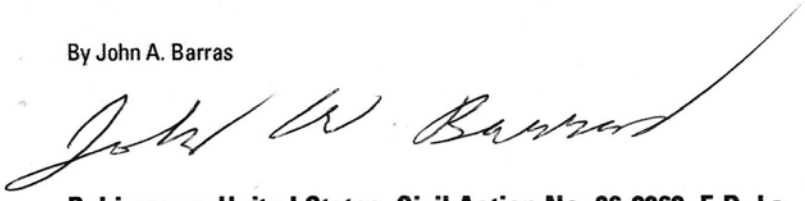
Land Area Changes and Forest Area Changes in the vicinity of the Mississippi River Gulf Outlet from 1956 to 2006

By John A. Barras



Robinson v. United States, Civil Action No. 06-2268, E.D. La

Submitted: December 22, 2008

Contents

Introduction 1

Opinions 1

Methodology 3

Assessment Unit (AU) Identification 3

Forested Area Change Assessments 6

Land Area Change Assessments 9

Area Calulations and Area Change Calculations 10

Discussion 11

Forested Area Changes 11

MRGO Channel and Spoil Disposal Area Changes 14

1956 to 2006 Regional Land Loss Trends 16

Historical Loss and Episodic Impacts 17

Chalmette Wetland AU and Golden Traingle to Proctor Point AU Land Loss Trends 18

Closing and General Statements 19

Materials Reviewed 19

References Cited 20

Figures

1. MRGO Assessment Units with 2006 Land and Water Area Backdop FA1

2. MRGO Assessment Units with 1956 Habitat Backdop FA2

3. MRGO Assessment Units with 1978 Habitat Backdop FA3

4. MRGO Assessment Units with 1988 Habitat Backdop FA4

5. MRGO Assessment Units with 2006 Land-Water Data Mereged with 2001 Marsh Community Types FA5

6. 1956, 1978, and 1978 Forested Class Area Summary by Physiographic Unit 12

7. 1956 and 1978 Forested Class Area Summary Percent Total Area by Physiographic Unit 14

8. Chalmette Wetlands 1932 T-Sheet Overlain on 1956 Habitat Data ... FA6

9. Chalmette Wetlands 1932 T-Sheet Tree Area on 1956 Habitat Data .. FA7

10. MRGO Assessment Units with 1956 to 2006 Trends Backdop FA8

Tables

1. Table 1. MRGO Assessment Units 5

2. Table 2. MRGO Physiographic Units 5

3. Table 3. Direct MRGO channel and spoil disposal area impacts.. ... 16

Appendix

Assessment Units Worksheet: MRGO_USGS_Analysis_Barras Assessment Units Worksheet

Land Area Changes and Forest Area Changes in the vicinity of the Mississippi River Gulf Outlet from 1956 to 2006

By John A. Barras

Introduction

The purpose of this document is to summarize historical changes in forested habitats and land loss trends adjacent to the Mississippi River Gulf Outlet (MRGO) from 1956 to 2006 using standard data sets routinely used by the U.S. Geological Survey (USGS) for wetland trend assessments in coastal Louisiana for Robinson v. United States, Civil Action No. 06-2268, E.D. La. The report will focus on 1) identifying changes in general forested habitats within the MRGO assessment area, 2) identifying direct habitat impacts from MRGO dredging and spoil placement, and 3) identifying land loss trends within the MRGO assessment area.

The "MRGO assessment area" (see fig. FA1) was selected in order to provide a comparison with the data presented in the reports of the Robinson plaintiffs' experts (specifically the FitzGerald-Penland report), and it is referenced as such because this litigation pertains to the MRGO. However, the habitat and land loss impacts resulting from construction and maintenance of the MRGO do not extend to the entire "assessment area." The direct impacts from the MRGO are the dredging and spoil placement. A reasonably conservative estimate of the area in which habitats may have been impacted indirectly by the MRGO is shown by the area marked as the "USACE model area."[1] This "model area" was selected by

[1] Indirect impacts are those that may result from changes in land forms and hydrology associated with construction of the channel.

experts for the United States based on professional judgment of the area relevant to the litigation and for which habitat data was incorporated into the hydraulic models used by Dr. Joannes Westerink.

