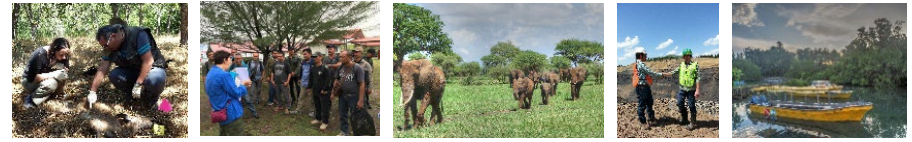




**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



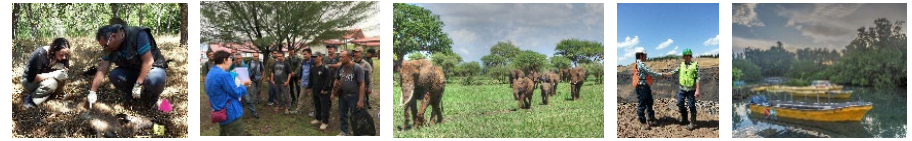
Best Practices for Restoring and Rehabilitating Ecosystem Services in Wetlands: Examples from the United States

EAAFP 11TH MEETING OF PARTNERS (MOP11)
BRISBANE, AUSTRALIA
14th March 2023

Fred Wurster
Hydrologist
U.S. Department of Interior - ITAP



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

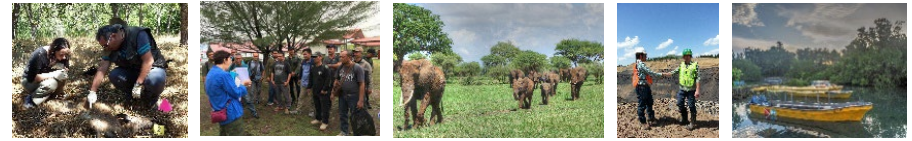


Management Strategies Benefiting Wetland Ecosystem Services

- **Establish Protected Wetland Areas**
- **Adaptive Management of Protected Wetlands**
- **Wetland Restoration using Nature Based Solutions**



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

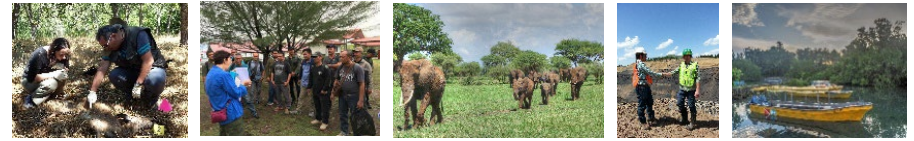


Disturbance to Wetlands: Drainage Ditches





**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

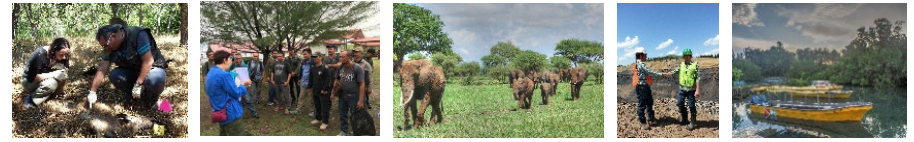


Disturbance to Wetlands: Canal Construction





**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

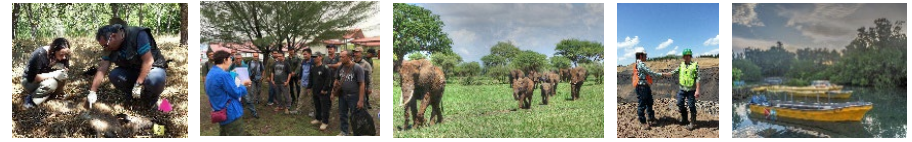


Disturbance to Wetlands: Water Diversion

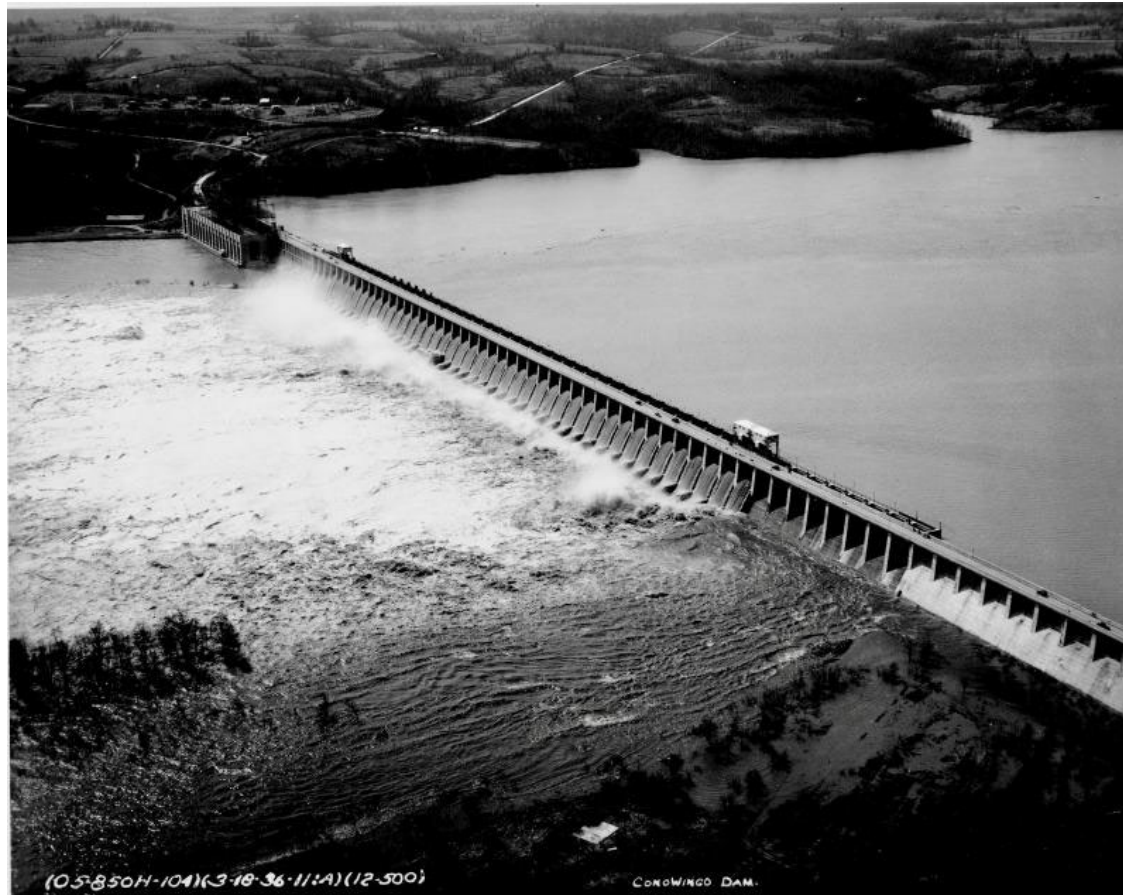




**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



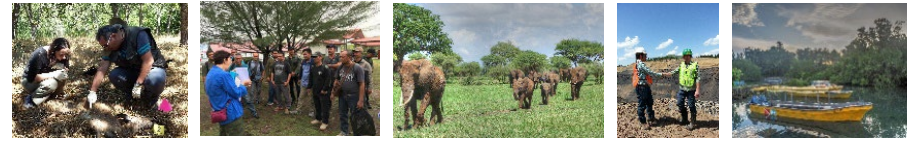
Disturbance to Wetlands: Dam Construction



Credit : Conowingo Dam Susquehanna River



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

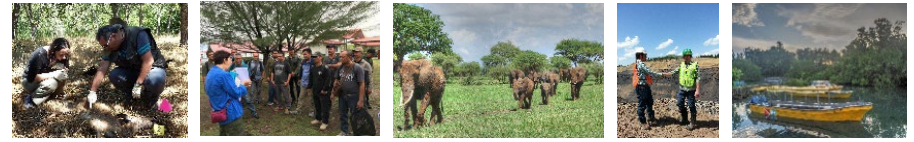


Disturbance to Wetlands: Dike / Levee Construction



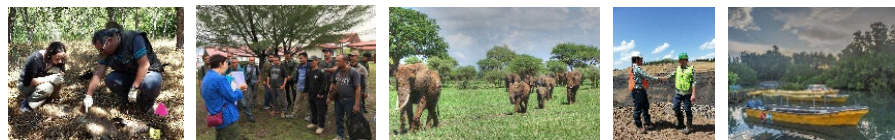


**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Disturbance to Wetlands: Road Construction



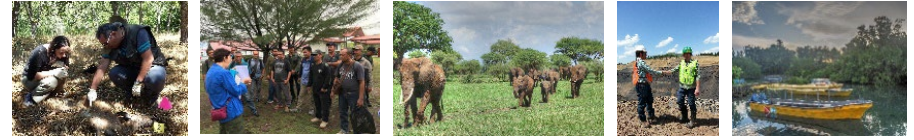


YEAR	WETLAND HECTARES IN U.S. Continental U.S. (Lower 48)
1780	~ 89,000,000
1980	~ 42,000,000

~ 5% of land area in Lower 48 is wetland in the 1980s

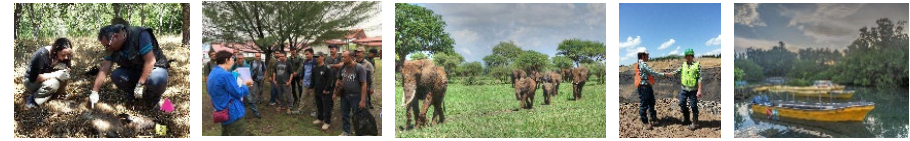


**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



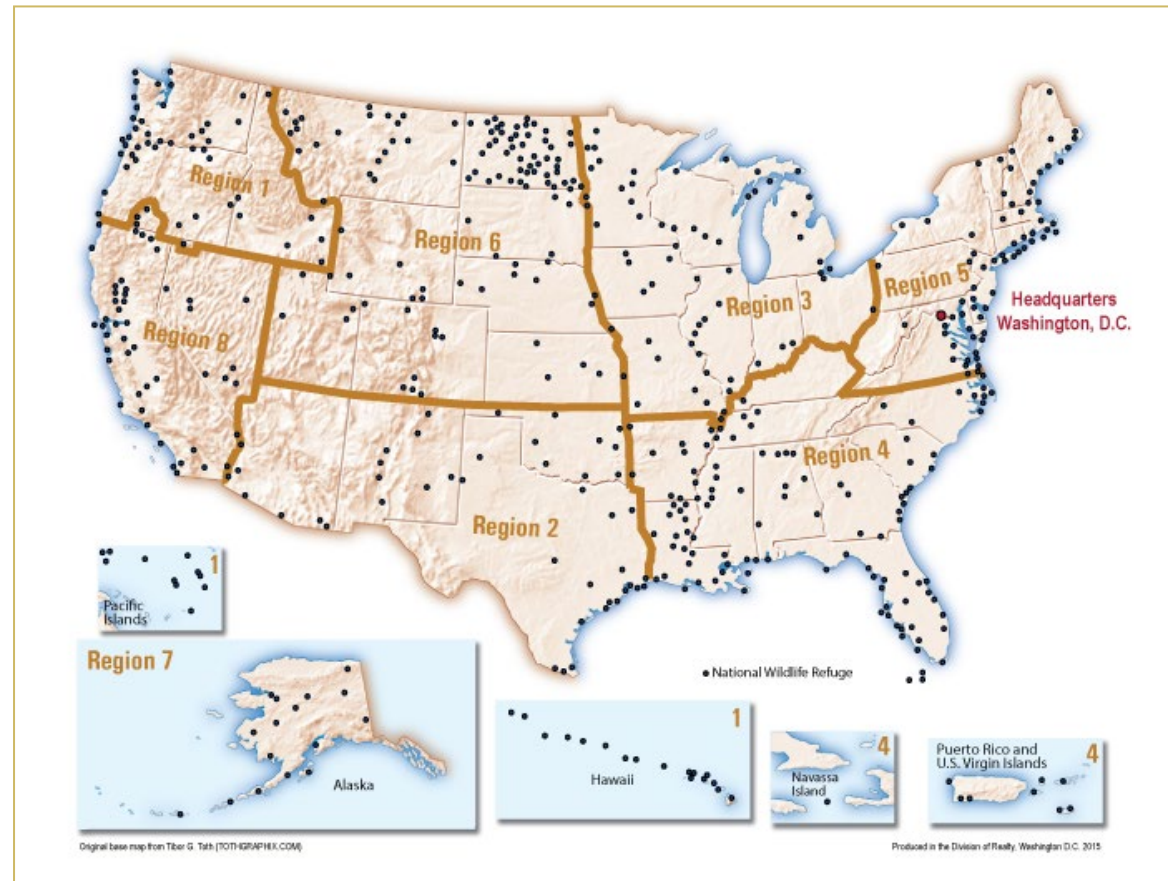
Management Strategies Benefiting Wetland Ecosystem Services

