Comprehensive Recommendations Supporting the Use of the Multiple Lines of Defense Strategy to Sustain Coastal Louisiana

2008 Report (Version I)

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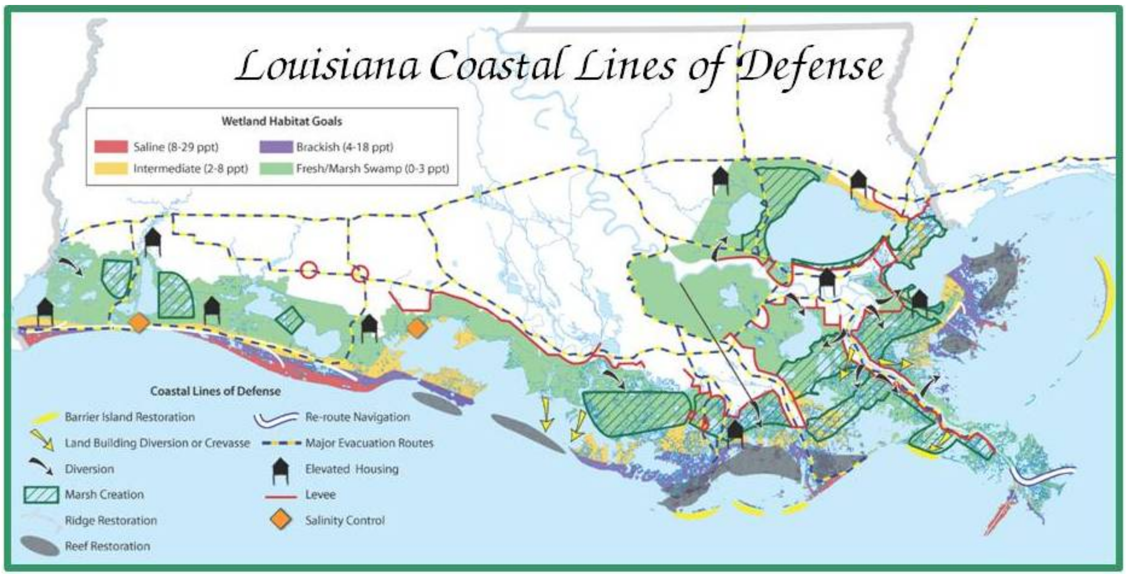

Summary Map of Multiple Lines of Defense

"It may be hubris to think we could ever engineer our way out of this fix, when nature seems so aligned against us. It is certainly hubris to think we could do it without taking nature's assistance when it is offered."

Quote from comments on the draft report by David Yeargin

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Report is available at MLODS.org, SaveOurLake.org, or CRCL.org

SAVE OUR COAST
LAKE PONTCHARTRAIN BASIN FOUNDATION

Coalition to Restore Coastal Louisiana

Executive Summary

This report recommends integrated coastal projects and levee alignments for the entire coast of Louisiana with the overriding goal of providing hurricane flood protection and sustaining the coastal estuaries. The report was developed utilizing the Multiple Lines of Defense Strategy (MLODS) (Lopez, 2006 – see Appendix A) and other sound science and engineering principles to define an array of alternative Lines of Defense and statewide habitat goals, which together may provide the most promising landscape for a sustainable economy and coastal ecology for south Louisiana.

The MLODS (Lopez, 2006) has been adopted by the State of Louisiana in its development of the *Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast* (CPRA, 2007). This report describes additional recommendations supporting the use of the Multiple Lines of Defense Strategy to sustain coastal Louisiana. The Multiple Lines of Defense Strategy has also been adopted by the United States Army Corps of Engineers (USACE) in its ongoing development of the Louisiana Coastal Protection and Restoration Plan (LACPR). This report should also be considered as additional input to that ongoing evaluation, adding robustness and external input. The overriding goal of all these efforts is to promote convergence on a set of optimal recommendations for coastal Louisiana that are based on sound science and engineering.

