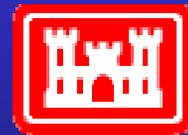


Wetland Functions and Design Strategy

**U.S. Section, PIANC Technical Workshops on
Passing Vessel Issues and Wetland Restoration**



**Portland, Oregon
October 28 - 30, 2003**



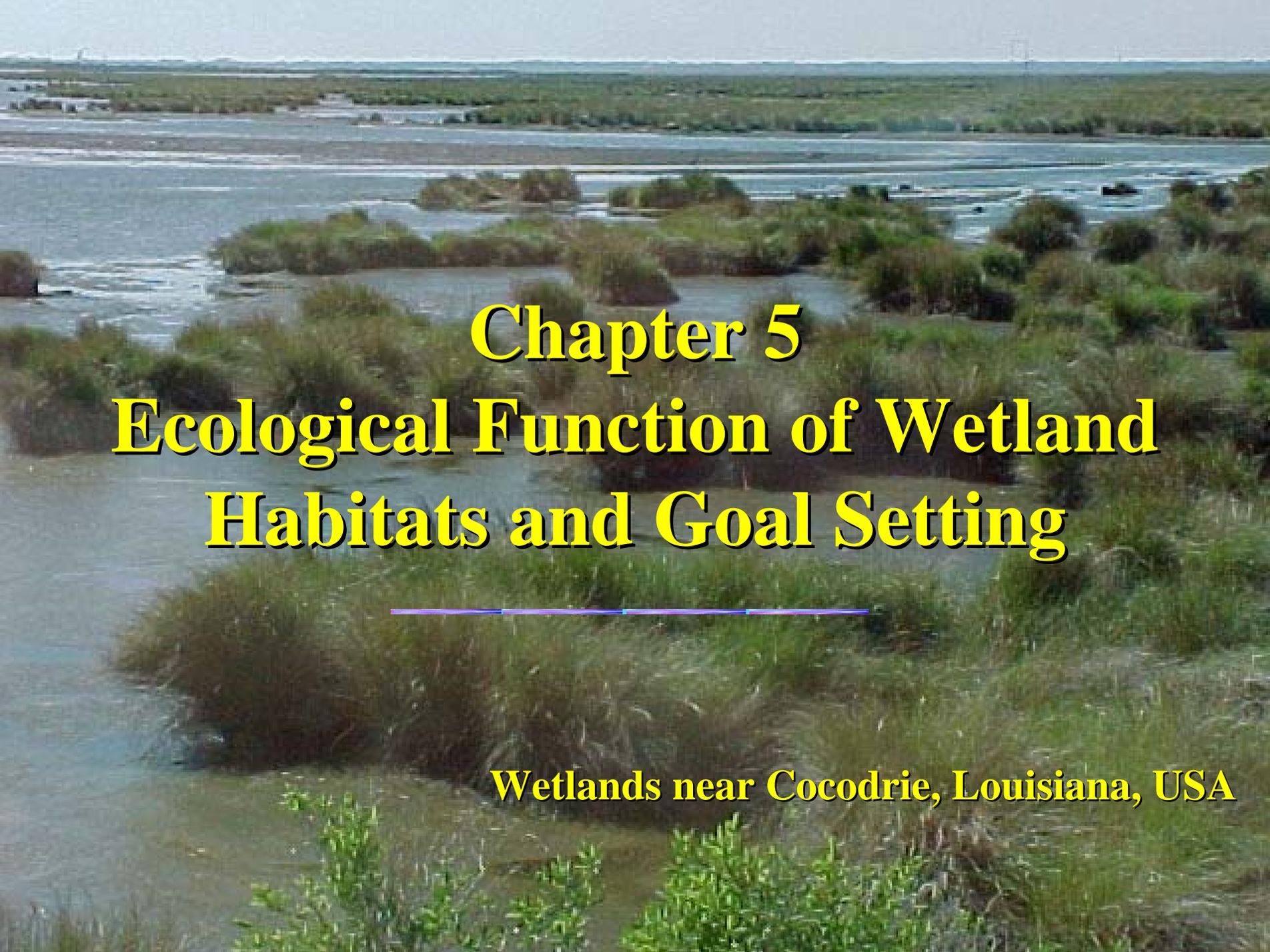
**US Army Corps
of Engineers ®**

Wetland Functions and Design Strategy



- **Based on EnviCom WG 7 Report:**

**“Ecological and Engineering Guidelines for
Wetlands Restoration in Relation to the
Development Operation and Maintenance of
Navigation Infrastructure”**

A wide-angle photograph of a wetland landscape. The foreground is dominated by dense, green marsh vegetation, including tall grasses and shrubs. In the middle ground, a large body of water, likely a bayou or marsh, stretches across the frame, with several small, vegetated islands or peninsulas protruding from it. The water appears calm with some ripples. In the far distance, a flat horizon line is visible under a clear, light blue sky. A few power lines and towers are faintly visible on the horizon. The overall scene depicts a natural, undisturbed wetland environment.

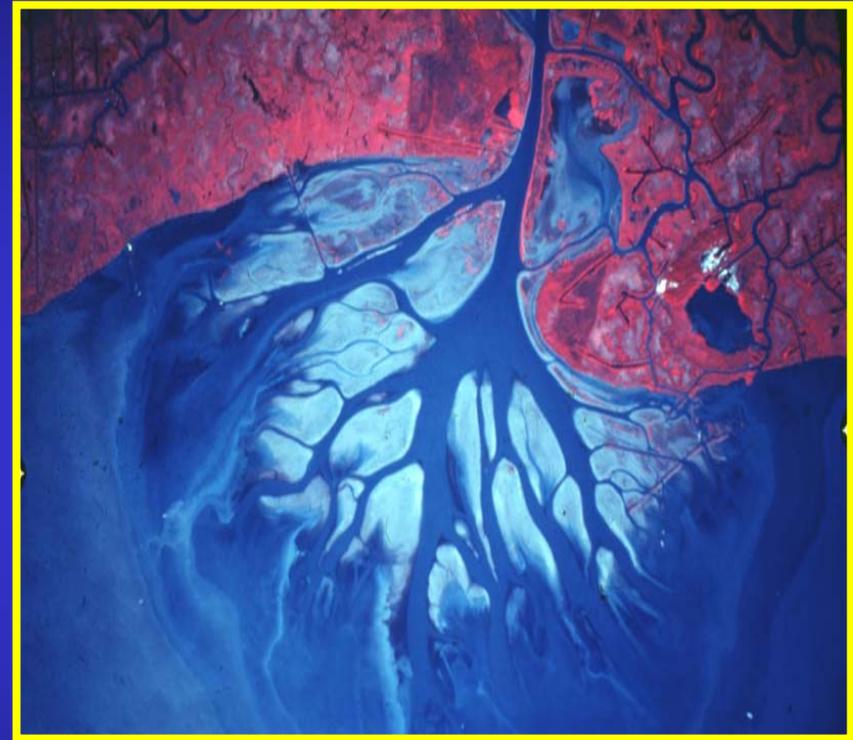
Chapter 5

Ecological Function of Wetland Habitats and Goal Setting

Wetlands near Cocodrie, Louisiana, USA

Wetlands

- **Transitional areas between terrestrial and fully aquatic ecosystems**
- **Marine or fresh water**



**Wax Lake Outlet,
Louisiana**

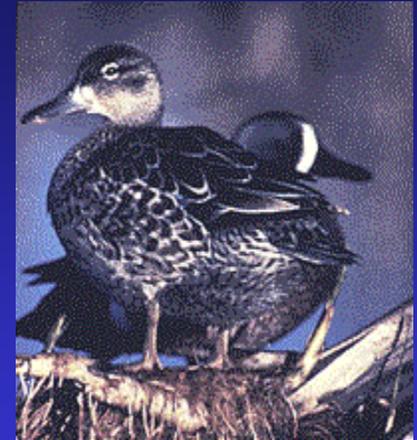
Ecological Functions

- **Indicate relationships between habitats and species**
- **Valuation of ecological functions**
 - **Uniqueness and significance**
 - **Presence of rare species**
 - **Contribution to biodiversity**
 - **Provision of habitat for wildlife**