Opinions

It is my opinion, to a reasonable degree of scientific certainty, as follows:

1. For purposes of assessing habitat change over time, dividing the MRGO assessment area into logical physiographic units consisting of uplands, fastlands, ridges, and wetlands provides a more rational means of examining forested wetland changes than using the Coast 2050 mapping units.
2. Total swamp habitat area decrease between 1956 and 1978 was 11,640 acres within the 1,051,217 acre MRGO assessment area, excluding the Chandeleur and Lake Borgne assessment units.
3. Total direct swamp habitat conversion between 1956 and 1978 within the MRGO channel and spoil disposal area, based on the 1978 spoil and channel disposal area, was 1,398 acres.
4. The 30,181 acres of episodic net land loss caused by Hurricane Katrina within the MRGO assessment area in 2005 is equivalent to the 29,151 acres of net less occurring between 1978 and 2004, a 26 year period.
5. The MRGO assessment area comprises 21.5% of the coastal area and 39.4 % of the deltaic plain.
    - The area accounts for 14.3% of coastal net land loss and 21.5% of deltaic plain net land loss between 1956 and 2006.
    - The area accounts for 11.5% of coastal net loss and 16.4% of deltaic plain net loss between 1956 and 1978.
    - The area accounts for 15.9% of coastal net loss and 15.5% of deltaic plain net loss between 1978 and 2004.

6. The MRGO has caused some direct and indirect land loss but other causes of loss, including historical hurricane impacts occurring during the 1960s, may have caused significant loss within the MRGO assessment area that hasn't been identified.

Methodology

Assessment Unit Identification

The MRGO study area is approximately 2 million acres and is bounded by the Mississippi River and the Inner Harbor Navigation Canal (IHNC) on the west and the Mississippi border on the east. The northwestern boundary then follows the western shoreline of Lake Pontchartrain around the lake to Fountainebleau State Park (fig. FA1). The Coast 2050 Mapping Units (CMU) were examined for potential use as land area trend and forest assessment units (LCWCRT, 1998). The CMUs, however, 1) lacked identification of natural ridges, 2) subdivided areas into smaller units that weren't needed for the forest change analyses, and general trend analyses, and 3) included excessive amounts of lake and sound areas in some cases. I created a new MRGO Assessment Unit (MRGO AU) data set to correct some of these deficiencies based on a modified version of the Coast 2050 mapping units (table 1; fig. FA1). The new configuration provides better identification of forested habitat trends and land loss trends within the study area.

The MRGO AUs were designed to aggregate into physiographic units to identify 1) uplands, 2) fastlands, 3) ridges, and 4) wetlands (table 2). Uplands are located north of Lake Pontchartrain and consist of Pleistocene uplands characterized by generally well-drained elevated areas that are not considered part of the modern delta plain. According to Louisiana coastal use regulations (LOSR, 2002), fastlands are the developed and agricultural areas surrounded by levees that are generally considered non-wetlands. Ridges are natural levees occurring outside of fastland areas. The Bayou La

Loutre Ridge, St. Bernard Ridge, Delacroix Ridge, and Bayou Sauvage Ridge form the major ridges within the study area. The St. Bernard Ridge and Delacroix Ridge are subsets of the Bayou Terre Aux Beoufs Ridge. Wetlands are predominately marsh areas occurring outside of the other AUs but exclude large lakes and sound areas.

The Lake Borgne AU comprises Lake Borgne's water area while the Chandeleur Sound AU comprises most of Chandeleur Sound and Breton Sound, including the Chandeleur Islands, south to Breton Island. Both the Chandeleur AU and the Lake Borgne AU were excluded from both the forested habitat and the land trend area analyses although area statistics were provided for both AUs (Appendix 1: MRGO_USGS_Analysis_Barras Assessment Units Worksheet). The Lake Borgne AU was excluded because the unit consisted entirely of open water. The Chandeleur AU was excluded because it consisted almost entirely of open water with the exception of the barrier island chains located across 25 miles of open water from the MRGO's entrance in Breton Sound near Fiddler Point.

Number	MRGO Assessment Units	Acres
1	North Area Upland	37,074
2	North Area Wetland	57,347
3	Central Area Fastlands (New Orleans East)	16,521
4	Central Area Wetlands	63,640
5	Central Area (Bayou Sauvage Ridge)	1,477
6	Chalmette Area Fastlands[1]	14,509
7	Chalmette Area Wetland[1]	21,502
8	Golden Traingle Wetland[1]	35,057
9	St. Bernard Ridge Fastland[1]	8,244
10	Loutre Ridge[1]	12,575
11	Delacroix Ridge[1]	2,178
12	MR Eastbank Fastlands[1]	16,776
13	MR Eastbank Wetland[1]	22,424
14	Biloxi Wetland[1]	259,540
15	Delacroix East Wetland[1]	168,333
16	Delacroix West Wetland[1]	300,699
17	Chandeleur Sound[2]	783,632
18	Lake Borgne[2]	179,300
	Total	2,000,826

