BUILDING LAND IN COASTAL LOUISIANA:

Expert Recommendations for Operating a Successful Sediment Diversion that Balances Ecosystem and Community Needs

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Facilitator of Working Group

Photo source: Getty Images

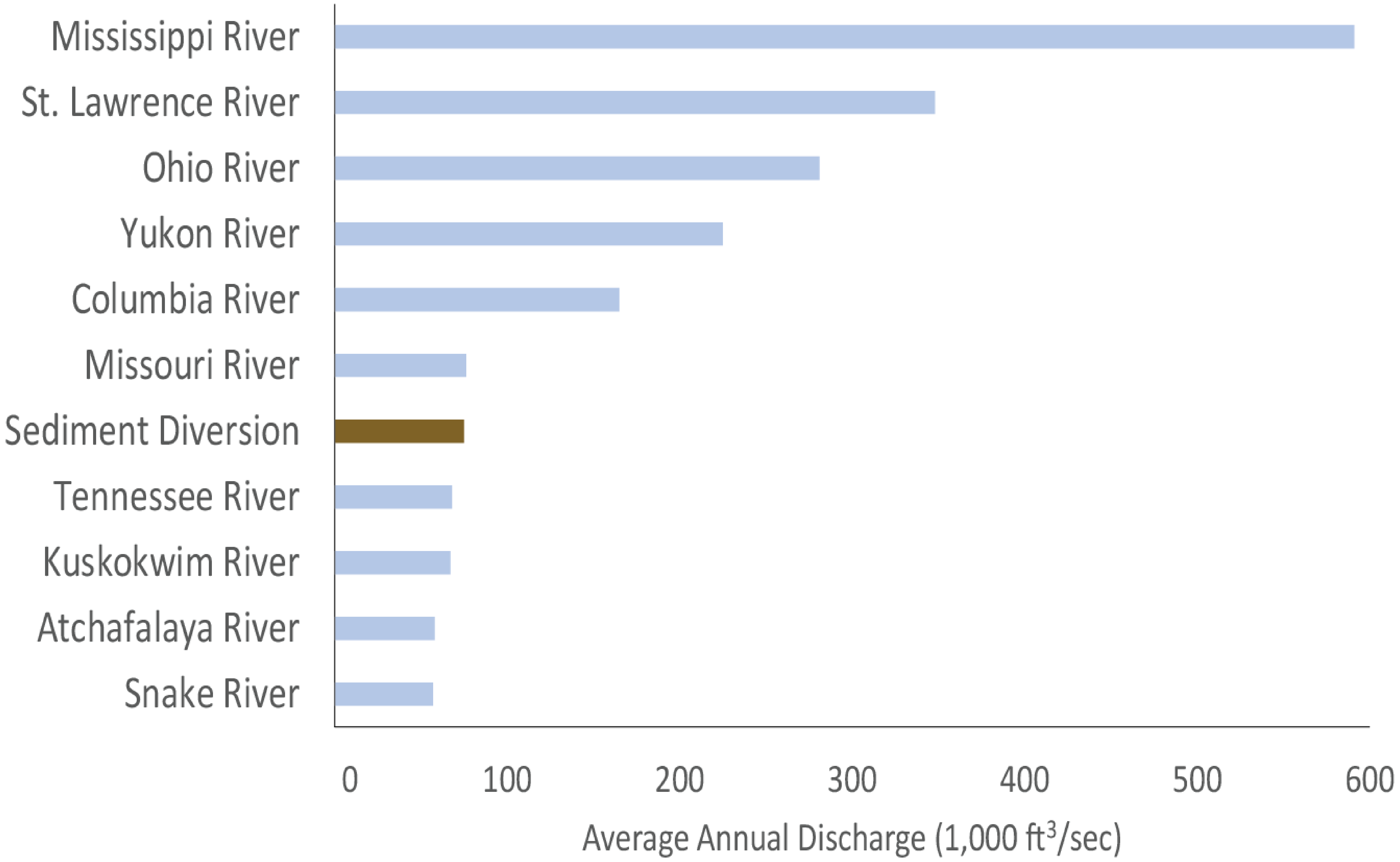
This is What We COULD LOSS

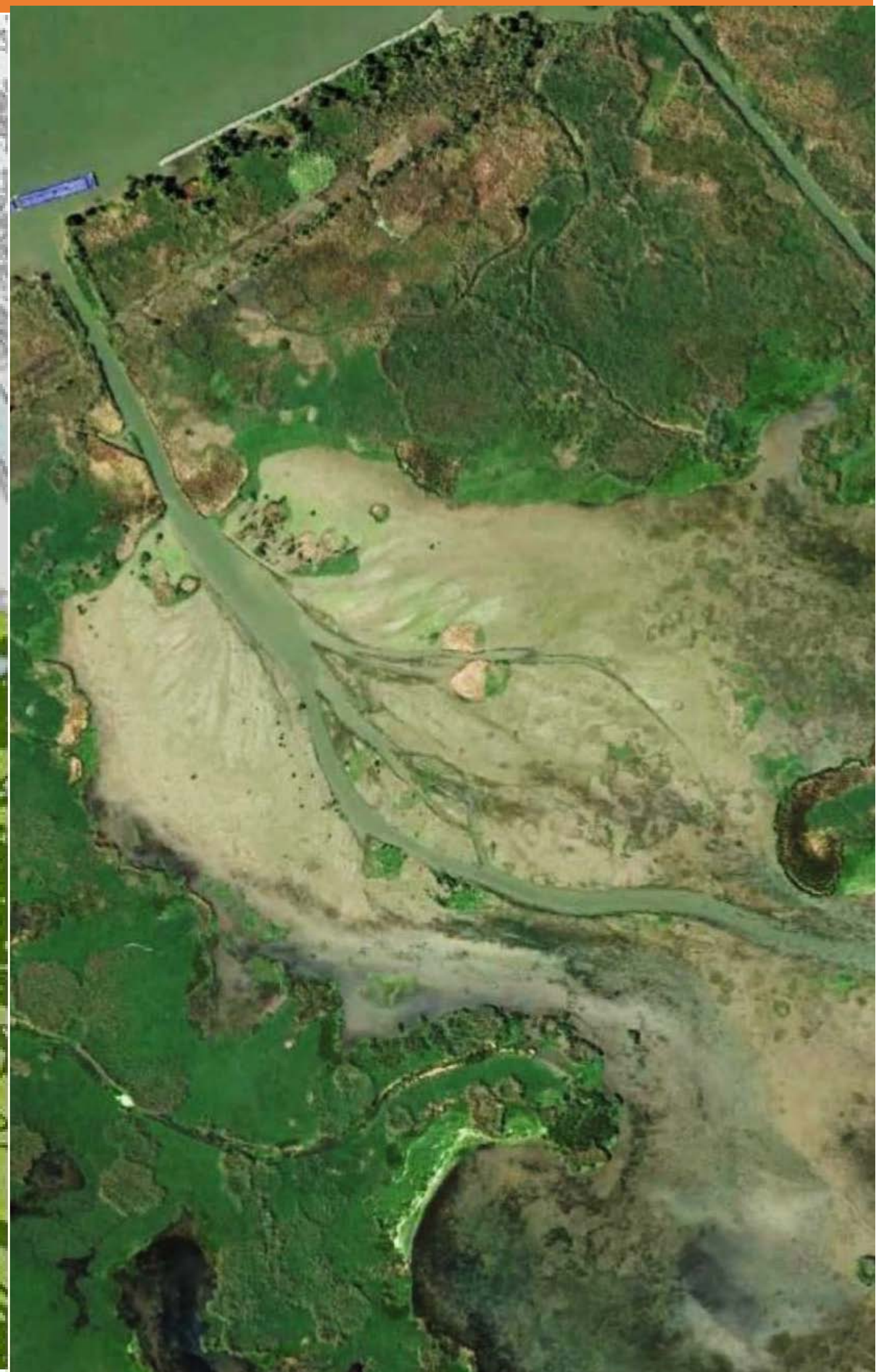
Future Without Action | High Scenario | Year 50

WHAT IS A SEDIMENT DIVERSION?

A series of gates built into the Mississippi River levee system that allow freshwater, sediment and nutrients to discharge from the river to the adjacent degraded marshes. Gates can be opened and closed to mimic the natural delta-building cycle of the river.

Average annual discharge of top 10 rivers in the U.S.





CONCERNS WITH CURRENT MODELING OPERATION STRATEGIES

- Can result in unrealistic operations
- Can overestimate effects to wetlands, vegetation, water levels, wildlife and fisheries, water quality and communities
- Likely to result in detrimental impacts to wetlands that are not fully accounted for in the modeling approach
- Does not optimize operations for land-building while considering other ecosystem needs as secondary goals or objectives

WORKING GROUP PURPOSE

The purpose of the Sediment Diversion Operations Expert Working Group (WG) is to explore, debate, discuss and document the complex environmental, social, economic and policy issues involved with the operation of a sediment diversion.

CORE MEMBERS

James Cowan, Jr.
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+42

MEETINGS

September 2015 – April 2016

STATE OF THE KNOWLEDGE

What do we know about diversion outcomes?

What relationships do we understand?

What lessons have we learned from other examples?

DATA GAPS AND MONITORING

What do we not know?

How should we address key uncertainties?

What is needed to set up an effective adaptive management program?