Ecological Community

- **Structure**
 - Number of species
 - Number of individuals
 - Size
 - Distribution
- **Function - rate of individual growth (productivity) and trophic status**



Ecological Network

- **Supports dynamic processes occurring at systems scale**
- **Overarches and connects many specific wetland sites**
- **Significance of each site:**
 - **Setting in ecological network**
 - **Position in life cycle of species**
 - **Food web support**
 - **Breeding and maternity grounds for fauna**
 - **Contribution to climatic stability, particularly rainfall and temperature**

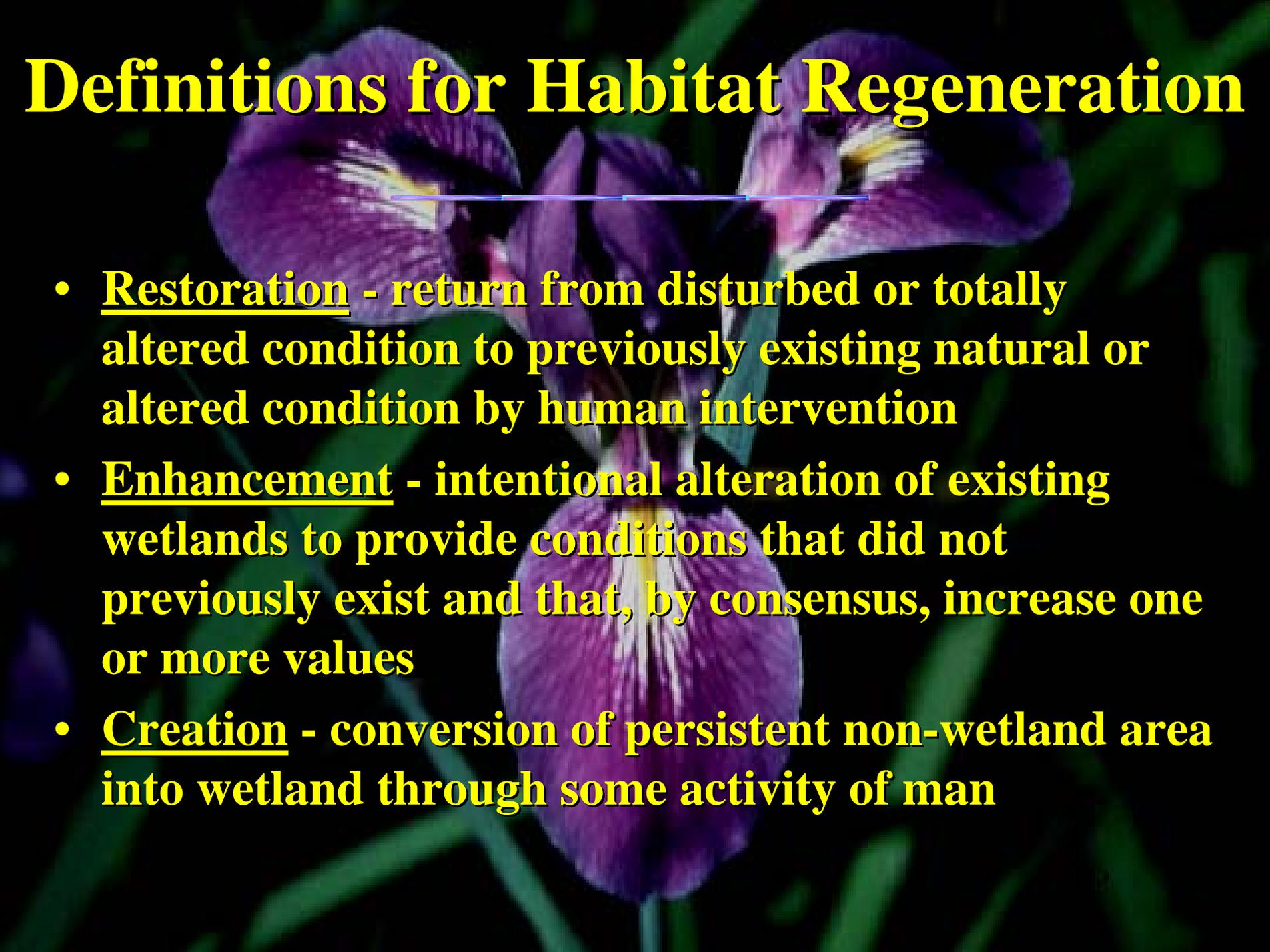


Mississippi Flyway, USA

Functions and Values

- **Ecological function**
 - Defined by dynamic physical, biological, and chemical processes that support overall structure
 - Manifested as habitat for flora and fauna
 - Greater biodiversity = greater functionality
- **Characterizes need for sustainable project planning and implementation**
 - Maintain ecosystem balance
 - Operational cost minimization
- **Wetland 'value' - judged in terms of end user needs**
- **Establish functions and values with participants**

Definitions for Habitat Regeneration

The background of the slide features a close-up photograph of several purple iris flowers. The petals are a vibrant purple with some white and yellow variegation. The flowers are set against a dark, blurred background of green leaves and stems. A thin, horizontal blue line is drawn across the middle of the image, passing behind the text.

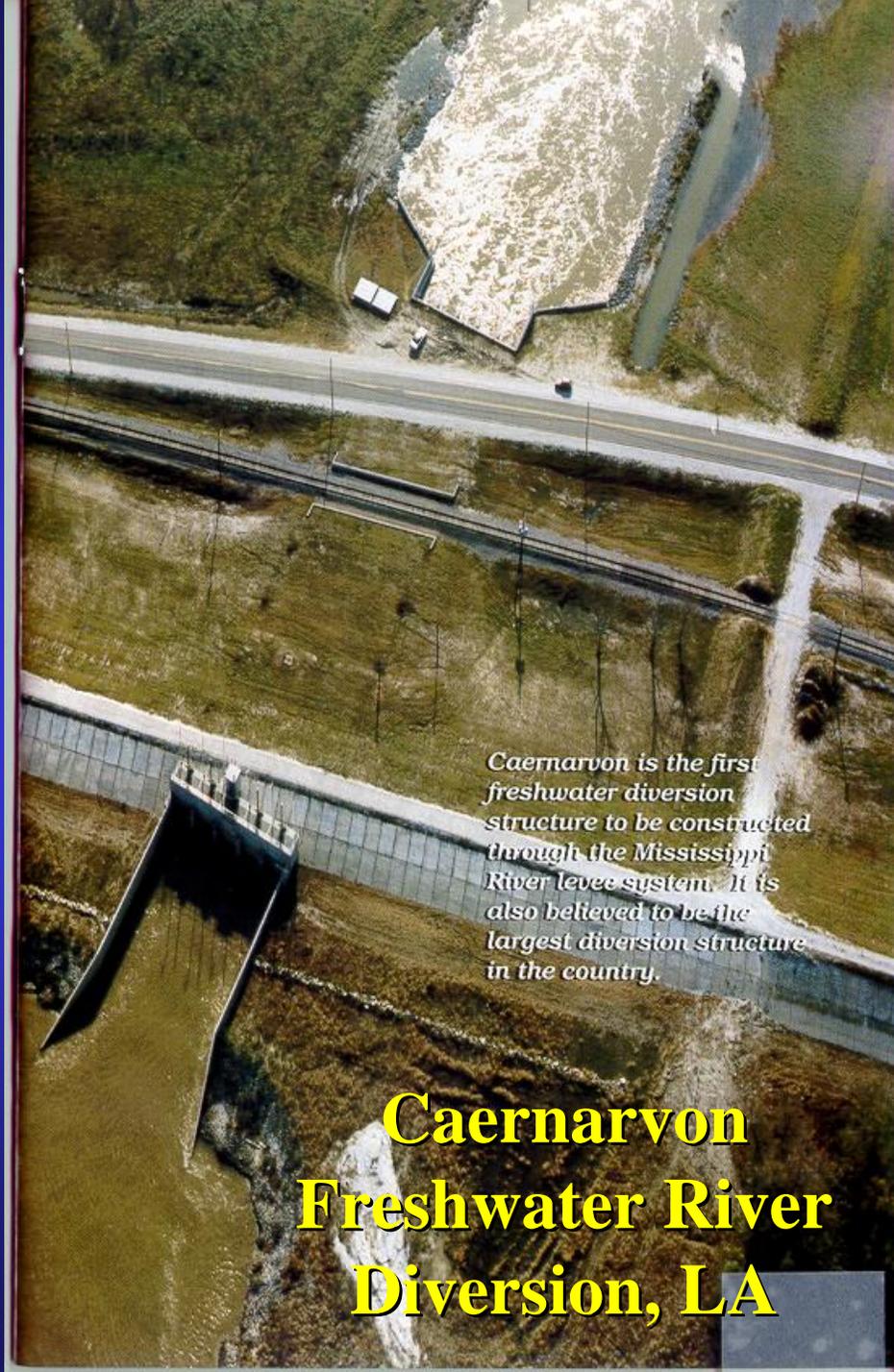
- **Restoration** - return from disturbed or totally altered condition to previously existing natural or altered condition by human intervention
- **Enhancement** - intentional alteration of existing wetlands to provide conditions that did not previously exist and that, by consensus, increase one or more values
- **Creation** - conversion of persistent non-wetland area into wetland through some activity of man