[1]Southern Assessment Units (861,835 acres)
[2]Excluded Assessment Units (962,933 acres)

Table 1. MRGO Assessment Units

Physiographic Area[1]	Acres	% Total Area
Fastland	56,047	5.3%
Ridge	16,230	1.5%
Wetlands	940,721	89.5%
Upland	38,219	3.6%
	1,051,217	100.0%

[1]Excludes the Chandeleurs AU and the Lake Borgne AU

Table 2. MRGO Physiographic Units

The MRGO AUs were digitized on-screen using the 1956 habitat data set. A 328 ft (100 m) buffer was added to AU boundaries bordering Lake Pontchartrain, Lake Borgne, and the sound areas (fig 2). The

same buffer was applied to ridge boundaries as well. Generally, ridge boundaries were based on the area of fresh marsh encompassing the ridge in 1956. For example, both the Loutre Ridge and the Delacroix Ridge boundaries were encompassed and bordered by a fringing fresh marsh area past the eastern boundary of the St. Bernard Ridge Fastland (fig. FA2). This AU consists of the western portion of the Bayou Terre Aux Beoufs natural levee that was completely enclosed by large levees by 1978, converting the area into a fastland. Most of the primary levee and drainage features used to identify fastland AUs were in place by 1956 with a few minor differences. The CMU fastlands designation required little modification for the most part except for the addition of Mississippi River east bank boundaries based on the 1956 bank (fig 2). The CMU fastland boundaries extended to the center of the Mississippi River near Chalmette and included both east and west bank fastlands as one unit south of Caernarvon. The configuration of the CMU fastland boundaries would confound area calculations of forested fastland areas on the east bank of the Mississippi River. Some partially developed areas in 1956 converted to almost completely developed fastlands by 1978. For example, the Central Area Fastland encloses the old Bayou Sauvage natural levee occurring east of the IHNC. This area, also known as New Orleans East, was partially developed by 1956. It appeared to be leveed and almost fully developed by 1978 (fig. FA3) and completely developed by 1988 (fig. FA4).

Forested Area Change Assessments

Reliably identifying forested habitat changes within the MRGO area requires using standard habitat classifications identifying forests based on a temporal change interval bracketing the construction of the MRGO. The 1956 habitat data records forest conditions existing immediately before construction of the MRGO. The 1978 data set depicts habitat conditions 22 years later, well after completion of the MRGO, allowing adequate time to assess changes in forested habitats. The 1956 and 1978 habitat data sets were aggregated from source National Wetlands Inventory (NWI) habitat data

sets based on Cowardin and others (1979) to assess regional habitat changes (Cahoon and Groat, 1990). The aggregated habitat classification scheme used in the Cahoon and Groat (1990) study was taken directly from an internal habitat classification scheme developed by the Louisiana Department of Natural Resources, Coastal Management Division for their Geographic Information system (GIS) habitat analysis applications (Appendix 1: MRGO_USGS_Analysis_Barras Assessment Units Worksheet).

The 1956 and 1978 habitat data sets used common classification schemes and are directly comparable. The swamp class contains primarily cypress and tupelo swamps but also includes swamp maple and willow swamps as well. The 1988 NWI habitat data set was developed as a decadal update for the 1978 habitat data set. The coverage area was expanded to include the entire coastal zone using an updated NWI classification scheme. The 1988 aggregated habitat coding scheme used the 1956 and 1978 aggregated coding scheme as a guide but did not directly follow the older coding scheme (attachment 2). One result is that the 1956 and 1978 swamp and forest classes are not directly comparable with the 1988 habitat categories. The 1988 swamp class identifies primarily cypress forest and mixed cypress-tupelo forests but excludes swamp maple and willow swamps. These classes were included with the 1988 “bottomland forest” class, which tends to cause some switching between swamp and forest classes between the 1978 and 1988 data sets. The eastern North Area Wetland AU depicts large amounts of “swamp” class in 1978 (fig. FA3) within the Pearl River basin that was classified as “bottom land forest”, “bottomland shrub/scrub”, and “cypress forest” in 1988 (fig. FA4). Interpreting changes between “swamp” and “forest” classes between 1978 and 1988 may not result in a direct habitat class comparison although the class names are similar. Similar types of changes occur throughout the study area. Also, the habitat and forest classes were not developed to identify forest density or health.