- 09.16.15 — RIVER HYDRODYNAMICS AND SEDIMENT
- 10.16.15 — BASIN GEOLOGY AND LAND-BUILDING
- 11.20.15 — WATER QUALITY
- 12.14.15 — WETLAND HEALTH
- 01.13.16 — FISH & WILDLIFE
- 02.17.16 — COMMUNITIES & SOCIO-ECONOMICS
- 03.14.16 — OPERATION STRATEGIES
- 04.13.16 — GOVERNANCE, LEGAL & STAKEHOLDERS

OPTIMIZED BY PARAMETER

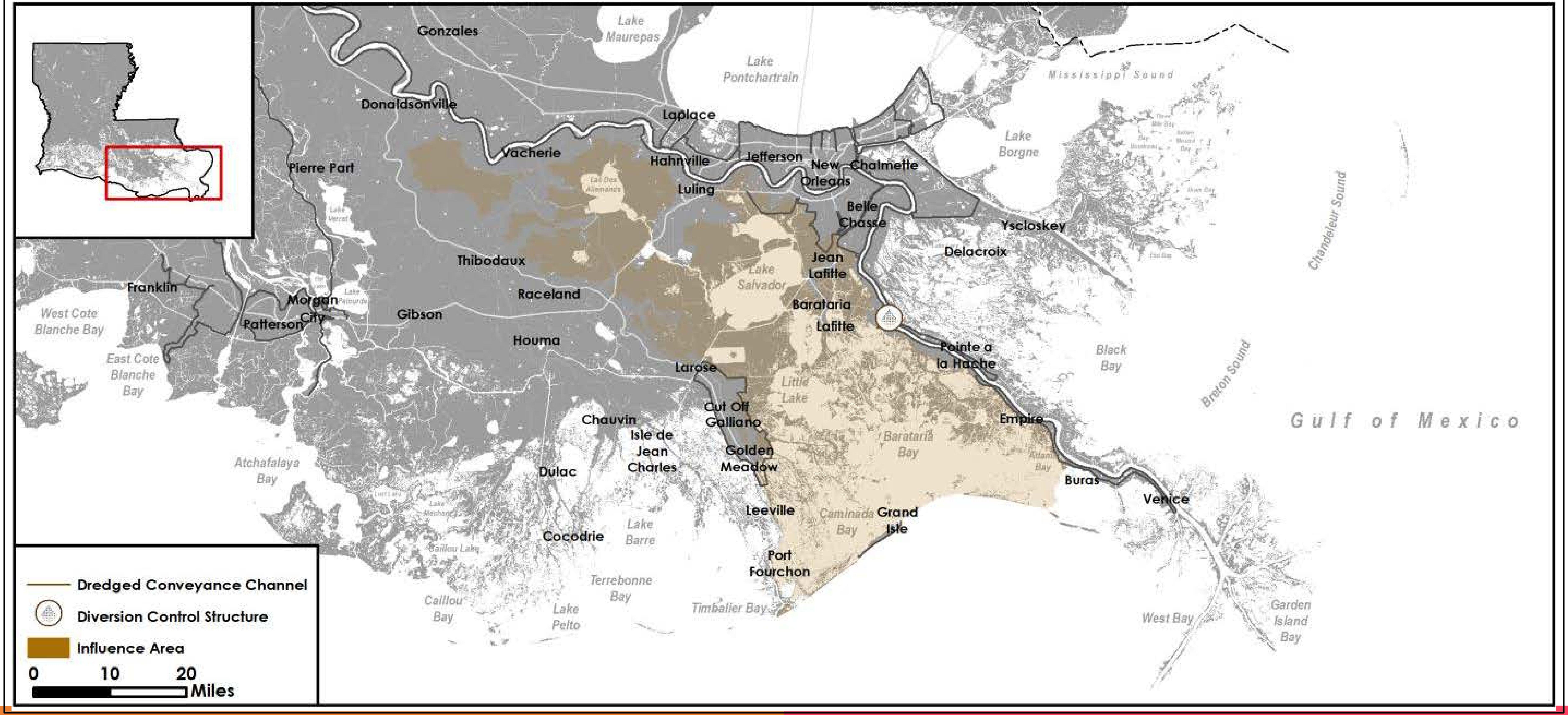
Considered each parameter as the only objective with no other constraints to determine the optimal operation strategy of a diversion to maximize that topic.

INTEGRATING STRATEGIES

After each topic (and their specific parameters) were discussed, the WG identified consistencies and conflicts in the various operations strategies.

BASIN CHARACTERISTICS

RESIDENCE TIME



- Highly frictional system
- Tidal signal dissipates quickly
- In theory, the basins should be out-welling systems which export material in a gradient fashion

- Flushing and residence time will decrease dramatically with higher magnitude discharges
  - 33 days for 300 m3/s versus 3.3 days for 3,000 m3/s (Das et al. 2010)
  - Residence time increases 50% when diversion is closed (Huang et al. 2011)

NUTRIENTS

Nutrient Loads

- It is not possible to have a sediment efficient diversion that captures a low volume of nitrogen
- Peak in nitrate flux coincides with spring flood; peak in nitrate concentration lags several months behind
- Other nutrients have different relationships with peak discharge
- Potential to alter nutrient ratios