Wetland Regeneration Measures

- **Vegetative plantings**
- **Bankline/shoreline protection**
- **Beneficial use of dredged materials**
 - **Wetland creation**
 - **Barrier island restoration**
 - **Tidal flats**
- **Estuarine hydrologic restoration**
 - **Re-establishment of system interconnectivity**
 - **Maintenance of water levels/quality**
- **River diversion**
 - **Freshwater**
 - **Sediments**
 - **Nutrients**

Habitat Regeneration Costs

- Major costs
 - Initial modification
 - Level of management to sustain
- Costs are function of degree nature supports change



Caernarvon is the first freshwater diversion structure to be constructed through the Mississippi River levee system. It is also believed to be the largest diversion structure in the country.

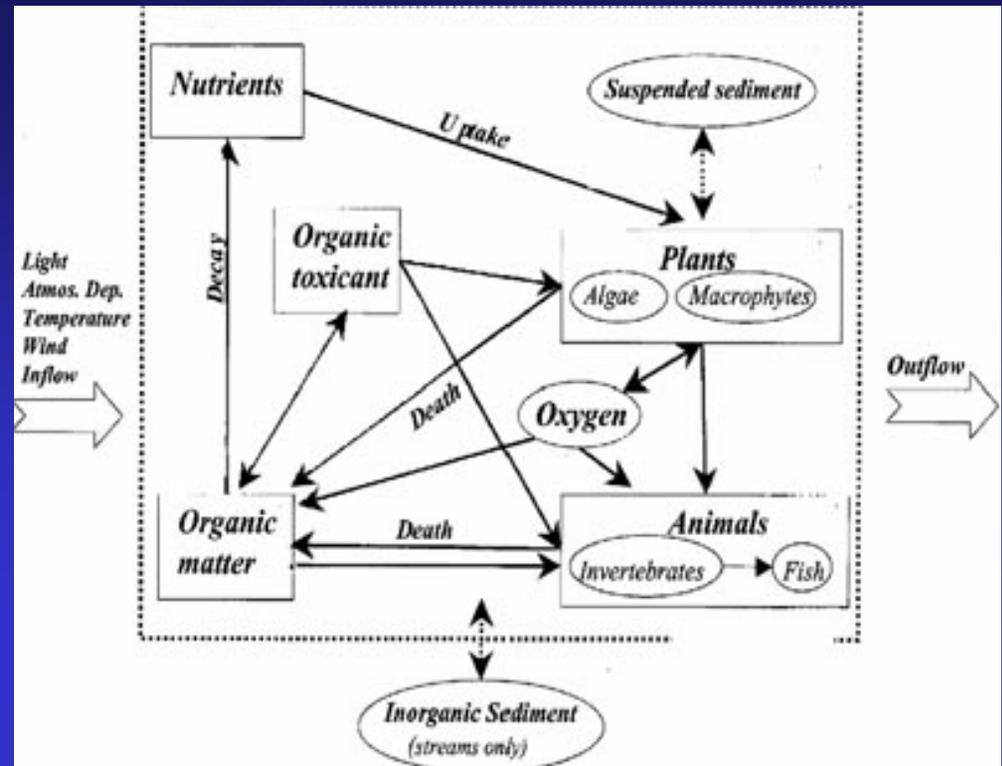
**Caernarvon
Freshwater River
Diversion, LA**

End User Functional Values

- **Varying user expectations of performance depending on intended use**
- **Ex: Inter-tidal habitat:**
 - **May provide feeding areas for wading birds**
 - **Different from that for erosion and flood protection**
- **Internat'l standardization**
 - **Hydrological – natural water control**
 - **Water quality improvement – natural water cleansing**
 - **Bio-habitat – flora and fauna production**
 - **Social/recreational – human dimension**



Planning Wetland Regeneration



- **Need understanding of:**
 - food web dynamics and trophic interactions
 - physical and chemical processes of structure and function of the biological community
- **Steering parameters should be identified**

Regeneration Best Practices



**Estuarine hydrologic
restoration**

- Focus on replacing lost or degraded ecological functions
- Habitat diversity in landscape design
- Minimize development in regeneration perimeter
- Use all aspects of habitat for wildlife use
- Plan at systems scale to avoid adverse impacts

Multi-objective Considerations

- Sustainable navigation project planning in balance with nature
- Social and recreational value



Mississippi River Gulf Outlet,
Louisiana, South Bank
Foreshore Protection

Mississippi River Gulf Outlet,
Louisiana, North Bank
Foreshore Protection

Habitat Structure and Functional Processes

- **Difficult to duplicate nature exactly**
- **Expect dynamic responses:**
 - biological (biotic) changes
 - environmental (abiotic) influences
- **Examine community and population responses**
- **Identify key factors affecting community structuring**

**Ex: Correct elevation, gradient,
wave exposure, and particle size
distribution**



**Attract
communities on
open coast**

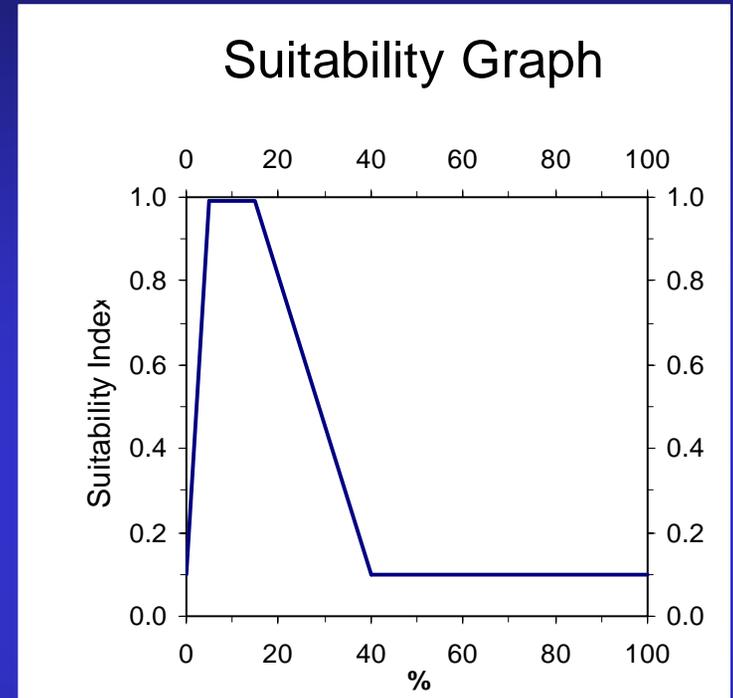
Breton Island, Louisiana

Ecological Sustainability

- **Project design**
 - Usually focuses on recreating historical conditions
 - Alternatively, may aim to optimize habitat conditions for as many species as possible, considering land limitations
- **Restoration close to original conditions**
 - Generally raises prospect of ecological success
 - Minimizes life cycle cost
- **Field investigations of existing conditions**
 - Reference sites – direct information of what should exist
 - Remnant plots – example of what presently exists
 - Historical context – indirect information of what once existed