South Louisiana has entered a period when the combination of two powerful forces is working against its survival: (1) coastal land loss and (2) more frequent intense hurricanes. Since the 1950's, the processes driving coastal loss have continued only slightly abated (USACE, 2004), reducing the effectiveness of Louisiana's coast to buffer against storm surge. Since 1990, meteorological and oceanic processes driving tropical systems have more frequently generated Category 4 and 5 hurricanes (Webster et al., 2005). More destructive hurricanes are also predicted for coming decades (Emanuael, 2005). South Louisiana's ongoing peril is the continued overlap of weakened hurricane protection with more frequent and intense hurricanes (Frischetti, 2001).

The Multiple Lines of Defense Strategy proposed by Lopez (2006) proposes to integrate two key elements to sustain the coast (**Figure 1**). The two planning elements are:

1) Utilizing natural and manmade features which directly impede storm surge or reduce storm damage (Lines of Defense),
2) Establishing and sustaining the distribution goals of wetland habitat types (Wetland Habitat Goals).

The Multiple Lines of Defense Strategy is not a new restoration technique; rather, it is a planning methodology to coordinate and prioritize conventional restoration methods and projects for coastal habitats and flood protection. Coastal restoration is targeted where it can provide flood protection benefits.

The "Lines of Defense" include the outer continental shelf of the Gulf of Mexico, the barrier islands, bays, sounds, marsh land bridges, natural ridges, manmade ridges, flood gates, flood levees, pump stations, non-structural measures (i.e., home and building elevations, flood proofing), and evacuation routes. Identification of these Lines of Defense on a map allows hydrologists, levee district managers, emergency personnel, etc., to view a common landscape template to evaluate,

abate, and monitor flood risk or other storm impacts. The result is a map that meets the suggestion of the National Research Council for Louisiana to develop a clear vision for the coast (NRC, 2006).

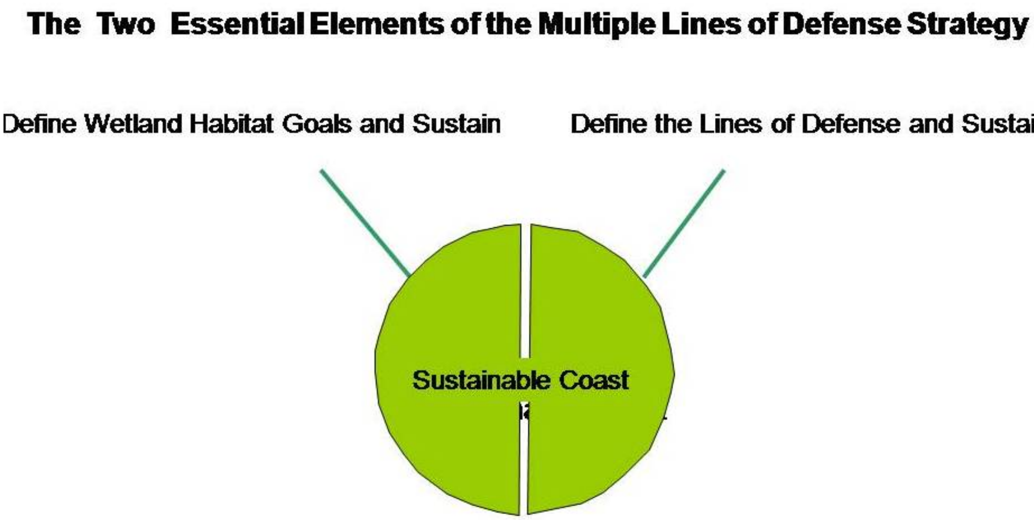

Figure 1: The Multiple Lines of Defense Strategy diagram shows how the two essential planning elements proposed should be defined and maintained with the result of sustaining coastal Louisiana. The Wetland Habitat Goals define the future salinity regime and wetland habitats for the coast. The Lines of Defense are either natural or manmade features that will reduce the impact of hurricanes on the coast. The underlying presumption is that a healthy, storm-buffering coast will support an economy sufficient to justify future investments to supplement necessary to keep the coast sustaining. A common vision is proposed for all plans, but co-mingling of all funds for restoration or flood protection is not desirable.

