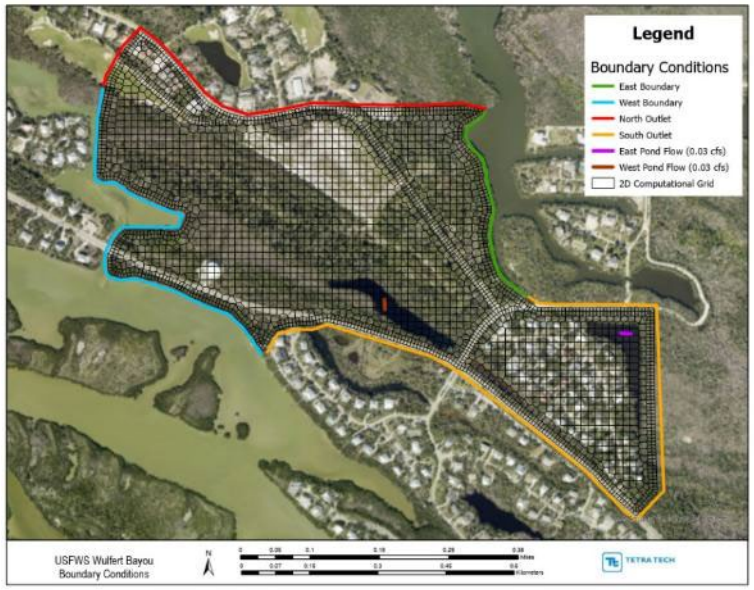
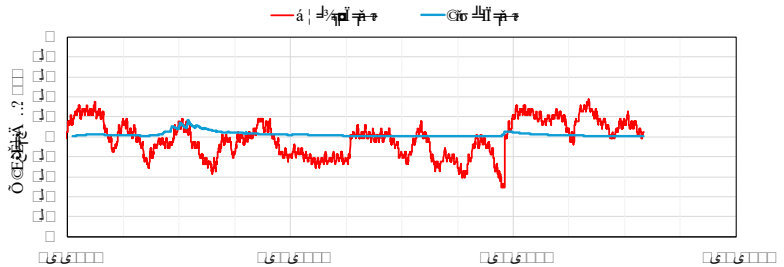


TABLE 6. SUMMARY OF WOTUS JURISDICTIONAL DETERMINATION

Feature ID	Field-Verified NWI Classification	Area (acre)	Jurisdictional Opinion
W1	E2FO3P/E2SS3P	17.6	Yes
WB1	E1UBL	2.6	Yes
Total		**20.2**	

Model Setup and Calibration





CALIBRATION

The **simulated** water surface elevation at DD_WQ1 is in **equilibrium around 1 ft NAVD88**, which is **about the same** as **observed** water surface elevation.

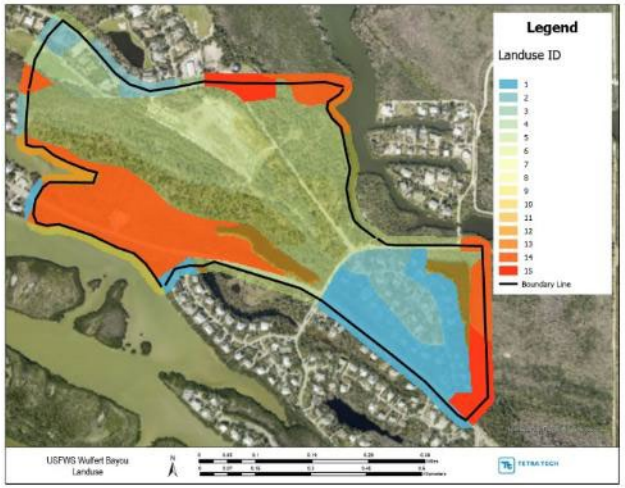
- **Set boundary conditions**
- **Establish normal depth** conditions at north and south outlets
- **East & West Pond Flow:** Maintain water balance in east and west with a constant flow of 0.045 cfs
- **Meteorological Data:** precipitation and evapotranspiration
- **Account for the water loss** by evapotranspiration, groundwater seepage, and vegetation uptake