Nutrient Fate

- Lowering salinities removes it as a limiting factor and increases the capacity of plants to uptake nutrients
- Increased nutrient loads will increase biomass and influence the above- and below-ground allocation ratios
- Will also change likelihood of sulphide toxicity and microbial community and respiration rates

Residence Time

- Long residence times will result in little export of nutrients as most are processed in the estuary
- Large diversions can increase export of nitrogen to GoM
- Phosphorous attached to sediments is more likely to accumulate in the basin

RECOMMENDATIONS FOR OPERATIONS

Photo source: USFWS (first two), Audubon, Bill Stripling

INITIAL OPERATIONS

Year 0 to Year 10

Initial Operation Plans

Operation strategies will change over time as the basin matures and the ecosystem adjusts to the new normal condition. Initial operation plans should include more monitoring and flexibility to modify operations as the conditions in the basin will be changing rapidly. Updates to the plan may occur more frequently based on an integrated and near real-time operations-monitoring feedback loop.

DISTRIBUTARY CHANNEL NETWORK

An estimated 5-10 years is needed to develop a distributary channel network that can move 75,000 cfs through the basin without causing backwater flooding. Operations should ramp up to 75,000 cfs over time to facilitate the development of the network.

WATER LEVELS

The diversion channel will be flowing into already fragmented, degraded wetlands. In some of these areas, water levels are already high at certain times. Research is needed on how long it will take water levels to even out and ensure the diversion is not inducing additional flood risk on adjacent communities.

EROSION

The outfall of the diversion consists of weak, highly erodible marshes. The jet plume that enters the basin will cause some scour in the channel and immediate outfall area. Efforts should be made to anticipate this erosion and limit it to areas of the developing channel network.

VEGETATION

Wetland loss could also occur from preexisting vegetation loss due to flood stress or the initial shock of changing conditions, especially during the growing season. Initial operations should focus on operating during the dormant season to reduce loss and allow vegetation to adapt to new conditions.

FISH & WILDLIFE

Similar to vegetation, fish and wildlife species can suffer from an initial shock of changing conditions. Initial operations should occur gradually to ensure fish and wildlife species, as well as the habitats they depend on, can self-organize around the new normal conditions.

WINTER OPERATIONS

November through February

SEDIMENT LOADS

First peak of the Water Year carriers the greatest concentration of sand, silt and clay. Highest suspended sediment loads occur from November to February.

FISH & WILDLIFE

Reduce or eliminate impacts to most commercial and recreational fish and wildlife species, especially during initial operations. Closing the diversion in March can facilitate the larval recruitment of blue crab and shrimp into Barataria Basin.

WATER LEVELS

The Gulf of Mexico stage is lowest in the winter, which helps to move water out of the basin and reduce the risk of elevated water levels for extended periods of time.

COLD FRONTS

Silts and clays initially deposited on bay and canal bottoms can be resuspended and deposited on the marsh surface by cold front passages prior to consolidation.