The Wetland Habitat Goals include swamp, fresh marsh, intermediate marsh, brackish marsh and salt marsh. Establishing the targeted wetland habitat regime and then optimally managing the habitat types, puts all the natural resources and resource managers on the same page with a unified biological and natural resource vision. Since each habitat has a differing profile of vegetation, fisheries, soils, hydrology, waterfowl, etc., it is imperative that geographic areas for each habitat be identified to optimize restoration and management. The establishment and maintenance of the Wetland Habitat Goals requires a corresponding salinity gradient goal. This salinity gradient would be maintained by controlled river reintroductions and, if needed, by hydrologic restoration to control salinity input.

Since Hurricane Katrina, much has been discussed regarding the “Dutch model” of flood protection. The flood surge events in Holland are not due to hurricanes and are far lower in height than the surges in Louisiana; nevertheless, the Dutch system has achieved a high level of flood protection using major engineering structures, with results similar to what the Lines of Defense proposes for Louisiana (right side of **Figure 1**). However, the Dutch have not managed their coastal estuary at a sustainable level, represented on the left side of **Figure 1**. The result has been a dramatic loss

(90%) of coastal wetlands and severe water quality problems which they are now retroactively attempting to remedy. In addition, the cumulative actions of the Dutch have engineered a landscape where approximately 60 percent of the population lives below sea level, similar to the New Orleans area. Thus, the Dutch will forever be actively managing their anthropogenic landscape, specifically with the challenge of future sea level rise.

Through a cooperative effort with the Netherlands and the U.S. Army Corps of Engineers, a study and report was completed that is titled "A Dutch Perspective on Coastal Louisiana Flood Risk and Landscape Stabilization" (International Research Office US Army, 2007). Although not fully appreciative of the local subtleties of our landscape, the report suggests using "multiple lines of defense" and concludes with a recommendation for southeast Louisiana titled "open estuary". Their open coast recommendation excludes levees blocking the estuary so that the estuary may accommodate surge. The report recognizes the value and absolute necessity of a wetland buffer complementing a tight levee around New Orleans. The report also emphasizes the hydrologic aspects of the estuary and includes an eclectic approach to restoration and flood protection very similar to proposals in this report. Some striking differences are that the Dutch report does not consider the roles of pumping stations, non-structural (elevation), or evacuation routes as part of their flood risk reduction plan.

At least two important aspects of the Multiple Lines of Defense Strategy should be noted:

> First, a natural ridge's ecologic function is primarily as a hydrologic barrier to surrounding wetlands. Therefore, use of the ridge as an economic corridor is compatible with the surrounding wetlands . Natural ridges, such as those along Bayou Lafourche, have parallel protection levees (back levees) that allow the wetlands on the outside of protection levees to retain their ecologic function, while being compatible with the protected side of the levee (the ridge) functioning as an economic corridor with flood protection. Therefore, the concept of "back levees" or "ring levees" along the perimeter of the ridges is emphasized. This makes back levees a potential ally to wetland restoration rather than its enemy.
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> Second is that with the MLODS, restoration is generally focused on the features of the coast that have survived many years of wetland loss, and therefore, generally avoids large areas where previous heavy wetland loss has occurred. This may avoid some areas with chronic causes for wetland loss that may be ongoing, such as subsidence. The MLODS does not attempt to "restore it all", but rather to restore what is absolutely necessary.

The Multiple Lines of Defense Strategy does not recommend a single continuous barrier levee for the coast. Sub-regional levee alignments are interrupted by landward extending basins allowing for maximum storage and attenuation of surge by both the areal extent and distribution of natural landscape habitats. The geometry of these alignments largely mimics the natural landscape of the coast.