- **Establish Protected Wetland Areas**
- Adaptive Management of Protected Wetlands
- Wetland Restoration using Nature Based Solutions



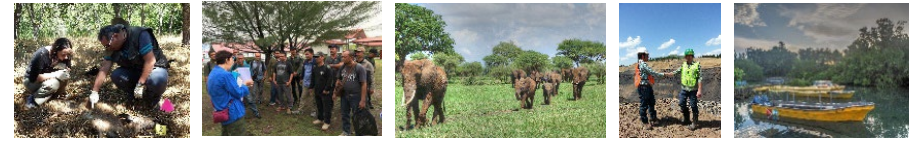
Protecting Wetlands: National Wildlife Refuge System

- Established 1903
- 567 Refuges in U.S.
- ~ 38,500,000 hectares
- ~ 4% U.S. Land Area
- Include all types of wetland ecosystems found in the U.S. and Territories

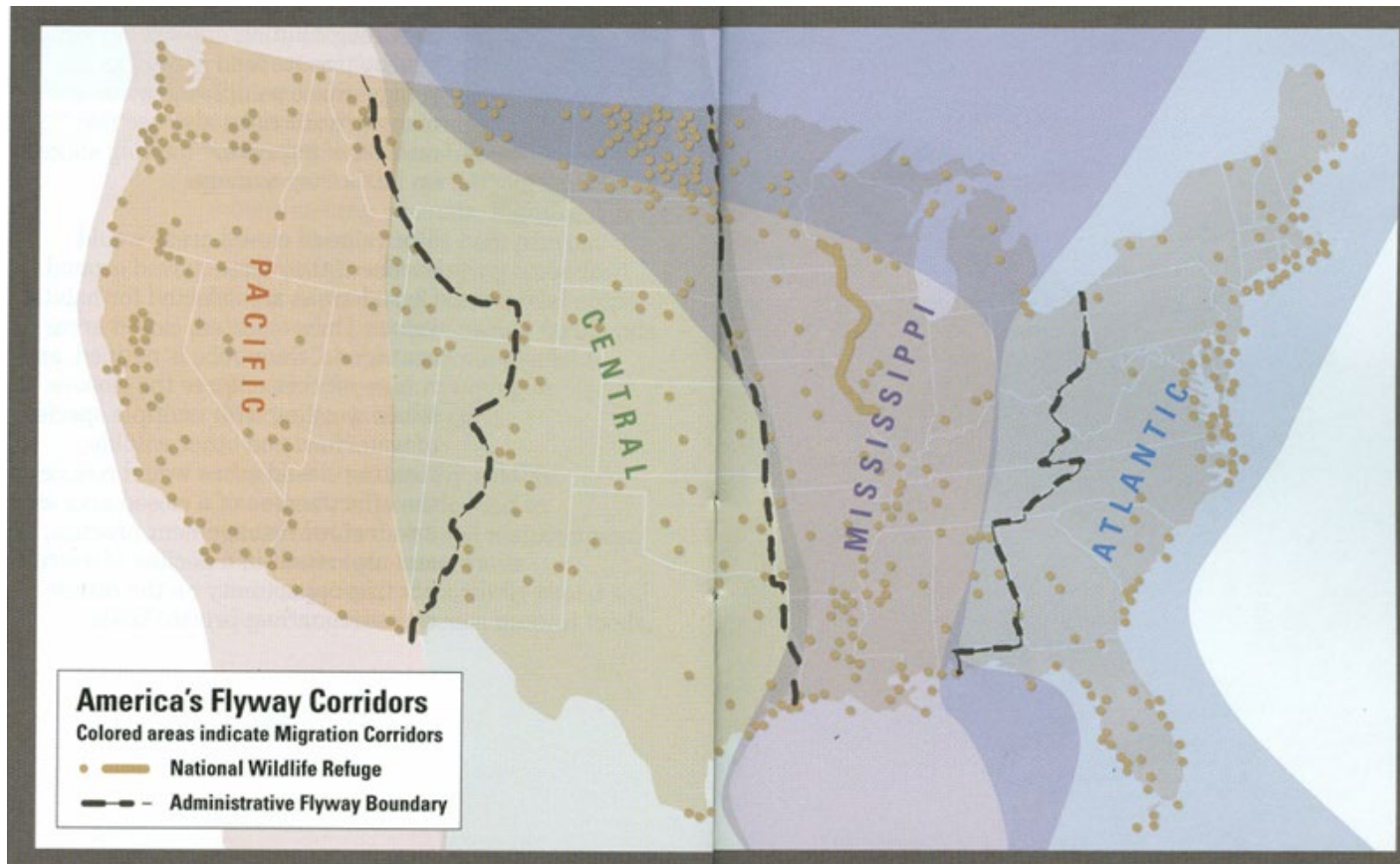




**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

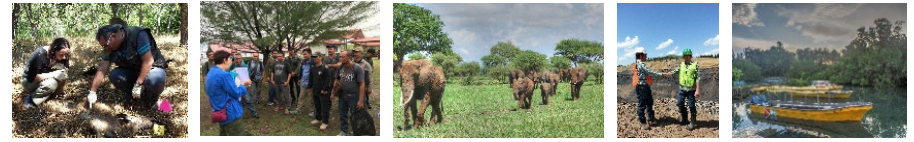


Protecting Wetlands: National Wildlife Refuge System





**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



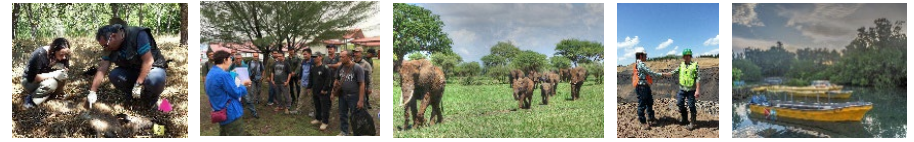
Yukon Flats NWR, Alaska 4,500,000 hectares



FWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

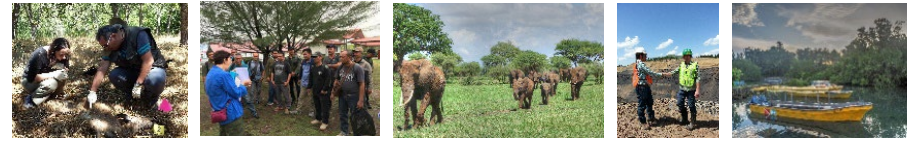


E.B. Forsythe NWR, New Jersey **19,000 hectares**





**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

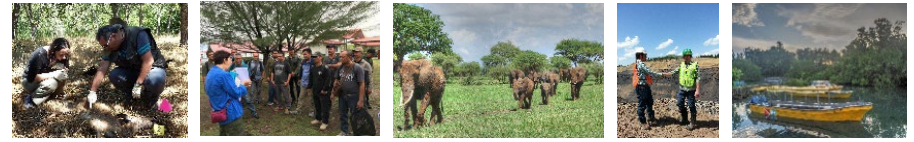


Ding Darling NWR, Florida 2,600 hectares





**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

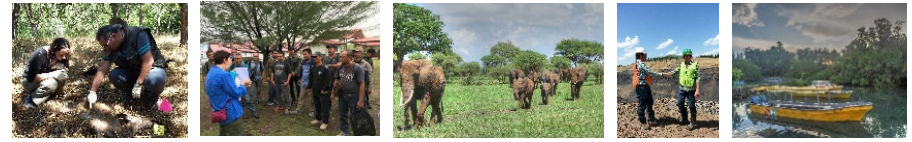


John Heinz NWR, Pennsylvania 500 hectares



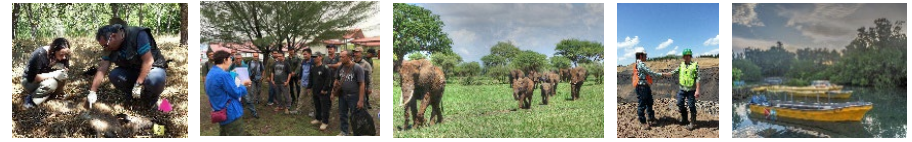


**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Management Strategies Benefiting Wetland Ecosystem Services

- Establish Protected Wetland Areas
- **Adaptive Management of Protected Wetlands**
- Wetland Restoration using Nature Based Solutions