NUTRIENT UPTAKE

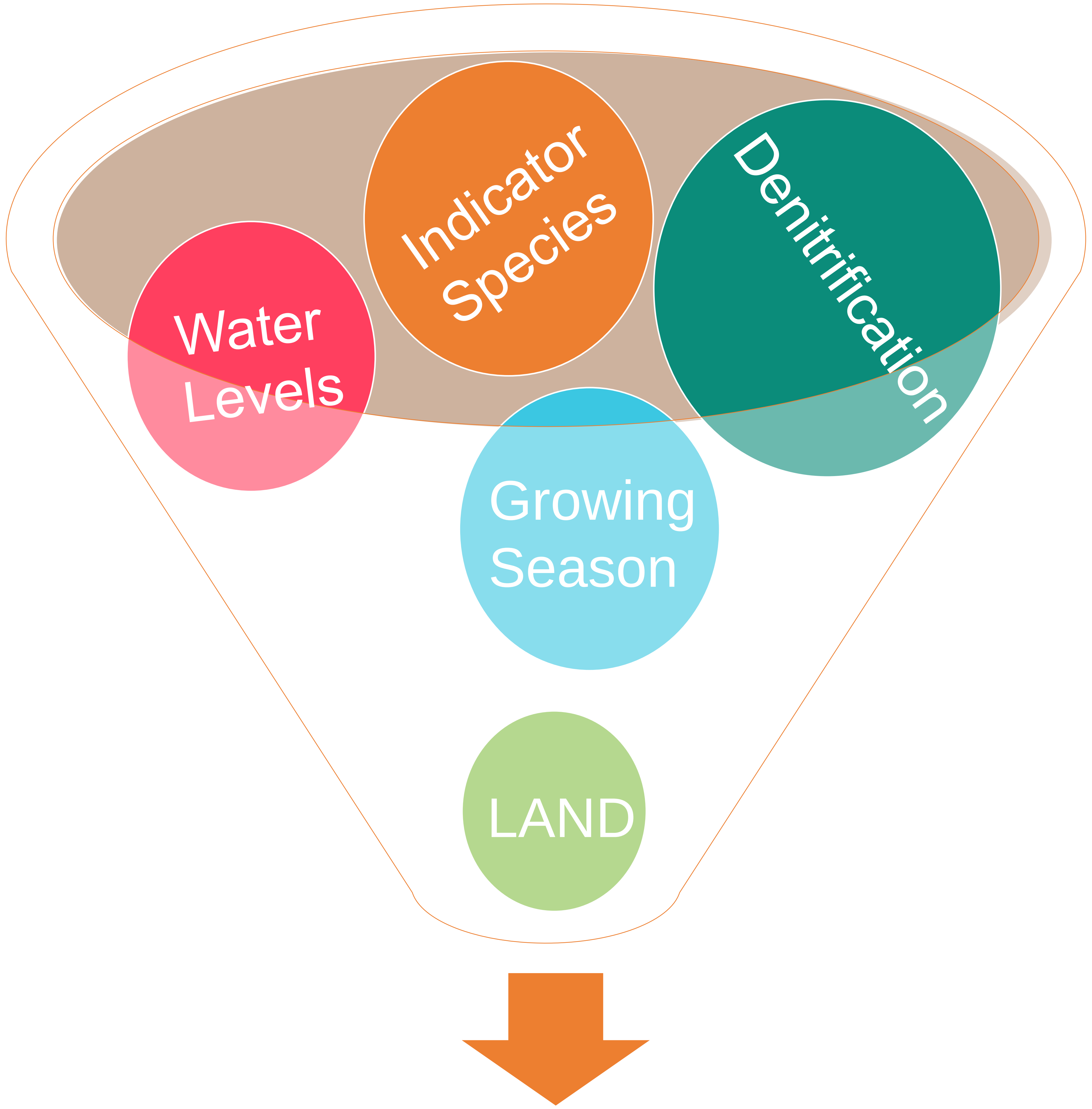
Cold fronts can also push nutrient-laden water onto the marsh surface and increase the denitrification potential of the basin during these months.

VEGETATION

Operation during the non-growing season will reduce vegetation stress and loss and allow prolonged and continuous flooding while plants are dormant.

SPRING & SUMMER OPERATIONS

Taking Full Advantages of the Highest Peaks during the Water Year



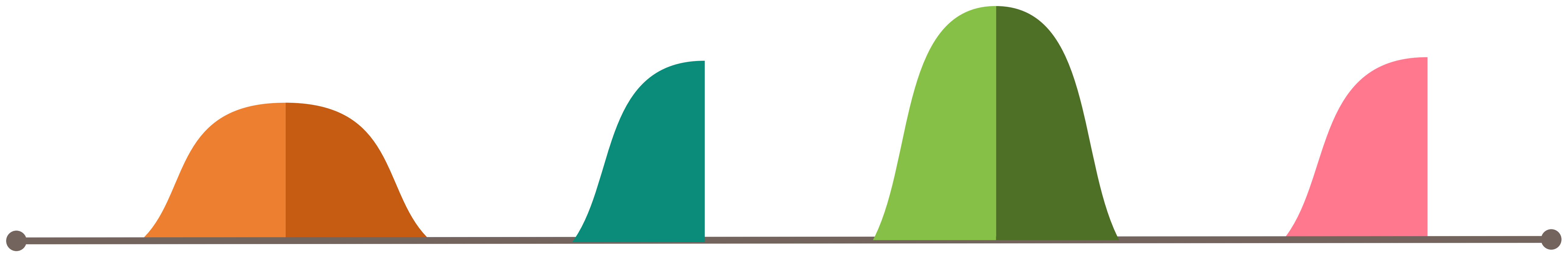
OPERATION STRATEGY

Operations during spring and summer are more complex and require a more intricate and balance operation strategy:

- Provide adequate dry period for vegetation (species specific), especially at the start of growing season.
- Optimize denitrification – rates are highest during the warmer months and concentrations in the river are at a peak.
- Minimize negative net effects on the community of indicator species. Include predictions of effect, research and monitoring to quantify effect, mitigation options and communicate any potential anticipated effects (or actual effects) to the public.
  - Alligators, once established, nest from mid-May to September and can be impacted by prolonged elevated water levels.
  - Blue crab spawn in May and from August to September
  - Brown shrimp juvenile recruit into the basin in April and May
  - Oyster spawning and establishment occurs in spring/ summer
  - Birthing season for bottlenose dolphins

TIMING OF OPERATIONS

What Scientists Refer to as the River's Hysteresis



Operating on the rising limb would result in:

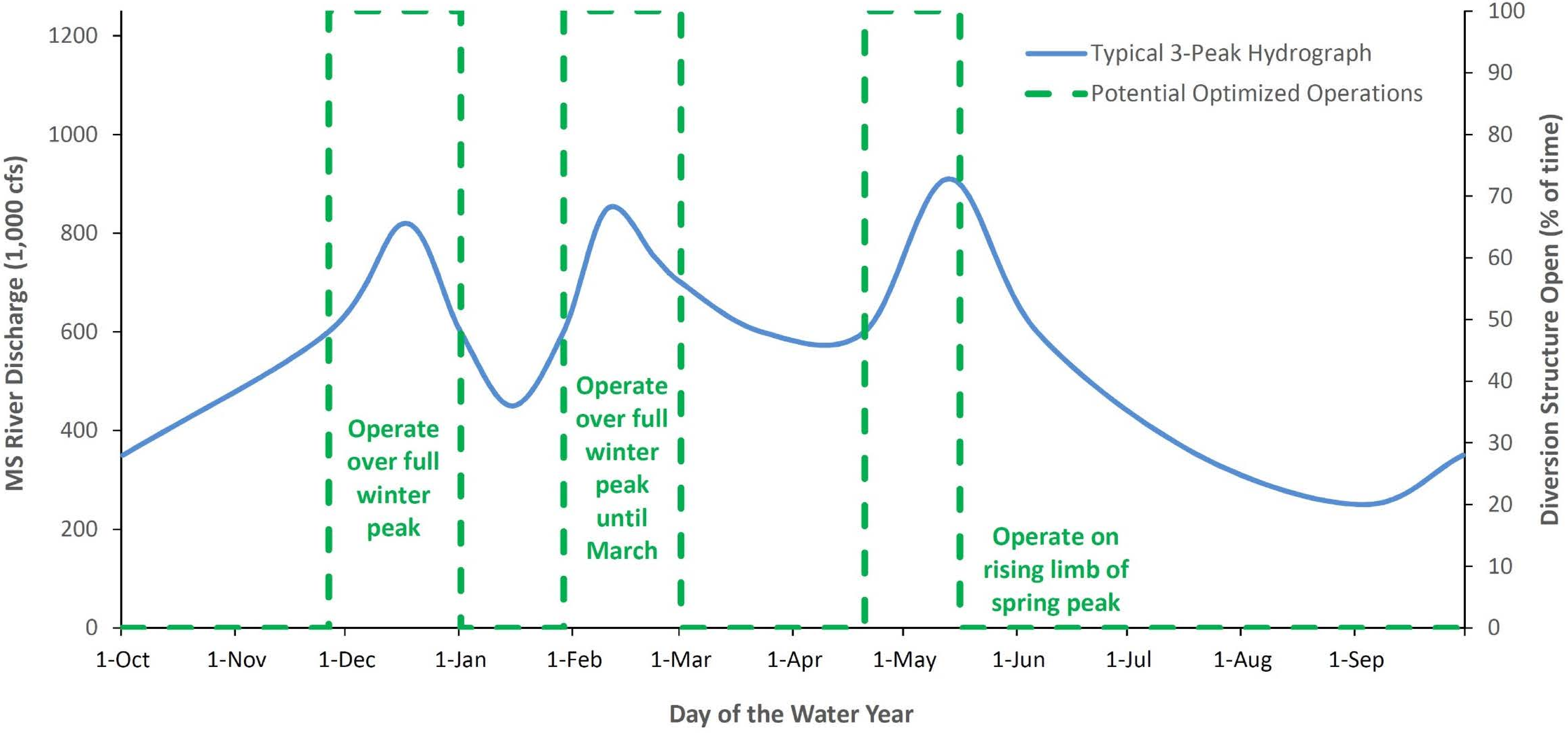
56%
of the water diverted

72%
of the sediment diverted

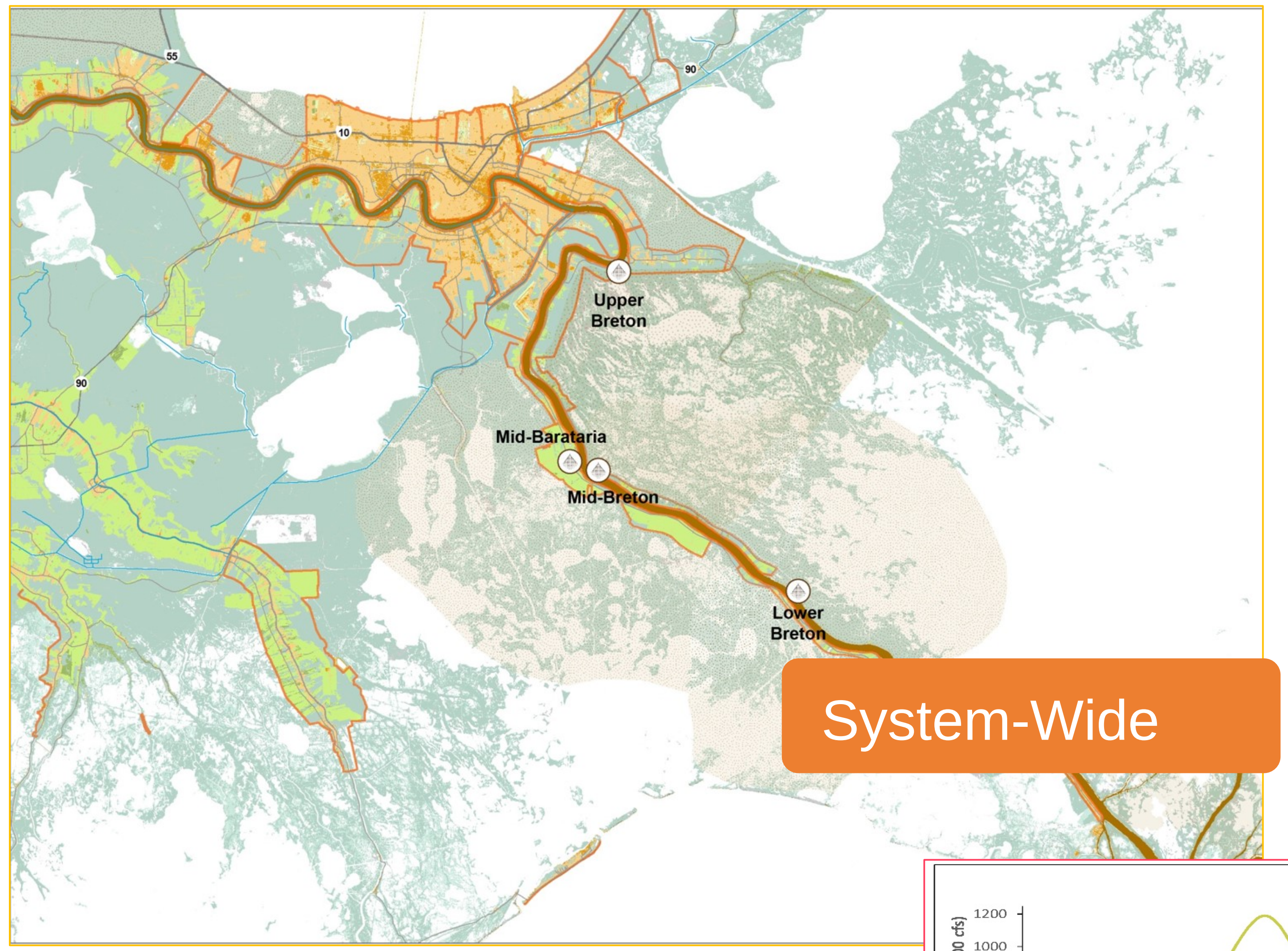
compared to operating on both the rising and falling limbs of the flood peak.

Another potential benefit of closing on the falling limb would be to **increase sediment transport capacity** in the river, thereby reducing the potential for shoaling.

