Sustainable Strategies for Habitat Restoration and Sediment Management in the Face of Global Climate Change

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Talking Points:

- Climate change
- Challenges for habitat restoration
- Challenges for sediment management
- Concluding remarks

"Innovative Sediment Management: How to do more with less?"

Climate Change is Happening (*and yes, even in the U.S. …*)

- Extreme events (e.g., storms, heat waves and regional droughts) have become more frequent and intense
- Average air temperature has increased 2°F
- US precipitation has increased 5% in last 50 yrs
- US rainfall volume is up 20 % in last 100 yrs
- Hurricanes in the Atlantic and Eastern Pacific are stronger
- Sea levels have risen approx. 20 cm globally over the past 100 yrs
- Arctic and mountain sea ice are shrinking
- Ocean currents and upwelling patterns are changing, and sea water is becoming more acidic

2/3's of the world's polar bears are expected to disappear in 50 yrs, and will be gone in the state of Alaska in 75 yrs

Projected Changes are Regional – Solutions will be Regional, as well

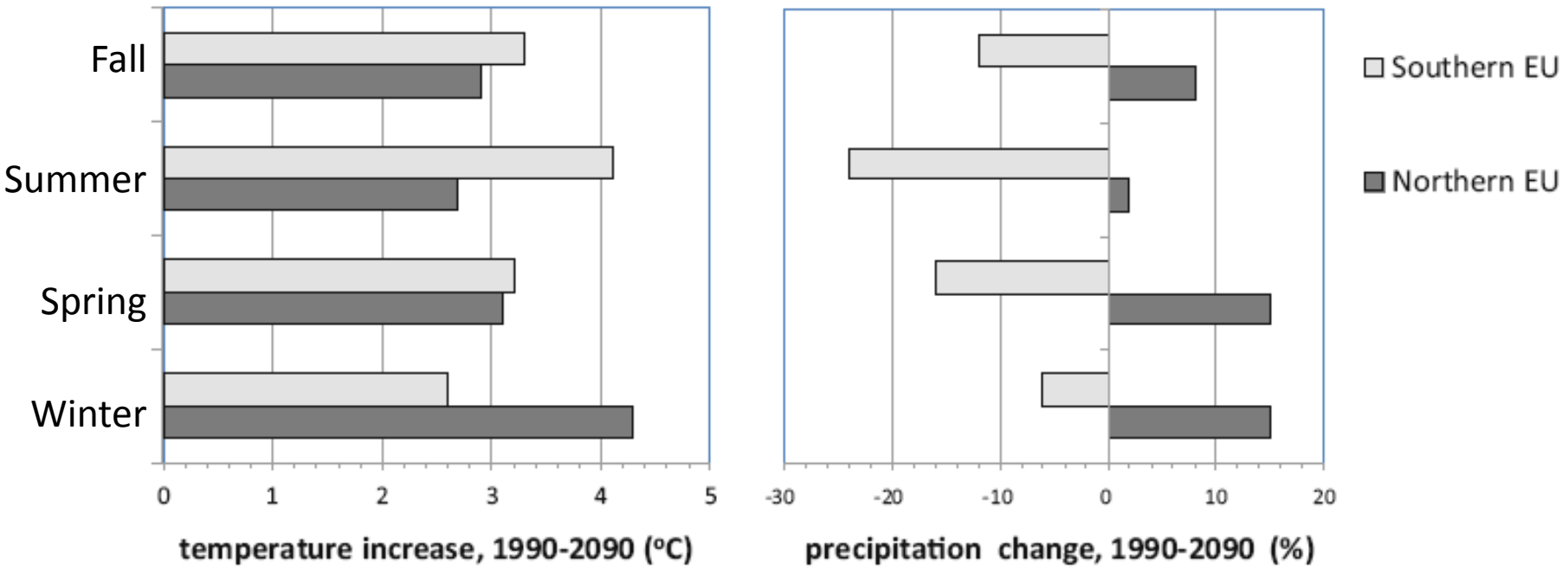


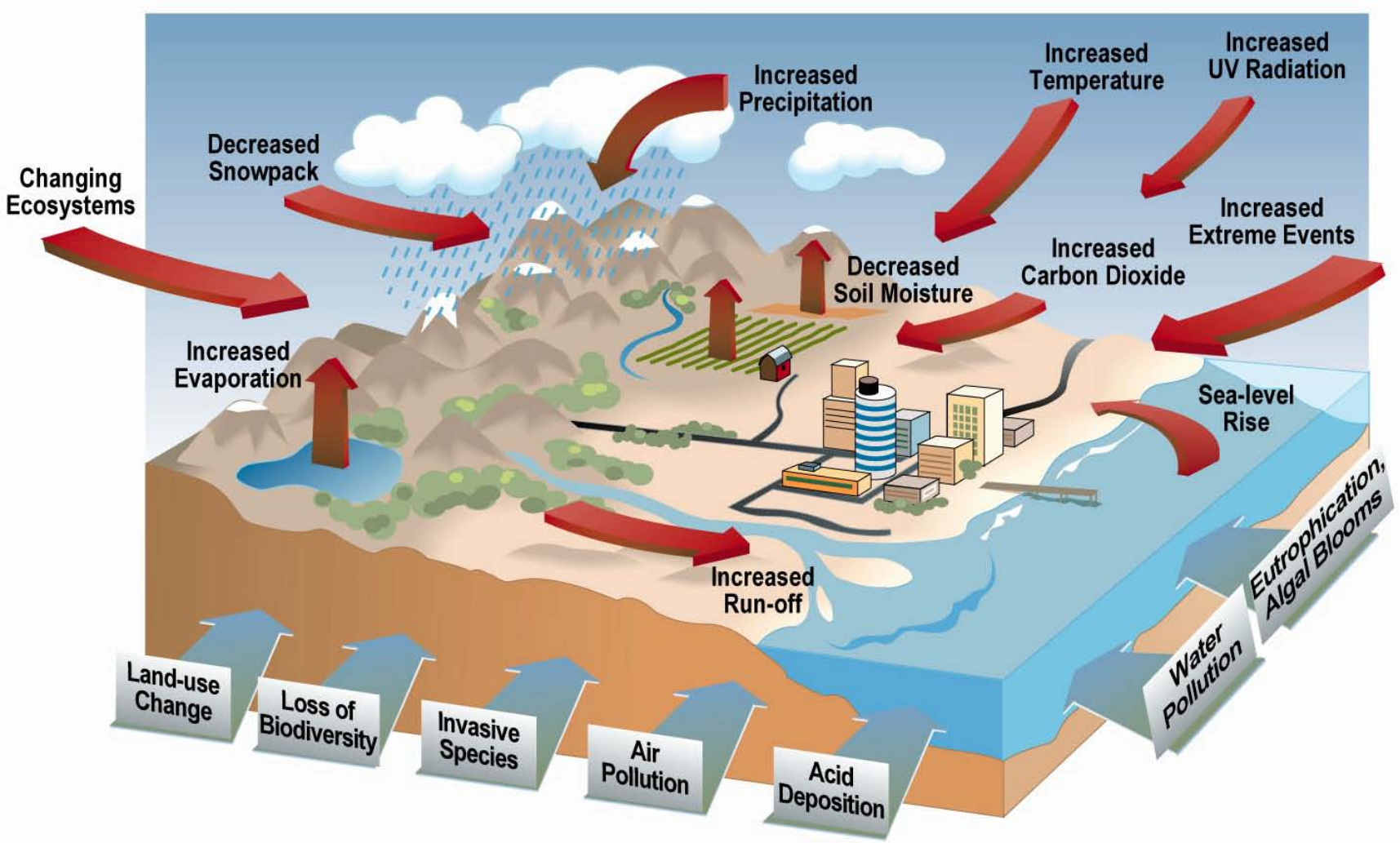
Figure 1. Estimated seasonal changes in Europe between 1990–2090 using the IPCC-SRES A1b scenario.

from: Vermaat et al., (2013). The Handbook of Environmental Chemistry 29: Risk-informed management of European river basins, Chapter 8, p. 223-238.

Vulnerable Regions in Europe

Regions	Climate change impacts
Coastal zones, floodplains and wetlands	- Changes in water quality due to algal blooms - Coastal erosion due to sea level rise - More frequent floods due to extreme events
Mediterranean region	- More frequent droughts and fires - Land degradation due to salinisation
Arctic region, including Greenland	- Economic and cultural impacts on indigenous communities - Loss of endemic species - Reduced seasonal sea ice - Thawing of permafrost
Mountain regions	- Retreat of glaciers - Changes in water discharge - Changes in avalanche frequency - Less frequent and secure snow cover - Loss of endemic plant species

Climate Change Stresses

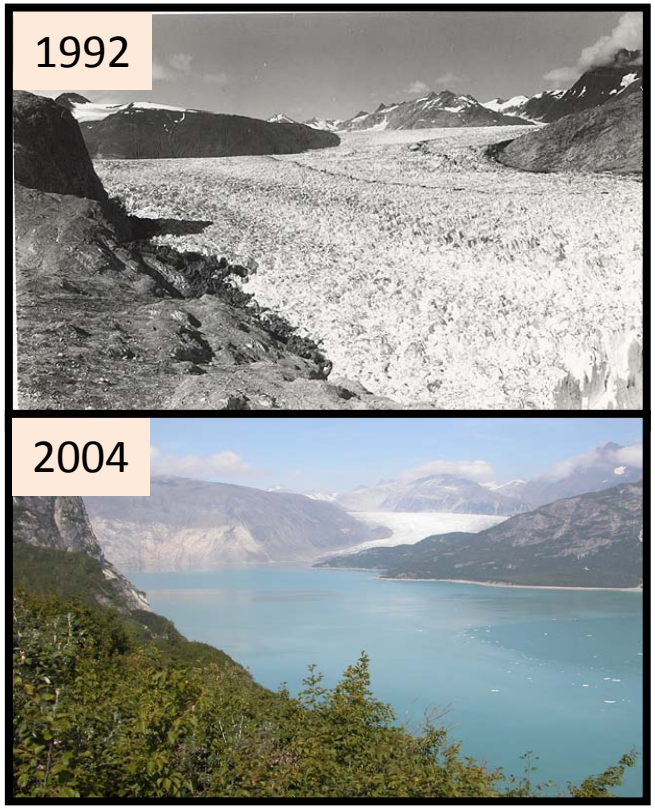


from: NAST (2001). U.S. National Assessment of Climate Change.

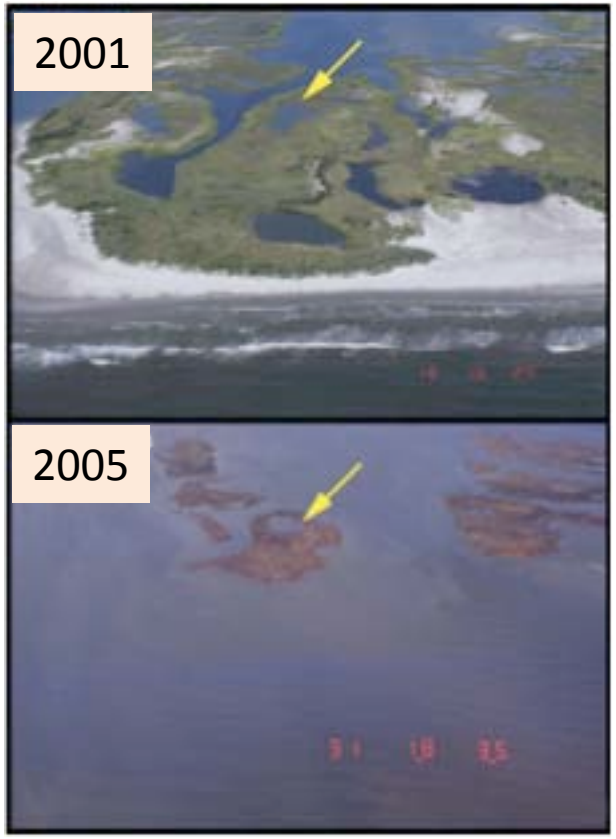
"Innovative Sediment Management: How to do more with less?"