The 1988 habitat data does identify very limited areas of "Dead Forest," but only 31 acres of this class are identified within the entire assessment area (the 31 acres are outside the USACE model area).

Fortunately, the 1956 and 1978 habitat data sets bracket the construction of the MRGO and offer the same habitat class comparisons over the 22 years. The 1988 "cypress forest" classification is likely a realistic estimate of 1988 cypress forest area, but will not include the other swamp classes (swamp maple, and willow) included in the 1956 and 1978 habitat "swamp" class. The 1956 and 1978 "swamp" forest estimates will include "cypress forest" as well as non-cypress swamp forest in some areas.

The Fitzgerald-Penland report uses the 1932 T-sheet demarcation of swamp to extend the swamp area in the Chalmette Wetland AU well past the 1956 habitat swamp delineation (fig. FA6; fig. FA7). The swamp class from the1932 T-sheet precedes the 1956 habitat data's swamp delineation by 24 years and extends the interpreted swamp area eastward, towards Lake Borgne, from 1000 ft to as much as 7,700 ft in some areas. The 1932 T-sheet also contains a "Marsh with Scattered Cypress Trees" class that extends the older swamp line another 500 ft to 3000 ft eastward. The presence of the 1932 "Marsh with Scattered Cypress Trees" class and the area differences between the 1932 T-sheet "swamp" class and the 1956 habitat "swamp" class indicates that the swamp forest in this area was transitioning to a marsh environment prior to the construction of the MRGO. The 1956 habitat data is likely a more reliable indicator of MRGO immediate preconstruction habitat conditions.

Caution should also be used in interpreting "swamp" forest area from more recent data sets as the "swamp" or wetland forest classifications are likely derived from or influenced by the 1988 NWI aggregated habitat data set. The 1993 GAP Louisiana land cover data set used the 1988 aggregated habitat data to augment classification within the state's coastal area (*GAP metadata*, 1998). The 2000 desktop habitat data set used to summarize current conditions for the Louisiana Coastal Area Study (LCA) and to serve as a base for ecological modeling was derived from combinations of multiple data

sets of varying vintages, including the GAP data, and does not reflect actual 2000 land cover conditions (*Twilley and Barras, 2004*). The recent assessment of land area changes by marsh communities after Hurricanes Katrina and Rita (*Barras, 2006*) contains a "swamp" class based on 2001 marsh community types (*Chabreck and others, unpub. data, 2001*). The swamp class is taken from a generic "swamp" zone on the 2001 marsh type data set that does not reflect updated swamp and forest classes. An example depicting the 2006 land-water data merged with the 2001 marsh community type data provides an example of this product (fig. FA5). The National Oceanic and Atmospheric Administration's Coastal Change Analysis Program (*C-CAP*) offers updated 1996, 2001, 2005, and 2006 land cover data sets for coastal Louisiana but does not specifically separate swamps from bottomland hardwood forests. The 1988 habitat data remains the most current temporally consistent data set containing a "swamp" habitat classification for coastal Louisiana. Both the GAP data and the 2000 desktop habitat data set were derived from the 1988 habitat data, and both are suitable for modeling applications.

Land Area Change Assessments

Land area changes discussed in this report use the same data sets and analysis methodology described in Barras and others (2008) to identify loss trends within the study area by AU. The 2008 study provides a recent spatially and temporally consistent source of quantitative information on land change across coastal Louisiana and succeeds prior reports addressing coastal trends by this author (Barras and others, 1994; Barras and others, 2003; Barras, 2006; Barras 2007a).

The USGS uses a series of data sets developed for prior coastal Louisiana trend assessments to provide historical and current land area characterizations within south Louisiana (Barras and others, 1994; Barras and others, 2003; Barras, 2006; Barras 2007a; Barras 2008). Coastal Louisiana land area changes are analyzed using a sequential series of 14 data sets summarizing land and water areas from 1956 to 2006 (Barras and others, 2008). The land-water data sets were derived from (1) modified,

photointerpreted NWI data created for wetland habitat classifications and (2) Landsat Thematic Mapper (TM) satellite imagery obtained from the USGS Center for Earth Resources Observation and Science (EROS) and then classified by land and water coverage. The 1956 and 1978 modified NWI habitat data sets represent historical coastal conditions and were produced using a labor-intensive and time-intensive photo-interpretation process (Wicker, 1980). A 1988 NWI habitat data set update was completed in 1993 (Barras and others, 1994) but no other habitat updates have been produced to date. Classified Landsat TM land-water datasets comprise the majority of the available coastal data sets after 1985. The imagery is low-cost, readily available, and the land-water classification methodology can be completed quickly versus traditional photo-interpretation techniques used to create the historical habitat data sets (Barras and others, 2003; Morton and others, 2005). The classified TM land-water data can be easily masked to exclude non-wetland areas to limit trend assessment to primarily wetland areas (Barras and others, 2008). However, the historical habitat data contains useful wetland habitat information, lacking in basic land-water classifications, that is required to determine changes other than land loss or land gain.