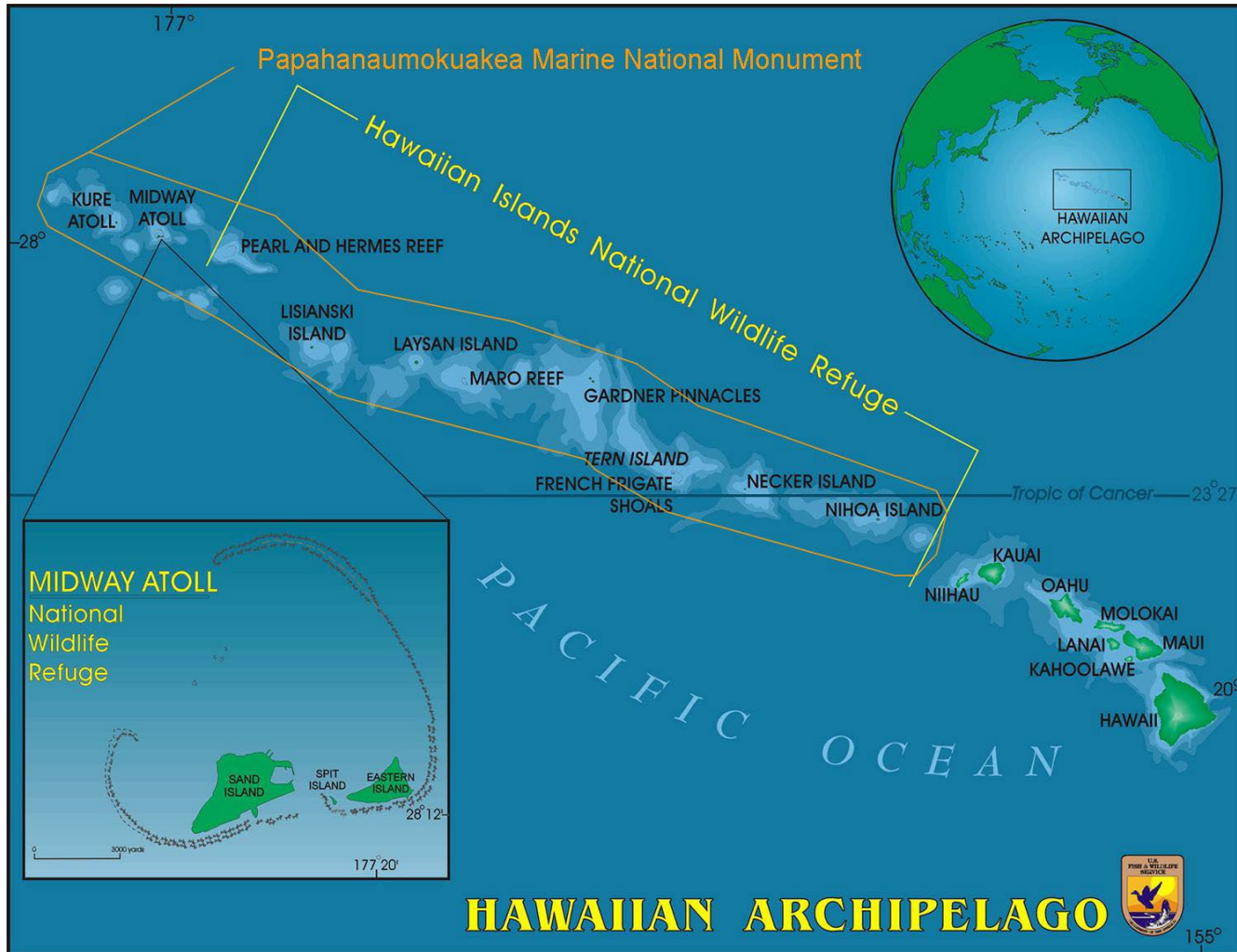
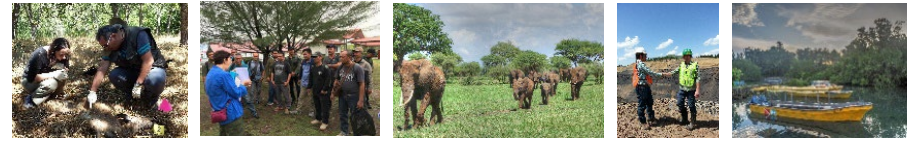


Common Adaptive Management Strategies on Refuges

- **Invasive Species Management**
- **Moist Soil Management**
- **Prescribed Fire**
- **Cooperative Farming Agreements**



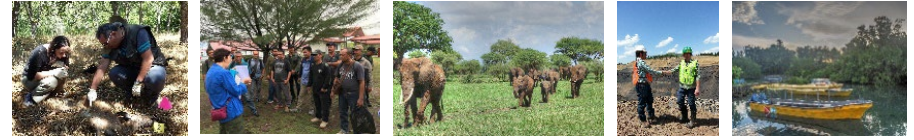
**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Credit: John Klavitter USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



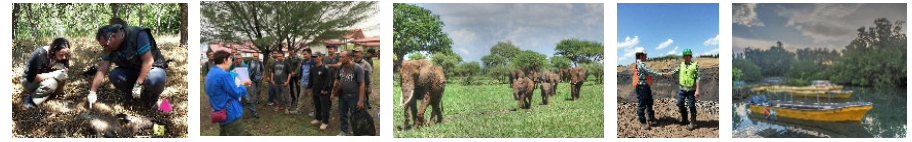
Invasive Species Management: Midway Atoll NWR



Credit: John Klavitter USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



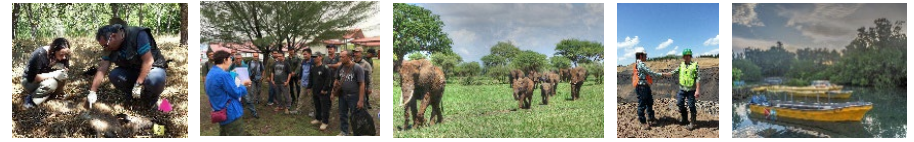
Invasive Species Management: Midway Atoll NWR



Credit: John Klavitter USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



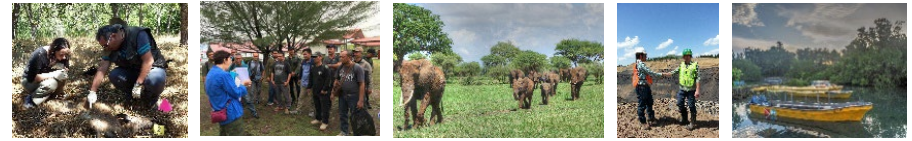
Invasive Species Management: Midway Atoll NWR



Credit: John Klavitter USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



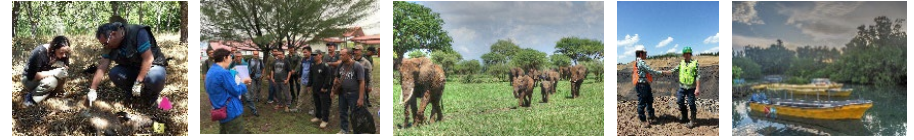
Invasive Species Management: Midway Atoll NWR



Credit: John Klavitter USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



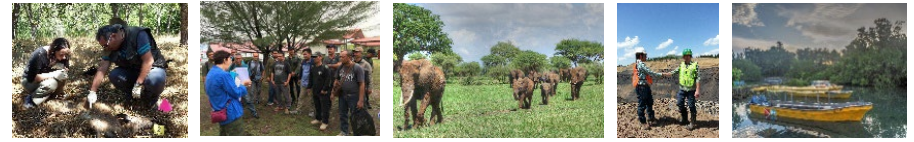
Moist Soil Management: Hanalei NWR, Kauai



Credit: Chadd Smith USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Endangered Waterbirds of Hawai'i



'Alae 'ula
Hawaiian Moorhen



Koloa Maoli
Hawaiian Duck

Eric VanderWerf



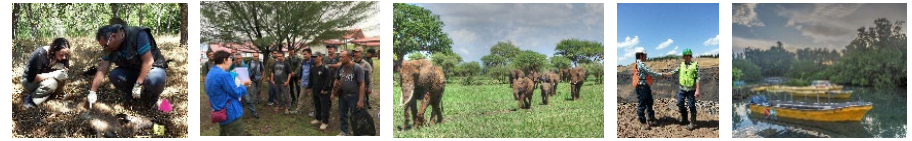
Nene
Hawaiian Goose



Ae'o
Hawaiian Stilt



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Wetland Loss Forces Waterbirds to Occupy Marginal Habitat

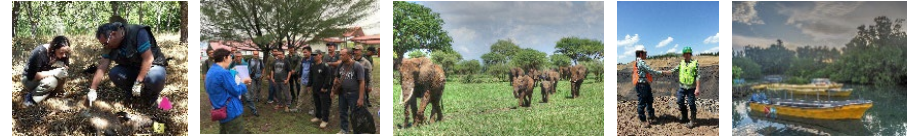


Kalo Lo'i (Taro farms)

Credit: Chadd Smith USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



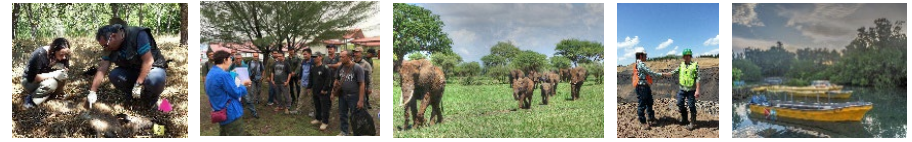
Opportunities To Create Waterbird Habitat in Old Rice Fields



Credit: Chadd Smith USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Treat Old Rice Fields with Mechanical Disturbance and Flooding



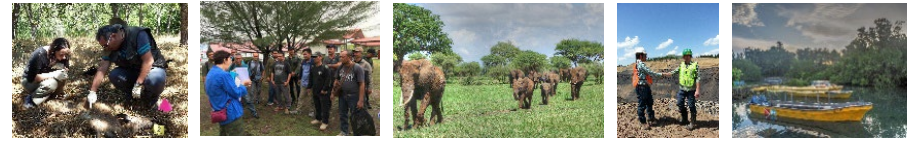
Expose

Mineral

Soils



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



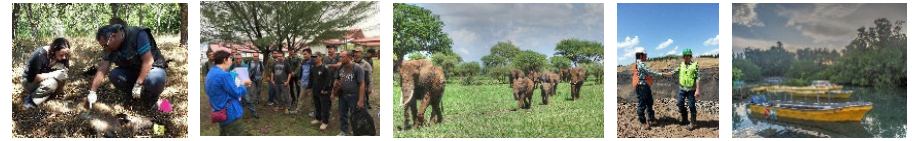
Germination of Preferred Wetland Plants from Seedbank



Germination of Preferred Wetland Plants From Seedbank



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



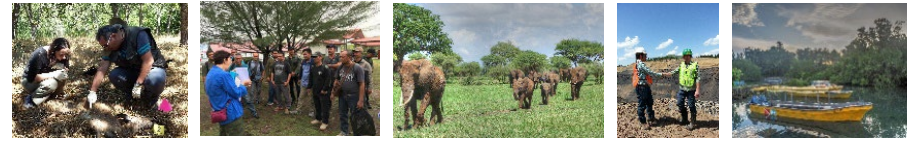
Germination of Preferred Wetland Plants from Seedbank



Credit: Chadd Smith USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Water Management for Vegetation and Habitat Diversity