1. Can *traditional management strategies* for natural and man-made aquatic habitat and protection of coastal infrastructure (e.g., commercial ports, utility infrastructure, and transportation routes) coexist with the threats posed by sea level rise, changes in sedimentation, climate, *etc*…?
2. Are we investing *too much time and effort* on projects for which the outcomes are not achievable or sustainable?
3. How do we *re-think our approaches*?

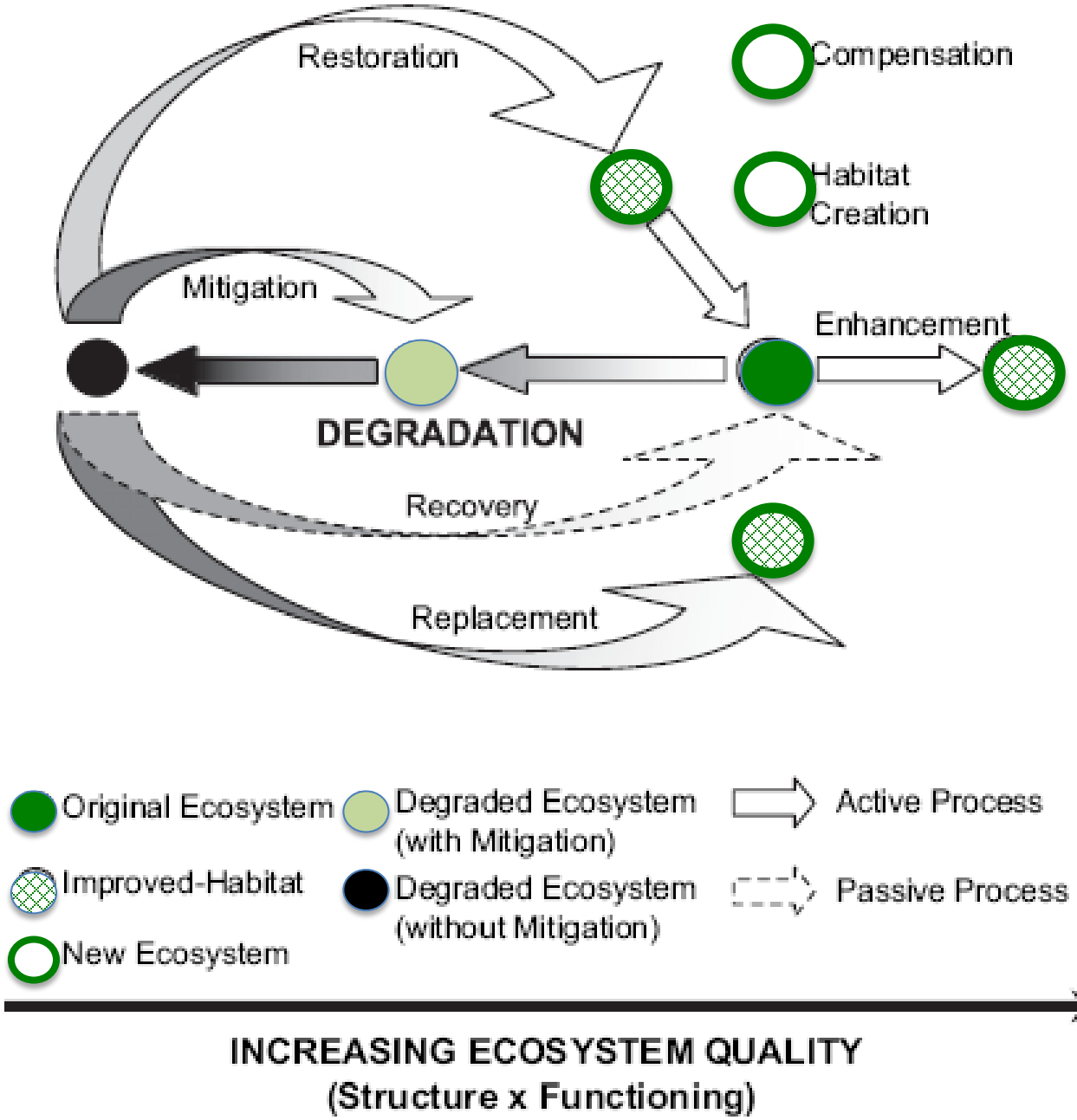
Habitat Today, Gone Tomorrow…



Muir Inlet, Glacier Bay NO, Alaska



Chandeleur Islands, east of New Orleans, before and after 2005 hurricanes



We need to be clear about what is to be protected or restored and how it is to be measured.

This is particularly important as we try to manage ecosystems with a backdrop of irreversible or long-term change.

from: Elliott, Burdon, Hemingway and Apitz (2007). Estuarine, coastal and marine habitat and ecosystem restoration: Confusing management and science – A revision of concepts. *Estuarine, Coastal and Shelf Science* 74, 349-366

environment360

Opinion, Analysis, Reporting & Debate

A Year After Sandy, The Wrong Policy on Rebuilding the Coast

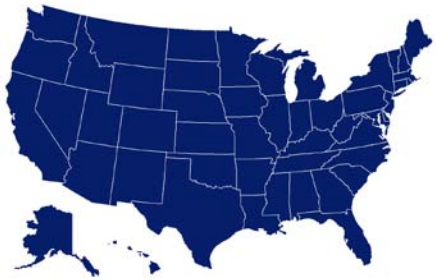
"One year after Hurricane Sandy devastated parts of the U.S. East Coast, the government is spending billions to replenish beaches that will only be swallowed again by rising seas and future storms. It's time to develop coastal policies that take into account new climate realities…."

New Zealand Coastal Policy Statement
…requires local governments to examine "managed retreat" — the abandonment of structures that are or will be impacted by sea level rise and other coastal hazards in the future.

Are these the two extremes of national climate change policy?

Is there a middle ground?

US$5b in beach replenishment, equivalent to filling an 80,000-seat stadium 10 times. …. federal spending on coastal management and protection is entirely reactive, not proactive.



from: http://e360.yale.edu/feature/a_year_after_sandy_the_wrong_policy_on_rebuilding_the_coast/2705/

Water Framework & Marine Strategy Directives: Indicators of Ecosystem Health are Based Upon Community ***Structure***

- In some ecosystems, a focus on recovery of *structure alone* may guarantee failure.
- "It is probable that the *diversity of function* is more important for the sustainability of ecosystem goods and services than species diversity per se…"

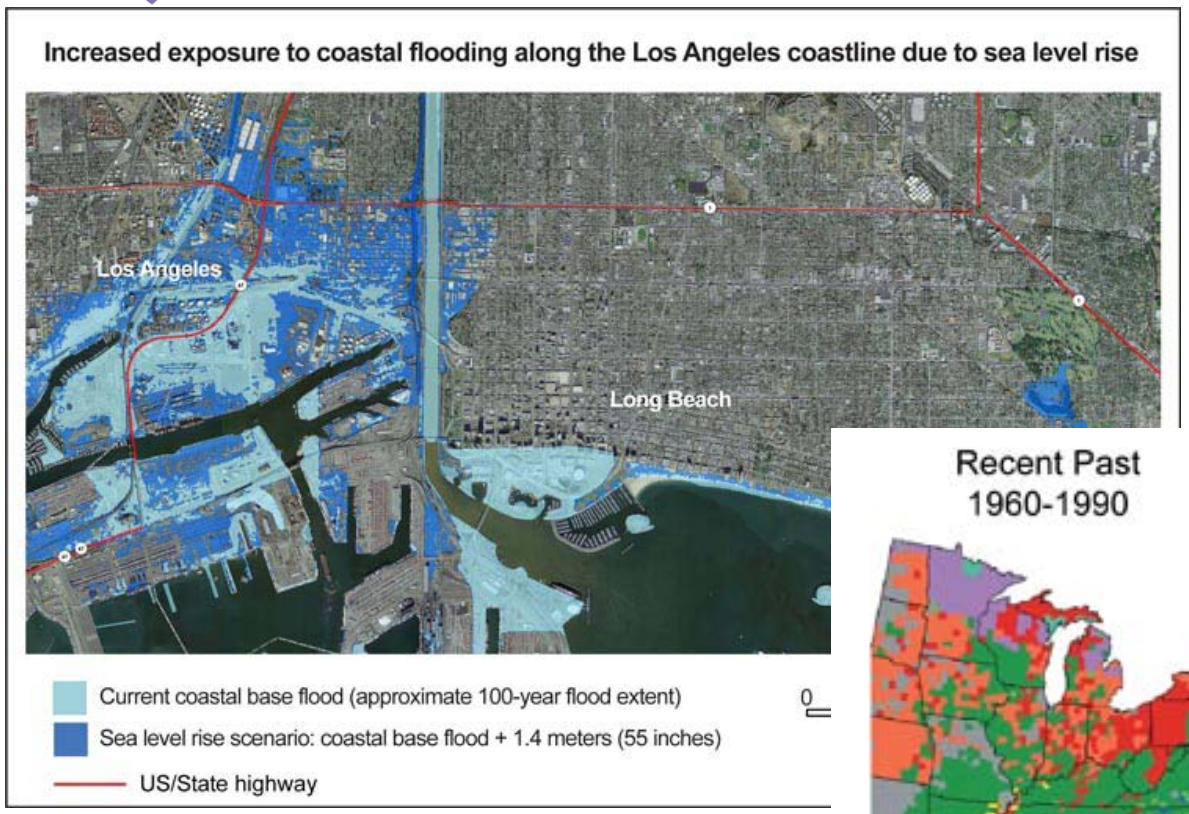
  [Wall 2004; SCOPE 64 (speaking on soils and sediments)]