Ecological Modeling

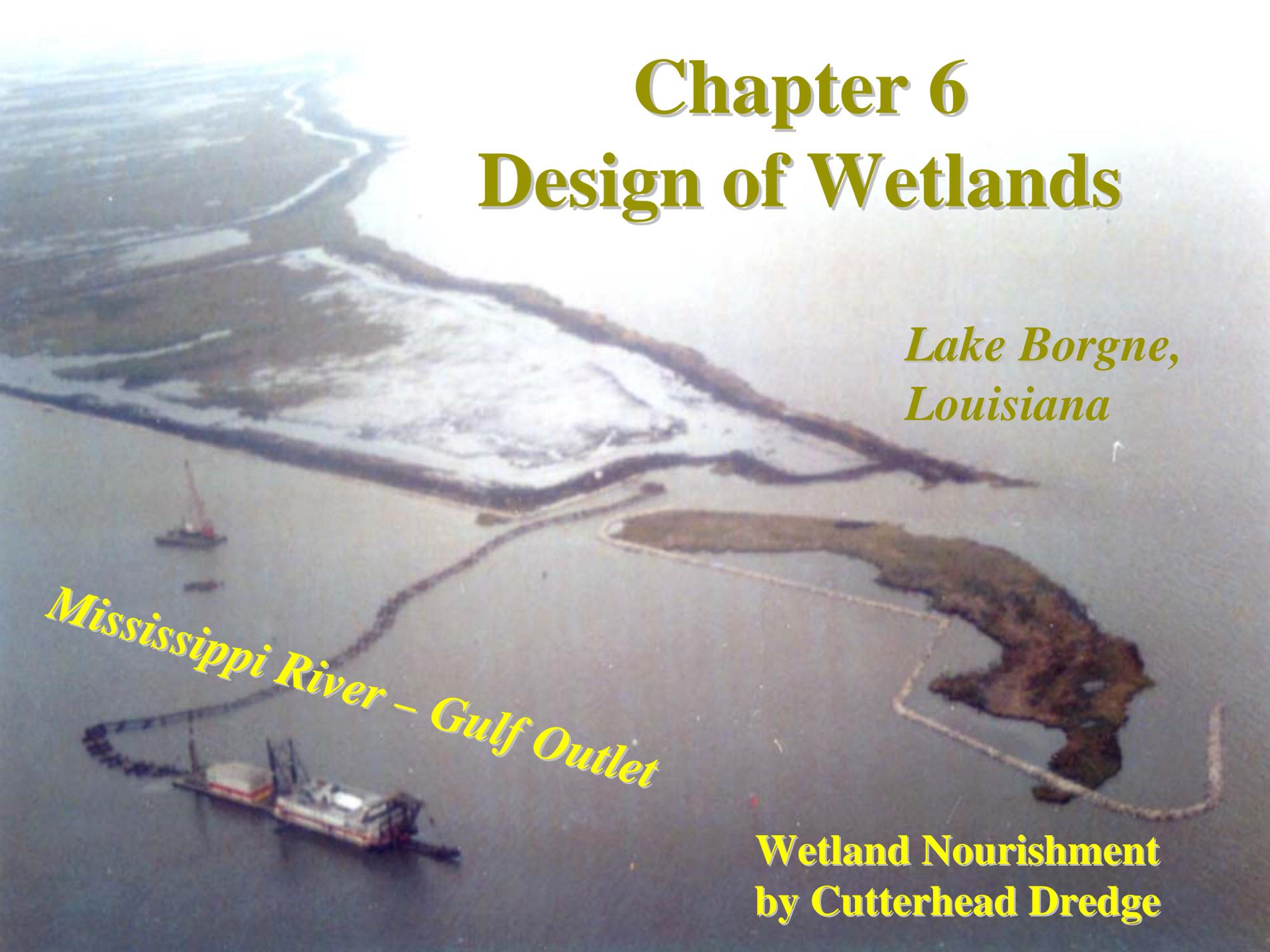
- **Ecosystem model structure**
 - Hydrology
 - Topography
 - Weather
- **Model results**
 - Existing conditions
 - Predicted future conditions
- **Community model considerations**
 - Flora
 - Fauna



Percent of total sub-aerial zone classified as dune habitat, Barrier Island Value Assessment Louisiana

Ecological Summary

- **Ecological function vs. user value?**
- **Find realistic compromise based on sustainability**
- **Quantify functional relationships**
 - Land and water
 - Flora and fauna
- **Monitor conditions**
- **Adapt as necessary to optimize habitat**
- **Establish and follow best management practices**



Chapter 6

Design of Wetlands

*Lake Borgne,
Louisiana*

Mississippi River – Gulf Outlet

**Wetland Nourishment
by Cutterhead Dredge**

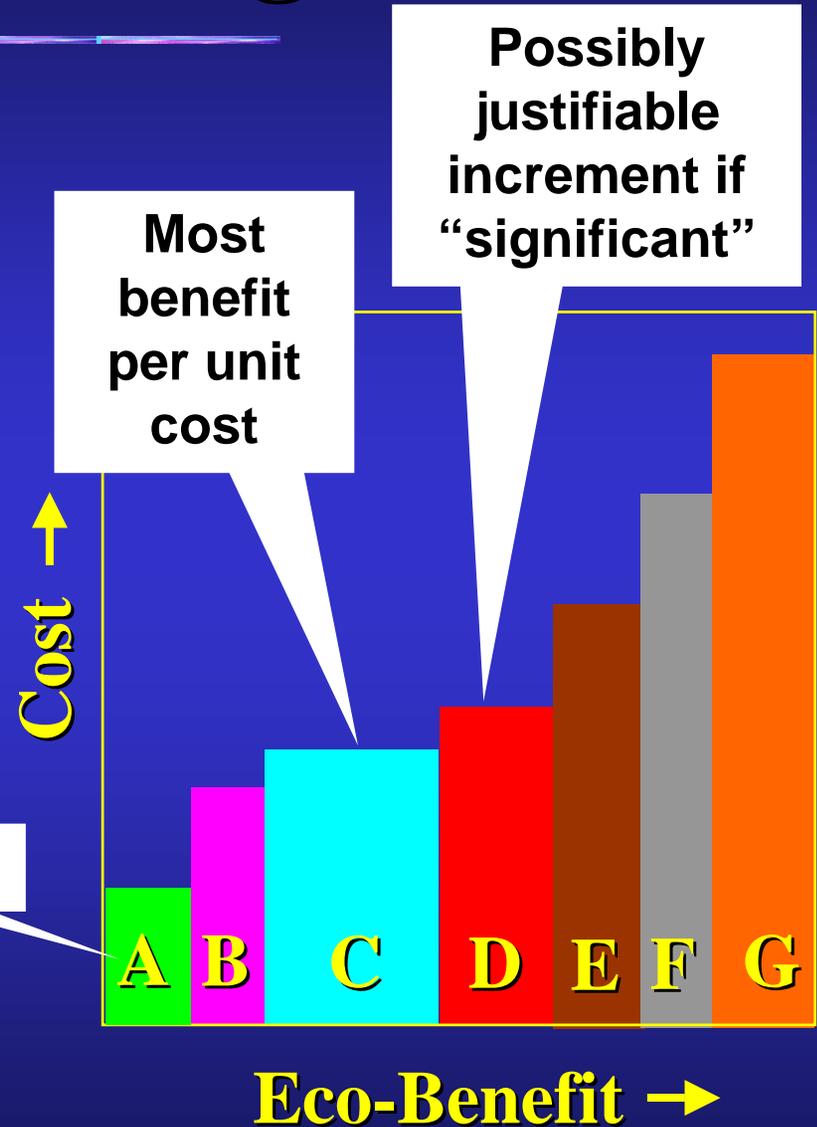
Project Planning



- **Involve customers, partners, and stakeholders**
- **Characterize hydrology and landscape**
- **Select metrics for alternative plan evaluation**
 - **Environmental**
 - **Economic**
 - **Social**
- **Formulate alternative plans**
- **Evaluate alternative plans**
- **Identify recommended plan**
- **Develop implementation plan**