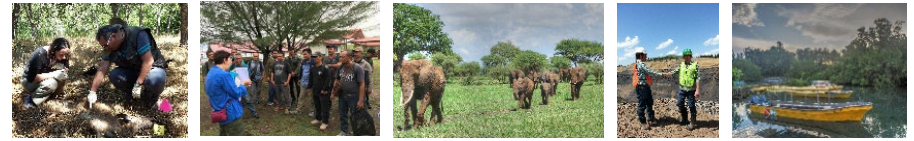


Vegetation and Habitat Diversity

Credit: Chadd Smith USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

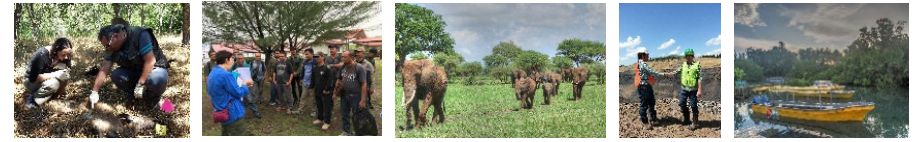


Improve Habitat for Endangered Hawaiian Waterbirds

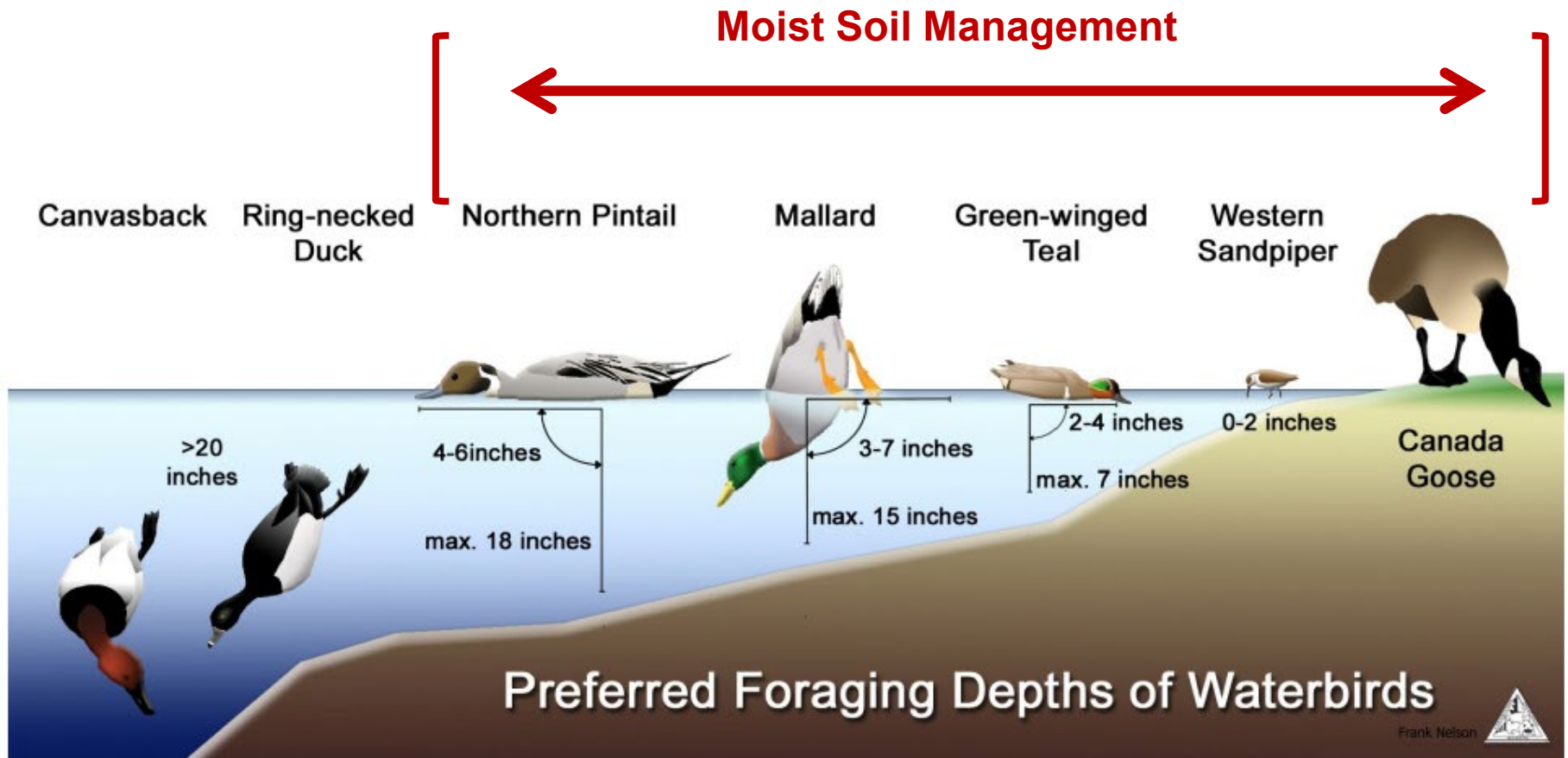


Bird Response

Credit: Chadd Smith USFWS

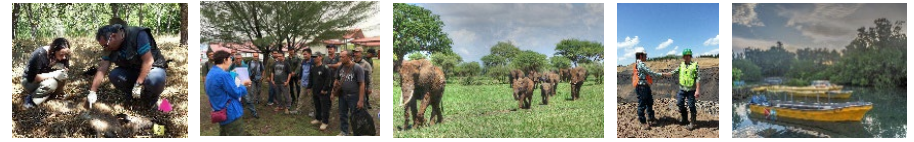


Moist Soil Management Applied for a Variety of Waterbirds





**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



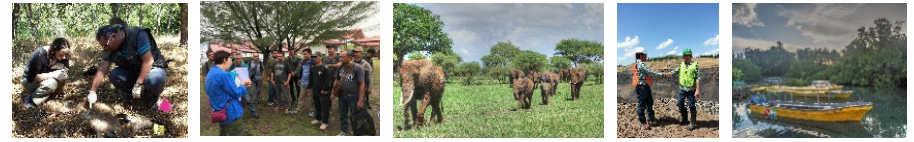
Ducks and Geese Alligator River NWR, NC



Credit: Kelley Van Druten USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



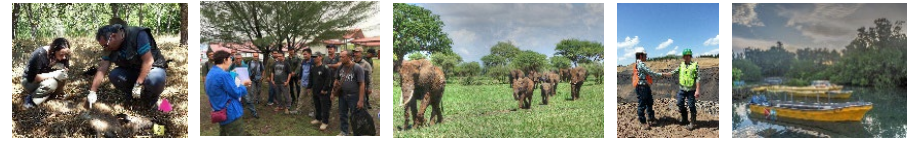
Shorebirds Chincoteague NWR, VA



Credit: Kevin Holcomb USFWS



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



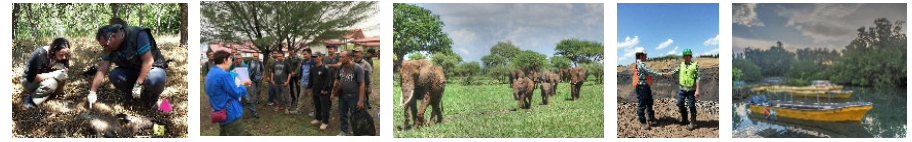
Sandhill Cranes Monte Vista NWR, CO



Credit: USFWS Mountain-Prairie Region



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

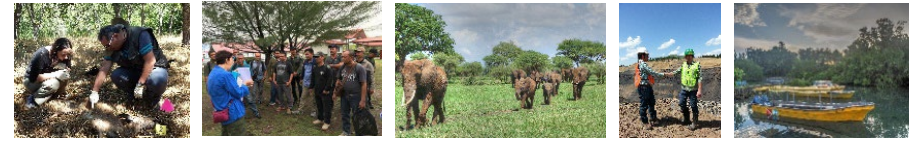


Management Strategies Benefiting Wetland Ecosystem Services

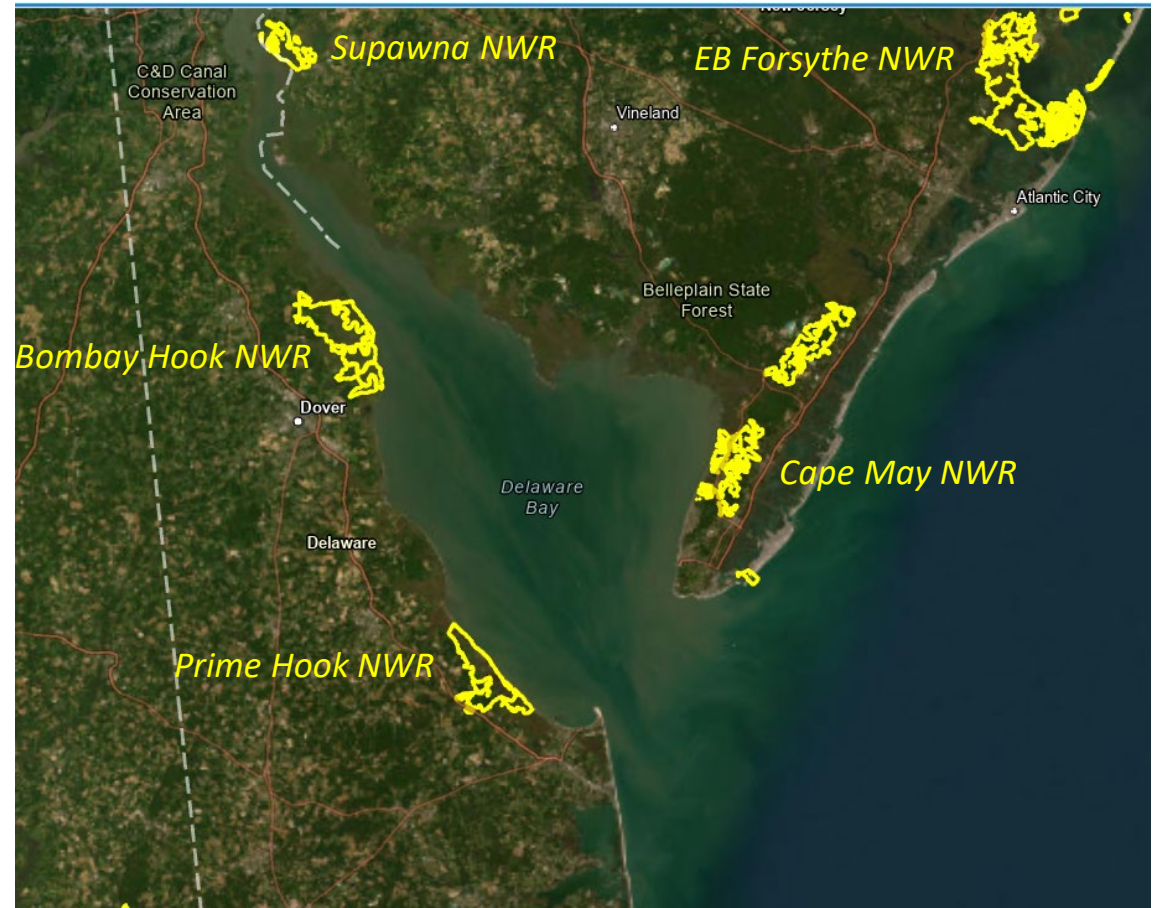
- Establish Protected Wetland Areas
- Adaptive Management of Protected Wetlands
- **Wetland Restoration using Nature Based Solutions**



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



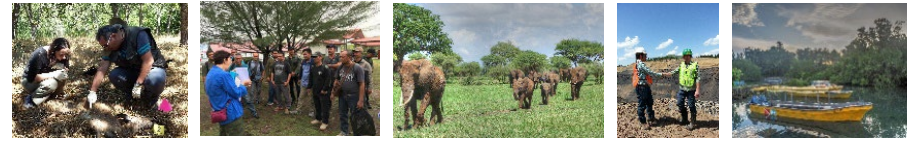
Wetland Restoration Example: Delaware Bay



Credit: Joseph Smith (USFWS) and Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



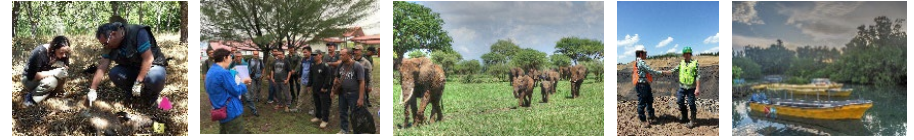
Wetland Restoration Example: Delaware Bay



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



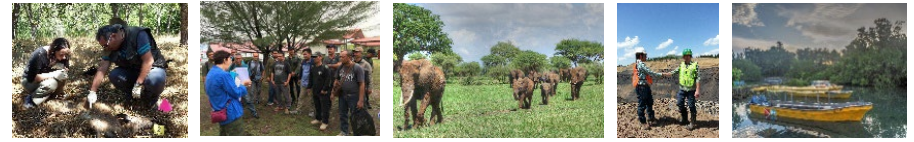
Wetland Restoration Example: Delaware Bay



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



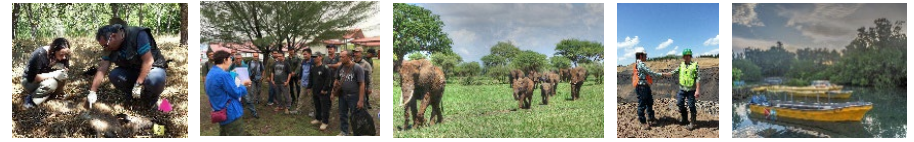
Wetland Restoration Example: Delaware Bay



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



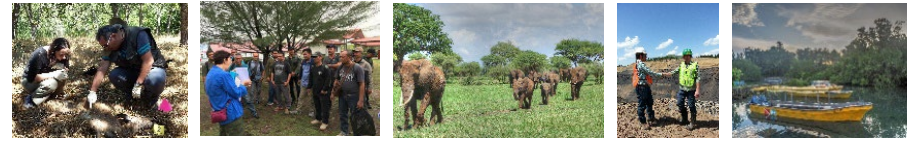
Wetland Restoration Example: Delaware Bay