DIVERSION STRATEGY - EXAMPLE

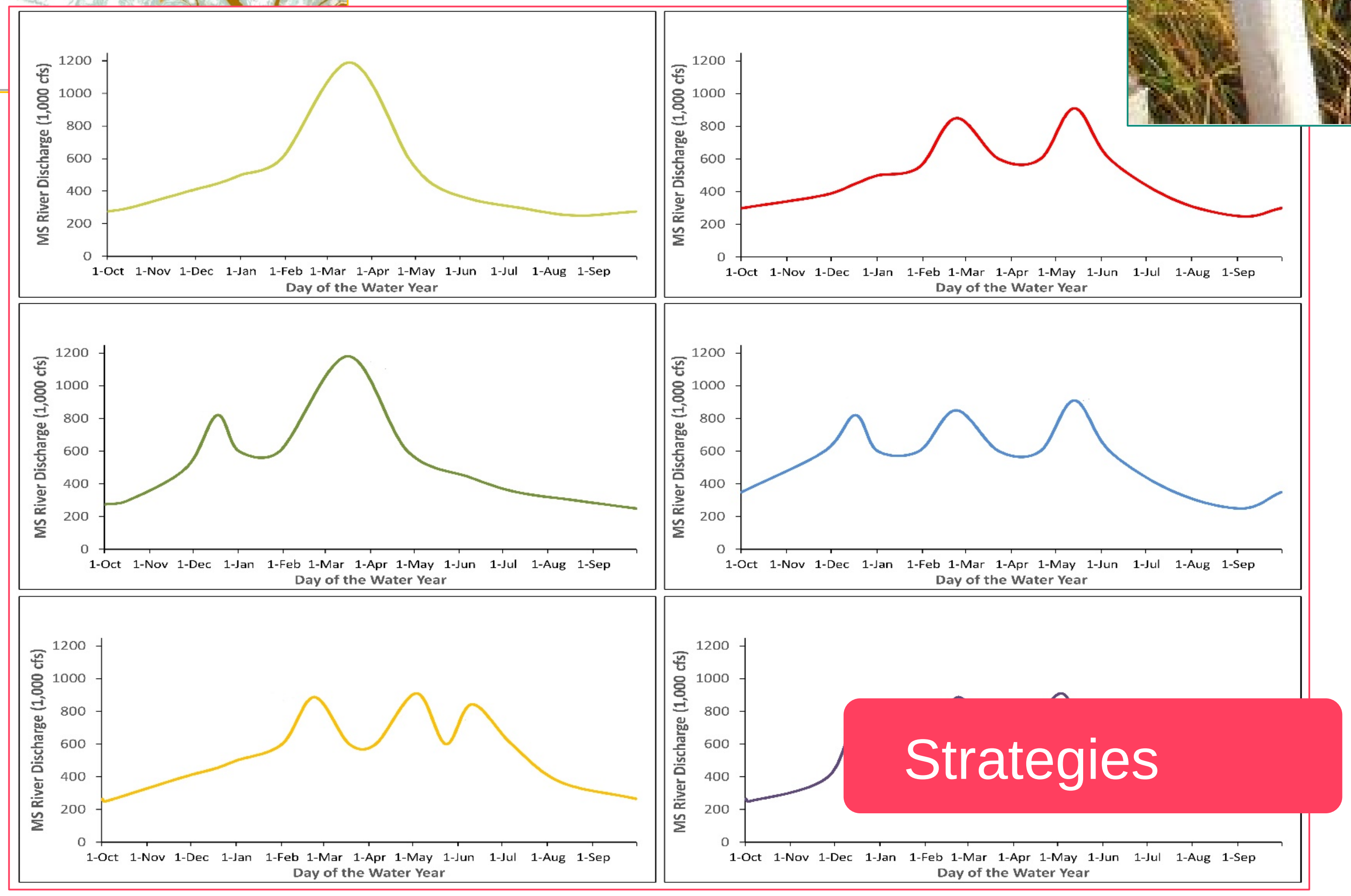


OPERATIONS PLANS



Indicators and Outcomes

Operation plans may initially be designed for each individual diversion, but should quickly move towards basin- and system-wide operation plans that include individual project and collective goals and objectives as well as basin-wide outcomes and indicators of success. Operation plans should take into account all diversions and flood control structures.



Expectation Management

Plans include overall strategies based on typical hydrographs supplemented annually based on predicted river and basin conditions, outcome of previous year's operations and other conditions.

Learning as Primary Management Function

The plan should outline a robust monitoring plan, including baseline data, to support an adaptive management process with defined feedback loops and timelines, including a system-wide assessment at least every 5 years.

Decision-Making Structure

The plan should outline a clear decision-making process and structure with roles and responsibilities for agencies, local governments, researchers and stakeholders.

MONITORING RECOMMENDATIONS

- In general, water quality data is biased to fair weather conditions, so where possible, permanent or temporary stations, including nutrient sensors, should be deployed
- Increase the offshore monitoring in coastal areas adjacent to major diversion sites, specifically focusing on salinity, nutrient concentrations and ratios, occurrence harmful algal blooms (HABs) and hypoxia.
- Monitor tidal passes to measure water, sediment and nutrient fluxes over diurnal tidal cycles, and also under different seasonal/climatic conditions. Monitor phosphorus concentrations and fluxes in bay sediments.
- Install a permanent monitoring station (or upgrade existing, such as Vicksburg) to capture nutrient loads up-river with ample travel time to consider in any operation management decision.
- Utilize CRMS stations, or anticipated SWAMP monitoring stations, to measure water quality in interior ponds and channels. Parameters to measure could include chlorophyll-a, nitrate, dissolved oxygen and turbidity.
- Conduct additional research to better understand how to minimize algal blooms or increase physical disturbance/dissipate blooms in problem areas (i.e., shock pulse from diversion).
- Conduct estuarine flux measurements and/or modeling to understand the spatial variability of residence times in the basin under various operation strategies.
- Research changes in microbial communities, biomass and other biogeochemistry factors

RECOMMENDATION REPORT

What Else is Included:

FISH & WILDLIFE SPECIES

SOCIAL SCIENCE & ECONOMICS

HYDROLOGY & GEOLOGY

GOVERNANCE & LEGAL

MAINTANENCE & OUTFALL MANAGEMENT

ADAPTIVE MANAGEMENT, MONITORING & RESEARCH

Photo source: NWF, Tim Carruthers, Loomis

QUESTIONS?

http://www.mississippiriverdelta.org/diversion-ops-report/

Peyronnin, N.S.; Caffey, R.H.; Cowan, J.H.; Justic, D.; Kolker, A.S.; Laska, S.B.; McCorquodale, A.; Melancon, E.; Nyman, J.A.; Twilley, R.R.; Visser, J.M.; White, J.R.; Wilkins, J.G. Optimizing Sediment Diversion Operations: Working Group Recommendations for Integrating Complex Ecological and Social Landscape Interactions. *Water* **2017**, *9*, 368.

THANK YOU!