Changes in land area include both permanent and transitory losses and gains caused by local and regional environmental factors occurring at the time images were acquired. The time-dependent factors that affect land-water classification include water-level variations caused by different tidal and meteorological conditions, possible misclassification of aquatic vegetation and flats, and seasonal variations in marsh growth cycles.

Area Calculations and Area Change Calculations

The MRGO AU data set was digitized in a vector polygon format using ERDAS IMAGINE® software (Leica Geosystems Geospatial Imaging, LLC, Norcross, Ga., 2007). The MRGO AU dataset was converted to a raster format with a minimum pixel spatial resolution of 82 ft x 82 ft (25 m x 25 m)

that is typically used for coastal Louisiana land change assessments (Barras and others, 2008). The ERDAS IMAGINE SUMMARY function was then used to generate assessment unit area statistics for habitat and land-water data sets. Physiographic unit summaries were derived from the source assessment unit statistics. Prism version 5.0b for Macintosh (GraphPad Software, San Diego, California) was used for linear regression based trend analysis (Barras and others, 2008).

Discussion

Forested Area Changes

The forested area change discussion focuses on identifying area changes in 1) forest class and 2) swamp class within the MRGO AU between 1956 and 1978. The shrub/scrub classes were included to show area relationship to forested classes. Summarizing area changes by physiographic unit provides a clear understanding of forest and swamp area extent before and after construction of the MRGO (fig. 6). The physiographic unit forest analysis includes all MRGO AUs except for the Chandeleur Sound AU and the Lake Borgne AU. The total forest class area remained essentially the same for all phyisiographic classes between 1956 and 1978. The swamp class decreased by 1,500 acres within fastlands and all swamp area on ridges (3,067 acres) was lost by 1978. It did not reoccur by 1988. The wetland physiographic unit lost 7,623 acres of swamp between 1956 and 1978. Total swamp area decrease for all physiographic units between 1956 and 1978 was 11,640 acres. These changes may reflect conversion of the 1956 “swamp” class to other habitats or to open water. The shrub/scrub wetland physiographic area increased dramatically between 1956 and 1978 by 22,023 acres. This increase was primarily due to colonization of the MRGO spoil disposal area by shrub/scrub vegetation.