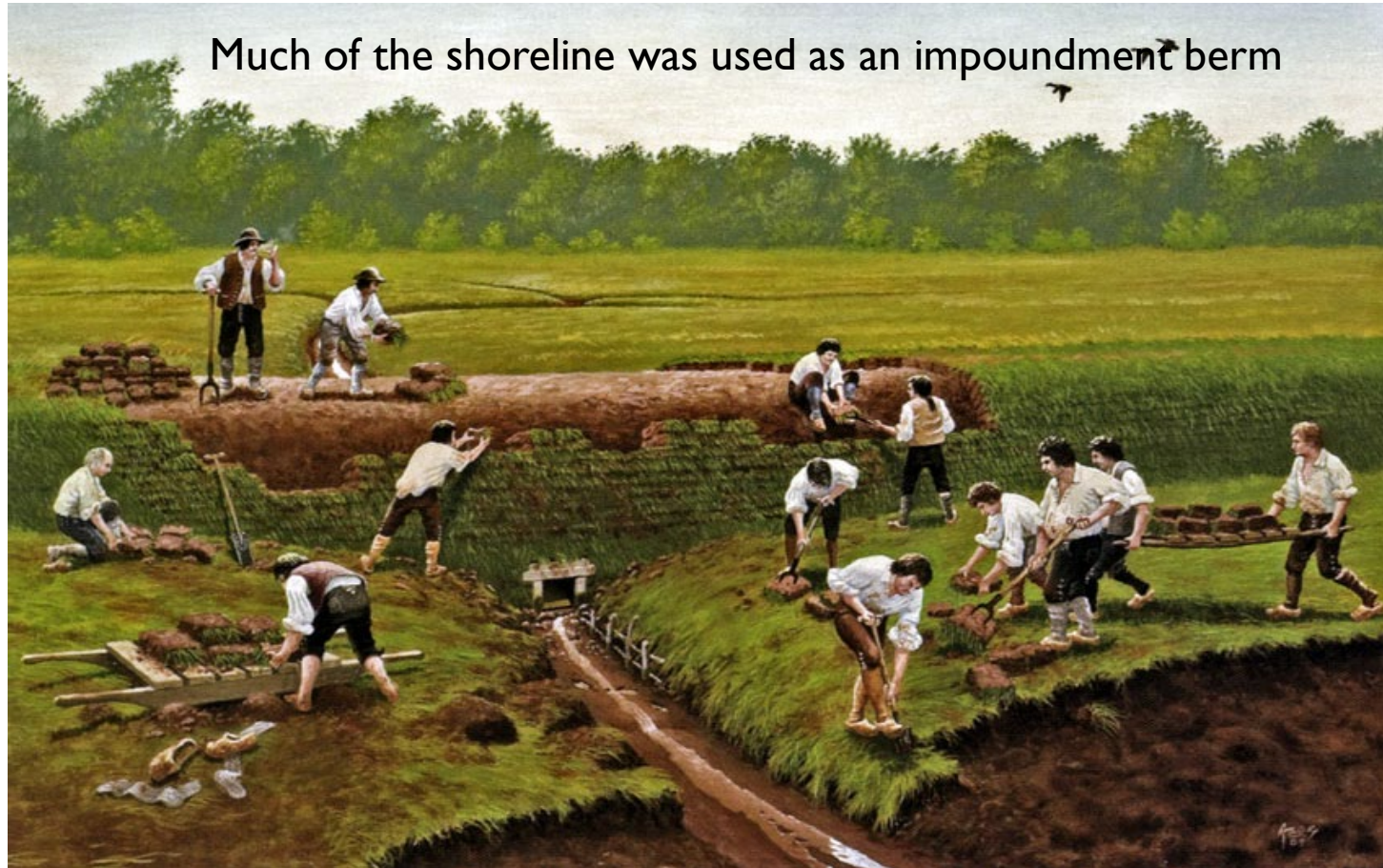
Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



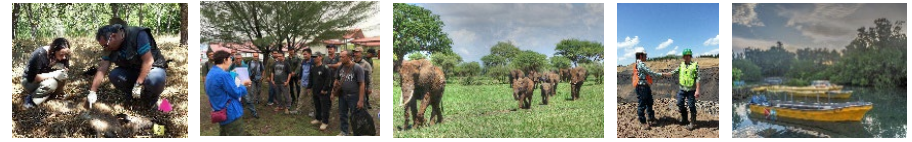
Disturbance to Delaware Bay Wetlands: Salt Hay Farming



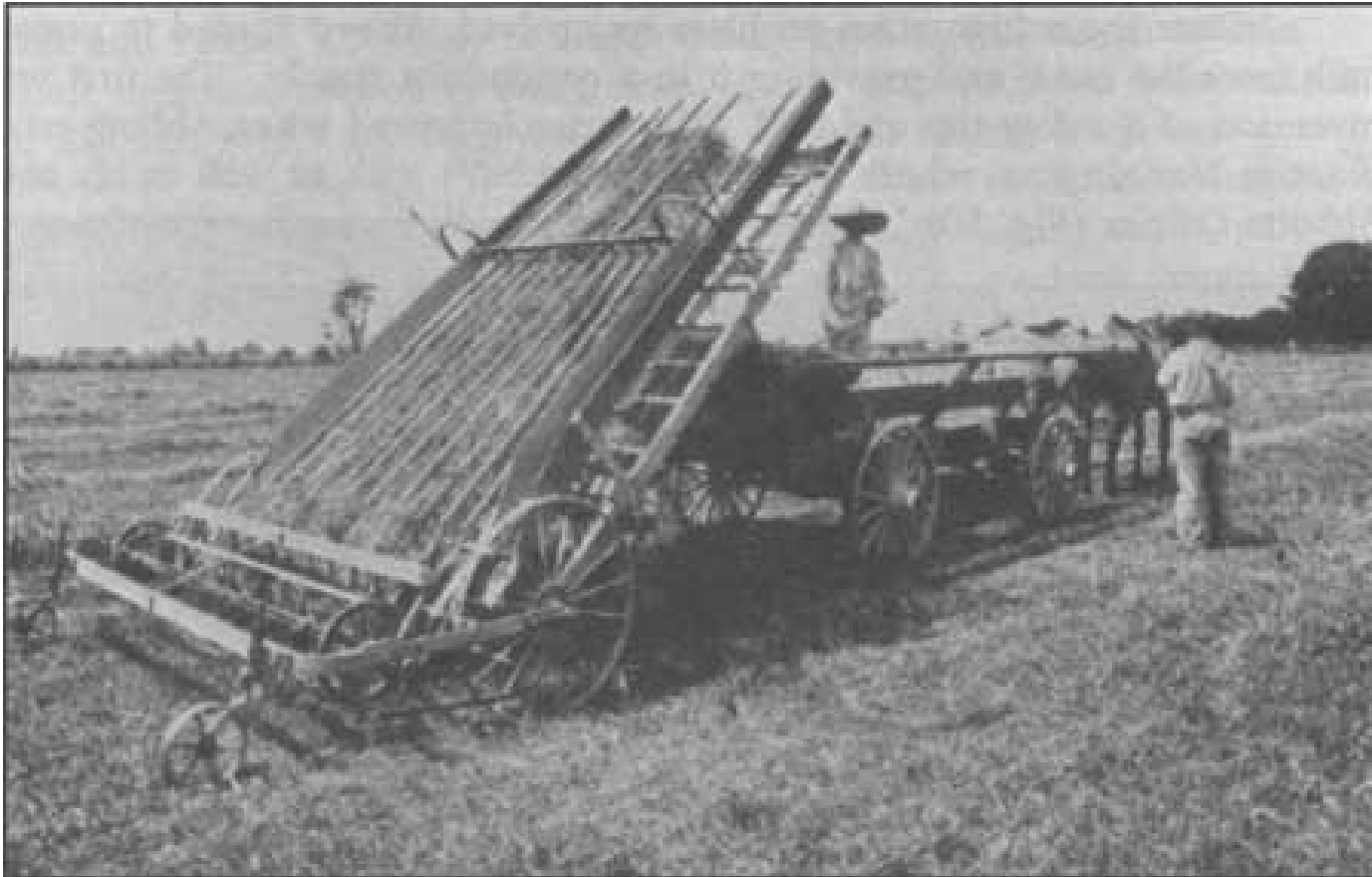
Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



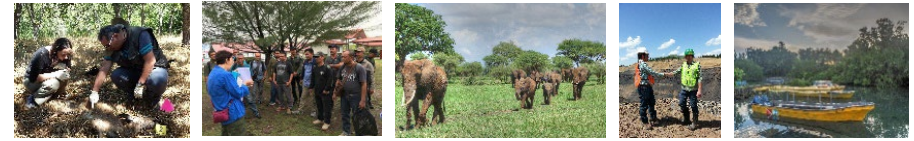
Disturbance to Delaware Bay Wetlands: Salt Hay Farming



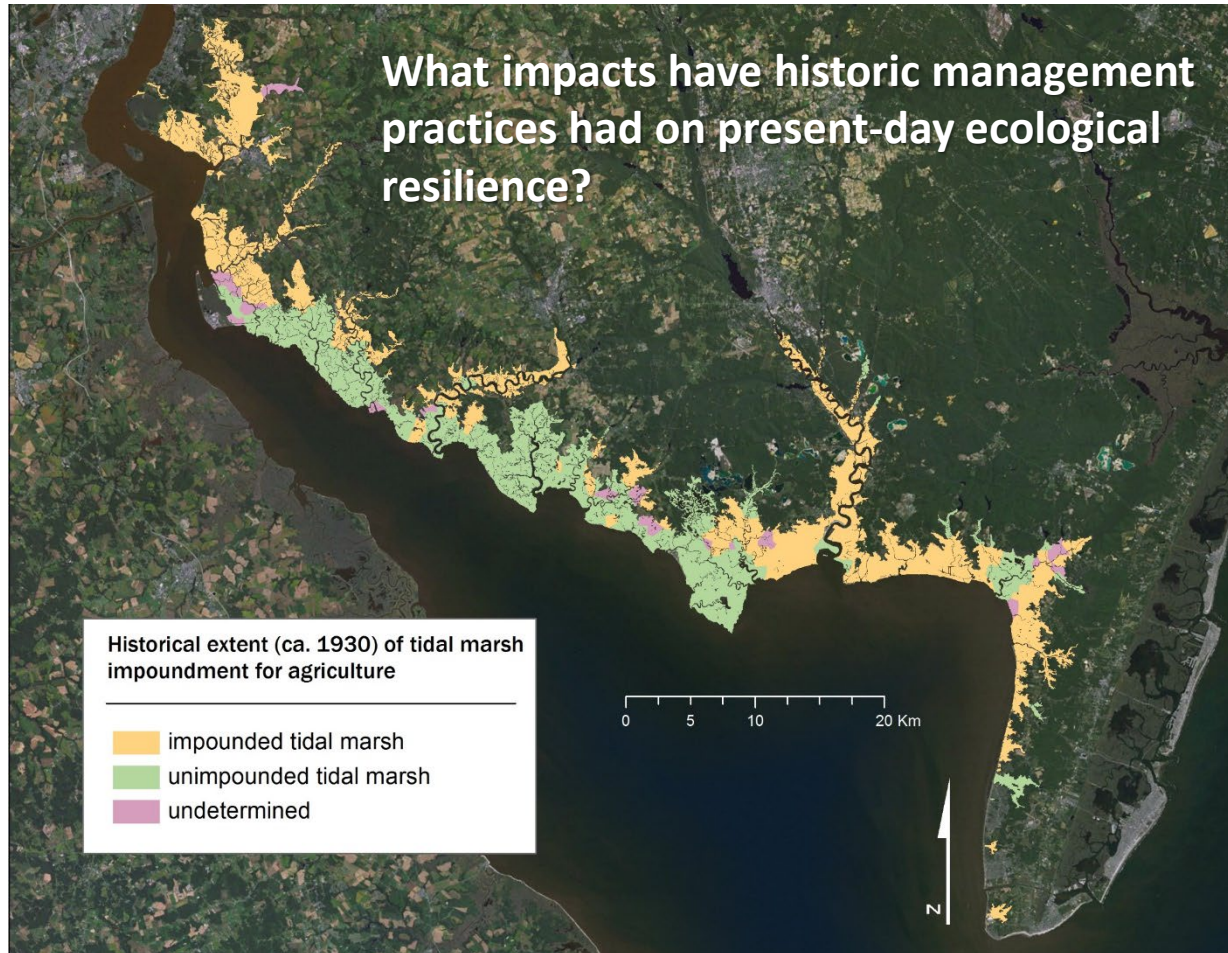
Credit: New Jersey Coastal Heritage Trail (U.S. National Park Service)



