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Prepared in cooperation with the Coastal Protection and Restoration Authority (CPRA) of Louisiana

Expectations of Maurepas Swamp Response to a River Reintroduction, Louisiana

Introduction

Mississippi River reintroductions (freshwater diversions) into wetlands previously disconnected from the river have been implemented in southeastern Louisiana as a means to rehabilitate degraded and submerging wetlands. To date, all active Mississippi River reintroductions have targeted marsh habitat. However, a 57 cubic meter per second (2,000 cubic foot per second) river reintroduction is being designed and implemented by the Coastal Protection and Restoration Authority (CPRA) of Louisiana to rehabilitate a degraded and submerging swamp forest of approximately 16,583 hectares (40,977 acres) in the Maurepas Swamp; 30 percent of the project area is closed forest canopy, 58 percent is transitional forest, and 12 percent is open canopy wetland (severely degraded forest and open marsh) (Keim and others, 2010a; Krauss and others, 2017) (fig. 1). The goal of this project is to reduce or minimize loss of swamp forest habitat in the project area through reintroduction of Mississippi River water. River reconnection has often been stated as the most critical step necessary to rehabilitate and preserve the integrity of the natural and cultural resources of the Maurepas Swamp ecosystem (Shaffer and others, 2016).

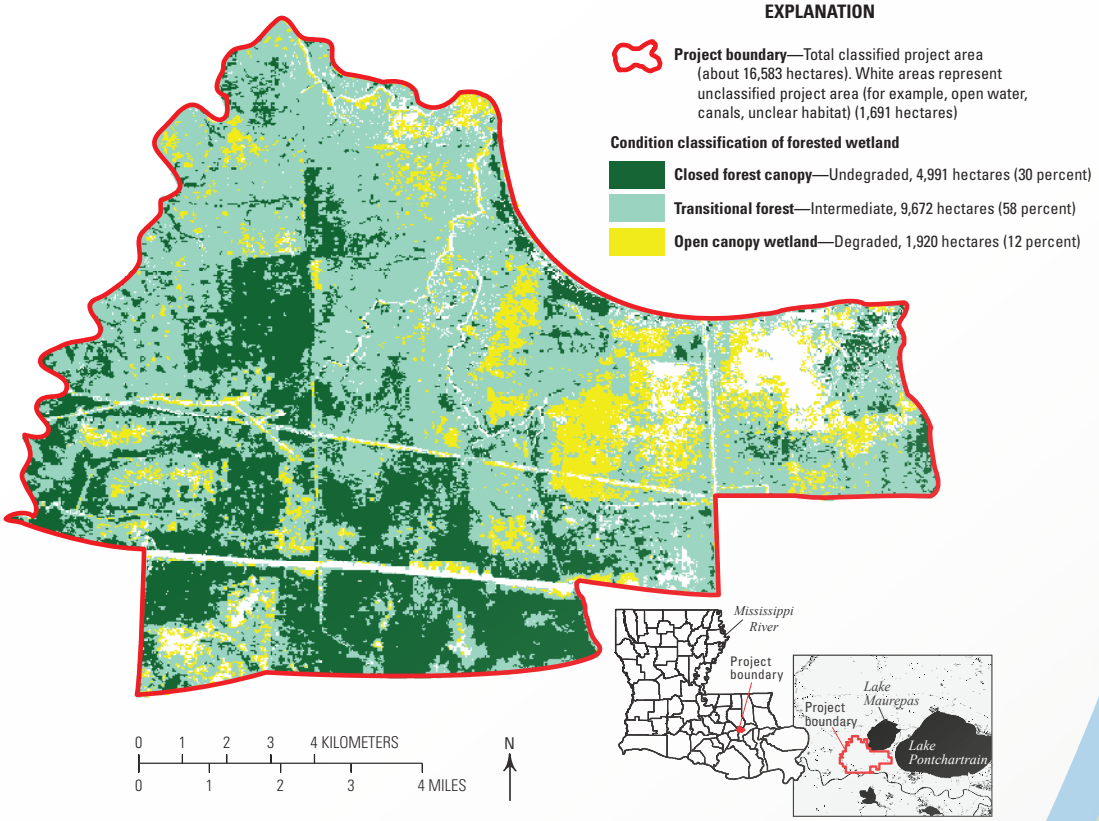

Figure 1. Condition classifications of forested wetlands in the Maurepas Swamp, Louisiana, project area (modified from Keim and others, 2010a; Krauss and others, 2017). "Open canopy wetland" represents severely degraded forest and open marsh.