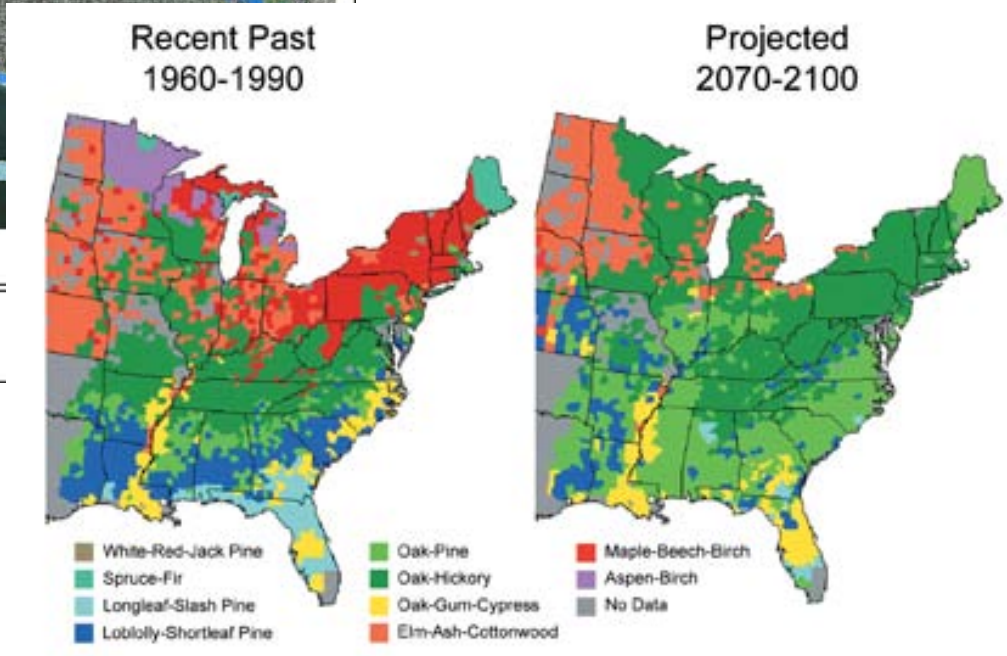
- There is a need to understand ecosystem *functions*, *their response to pressures and their relationships to ecosystem services.*

Shifting Baseline Condition is a Barrier to Habitat Restoration

- USEPA and EU regulatory frameworks are focused on the restoration of "baseline" conditions defined by morphological and ecosystem structures that may no longer be viable in a changing climate.
  - *The pace of climate change may already make traditional concepts of habitat restoration moot.*
- It may not be possible to overcome the forces of sea level rise, increasing sea surface temperatures, ocean acidification and invasive species to preserve, protect, or restore certain ecosystems.
- We need to ask: *Even if changed, is this a functioning ecosystem?*

What is “Baseline Condition”?

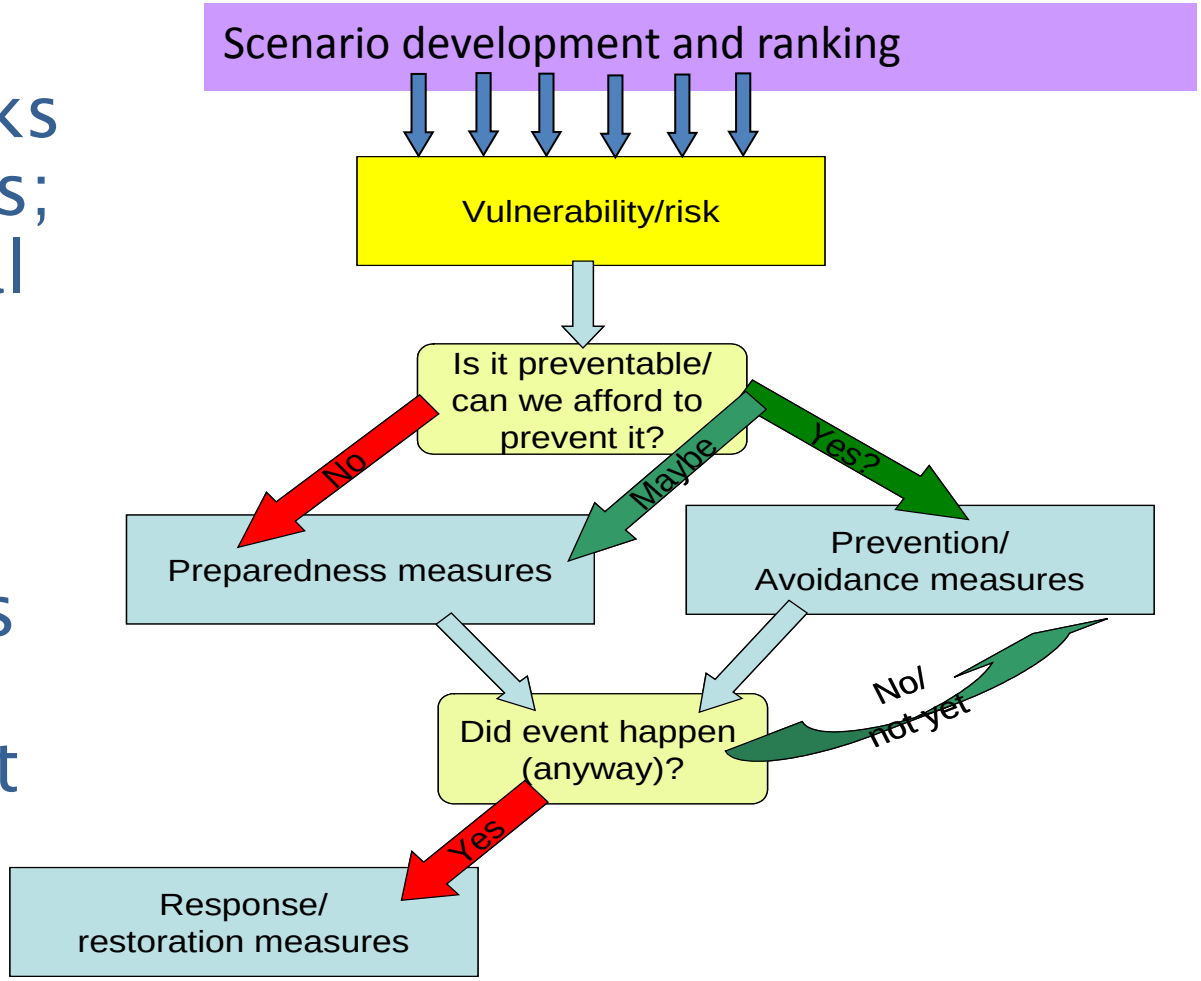




from: Global Climate Change Impacts in the US (2009)

Strategies need to be tailored and adaptive

- Identify potential risks and liabilities; and potential costs
- Identify key uncertainties for adaptive management



adapted from: S E Apitz (2007)

Adaptation: Responding to Sea Level Rise

- Protect: build hard structures such as levees and dikes (this can increase future risks by destroying wetlands and creating a false sense of security that encourages more development in vulnerable areas)
  - "Hard defenses"
- Accommodate rising water: elevate roads, buildings, and facilities; improve flood control structure design; enhance wetlands
  - "Soft defenses"
- Retreat: accommodate inland movement through planned retreat; require setbacks for construction; improve evacuation planning
  - "Managed realignment"

Other Habitat Considerations

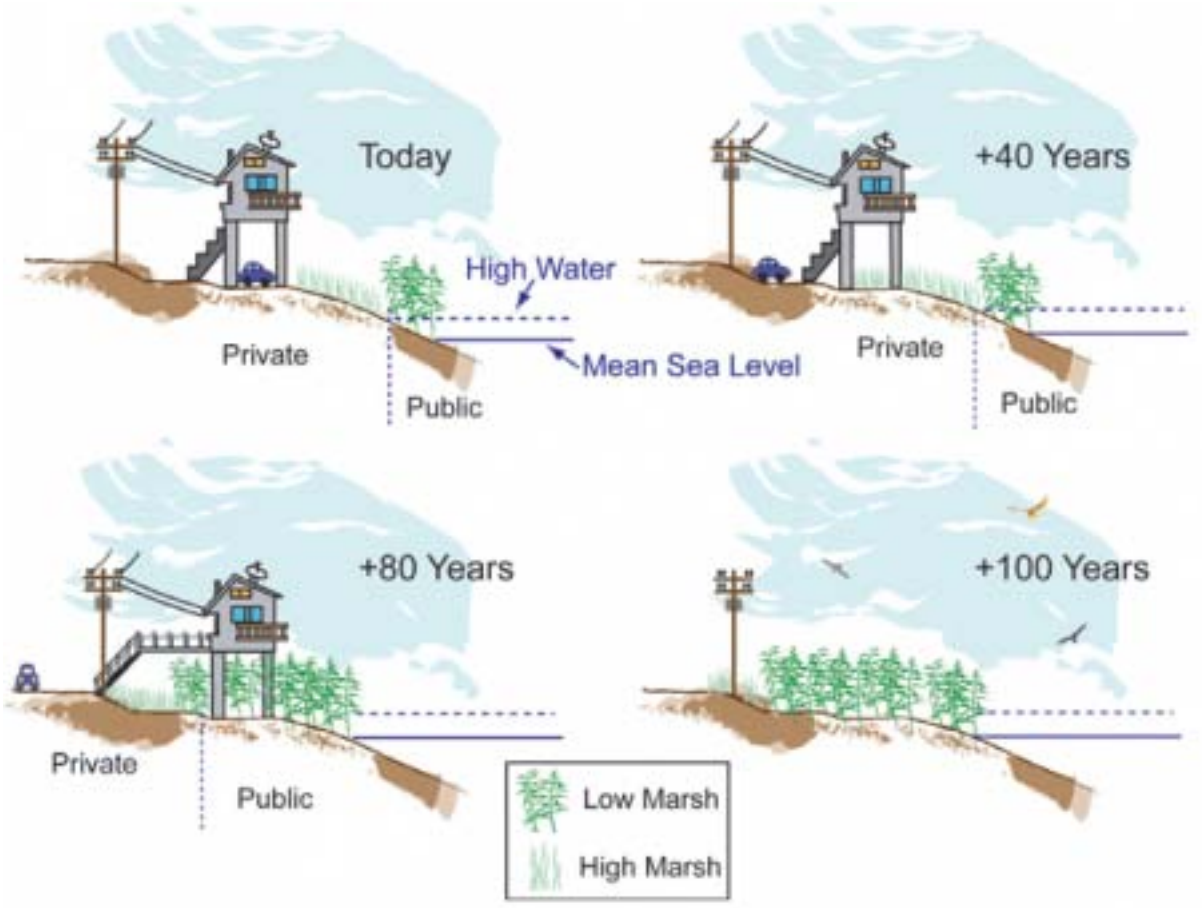
Declining water resources

- Increase public awareness
- Encourage water conservation
- Fix water distribution systems to minimize leakage
- Increase freshwater storage capacity
- Explore alternative sources including importing water, desalinating seawater, and using treated wastewater

Unmanaged ecosystems

- Establish baselines for ecosystems and their services
- Identify thresholds
- Monitor for continued change
- Restore ecosystems that have been adversely affected
- Identify refuge areas that might be unaffected by climate change and can be preserved
- Relocate species to areas where favorable conditions are expected in the future

Adaptation: Preserving Coastal Retreat



Rolling Easements:

- Allow some development near shore – but no armoring, set-backs based on erosion rates, small & removable structures, etc.
- Recognize nature's right-of-way to advance inland.