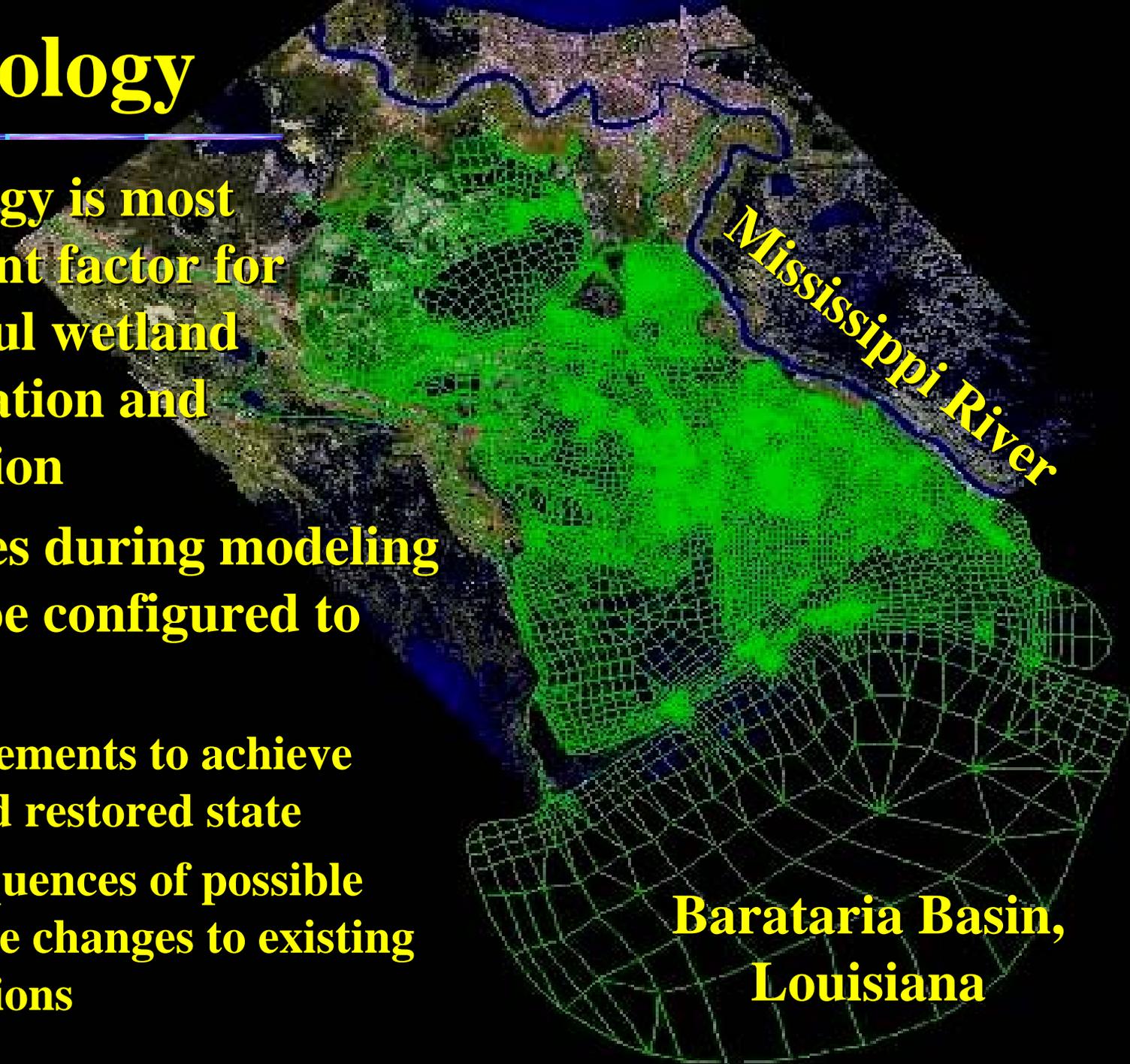
Principles for Planning Success

- **Methodical and consistent planning and management**
- **Restoration of sustainable functions**
- **Site-specific approach that addresses**
 - Problems
 - Needs
 - Opportunities
- **Rigorous alternative plan formulation and analysis**



Hydrology

- Hydrology is most important factor for successful wetland conservation and restoration
- Measures during modeling should be configured to address
 - requirements to achieve desired restored state
 - consequences of possible adverse changes to existing conditions



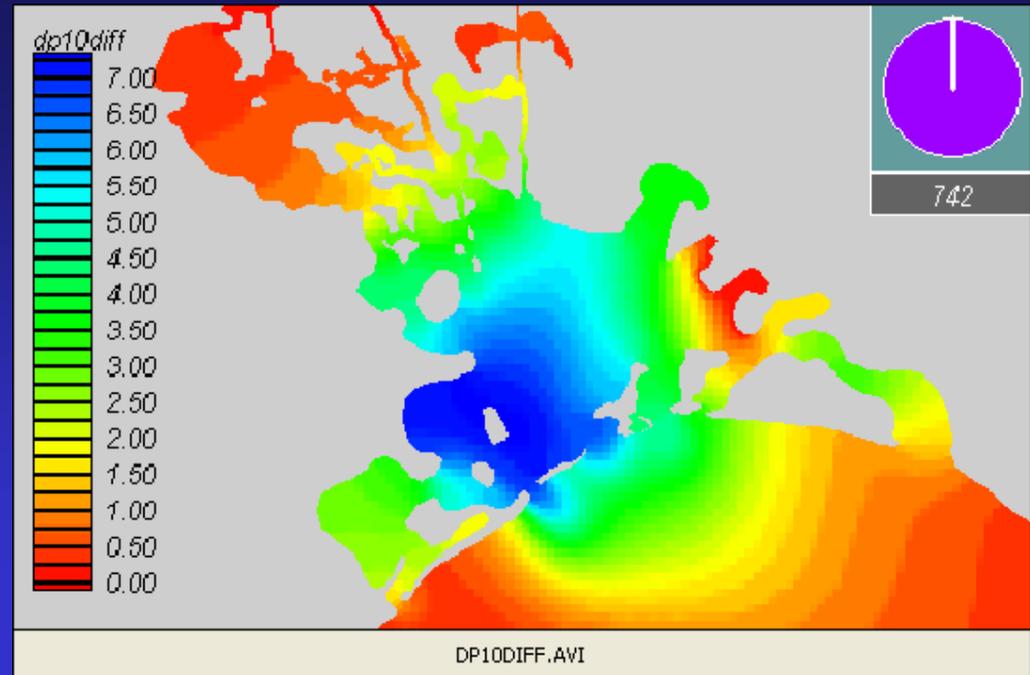


**Birdsfoot Delta of
Mississippi River,
Louisiana**

Hydrology

- **Possible scenarios**
 - **Inundation (permanently, regularly, seasonally, or never)**
 - **Saturation (permanently, regularly, seasonally, or never)**
 - **Tidally influenced, river fed, and/or groundwater fed**
 - **Fresh, intermediate, brackish, or salt water conditions**

Hydrology



- **Watershed (catchment) planning is important**
 - **Considers impacts on systems scale**
 - **Should characterize land uses, activities, and hydrologic and hydraulic functions of basin**
 - **Strive to minimize extreme peak discharges**

Platform, Methods, and Materials

- **Morphology - Prevent destabilization of existing features**
- **Soil**
 - Sand, silt, clay
 - Locally available/imported
 - Soils should be appropriate for plant growth
 - Soils should have proper physical, chemical, and biological parameters for bio-engineered applications
- **Other materials imported for:**
 - Erosion protection
 - construction of water control structures, barriers, etc.