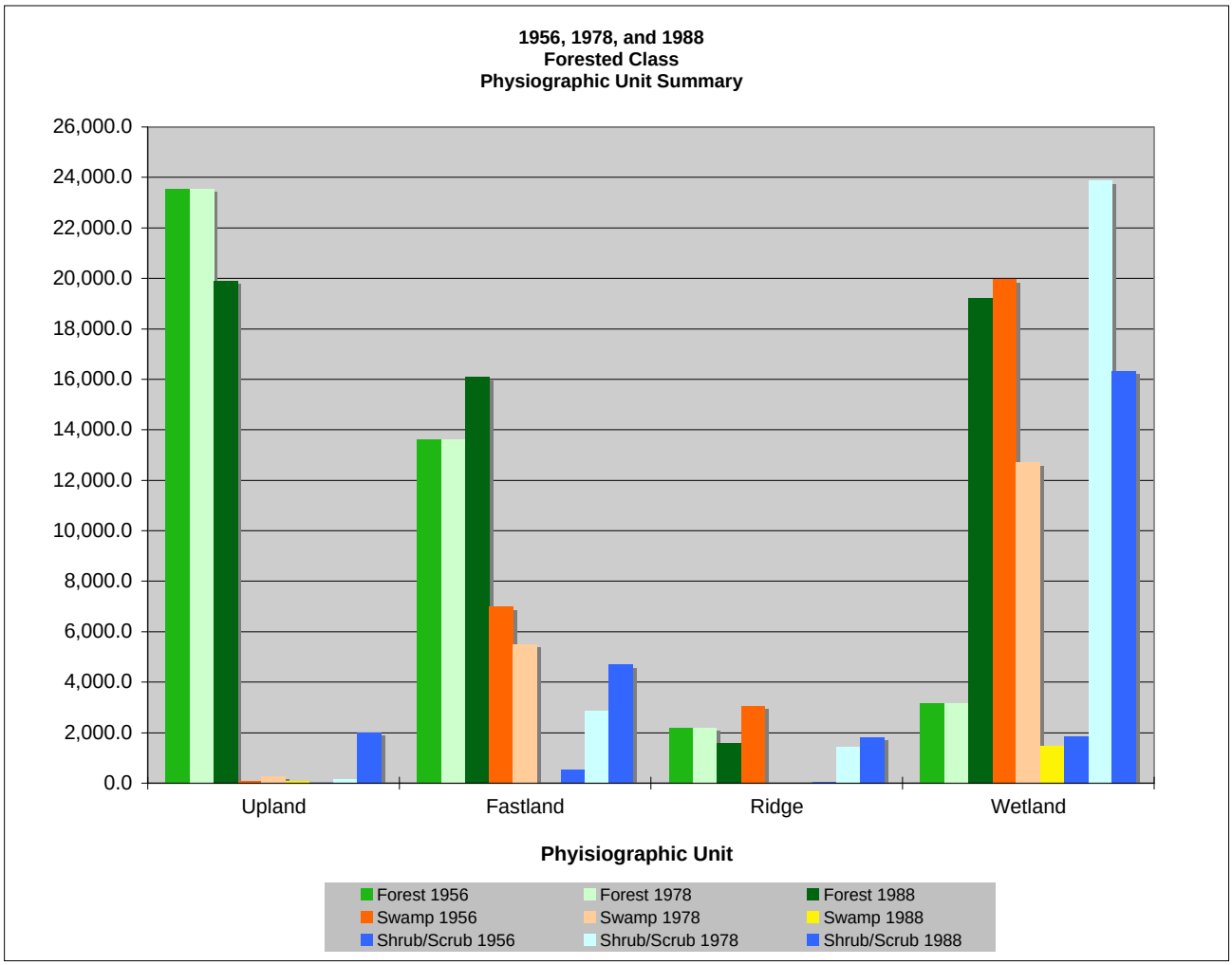


Figure 6. 1956, 1978, and 1988 habitat forested class area summary by physiographic unit.

Comparison of 1956, 1978 and 1988 forest, swamp, and shrub/scrub classes shows a switching pattern between swamp and forest class areas within the fastland and wetland physiographic units. Some of the switching is partially caused by differences in the 1978 and 1988 habitat aggregation schemes discussed earlier. The fastland physiographic unit's 1988 habitat swamp class area decrease may also include non-developable drained or partially drained areas that have converted to bottomland hardwoods or shrub/scrub habitats. The ridge physiographic unit lacks swamp area in 1988 indicating

no regeneration of cypress forest area after 1978. The wetland physiographic unit still shows a marked increase in shrub/scrub area after 1978.

Examination of habitat forest, swamp, and shrub/scrub classes by percent total area of each physiographic unit provides an overview of total area composition (fig. 7). The upland unit contains greater than 60% of the total 1956 and greater than 50% of the 1978 forested area. The fastland areas contain 24% of the 1956 forested area and 19% of the 1978 forested area. The swamp class comprised 12.5% of the 1956 fastland area and 10% of the 1978 fastland area. The ridge area (Loutre Ridge, the Delacroix Ridge, and the Bayou Sauvage Ridge) incurred total swamp loss or conversion of 3,067 acres between 1956 and 1978. The wetland unit swamp areas decreased by 7,263 acres between 1956 and 1978, primarily due to complete loss of swamp habitat in the Chalmette Marsh AU (fig. FA3). The 16,395 acre increase in forest within the wetland physiographic unit is almost equivalent to total 1956 swamp area and exceeds total 1978 swamp area by 6,511 acres. This implies that a large part of the change was caused by forest and swamp classification switching between 1978 and 1988. Adding the 1,498 acres of 1988 swamp class to the 19,217 acres of forest class results in a total forested area of 20,714 acres, which is only 2,423 acres less than the total 1956 forested area of 23,138 acres for the unit. Habitat acreages and change acreages by individual assessment unit can be found in the referenced spreadsheet (Appendix 1: MRGO_USGS_Analysis_Barras Assessment Units Worksheet).