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Degradation of the Maurepas Swamp is representative of the degradation in many coastal Louisiana swamp forests. Because this is the first river reintroduction into swamp forest in Louisiana, expectations of successful rehabilitation of the Maurepas Swamp have been made relative to what scientists know about healthy swamp forests. The performance measures (PMs), developed by the U.S. Geological Survey (USGS) in cooperation with the CPRA and two universities (Krauss and others, 2017), will serve to adjust operation for optimum positive performance, and measurement and monitoring will inform the design of other river reintroductions targeting freshwater swamp forests in the future.

Expectations

Wetland restoration projects often have many expectations associated with improving habitat function. However, it is often most effective to track a small number of more easily assessed and specific responses in postrestoration monitoring. Expectations of habitat response can be expressed as PMs. Metrics associated with a PM can be tracked through scientific efforts over time and assigned numeric value relating to the PM. Implementation of current and future projects can then be altered adaptively to produce desired outcomes or left unchanged if PMs are being met. For the river reintroduction into the Maurepas Swamp, water flow can be managed adaptively and will be a primary means by which adjustments are made if required.

Five PMs have been established (Krauss and others, 2017) to track swamp forest response to the Mississippi River reintroduction into Maurepas Swamp. These PMs are associated with restoring hydrology, reducing salinity, facilitating elevation gain, rehabilitating forest structural integrity, and facilitating nutrient uptake and retention.

Establishing a Hydrologic Regime Consistent With Swamp Forest Sustainability (PM1)

Reestablishing hydrological patterns that mimic the flooding conditions that existed before levees disconnected the Maurepas Swamp from the Mississippi River is an important goal. While not all aspects of hydrologic rehabilitation are attainable, reestablishing duration and frequency of flooding will serve as PM1. At any given location in the swamp, hydrologic connectivity with the Mississippi River should occur at intervals between twice annually and once per decade. Hydrologic management must allow for the potential for water drawdowns to simulate periodic winter and spring drought conditions in the Mississippi River watershed that are necessary for tree seedling germination and establishment every 3–13 years. Within the 3–13-year cycle, a dry winter may require a delay in the opening of the diversion structure in early spring. Such dry periods promote water drawdowns and expose soils to facilitate establishment of tree seedlings, as would have occurred naturally during dry periods.

Reducing Saltwater Intrusion (PM2)

PM2 focuses on maintaining acceptable salinity concentrations throughout the Maurepas Swamp. The dominant forested wetland tree species in the Maurepas Swamp are *Taxodium distichum* (baldcypress) and *Nyssa aquatica* (water tupelo). Both species typically occur in freshwater habitats throughout their geographic range, but they differ slightly in the tolerances to salinity. Mean annual target porewater salinity for the Maurepas Swamp is less than 1.3 parts per thousand (ppt) for areas with higher concentrations of baldcypress but below 0.8 ppt for areas with higher concentrations of water tupelo. While pulses of salinity from storms or severe droughts may be difficult to manage, adaptive management of the diversion structure to increase freshwater flow through the structure to lower salinity may be possible when necessary.

Increasing Rates of Soil Surface Elevation Gain (PM3)

PM3 focuses on maintaining wetland soil surface elevations over time and thus reducing swamp forest submergence. Wetlands forming in large deltas often have high rates of submergence of the soil surface because of settling and dewatering of recently deposited sediments, compaction of older buried soils, and geologic subsidence occurring far beneath overlying wetlands. If rivers are disconnected from the wetlands, as in the Maurepas Swamp, adequate sediment is not delivered, and surface elevation losses are unbalanced. Surface elevation of the Maurepas Swamp must build vertically at rates that match or exceed the combination of elevation loss plus sea-level rise (termed "relative sea-level rise"), or at least at higher rates than is currently happening. Wetlands of the Maurepas Swamp should have surface elevation gains of 8–9 millimeters per year, or higher, as a result of the river reintroduction in order to keep up reasonably well with relative sea-level rise, even though sediment delivery to the Maurepas Swamp may be modest. Additional sediment amendments may be needed in the future if sediment loading capacity from the freshwater reintroduction is too low.