Service-based Assessment in the UK

"Hard Defence" v. "Managed Realignment"

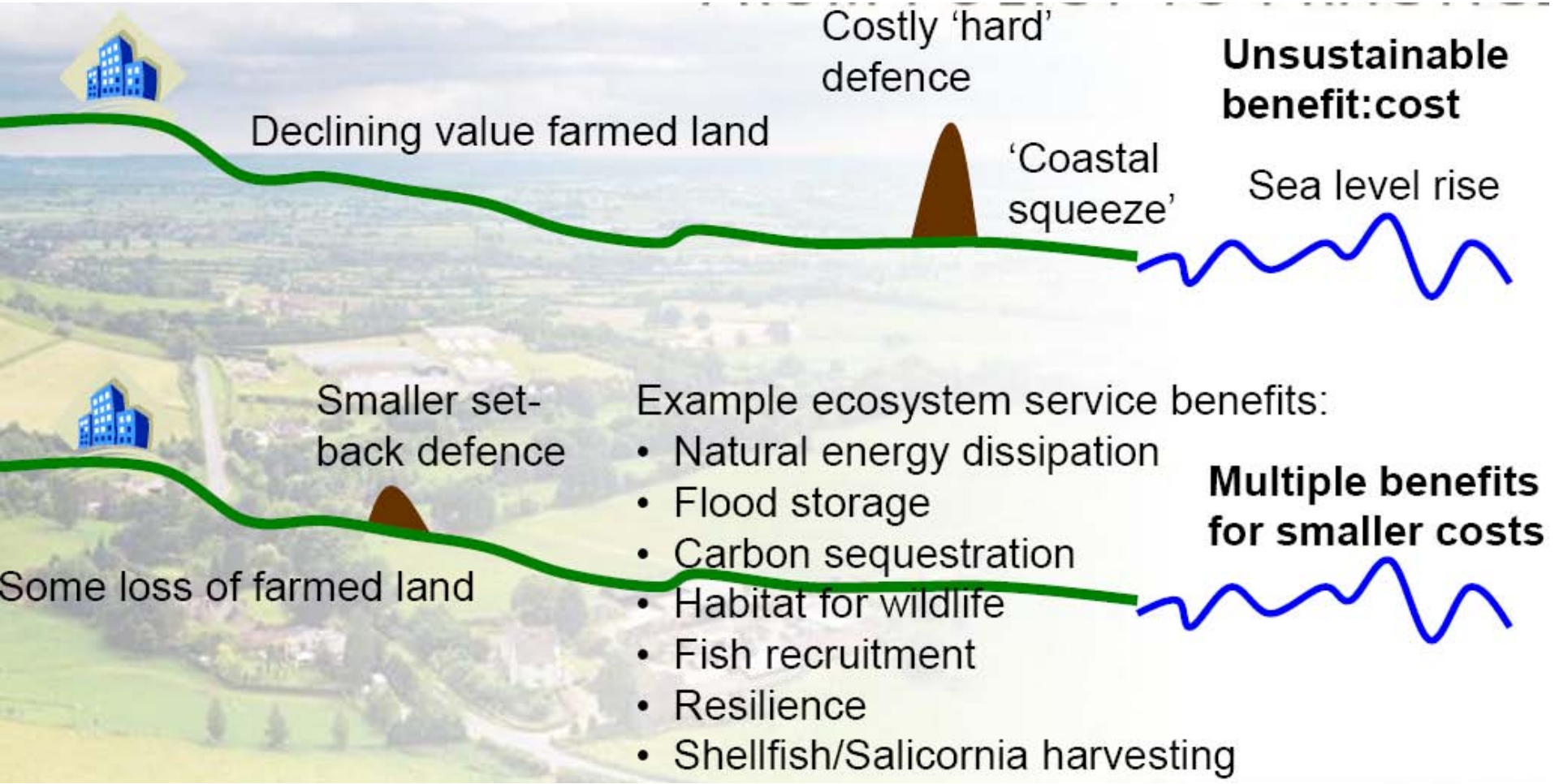
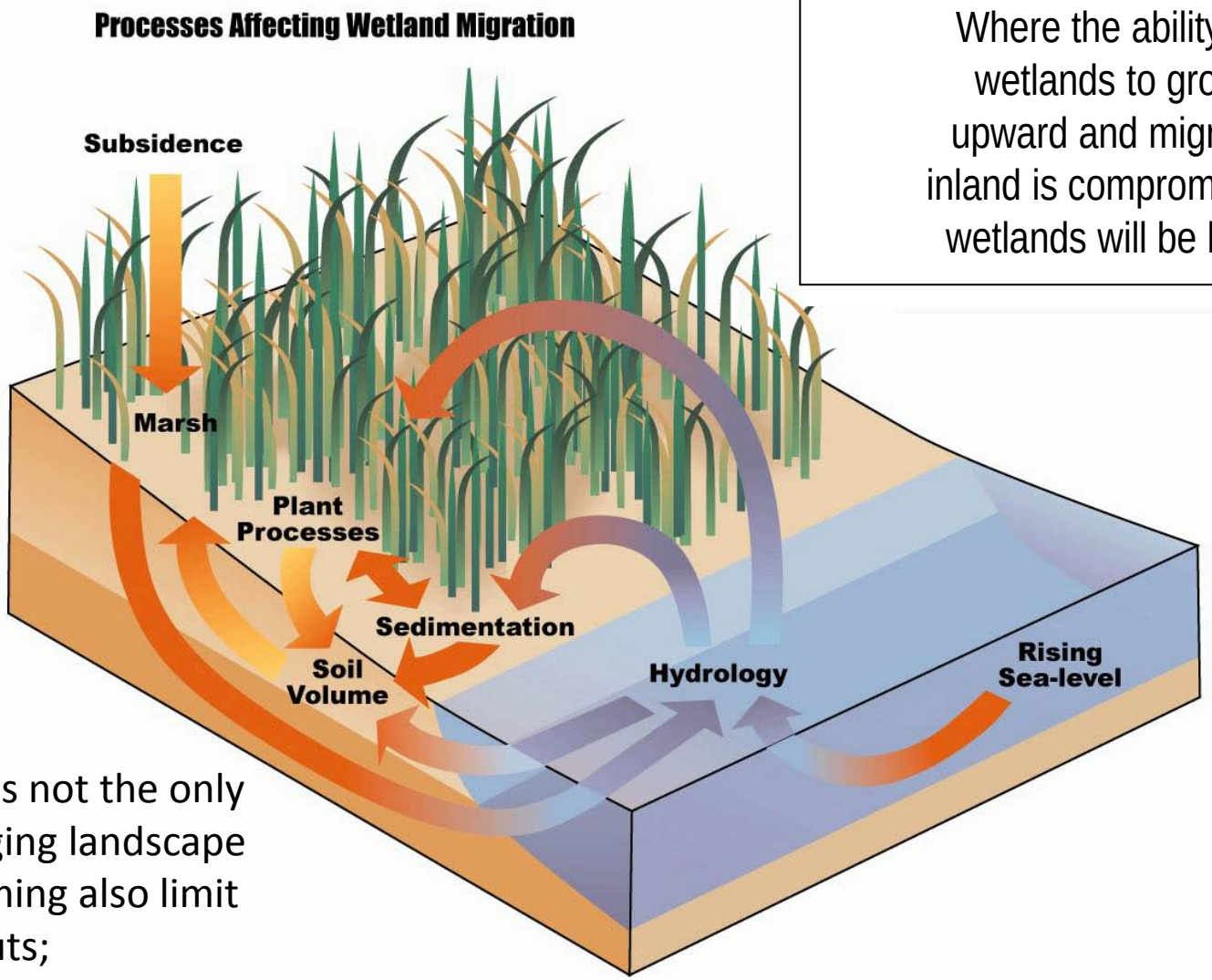


Image courtesy of Mark Everard

Consequences of Options can be Compared Considering Ecosystem Services

Option	Do nothing	Do minimum	Improve defences (rebuild)	Managed Realignment (vision)	Managed Realignment (unconstrained)
Supporting services					
Soil formation	+	+	0	+	+
Primary production	+	+	-	+	+
Nutrient cycling	+	+	-	++	++
Provisioning services					
Ecosystem goods	+fish/-agri	+fish/-agri	-fish	+fish/-agri	+fish/-agri
Fresh water	0	0	0	0	0
Biochemicals/genetics	?	?	?	?	?
Regulating services					
Air-quality regulation	0	0	0	0	0
Climate regulation	+	+	-	+	+
Water regulation	+	+	-	+	+
Water purification	+	+	-	+	+
Pest regulation	?	?	?	?	?
Disease regulation	?	?	?	?	?
Pollination	+	+	-	+	+
Erosion regulation	+	+	--	++	++
Cultural services					
Recreation and tourism	-	-	0	++/-	++/-
Aesthetic	+/-	+/-	+	+	+
Educational	0	0	0	+	+
Cultural heritage	--	--	0	-	-

Table courtesy of Mark Everard



Where the ability of wetlands to grow upward and migrate inland is compromised, wetlands will be lost.

Sea level rise is not the only driver – changing landscape use and damming also limit sediment inputs; compromising wetlands and coastal defence

from: Reed (*Earth Surf Proc Landforms*, 1995)

In the UK, Dredged Material is used for mitigation, compensation and beneficial use, creating higher value habitat and increased flood defence **- trickle recharge returns sediment lost to damming**

Possible Solutions

The Tidal Elbe Concept

Concept for a sustainable development
of the Tidal Elbe River as an artery
of the metropolitan region Hamburg and beyond

A contribution for discussion by Hamburg Port Authority and
the Federal Administration for Waterways and Navigation

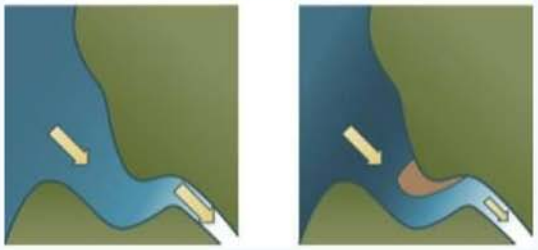
Hamburg Port Authority

Dr.-Ing. Hans Peter Dücker
Dipl.-Ing. Heinz Glindemann

Wasser- und Schifffahrtsverwaltung des Bundes
Wasser- und Schifffahrtsdirektion Nord

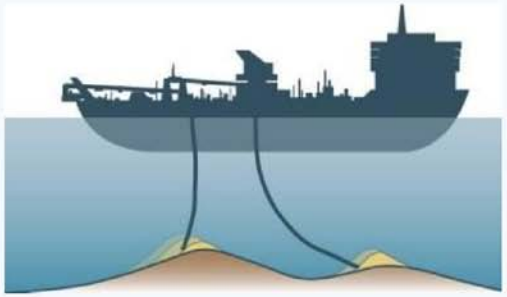
Dr.-Ing. Hans-Heinrich Witte
Dipl.-Ing. Karsten Thode

3 main ideas



Attenuation of tidal energy by river engineering
(mouth of Elbe)

Giving more space to the flood
(upper part of Elbe)