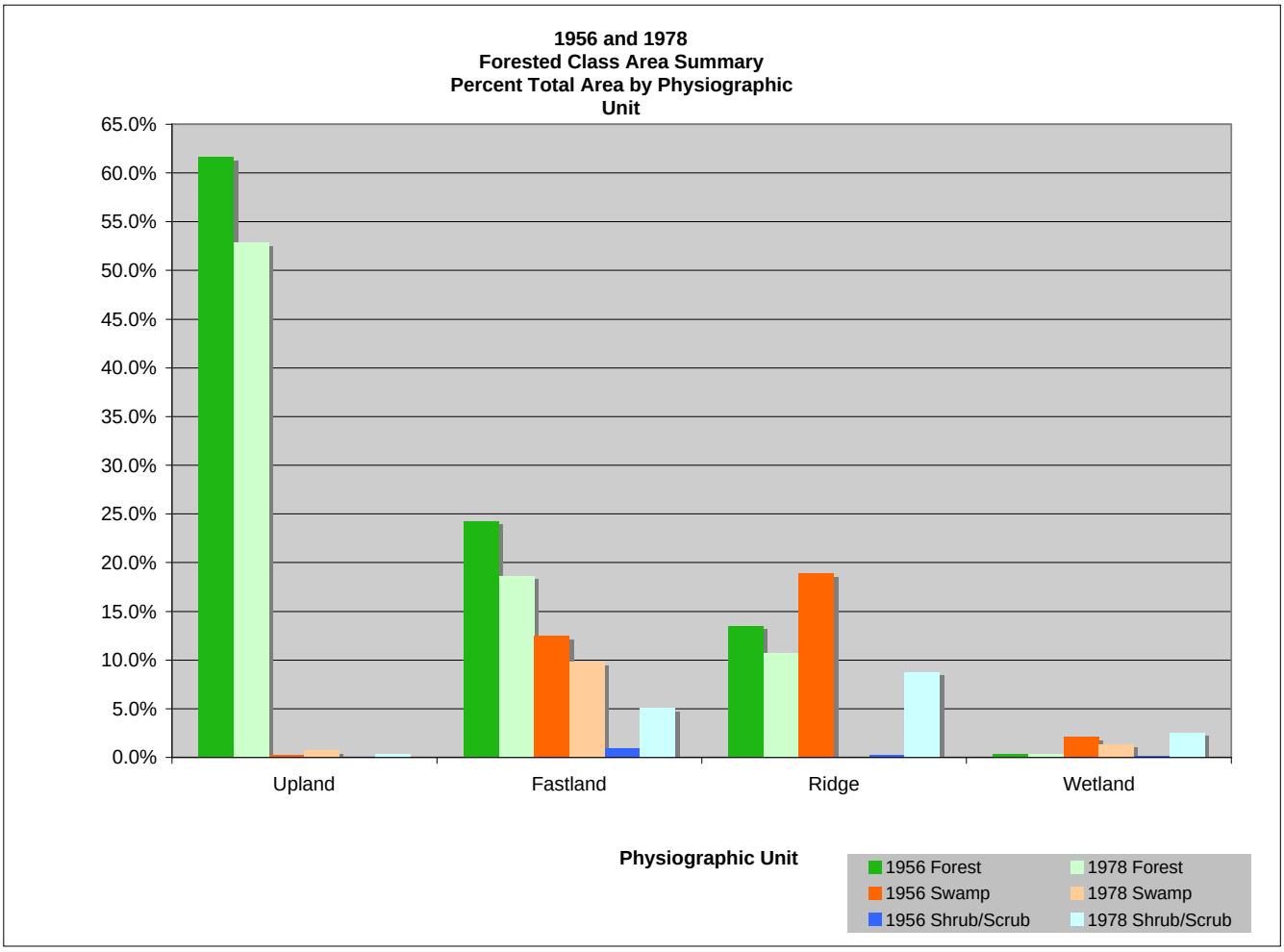


Figure 7. 1956 and 1978 Forested Class Area Summary Percent Total Area by Physiographic Unit

MRGO Channel and Spoil Disposal Area Changes

Both the MRGO channel and spoil disposal area boundaries were digitized directly from the 1978 habitat data and then converted to a raster format for summarizing habitat and land-water area statistics (fig. FA1). Direct dredging of the 5,675 acres MRGO channel resulted in 3,936 acres of new water area at the expense of 4 acres of fresh marsh 3,810 acres of non-fresh marsh, 62 acres of swamp, 2 acres of forest, and 2 acres of developed area (table 3). The spoil disposal area encompassed 21,932 acres and resulted in the filling of 2,718 acres of ponds, 38 acres of fresh marsh, 8,014 acres of non-

fresh marsh, 592 acres of forest, 1,336 acres of swamp, and 53 acres of agricultural/pasture areas. Net habitat conversions include a 50 acre gain of shrub/scrub habitat, 12,827 acre gain of shrub/scrub colonized spoil habitat, and a 1,300 acre gain of developed area. Total direct swamp habitat conversion between 1956 and 1978 was 1,398 acres.