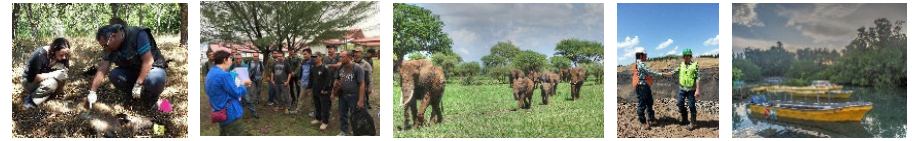
**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Disturbance to Delaware Bay Wetlands: Salt Hay Farming

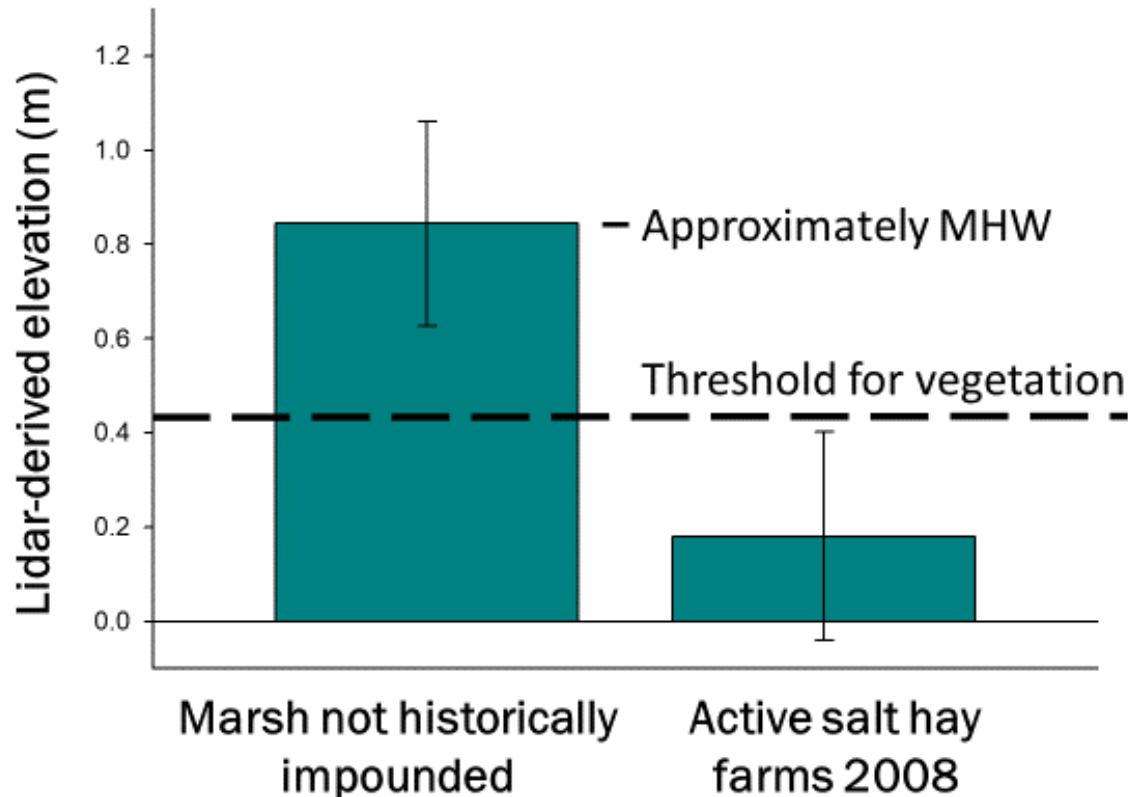


Credit: Joseph Smith (USFWS) & Larry Niles



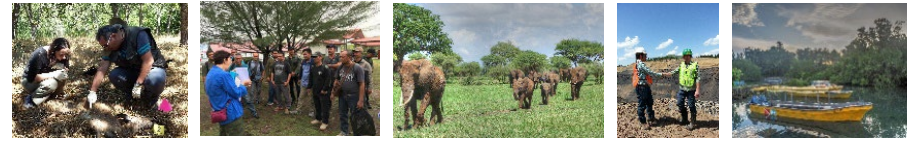
Disturbance to Delaware Bay Wetlands: Land Subsidence

FARMING IMPACTED ELEVATION

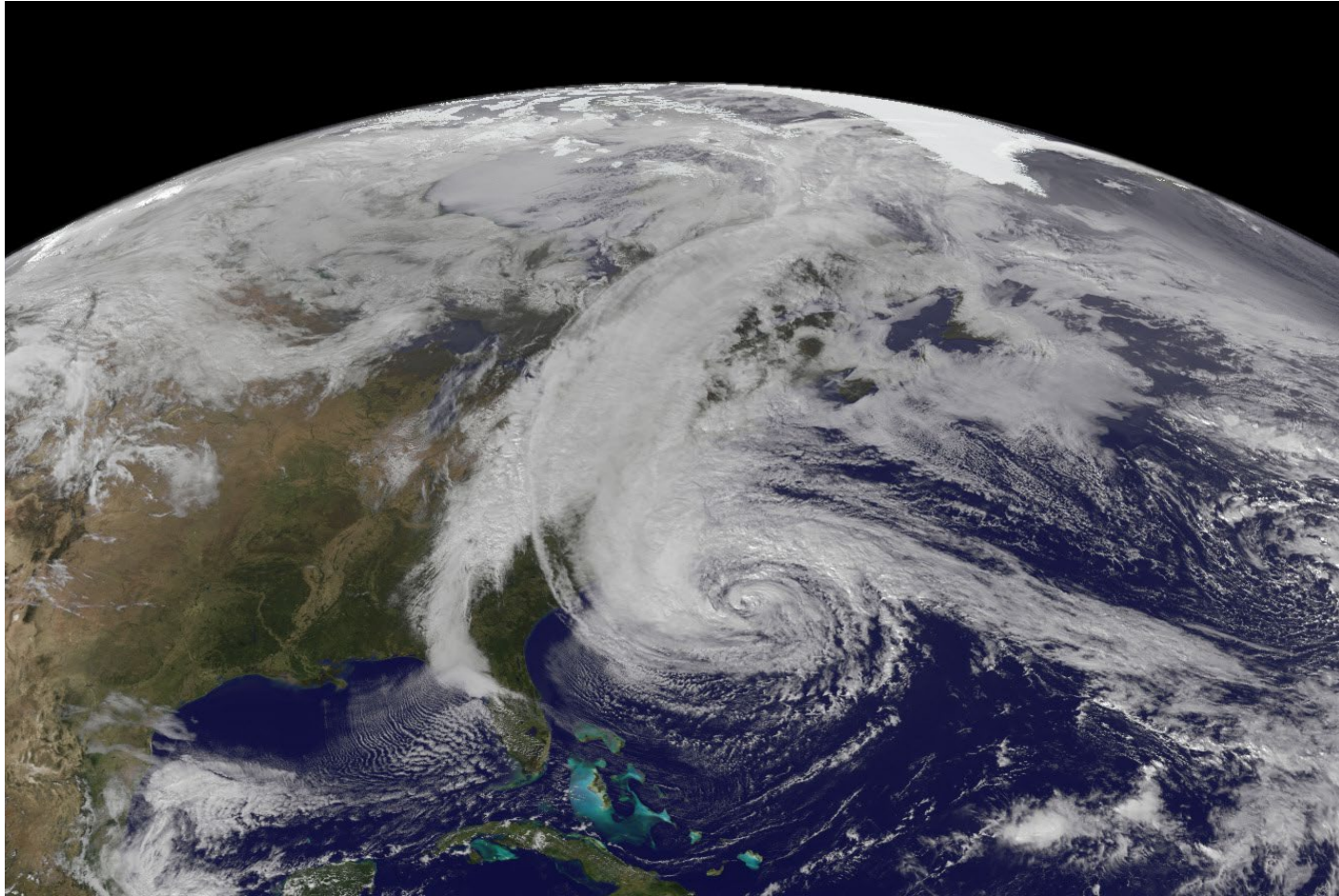




**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



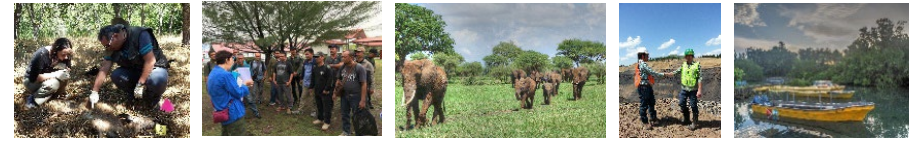
Disturbance to Delaware Bay Wetlands: Hurricane Sandy 2012



Credit: Joseph Smith (USFWS) & Larry Niles



U.S. DEPARTMENT
OF THE INTERIOR
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



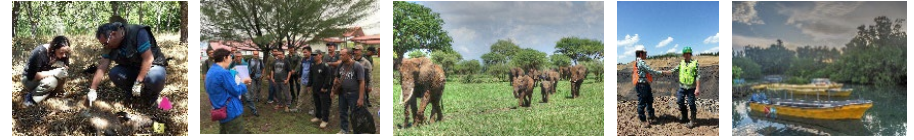
Wetland Restoration: Prime Hook NWR, Delaware



Credit: Bart Wilson (USFWS)



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



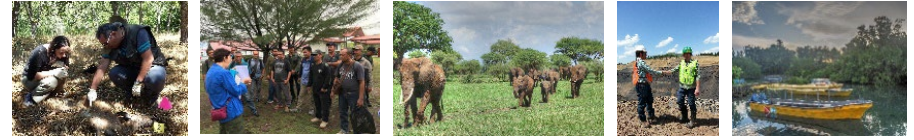
Wetland Restoration: Prime Hook NWR, Delaware



Credit: Bart Wilson (USFWS)



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



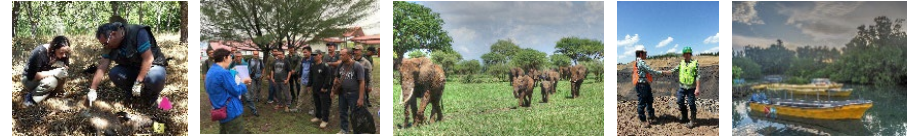
Wetland Restoration: Prime Hook NWR, Delaware



Credit: Bart Wilson (USFWS)



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Wetland Restoration: Prime Hook NWR, Delaware