The levee alignments proposed by the Multiple Lines of Defense Strategy generally follow existing levee alignments and take advantage of existing foundations for levee improvement while minimizing the mitigation needed for new levee alignments. Levees are tightly positioned around major municipalities and are generally on the perimeter of ridges or the upland-wetland interface where soil foundations are superior. This is important for flood protection for two main reasons. First, the superior soil foundations will reduce the threat of subsidence to the levee system and to the communities inside the levees. This will discourage coastal communities from further development outside of levee in areas poorly suited for development. Second, utilizing the upland-wetland interface will ensure that nearly all wetlands and wetland restoration projects are located outside of any levee system. This allows for the highest chance of survival for wetlands with estuarine functions and assures that any investment in restoration is part of the coastal buffer which is external to the levees; thus all restoration features provide both ecologic and flood protection benefits. In addition, levee alignments avoid large scale angular geometries that may result in funneling effects which amplify surge heights, such as those that occur at the convergence of the Mississippi River Gulf Outlet (MRGO) and the Gulf Intracoastal Waterway (GIWW) east of New Orleans (Mashriqui, 2006)

The restoration recommendations are an eclectic set of restoration techniques including diversions, marsh creation, shoreline protection, barrier islands restoration, structures to reduce saltwater intrusion and oyster reef restoration. Marsh management is avoided except for the Chenier Plain where modest management is necessary to restore the historical hydrology and extent of fresh marsh until large scale hydrologic restoration occurs. Other areas of the coast have broad estuarine gradients. Marsh creation is used to redevelop the critical marsh land bridges and reduce the tidal prism, while being sustained by proposed nearby freshwater diversions. (Marsh creation includes either local sediment sources or “long-distance” piped sources of sediment.) Recommended protection and restoration of oyster reefs targets historic oyster barrier reefs and is intended to help sustain the outer marshes exposed to large bays or sounds. The Gulf shoreline and barrier island recommendations are proposed to introduce new sand and to reduce sand loss. Offshore breakers for barrier islands are recommended in a few instances but only at the terminal end of longshore sediment drift.

The Multiple Lines of Defense levee alignments are intended to be fully compatible with regular moderate flooding of the wetlands with diversions and also with more extreme pulsing events which would raise water levels even higher. In all, twenty-eight diversions, three controlled crevasse-type pulsing diversions, and three land-building diversions are proposed. (This tabulation includes the Caernarvon and Davis Pond diversions, and the Wax Lake and Atchafalaya deltas.)

Comparison of the proposed levee alignments to the Wetland Habitat Goals shows that most of the levees (77%) would have fresh habitat adjacent to them on the flood side. This creates an opportunity to restore extensive cypress swamps adjacent to the levees and provide a significant measure of protection by dampening surge’s energy (waves and currents), thereby reducing the chance of damage to the levee. None of the proposed levees are adjacent to brackish or salt marsh habitats where woody vegetation cannot grow. This favorable result is one of the natural outcomes of utilizing natural ridges for back levee alignments, recognizing that many of the ridges historically had fresh habitats adjacent to them.

Diversions in this report are of three types.

"Sustaining diversions" are intended to sustain marsh land bridges identified as a Line of Defense. These diversions are generally less than 40,000 cubic feet per second (cfs) and would include structures to pass the water through the MR&T levee, such as siphons, box culverts, etc. Although the processes involved need ongoing monitoring and assessment, the working hypothesis is that nutrients will stimulate productivity that will increase resiliency and sustainability of the marsh. In addition, salinity may be managed to emulate a natural spring cycle of overflow and freshening while avoiding severe salinity spikes that may be detrimental.

"Delta-building diversions" have annual discharges over 75,000 cfs with deep-water conveyance channels through the MR&T levee to convey significant discharge from normal spring Mississippi River stages. They are intended to flow continuously over long periods to build substantial wetlands in an areas in need flood protection.

"Controlled-crevasse diversions" are intended to have periodic discharges when the river is exceptionally high so that large scale overland flow is possible *without a large deep-water conveyance channel.* These structures would be opened possibly every few years when there is sufficient head on the river. The controlled crevasses would likely be designed similarly to the existing Bonnet Carré or Morganza Spillways but with significant design changes to maximize restoration benefits. The use of the spillway type structure as a controlled crevasse diversion could be vital to introducing sediment into the estuary and is intended to be an important adaptive management tool that could be used more aggressively if necessary to maintain the wetland extent and functioning of the estuary.