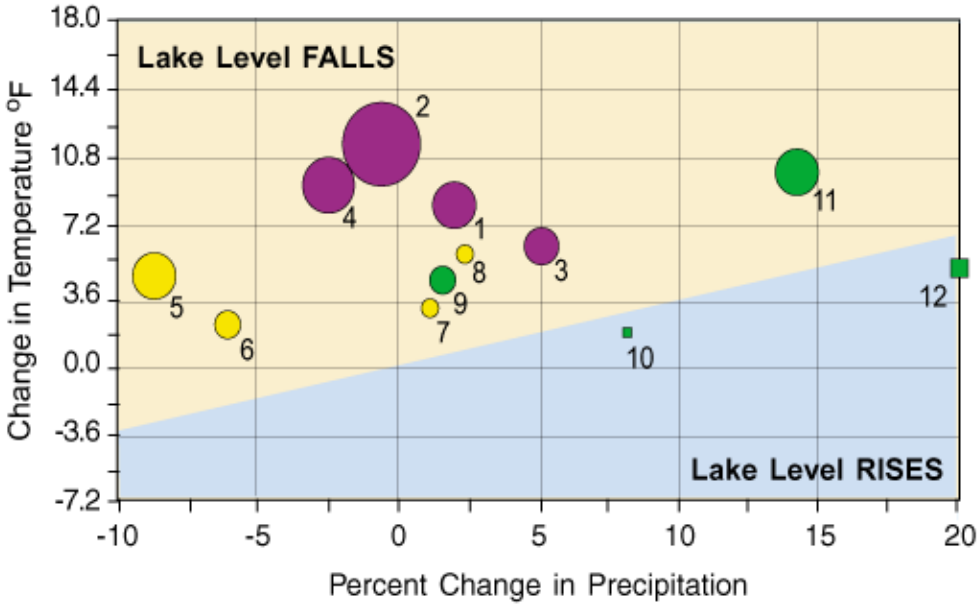
Optimisation of sediment management
(whole Elbe system)

Predicting Sediment Volumes is not Enough

- Sediment role and impact are affected by sediment quantity, quality, location and transport in spatially-explicit ways.
- Climate change will not only change "natural" hydrodynamics, but also how we manage and utilize landscapes.
  - *Understanding how this affects the soil-sediment continuum will be essential.*
- Predictive modeling tools can help:
  - Digital Elevation Model
  - Hydrodynamic Model
  - Sediment Transport Model
  - Sediment Regional Risk Models (SRRM) and Sediment-Ecosystem Regional Assessment (SEcoRA)

Commercial Shipping Concerns in the U.S. Great Lakes Region

Lake Michigan-Huron



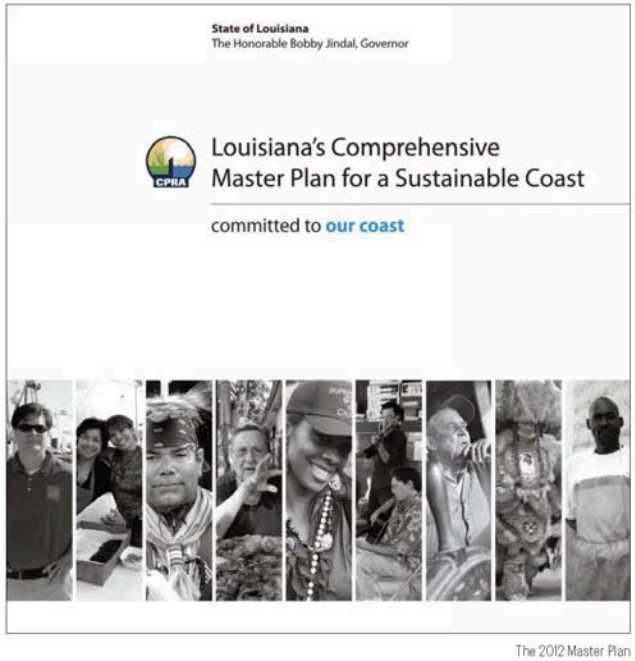
- For each inch of draft lost, 1,000 foot ships must offload 270 tons of freight.

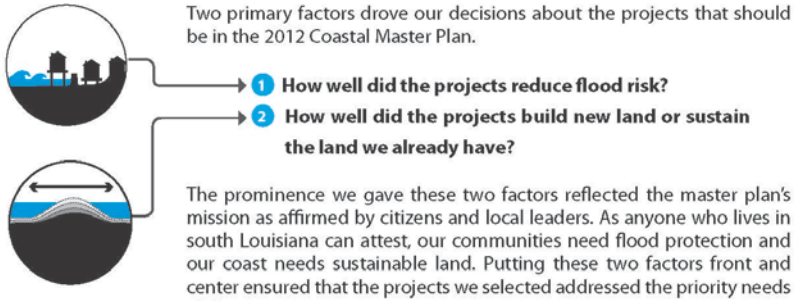
- Options proposed at the *Chicago Lake Levels Workshop*:
  a. Lengthen shipping season,
  b. More & frequent dredging,
  c. Shallower-draft ships, and
  d. Shift to land transport

Research Needs:

- *Does dredging exacerbate or ameliorate contaminated sediment risks?*
- *What are the consequences of each commercial option?*
- *How will climate change evolve in the Great Lakes region?*

Example: State of Louisiana v. Climate Change





Two primary factors drove our decisions about the projects that should be in the 2012 Coastal Master Plan.

1. **How well did the projects reduce flood risk?**
2. **How well did the projects build new land or sustain the land we already have?**

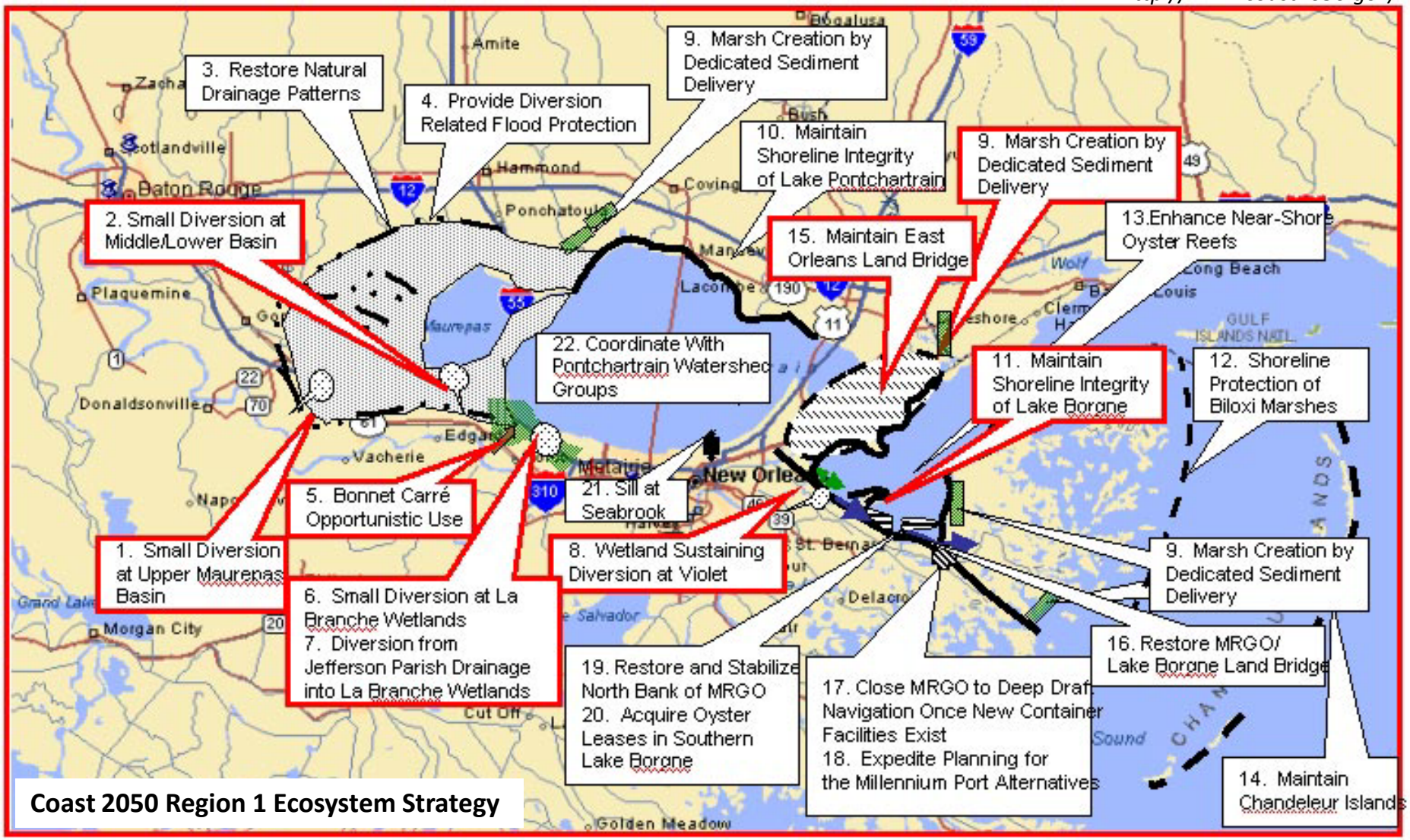
The prominence we gave these two factors reflected the master plan's mission as affirmed by citizens and local leaders. As anyone who lives in south Louisiana can attest, our communities need flood protection and our coast needs sustainable land. Putting these two factors front and center ensured that the projects we selected addressed the priority needs of the coast.

[redacted]