American crocodile *Crocodylus acutus* basking at Ding Darling NWR

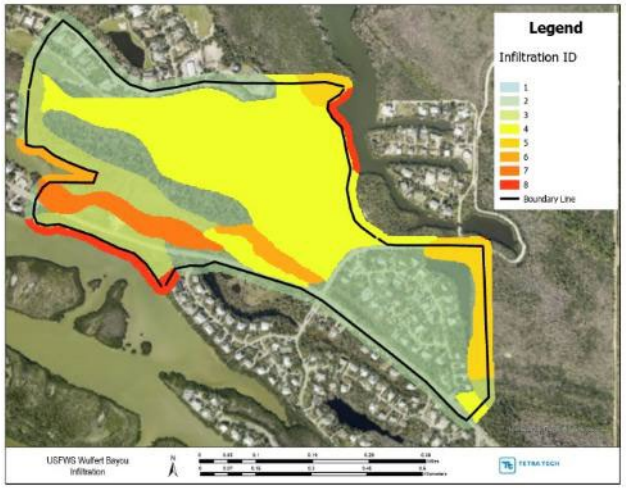
Source: jimfbleak, Public domain, via Wikimedia Commons https://upload.wikimedia.org/wikipedia/commons/6/6f/Floridacrocodile1.JPG

Model Data Sources

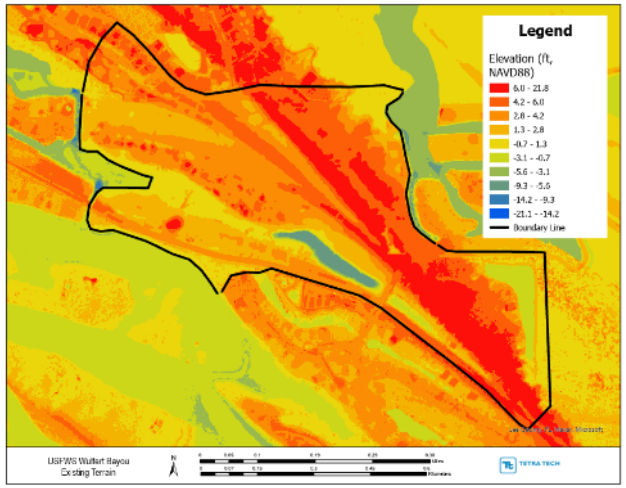
Land Use Data (FDEP)



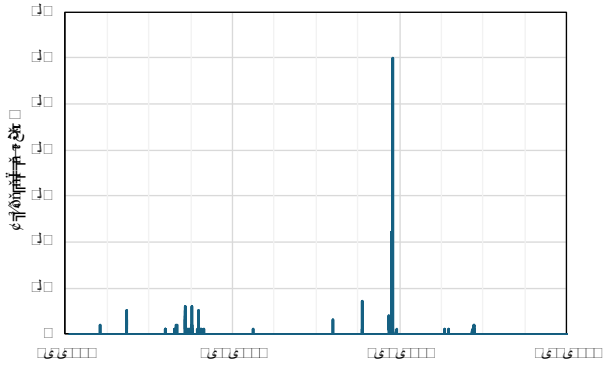
Infiltration Data (NRCS)