Managing Environmental Quality

- **Ports, inland navigation, and related industry**
 - Air/water pollution, unnatural hydrodynamic forces
 - Impacts quality of water, soil, and wetlands
- **Counter measures:**
 - Use adaptive management to address ecosystem stress
 - Ensure industrial effluent (hydraulic waste loads) meet water quality standards
 - Manage turbidity from wheel wash, dredge operations
 - Control pollution: heavy metals, oil, grease, etc.
 - Salinity control into freshwater wetlands
 - Debris control: windblown/floating
 - Biological control of pests and insects
 - Invasive exotic species control

Setting Habitat Objectives

- **Heterogeneity and connectivity critical for fish and invertebrate function and propagation**
- **Small/isolated habitat plots limited in function**
- **Restored by reestablishment of ecosystem linkages**
- **Creation of interconnecting waterways promotes habitat functionality and biodiversity**

Social Considerations and Wetlands

- **Ascertain social sensitivity to navigation and related industry development**
- **Owner interests of wetland**
- **Population attraction to region of development**
- **Wetland restoration requires:**
 - **Political will**
 - **Institutional structure**
 - **Effective legal framework**
 - **Public awareness and support**
- **Encourage public participation**
- **Joint responsibility for wetlands management**

Generate Plans



- **Alternative plan development**
 - Formulate possible alternatives
 - Includes no action (i.e., do-nothing)
 - **Solicit public input**
 - Identify perceived environmental conditions
 - Inquire level of interest/opposition in alternatives
 - Gain input on setting screening criteria
 - Discuss methods of cost analysis and determination of environmental outputs
- R2-22. Restore/maintain Barrier Shoreline, Port Fourchon to Sandy Point

Design Principles to Support Planning Process

- **Control conditions and processes**
 - **Hydrological**
 - **Morphological**
 - **Chemical**
 - **Biological**
 - **Energy**
- **Create achievable situation to support desired ecosystem**

Design Process Overview

- **Develop understanding of existing conditions and related trends**
- **Scope major restoration strategies**
- **Design hydrology, layout, and landscape**
- **Quantify design features**
- **Develop plans and specifications**
- **Perform analysis of needed construction equipment, labor, and materials**
- **Develop estimated construction costs**

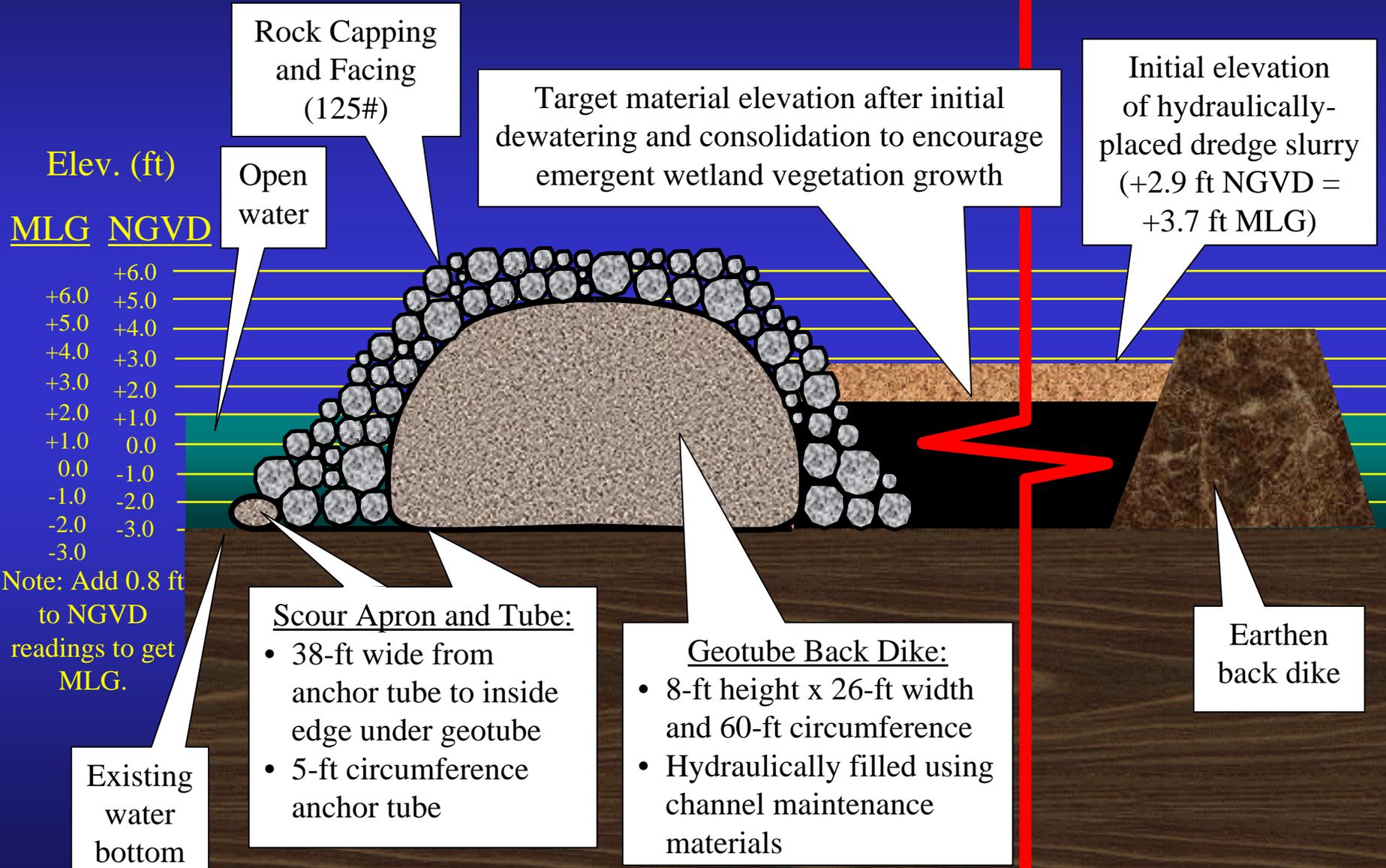
Landscape Layout/design Questions

- Nature and/or human use?
- Interests of public and owner site?
- Existing land use?
- Existing water management policies?
- Can design be integrated with other plans that may exist?
- Site access?
- Possible to combine navigation and wetland development?
- Prospects of food web support and nature development?
- Create areas for vulnerable migration species?
- Mitigation fisheries, grazing, and agriculture?
- How will loss of existing cultural heritage be prevented?
- Nature research and education of people?
- How to cross-train scientists and engineers?

Technical Design

- **Technical design measures are generally related to:**
 - Existing/required physical environmental features
 - Existing/desired quality of environment
 - Existing/targeted diversity of biological community
- **Condition reshaping should mimic natural shapes**
- **Use natural materials and sustainable work methods**
- **Minimize disturbance/pollution during construction**

Design Example – Fifi Island, Louisiana



Examine Initial Set of Plans

- **Analyze study alternatives**
 - Assemble sustainable measures for each alternative
 - Perform engineering and design of each measure
 - Model short- and long-term effects
 - Refine layout of measures and designs
- **Screen alternatives**
 - Develop and execute multi-criteria analysis
 - Capture diversity of interests held by users
 - Assign weighing factors for various interests
 - Advance top ranked alternatives in more detailed analyses

Study Top Alternatives in Detail

- **Optimize top alternatives, considering**
 - **Legislation (compliance with laws, policy, and guidance)**
 - **Ecosystem sustainability**
 - **Navigation needs**
 - **Social requirements (agricultural, recreational etc.)**
 - **Environmental quality (perception of living environment, landscape, biodiversity, and habitat)**
 - **Practical project execution logistics**
 - **Property (ownership considerations)**
 - **Economy (cost relative to benefits)**
- **Identify recommended alternative**

Project Implementation Plan

- **Data and design conditions**
- **Background, goals and objectives, success criteria, and type of restoration**
- **Design (hydrology, layout, landscape)**
- **Permits and licenses**
- **Site ownership and maintenance**
- **Construction plans and specifications**
- **Project construction schedule**
- **Environmental work windows**
 - **Tidal variations, seasonal variations**
 - **Disturbance of breeding/wading of birds**
 - **Vegetative planting timing for growing season**

Recreational Planning

- **Observation spaces/equipment**
- **Footpaths**
- **Visitor's center**
- **Tours**
- **Protection against tourist erosion or vandalism**
- **Restricted public access to sensitive areas**

Project Execution

- **Engage those involved**
 - Refine goals
 - Shape project
- **Results monitoring**
- **Benchmark actual success level against goals**
- **Reach goals using adaptive management**
- **Identify and follow best practices in land management**

Construction and O&M Planning Considerations

- **Management organization plan**
- **Lines of communication (internal/external)**
- **Scheduling, budgeting, and funding**
 - **Construction**
 - **Monitoring**
 - **Operations and maintenance**
- **Quality Assurance**
- **Elements of the “as-built” plan**
- **Operations and maintenance details**
- **Evolution in criteria for maintenance plan**