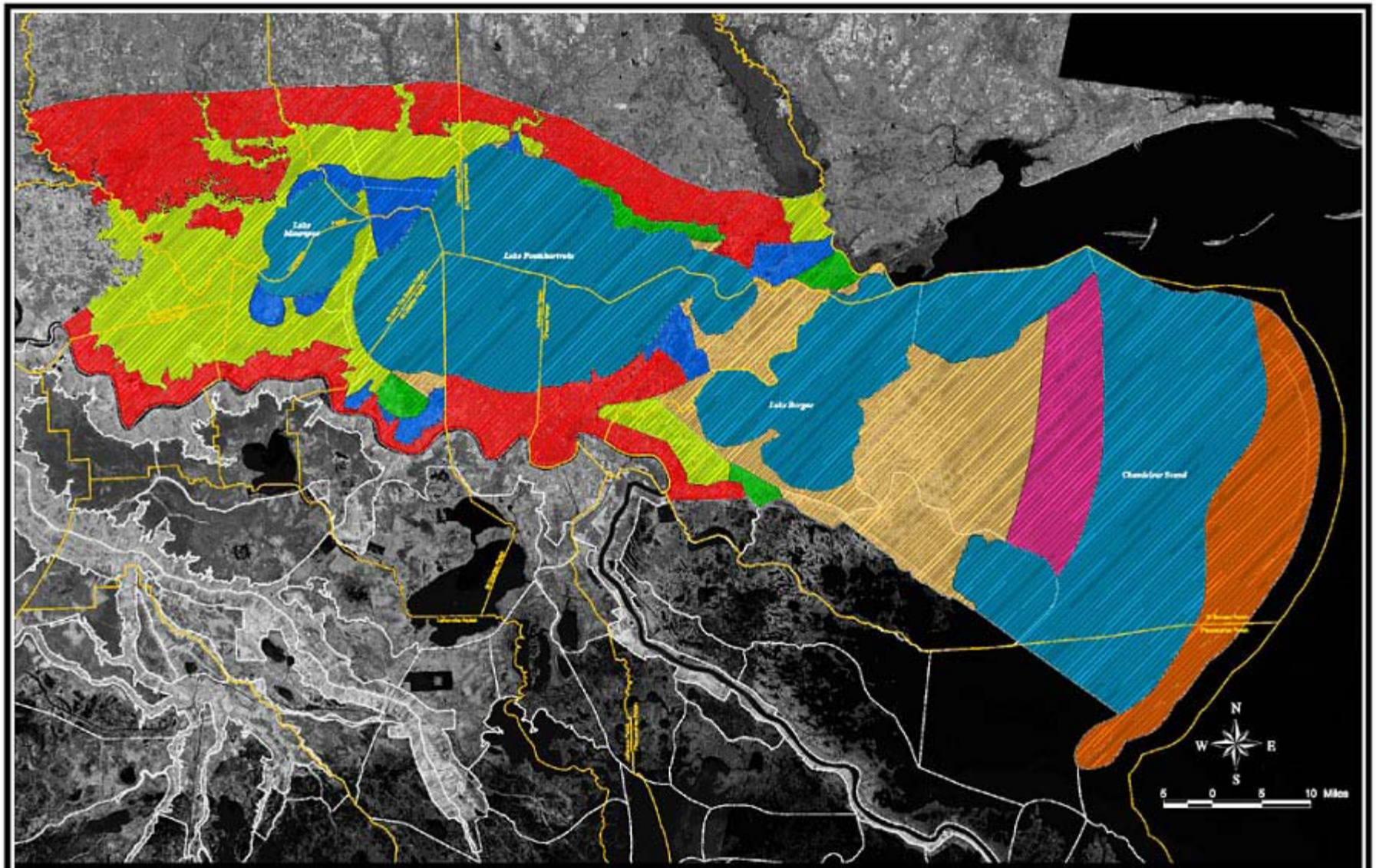
Modeling in a Systems Context

Louisiana Coast 2050 Restoration Strategy

http://www.coast2050.gov/



Coast 2050 Region 1 Ecosystem Strategy



DRAFT HABITAT OBJECTIVES - SEPTEMBER 1998 REGION 1

Habitat Type
- Freshwater Marsh
- Intermediate Marsh
- Brackish Marsh
- Saline Marsh
- Barrier Island/Chenier Shoreline
- Fastlands/Developed Areas
- Forested Wetlands
- Open Water
- Mapping Unit Boundary
- Parish Boundary

USGS

Louisiana Coast 2050 Restoration Strategy

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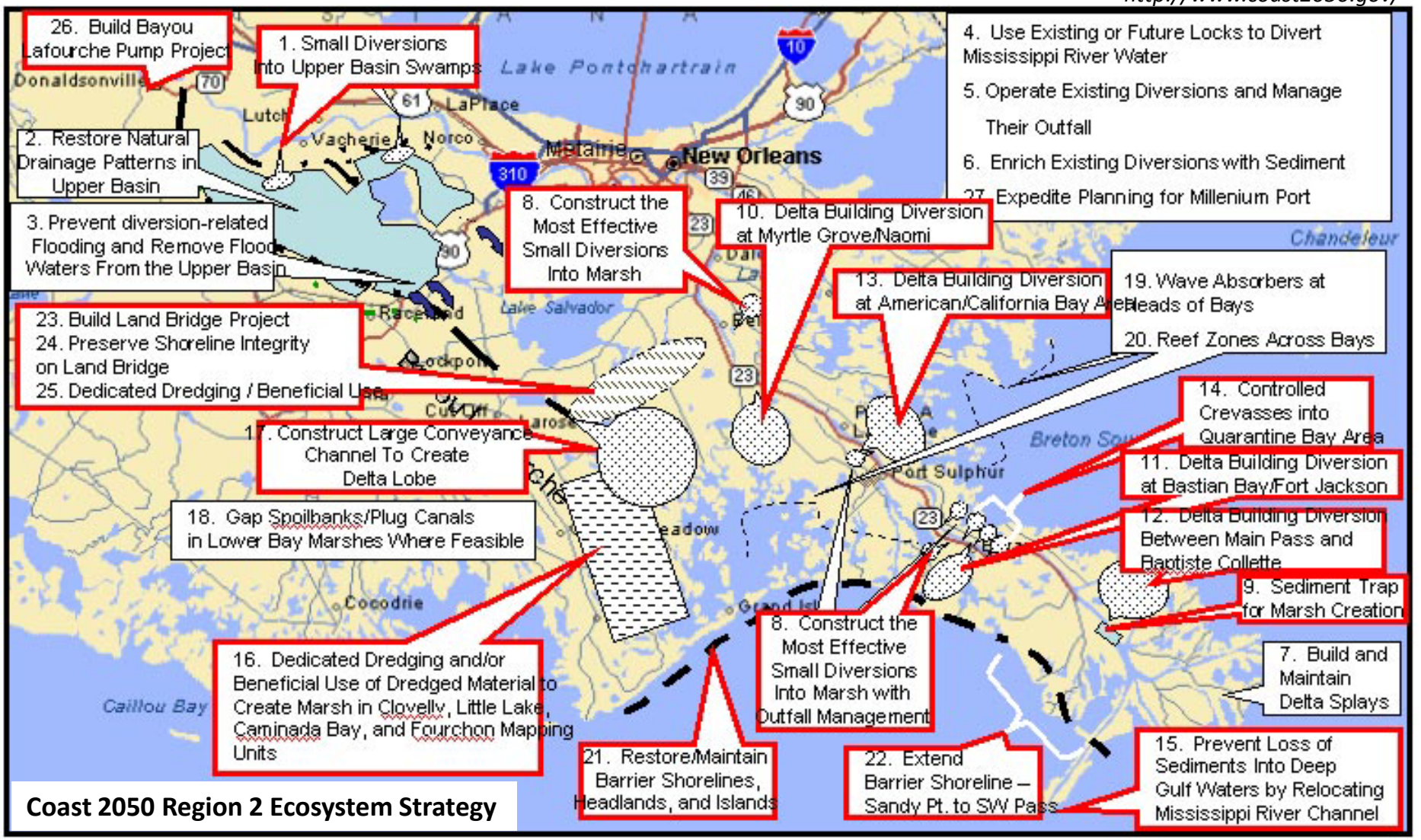
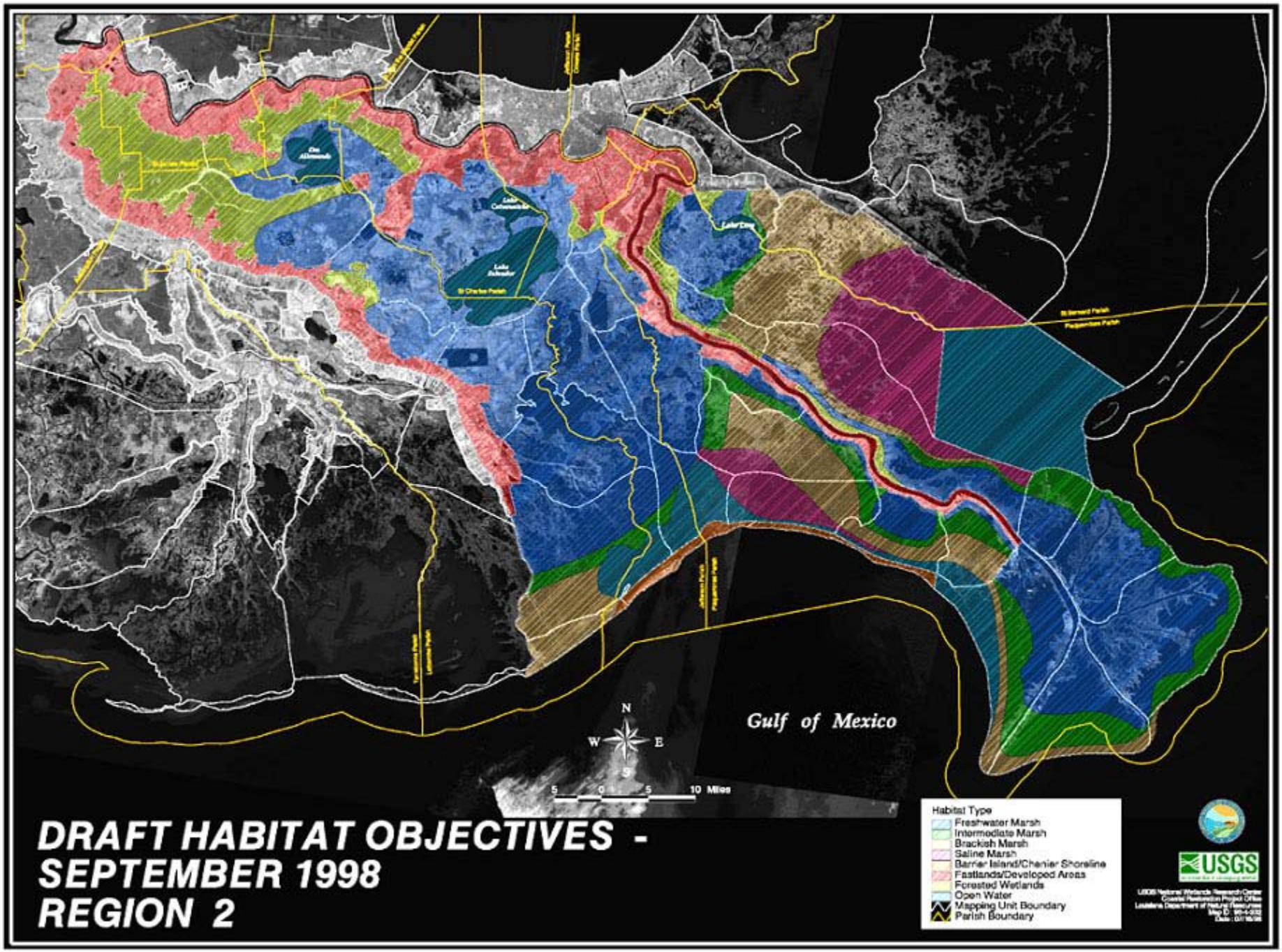
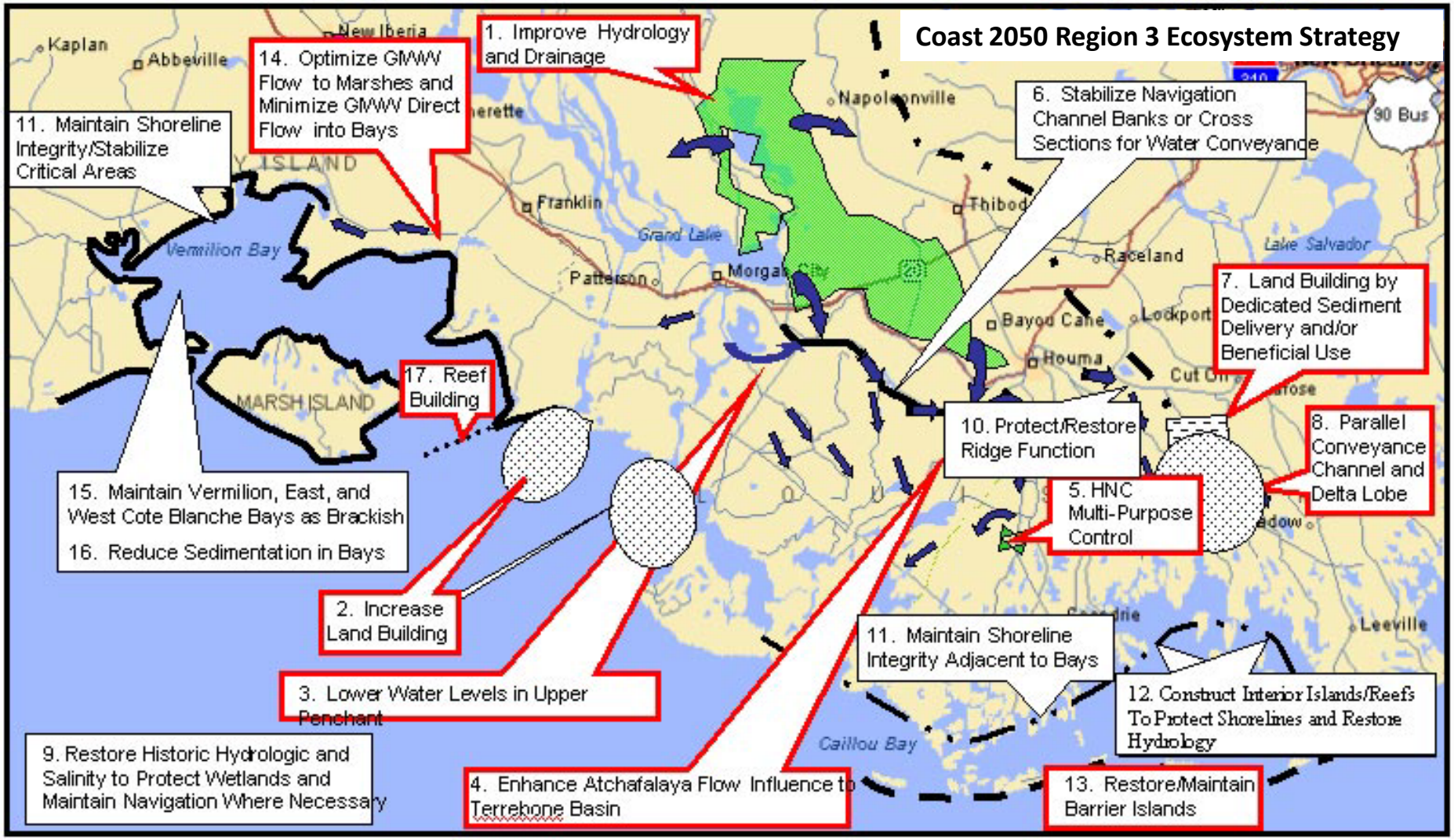