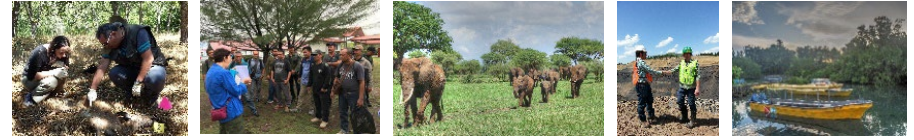
2019



Credit: Bart Wilson (USFWS)



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



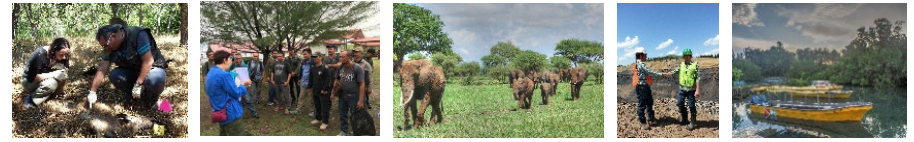
Beach Restoration: Cape May NWR, New Jersey



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



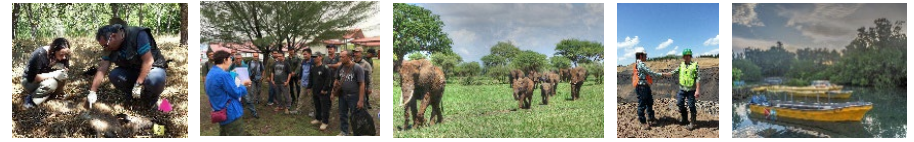
Beach Restoration: Cape May NWR, New Jersey



Credit: Dr. Joseph Smith (USFWS) & Dr. Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



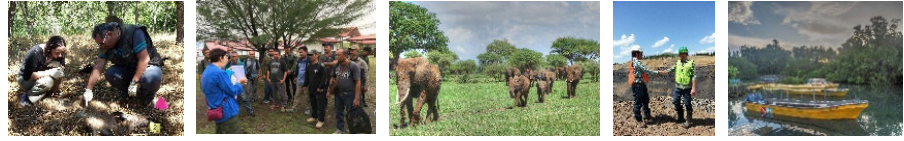
Beach Restoration: Beach Clean Up



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



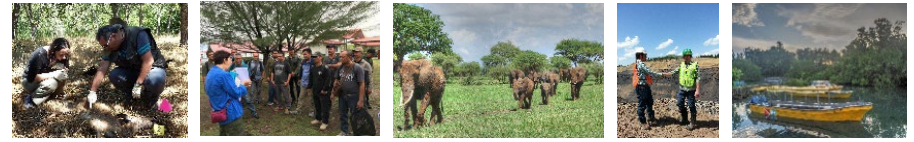
Beach Restoration: Sand Placement



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Beach Restoration: Before and After



South Reeds Beach before



Kimbles Beach before



Pierces Point before



South Reeds Beach after



Kimbles Beach after

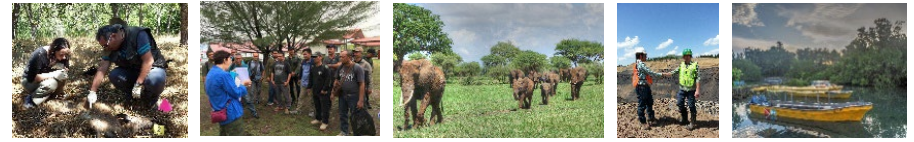


Pierces Point after

Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



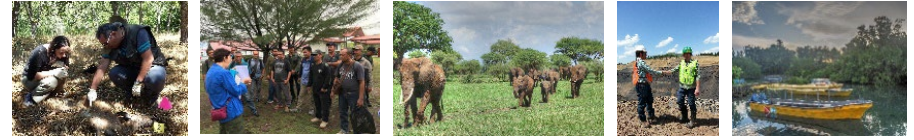
Beach Restoration: Measuring Success



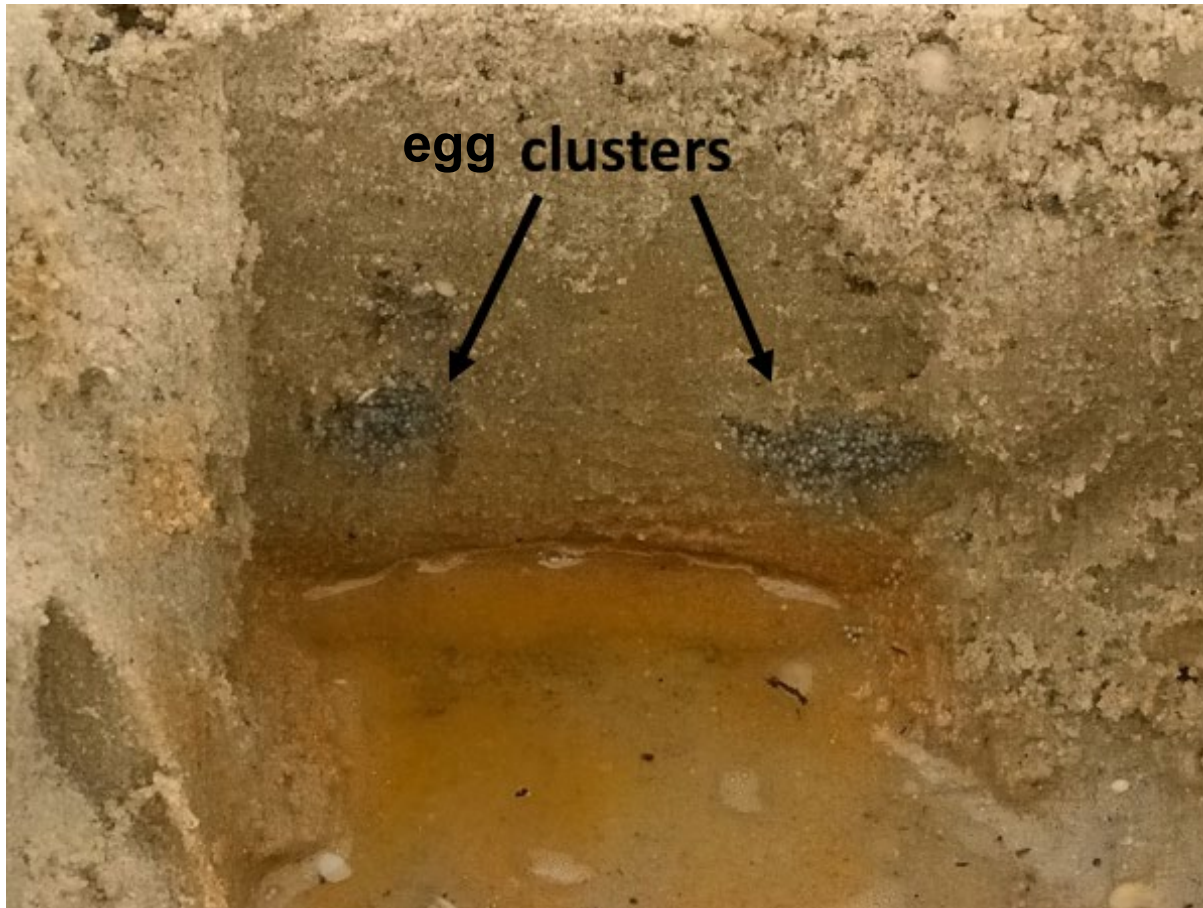
Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



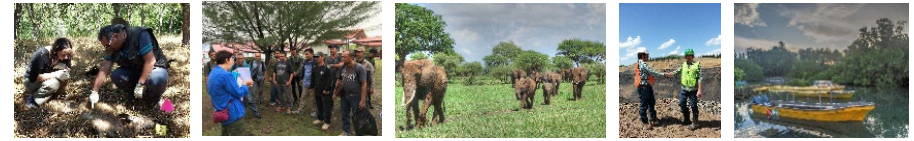
Beach Restoration: Measuring Success



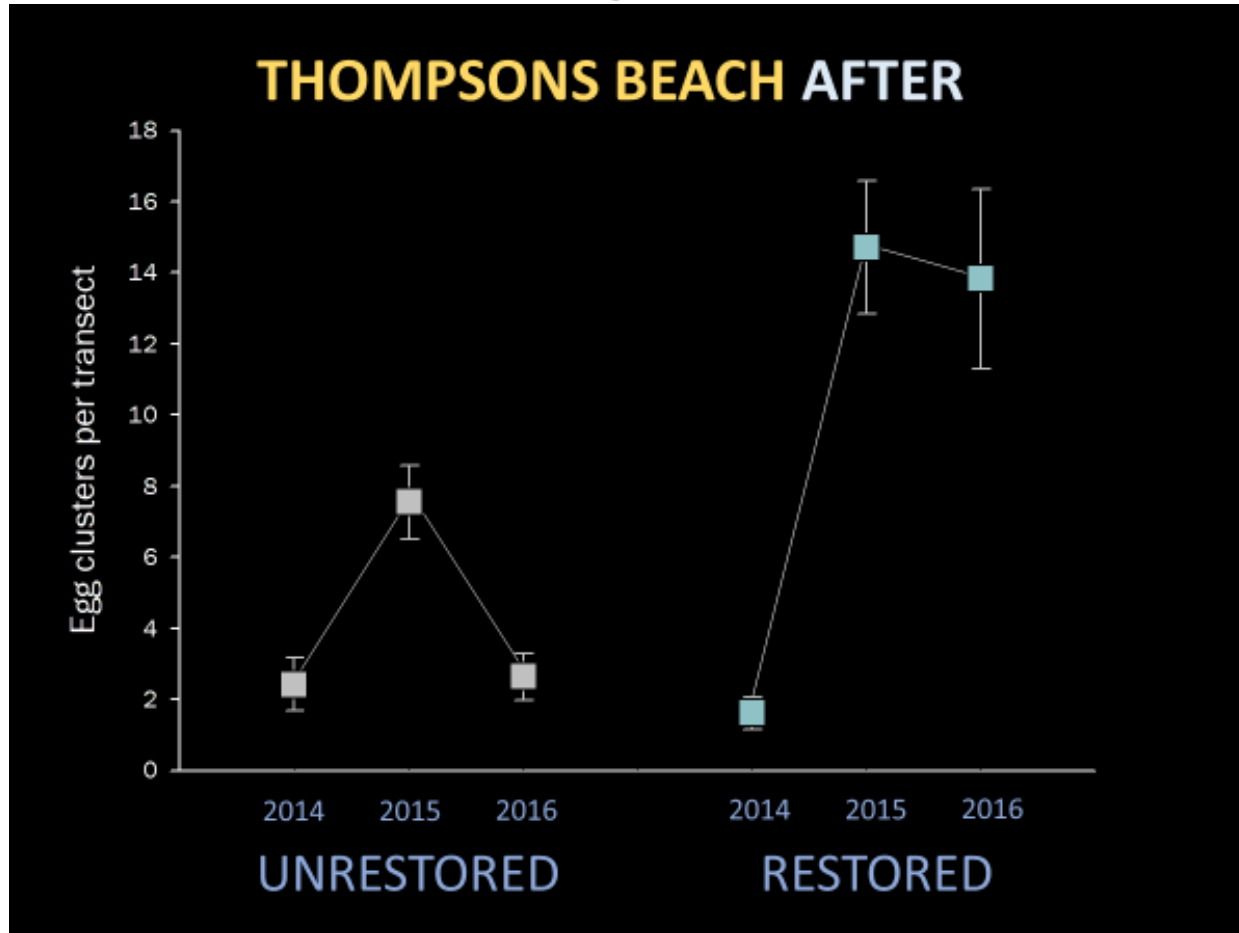
Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