Adaptive Management

- **Succession of wetland sites is difficult to predict**
- **Unexpected conditions can arise during construction**
- **Maintain flexibility in design**
- **Work with nature's response to implementation**
- **Consider potential needs for augmentation during and after construction**
 - **Identify and prioritize problems**
 - **Systematically take action**
 - **Evaluate results**
 - **Refine features and operations**

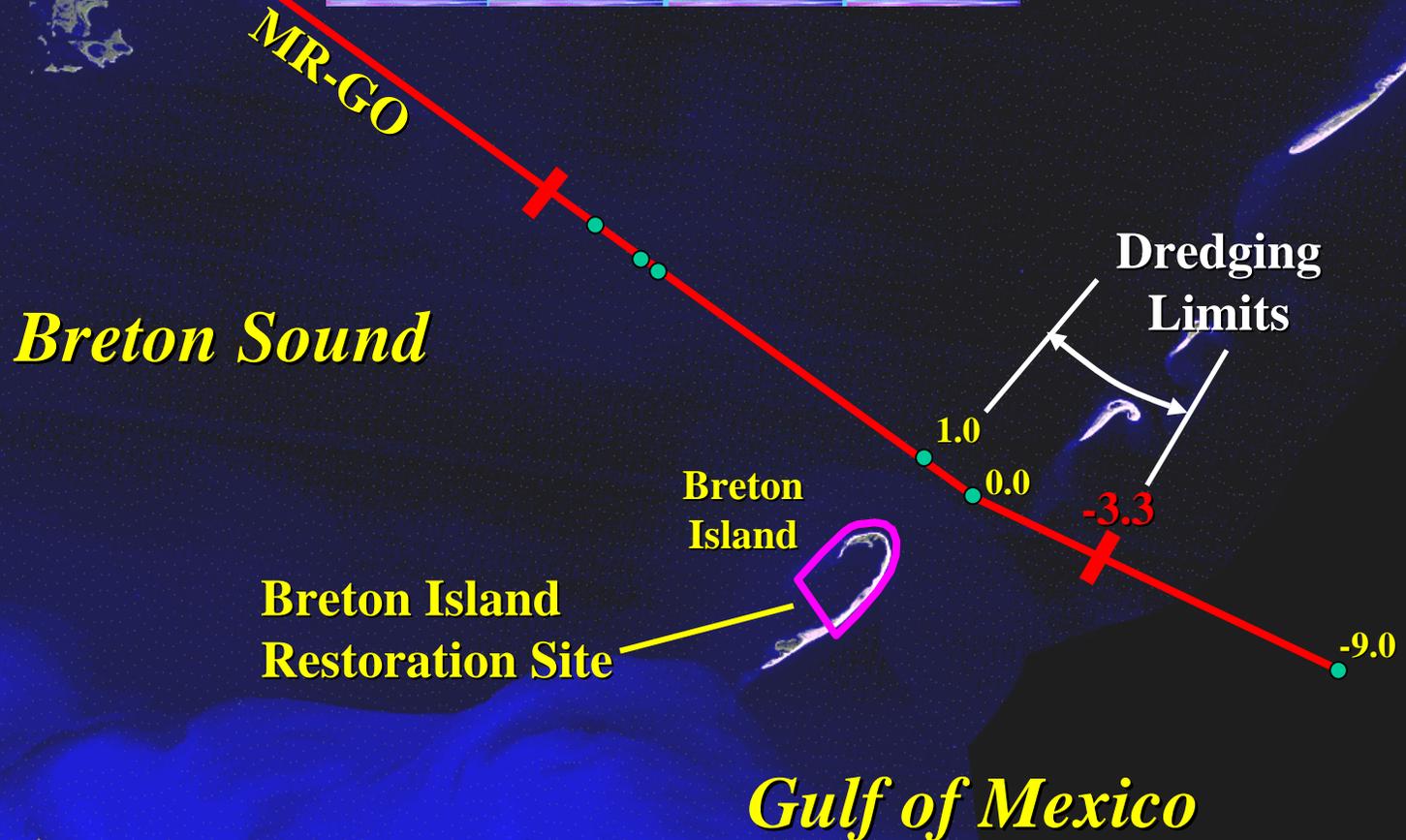
Wetlands Design Summary

- **Plan**
- **Design**
- **Construct**
- **Operate**
- **Monitor**
- **Maintain**
- **Assemble/follow best practices**



**Sabine National Wildlife
Refuge Wetland Creation,
Louisiana, USA**

Example Project: Mississippi River-Gulf Outlet Breton Island Restoration



Breton Island - 1995
Pre-Hurricane Georges

**North
Breton
Island**

*Gulf of
Mexico*

*Breton
Sound*

**South
Breton
Island**



*Breton
Sound*

**North
Point**

**South
Point**

*Gulf of
Mexico*



Breton Island

**January 1999
Post-Hurricane Georges**

**Hurricane struck Gulf
Coast September 1998**

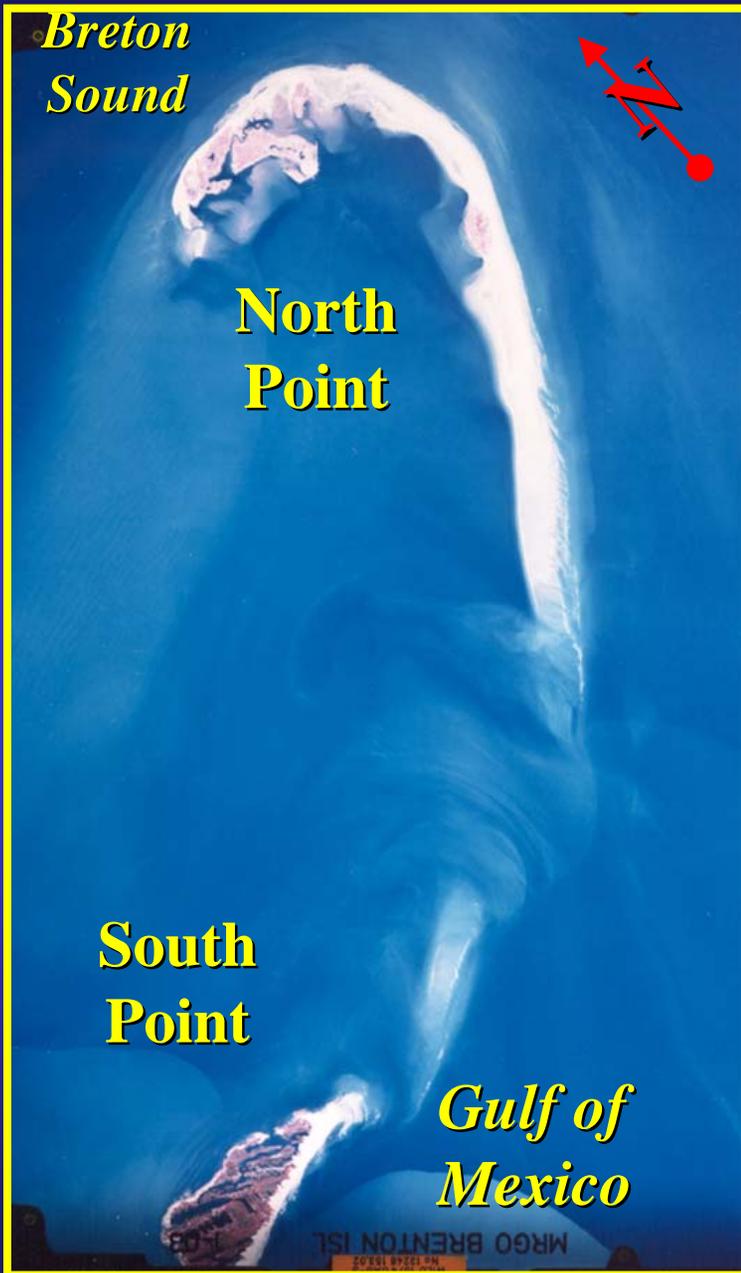
Post Hurricane Georges Conditions February 1999 Beneficial Use of MRGO Dredged Material at Breton Island



Breton Island

February 2000 Post Dredged
Materials Placement





Breton Island

January 2001

Dredge CALIFORNIA
working between Mi. 1.0 to Mi. -2.0
MRGO Channel Maintenance Dredging
October 2001