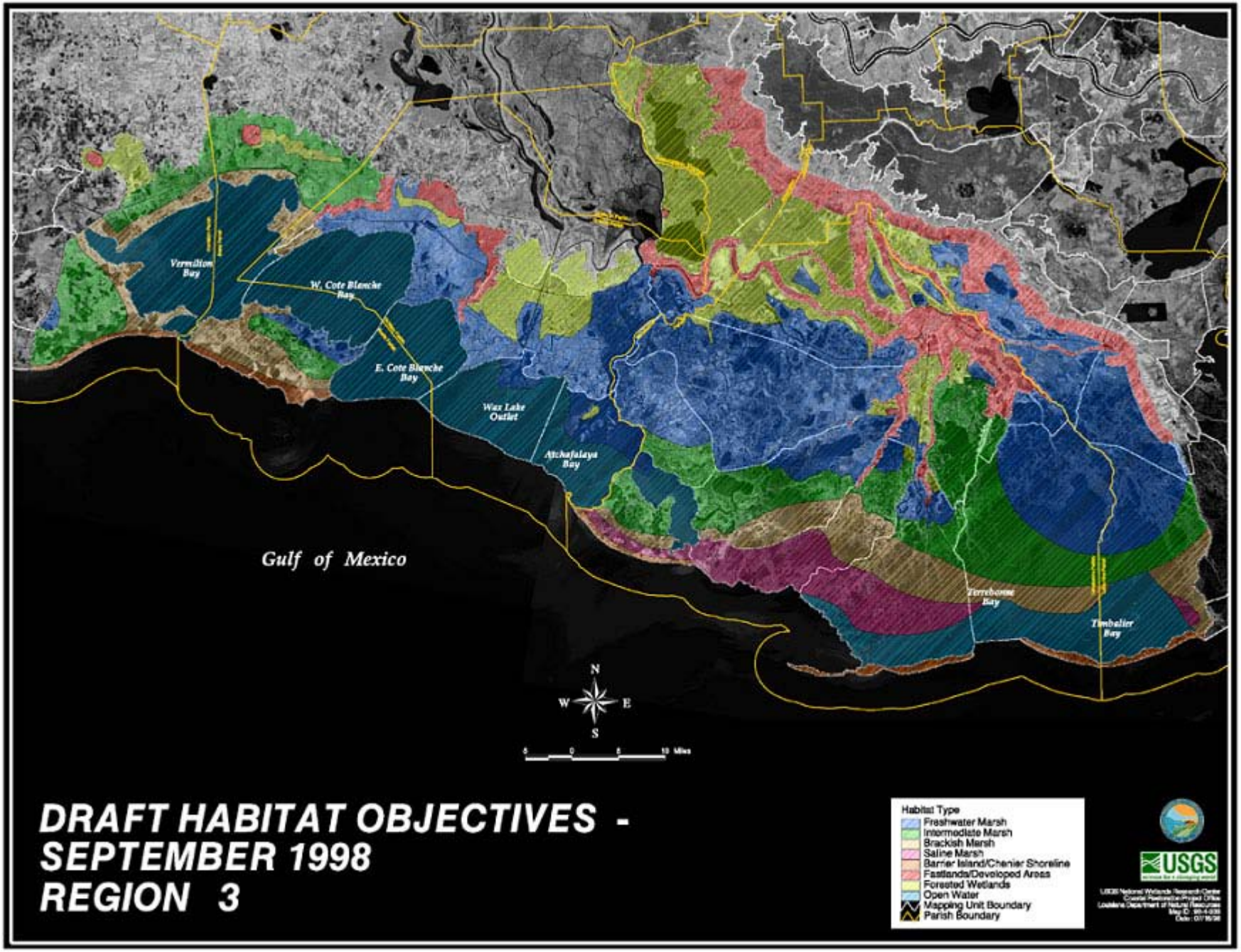


DRAFT HABITAT OBJECTIVES - SEPTEMBER 1998 REGION 2

Louisiana Coast 2050 Restoration Strategy

http://www.coast2050.gov/

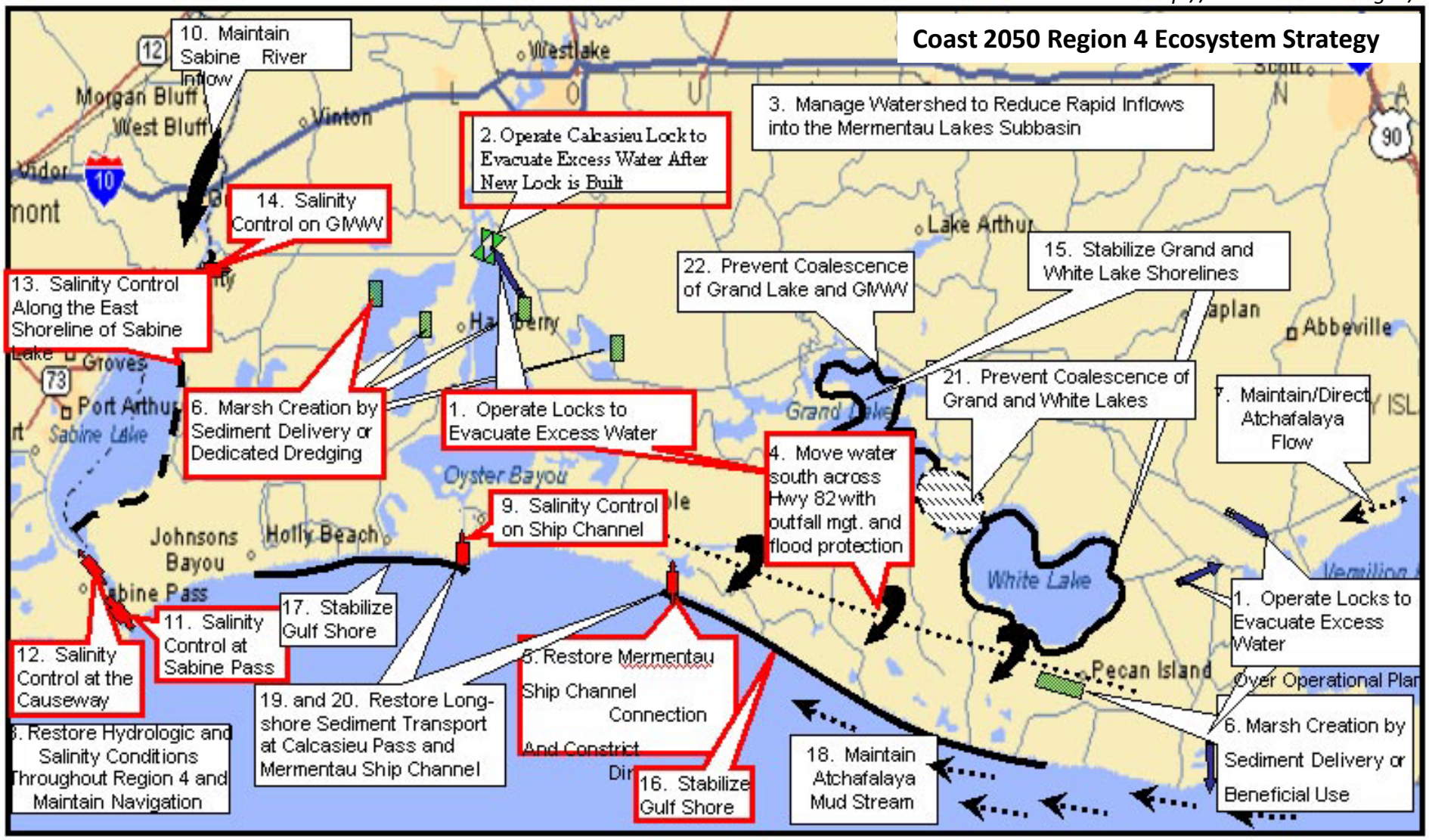


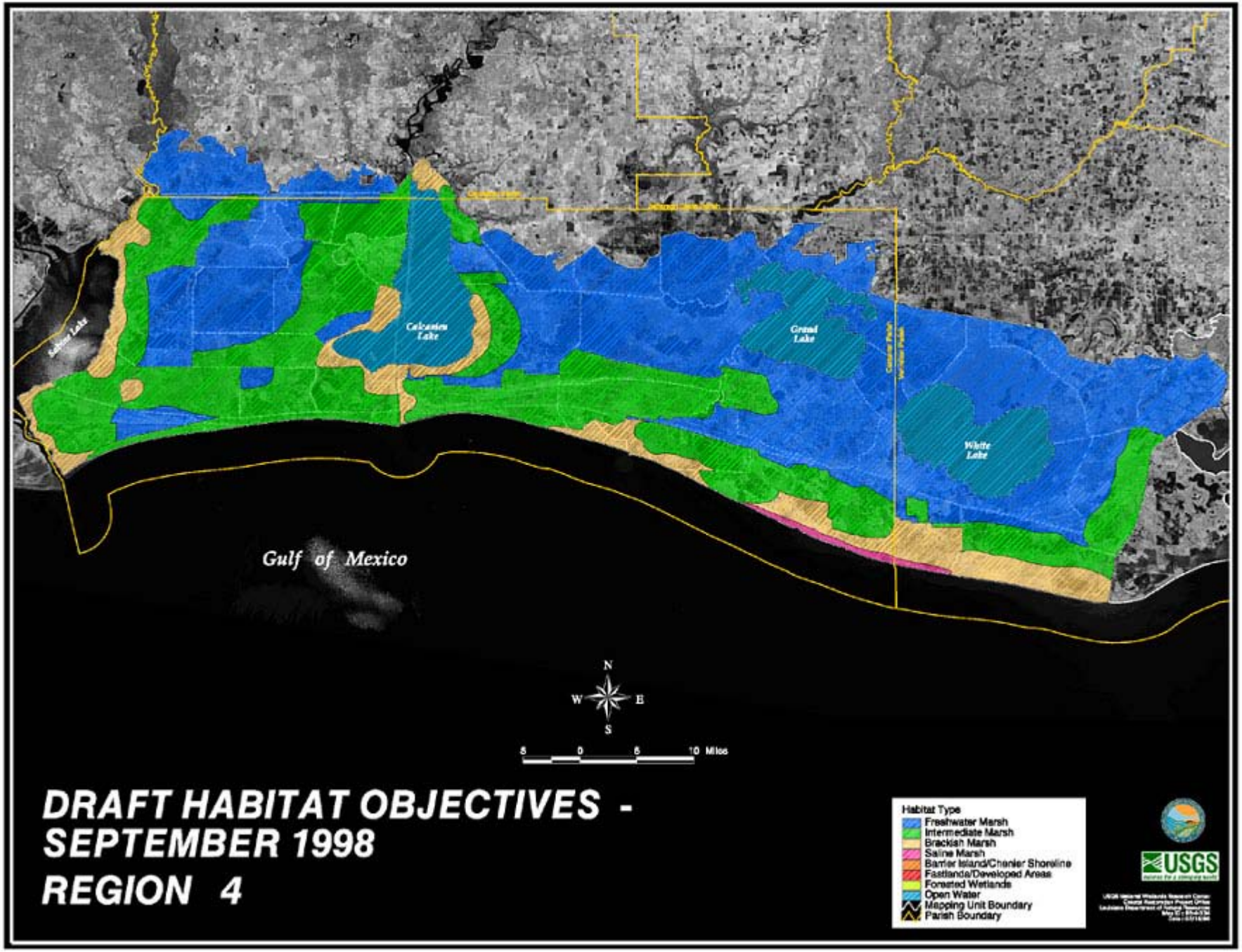


DRAFT HABITAT OBJECTIVES - SEPTEMBER 1998 REGION 3

Louisiana Coast 2050 Restoration Strategy

http://www.coast2050.gov/





DRAFT HABITAT OBJECTIVES - SEPTEMBER 1998 REGION 4

Sediment Management

- Coastline, river and island ecosystems will naturally realign in response to changes, so it is reasonable to conclude that the long-term maintenance dredging and shoreline preservation and defense construction project costs will increase.
- An understanding and integration of upland processes, including landscape management changes, will be essential to *adaptive* coastal management.

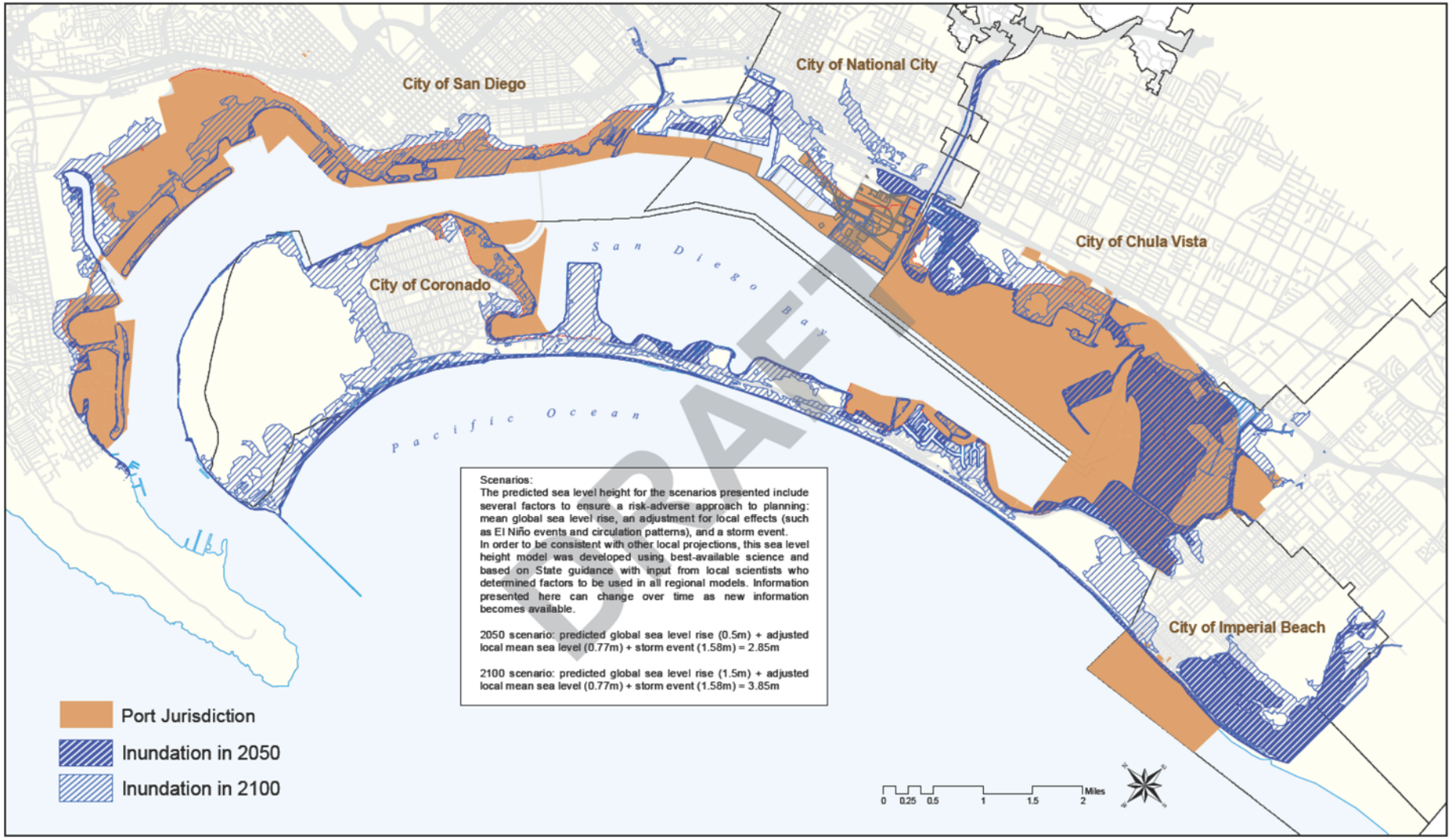


FIGURE #

San Diego Bay

Sea Level Rise in 2050 and 2100