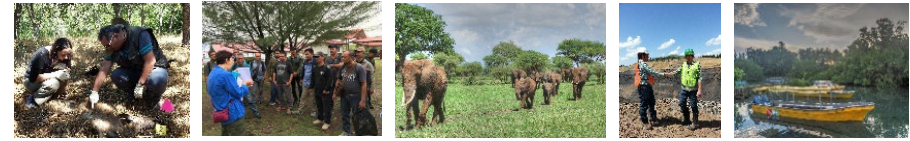
Beach Restoration: Measuring Success



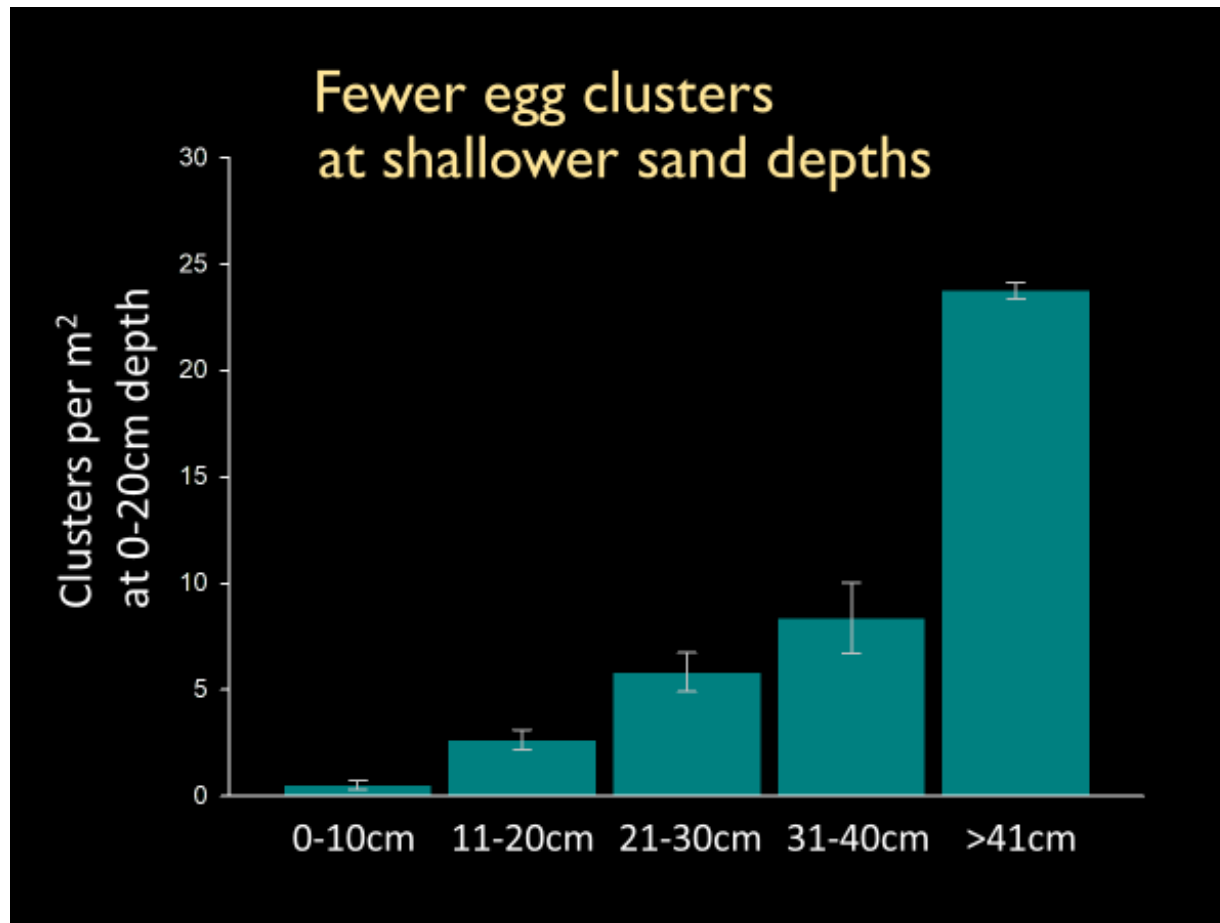
Credit: Joseph Smith (USFWS) & Larry Niles



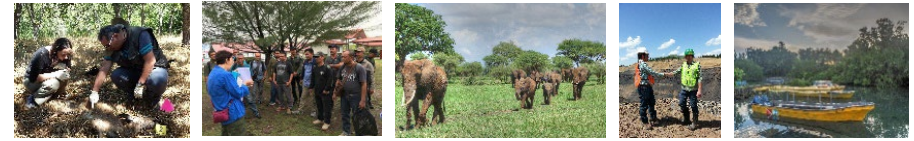
**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



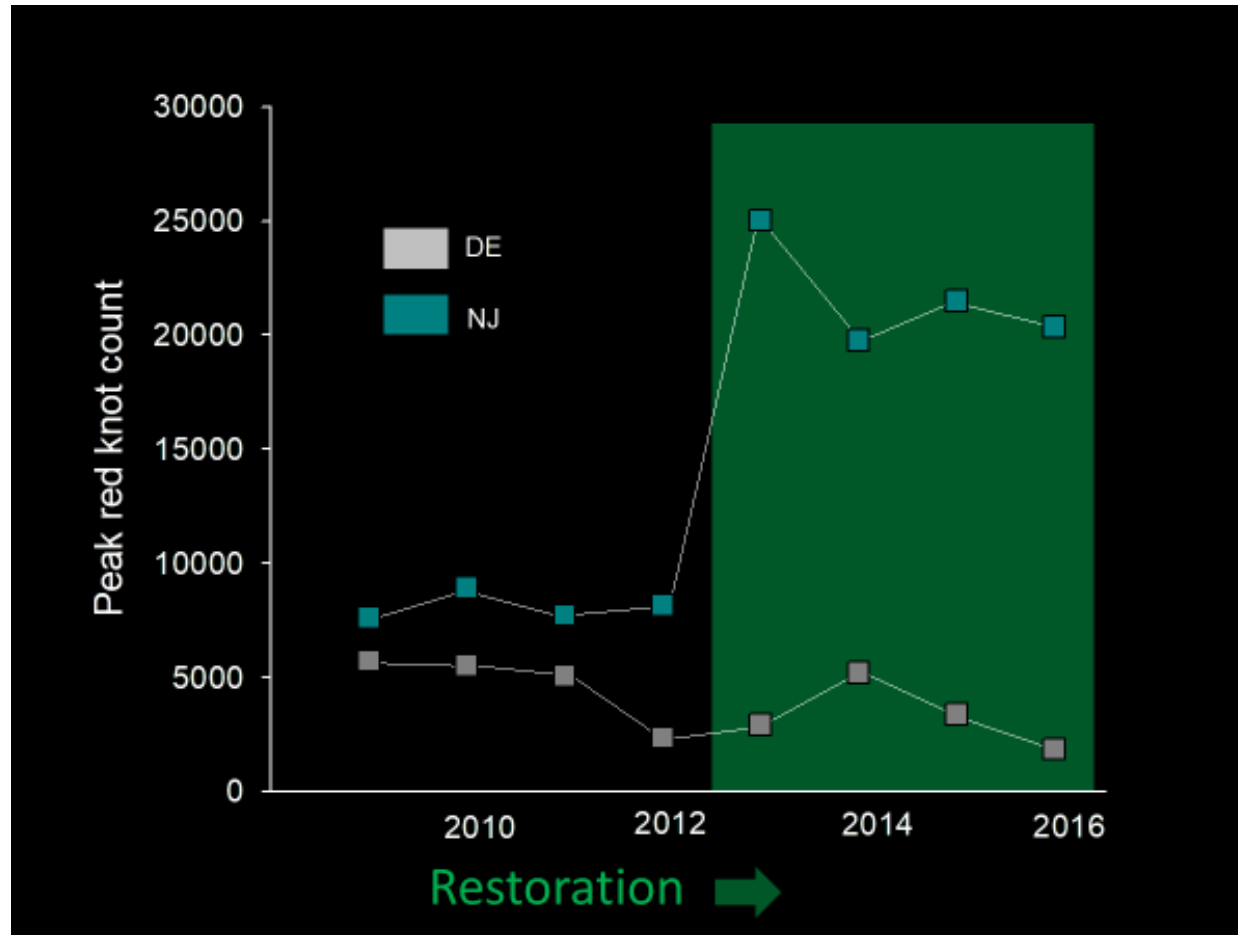
Beach Restoration: Measuring Success



Credit: Joseph Smith (USFWS) & Larry Niles

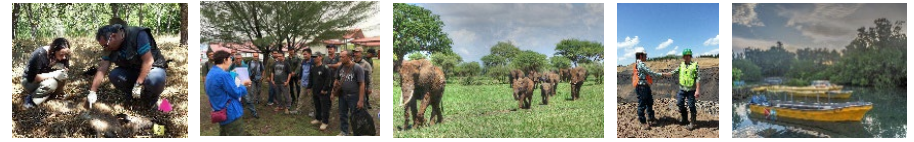


Beach Restoration: Measuring Success





**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



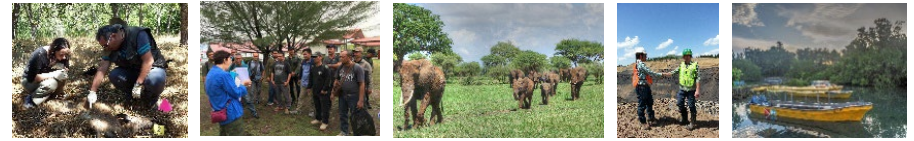
Beach Restoration: Cape May NWR, New Jersey



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



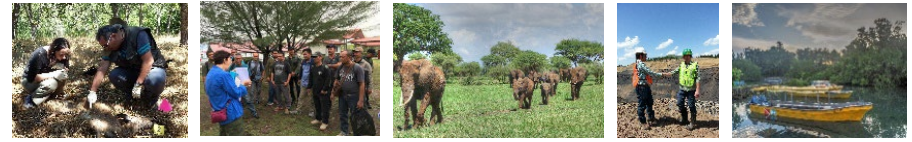
Beach Restoration: Cape May NWR, New Jersey



Credit: Joseph Smith (USFWS) & Larry Niles



**U.S. DEPARTMENT
OF THE INTERIOR**
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM



Management Strategies Benefiting Wetland Ecosystem Services

- **Establish Protected Wetland Areas**
- **Adaptive Management of Protected Wetlands**
- **Wetland Restoration using Nature Based Solutions**



U.S. DEPARTMENT
OF THE INTERIOR
INTERNATIONAL TECHNICAL
ASSISTANCE PROGRAM

THANK YOU

Fred Wurster
Hydrologist
U.S. Fish and Wildlife Service
fred_wurster@fws.gov

Joseph Smith, PhD
Wildlife Biologist
E.B. Forsythe NWR, New Jersey
joseph_smith@fws.gov

Larry Niles, PhD
[American Littoral Society](#)

Chadd Smith
Engineering Equipment Operator
Ridgefield NWR, Washington

Bart Wilson, PhD
Geomorphologist
U.S. Fish and Wildlife Service

Kevin Holcomb
Wildlife Biologist
Chincoteague NWR, Virginia

Kelley Van Druten
Wildlife Biologist
Coastal North Carolina Refuge Complex

Disclaimer: The views expressed on this document are those of the author/s and do not necessarily reflect the views and policies of the Asian Development Bank (ADB) or its Board of Governors or the governments they represent. ADB does not guarantee the accuracy of the data included in this publication and accepts no responsibility for any consequence of their use. By making any designation of or reference to a particular territory or geographic area, or by using the term "country" in this document, ADB does not intend to make any judgments as to the legal or other status of any territory or area.