The widths of the three types of diversions' footprints at the river vary. A sustaining diversion with a structure is likely to be 100 to 600 foot wide. A delta-building diversion with a deep water channel is likely to be 500 to 1500 feet wide. A controlled crevasse of a "spillway type design" is likely to be several thousand feet wide. The footprint, design and performance of these vary and should be considered in overall planning of restoration. Although similar examples of all three types of diversions currently exist in Louisiana, all three types can be designed now with significant enhancements with more focus and benefit to restoration.

All of these diversion outfall areas have regional target habitat goals and an individual defined minimum area of overland flow, i.e. water elevation is sufficient to overtop the marsh soil elevation. The individual diversion recommendations for each Planning Unit use these diversions to sustain the Lines of Defense, such as marsh land bridges. ***In addition, the combined capacity of diversions within a given Planning Unit is designed to have the capacity to flood the entire wetland basin. This maximum capacity would likely occur in flood years and is intended to assure that all reaches of a basin can, at times, be flooded beneficially.***

The total (maximum) spring-time discharge capacity proposed for the Mississippi River diversions is 436,050 cfs (Planning Units 1, 2 and 3a). Most of this discharge is roughly split east and west of the river between Planning Units 1 and 2**.** The total discharge is less than the informally suggested discharge available from the river by the USACE (as much as 525,000 cfs during the spring average discharge of 700,000 cfs). Not all potential discharge would occur simultaneously to maintain at least 300,000 cfs flowing past New Orleans, which is needed to prevent a salt water wedge from developing and contaminating the drinking water supply taken from the river. It is recommended that all diversions emulate the natural spring cycle of overbank flow in March through June.

Additional freshwater is also proposed for Planning Units 3a and 4. Discharge through the Atchafalaya River is proposed to be modified in two ways. It is recommended that a pulse diversion of at least 140,000 cfs is constructed into the Penchant Basin or into Bayou Penchant (see PU-3b #10). In addition, through outfall management, it is recommended that an additional 2,000 cfs discharge be directed westward down the GIWW into Planning Unit 4 (PU-4 #17).

In the spring of normal Mississippi River stage years, the diversion proposals could divert approximately 60% directly into the estuary. In the Atchafalaya River, approximately 10% of the discharge would be diverted in most years either east or west into wetlands with the remaining discharge continuing to build the Atchafalaya and Wax Lake Deltas and contribute sediment to long-shore drift.

A River Flood Restoration Action Plan is proposed to take advantage of an exceptionally high water event on the Mississippi or Atchafalaya Rivers, such as those experienced in 1997 and 2008. In these high flood stage years, the combined proposals could divert 1,300,000 cfs of the discharge from the Mississippi River into the wetlands through diversions and spillways.

Under current legislation, the Atchafalaya receives 30% of the Mississippi River discharge through the Old River Control Structure. The proposed diversions do not seem to require a change to this discharge allocation through the Old River Control Structure. Nevertheless, there are reasons to re-evaluate the operational goals of the Old River Control Structure and therefore the discharge allocation. Flexibility to control discharge through the Atchafalaya and Mississippi Rivers could prove to be extraordinarily useful for adaptive management, especially considering that navigation and drinking water needs must always be met even with the uncertainties of future conditions, such as relative sea level rise. Considering the overriding priority to restore the coast and create high levels of flood protection, the management priorities need to be re-considered for the Old River Control Structure.

The MLODS recommendations are proposed as pragmatic solutions that are focused on restoring a functional estuary and on adequate flood protection for the coast. The **long term** goal is that together these should provide for a sustainable economy that draws some of its economic base from the natural resources of the coast, but also “pays back” a modest investment to maintain the coast with ongoing restoration. The **short–term** goal is to raise protection to 100 year level or higher, which requires a much more intensive capital investment into our coast and flood protection system. This large capital investment in restoration and flood protection should be targeted on the Lines of Defense suggested in this report.