Disclaimer: This map has been developed to communicate the potential risks, impacts, and exposure of future sea level rise inundation to Port tidelands. This map is intended to inform policymaking and should not be used for site-specific decision-making purposes. Actual impacts of inundation may vary depending on the resolution of topographic features and elevation

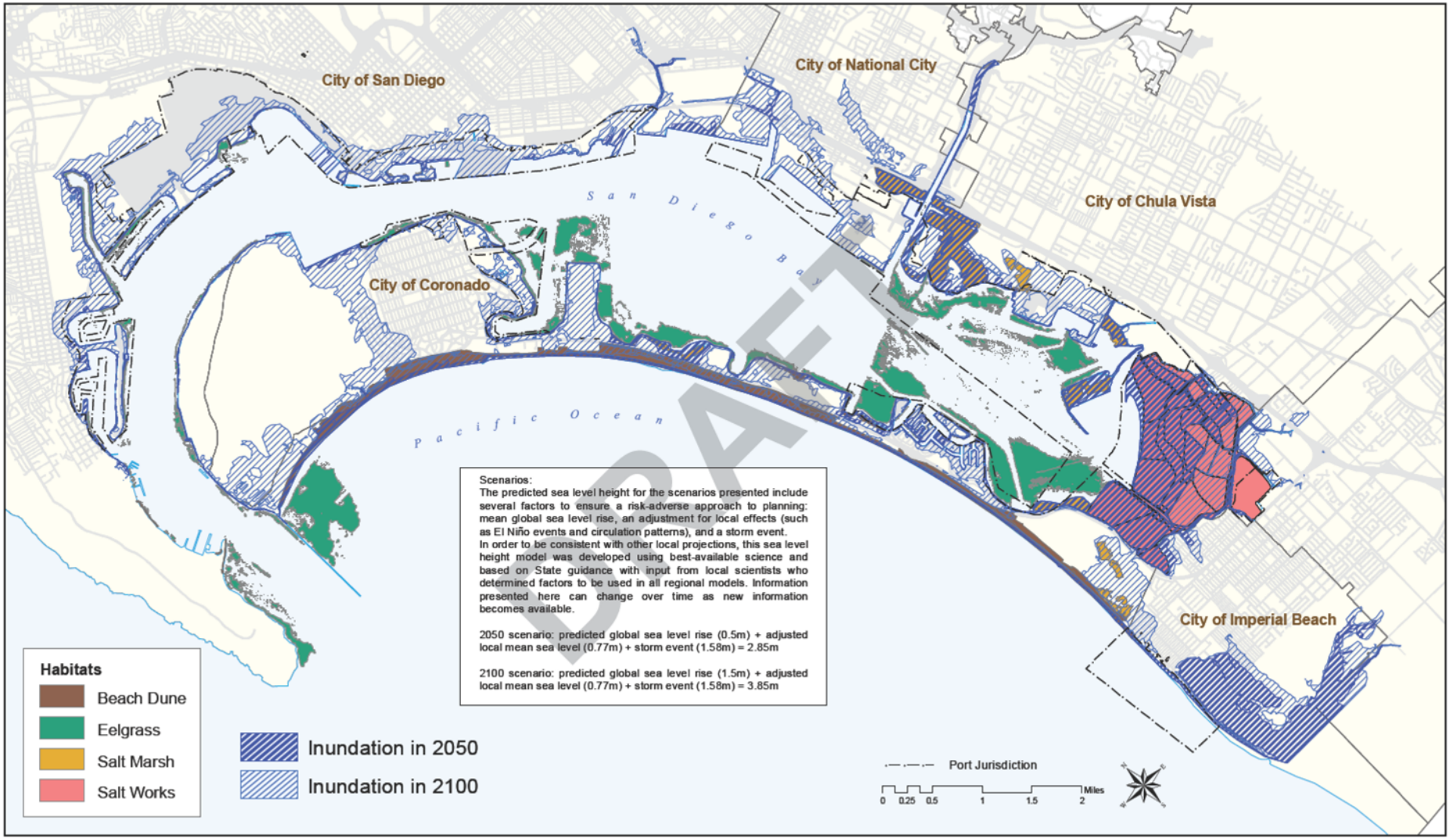


FIGURE #

San Diego Bay

Marine and Coastal Habitats

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Concluding Remarks

- Infrastructure protection and habitat restoration plans must take inevitable ecosystem and landscape changes into account.
- Changing land use with changing climate is a historic and future reality.
- For high-value assets, we may need to invest increasingly more
  - *Sometimes avoiding failure requires that you re-define success*
- In many cases, a broader assessment, across scales and regional objectives, will allow us to re-think our objectives and work with nature.

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