1.95 million cubic yards dredged and placed at
Breton Island for Restoration
under Corps O&M Program

Breton Island Restoration in Connection with MRGO Channel Maintenance Dredging October 2001

Dredged materials placed to +3 ft MLG from north to south in nodes spaced about 500 ft apart along island rim and out approx. 100 yards from existing shore



Breton Island Restoration

Approx. North



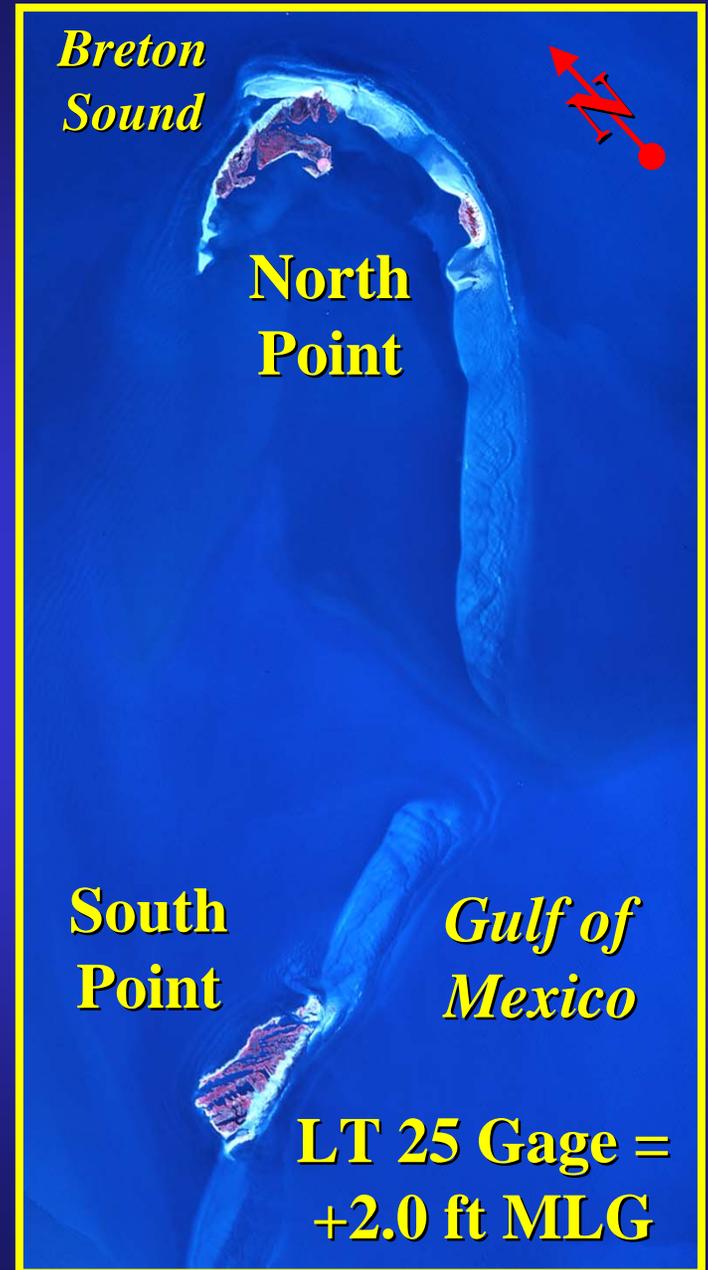
Newly developing shore face along south edge of island through hydraulic sorting and littoral drift of dredged sediments

Breton Island

October 2002
Post 2001 Placement and
Post Isidore and Lili Storms
(Sep-Oct 2002)



**Breton
Island**



*Breton
Sound*

**North
Point**

**South
Point**

*Gulf of
Mexico*

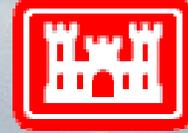
**LT 25 Gage =
+2.0 ft MLG**



No Picture



Questions?



US Army Corps
of Engineers ®

Point of Contact:

Edmond J. Russo, Jr., P.E.

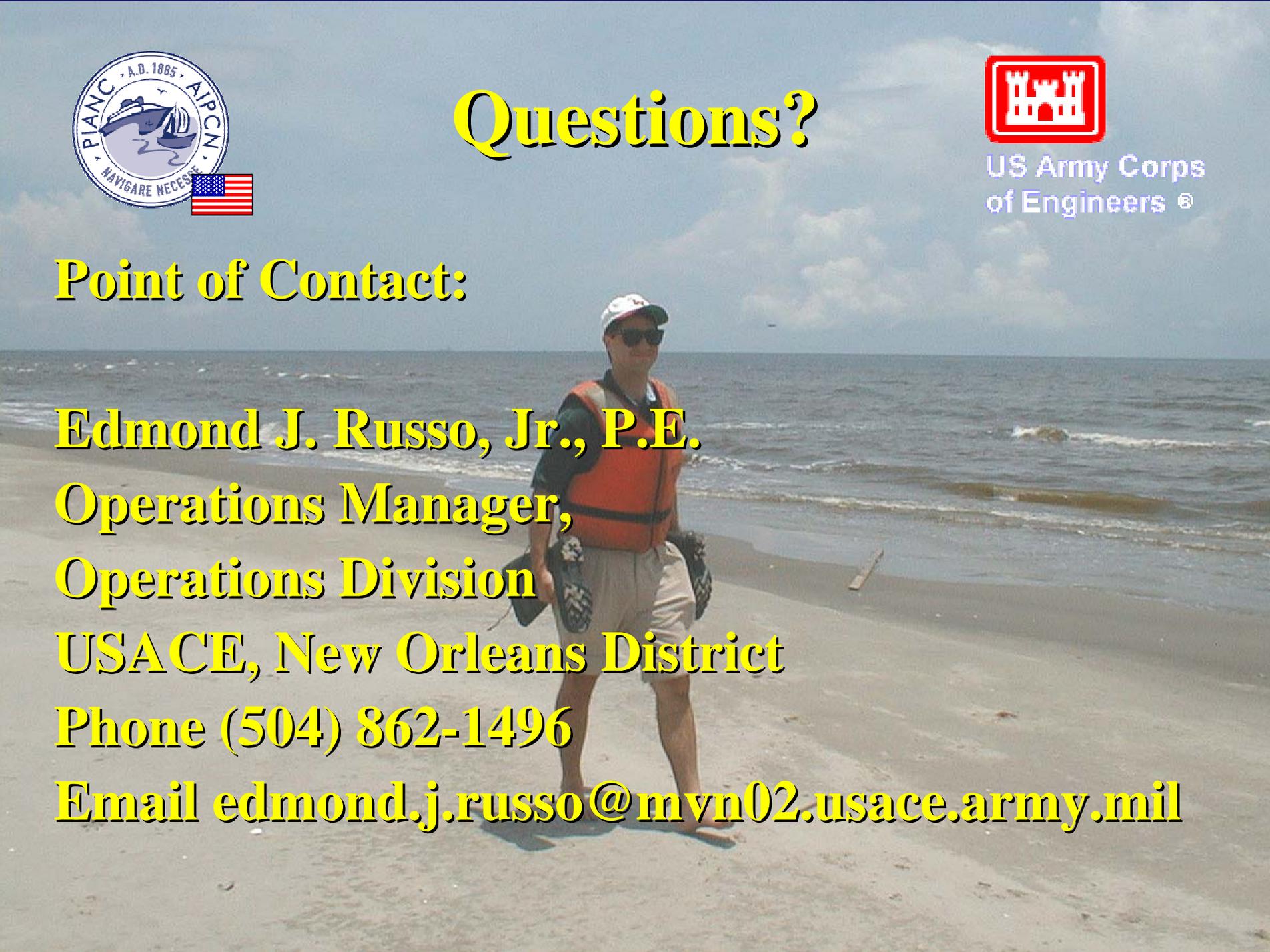
Operations Manager,

Operations Division

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Email edmond.j.russo@myn02.usace.army.mil



SERVICE TO THE PUBLIC

Navigation

River Flood Control

Hurricane Flood Control

Environmental Enhancement

Wetlands Restoration

Support for Others