Increasing Forest Structural Integrity (PM4)

PM4 is designed to target the visual and structural integrity of the Maurepas Swamp. The structure of swamp forests is measured by assessing individual tree diameters, individual tree heights, tree density, and understory distribution and abundance of herbaceous plants, tree seedlings, and tree saplings. These characteristics are fairly well defined for healthy swamp forests. Three metrics were developed for rating forest structural integrity: one targeting stand density, one targeting leaf area index, and one targeting species composition of overstory trees and herbaceous understory plants. Swamp forests in the Maurepas Swamp should realize increases in stand density index (SDI) (Keim and others, 2010b) of as much as 30–45 percent of maximum values for the stand type while maintaining an overstory leaf area index (LAI) of 2.0–2.9 square meters of leaf area per square meter of ground area or higher. Simultaneously, the Forested Floristic Quality Index (FFQI) (Wood and others, 2017) will be used. The FFQI is a technique used to evaluate habitat integrity on the basis of native species composition. These values should increase by approximately 12 percent upon river reintroduction, although expected changes to understory vegetation may be more rapid than for overstory trees.

Facilitating Nutrient Uptake and Retention (PM5)

PM5 focuses on nutrients delivered from the river reintroduction into the Maurepas Swamp. The forested wetlands of the Maurepas Swamp have low nutrient concentrations because of the swamp's long-term disconnection from the Mississippi River and stagnant water flows (Shaffer and others, 2016). Furthermore, waters of Lake Maurepas have low levels of dissolved inorganic nitrogen (N) (that is, nitrite, nitrate, and ammonium) that are far less than N concentrations in the Mississippi River (Lane and others, 2003). Assessing inputs of N in the form of nitrate, the most common form of N, into the Maurepas Swamp is critical because evidence suggests that swamp forests can benefit from more N but that excess N can cause soil loss or eutrophication in downstream water bodies. To maximize uptake of N and prevent negative consequences of excessive N, nitrate loading into the Maurepas Swamp from river water should be approximately 11.25 grams of N per square meter per year. This nitrate loading is significantly more N than the swamp forest receives currently, and modeling indicates that a large percentage of nitrate will be taken up by vegetation rapidly from diverted river water.

Summary and Acceptable Ranges

Along with each PM, acceptability ranges also were developed because of the broad range of variability associated with each expectation (table 1). These acceptability ranges were established by consulting statistical metrics within the scientific literature. Observed variations (standard deviations) associated with mean responses for each variable assessed from natural swamp forests were generally applied (Krauss and others, 2017).

Monitoring of all variables associated with each PM will be undertaken in cooperation with the CPRA and will be comprehensive enough to assess metrics associated with PMs adequately over time and to direct changes to the adaptive management protocol for the diversion structure.

Table 1. Summary table of target values for performance measures (PMs) 1–5 and specific metrics detailing expectations of swamp forest response to a Mississippi River reintroduction into the Maurepas Swamp, Louisiana.

PM	Metric	Target	Low range	Lower OK?	High range	Higher OK?	Time frame (years)
1	River connectivity (year)	5.3	0.5	No	10	No	10–15
1	Low water event (year)	8	3	No	13	No	10–15
2	Baldcypress water salinity (parts per thousand)	1.3	1	Yes	1.6	No	2–5
2	Water tupelo water salinity (parts per thousand)	0.8	0.5	Yes	1.1	No	2–5
3	Surface elevation gain (millimeters per year)	8–9	5	No	12	Yes	5–10
4	Stand density index (percent maximum)	45	30	No	60	Yes	1–5
4	Leaf area index (square meter per square meter)	2.9	2.0	No	3.8	Yes	1–5
4	Forested Floristic Quality Index (Wood and others, 2017) (percent increase)	12.3	0	No	25.8	Yes	1–5
5	Nitrate loading (grams of nitrogen per square meter per year)	11.3	7.1	No	15.4	No	2–5

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