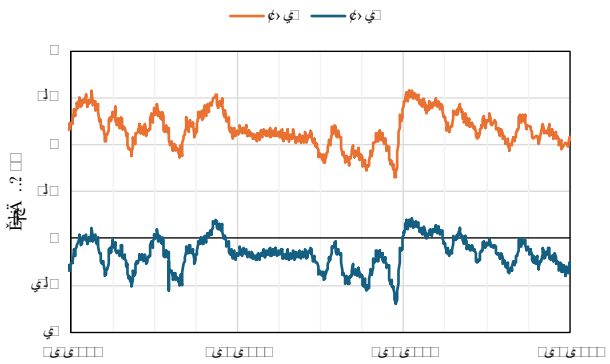
Existing Terrain



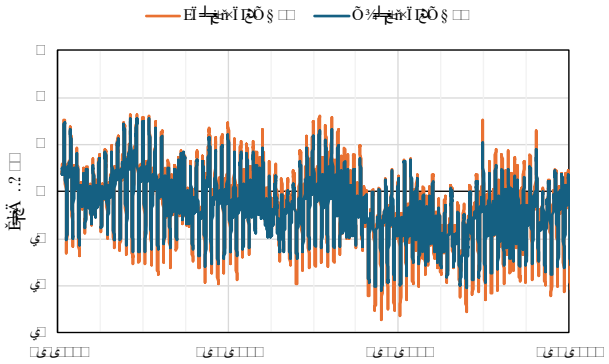
Precipitation data



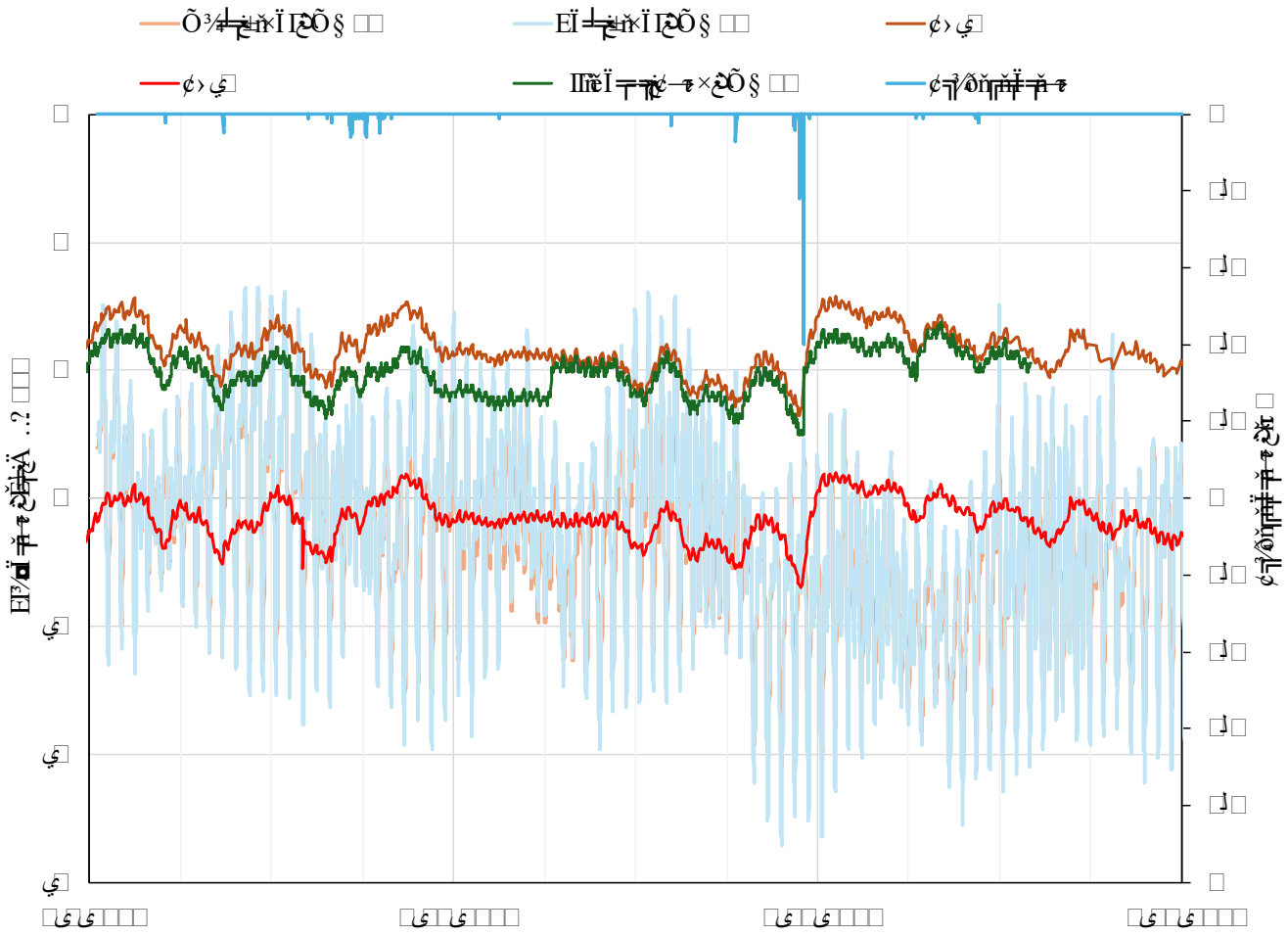
Groundwater data



Tidal data



Hydrology of the System



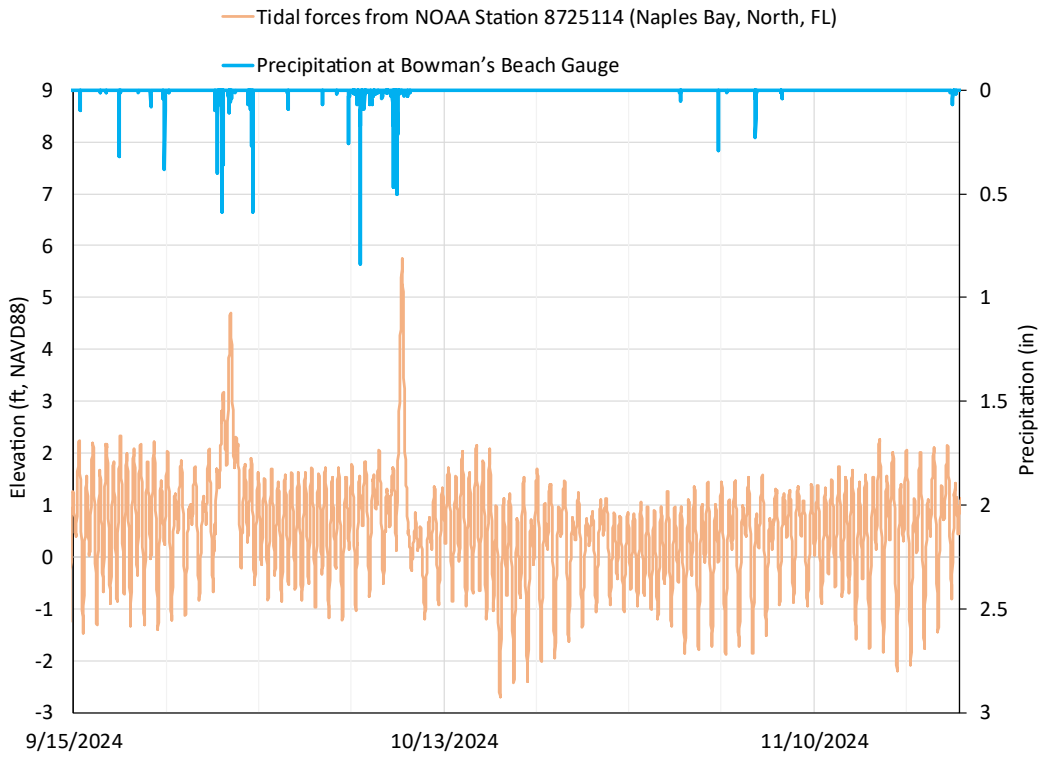
- Groundwater, precipitation, and tidal forcing are the **main drivers** of the system.
- There is a **groundwater gradient** from west to east (PZ-1 to PZ-2)
- The **water level in the pond** is balanced by losing and gaining from the **groundwater**.

Hydrology of the System

Modeling the impact of storm events on site hydraulics

Storm events during the period of 9/15 to 11/21/24:

- King Tides of up to 2 feet NAVD88
- Storm Surges of up to 5.76 feet NAVD88
- Rainfall of 0.84 inches.



Mangrove roots at Ding Darling NWR

Source: U.S. Fish and Wildlife Service Headquarters, Public domain, via Wikimedia Commons https://commons.wikimedia.org/wiki/File:Red_Mangroves_at_Ding_Darling_National_Wildlife_Refuge_(53604220515).jpg