Net loss within the 1978 combined MRGO channel and spoil disposal boundary between 1978 and 2006 is 1,500 acres. The annual 1985 through 2006 trend rate is -49.9 ± 3.8 acres/yr (Barras and others, 2008). The total MRGO channel and spoil disposal area of 27,607 acres accounts for 2.6% of the total 1,051,216 million acre physiographic unit area and 1.4% of the 2,014,212 million acre MRGO Assessment Unit area. More detailed information is available in the attached workbook (Appendix 1: MRGO_USGS_Analysis_Barras; MRGO Habitat 1956 to 1988 worksheet; MRGO 1978 LW Channel Area worksheet; MRGO 1978 LW Spoil Area worksheet; and MRGO 1978 LW Channel+Spoil Area worksheet).

MRGO Channel and Spoil Disposal Area 1956 to 1978 Habitat Changes			
Habitat	**MRGO 1978 Channel acres**	**MRGO 1978 Spoil Disposal Area acres**	**Total Changes acres**
Water	3,936	-2,718	1,218
Fresh Marsh	-4	-38	-42
Non-Fresh Marsh	-3,810	-8,014	-11,824
Forest	-2	-592	-594
Swamp	-62	-1,336	-1,398
Shrub/Scrb	0	50	50
Shrub/Scrub Spoil	8	12,827	12,835
Ag/Pasture	0	-53	-53
Developed	-2	1,300	1,298
Inert	0	1,635	1,635
Beach	0	0	0

Table 3. Direct MRGO channel and spoil disposal area impacts.

1956 to 2006 Land Loss Trends

Land loss trend methodology uses the data sets and trend assesment methods used in Barras and others (2008). Total 1956 to 2006 net land loss for the MRGO assessment units, including the Lake Borgne AU and the Chandeleurs AU, is 123,183 acres and accounts for 14.3% of the total coastal net loss of 863,357 acres and 19.5% of the deltaic plain's net loss of 630,388 acres (Barras and others, 2008). The MRGO study area accounts for 21.5% of the total LCA coastal area of 9,336,315 acres and 39.4% of the deltaic plain's 5,078,412 acres. Current liner regression loss rates using ten land-water data points from 1985 to 2004 is 2,502 ± 411 acres/yr. The 1985 through 2006 rate is 2,951 ± 460 acres/yr. Annual loss rates should be used with caution. The immediate impacts of extreme storms can alter the long-term, time-averaged trends of landscape change. Annual rates may not be appropriate for projecting losses from such events.

Historical Loss and Episodic Impacts

Historical 1956 to 1978 net loss for the study area is 63,851 acres and accounts for 11.6% of the 552,970 acres of coastal net loss and for 16.4% of the 388,473 acres of deltaic plain net loss during this period. Net loss during the 1978 to 2004 period was 29,151 acres over a 26 year period. The 2004 to 2006 episodic loss attributable to Hurricane Katrina is 30,181 acres. Hurricane Katrina's probable loss was roughly equivalent to the 26 years of prior loss that occurred during a period of minimal strong hurricane impacts, 1978 to 2004, within the study area. Recent studies have documented prior physical storm impacts resulting in removal of marsh material, including minor impacts within the study area, using Landsat TM imagery (Barras 2007a, Barras 2007b, fig. 9, Barras and others, 2008). Hurricane Betsy, a category 4 storm, directly impacted the study area on Sept. 9, 1965, within a few years of the completion of the MRGO. The area was also impacted by Hurricane Camille, a category 5 storm on August 17, 1969. Some loss within the study area during the 1956 to 1978 time interval is likely caused by these hurricanes. The large staggered ENE to WSW trending ponds present in the Chalmette Wetland AU and Golden Triangle AU, between the western shoreline of Lake Borgne and the eastern boundary of the Chalmette Fastland AU suggest formation by hurricane surge suggesting that storm induced physical wetland damage was occurring within the area before 1956. A detailed examination of the study area using historical aerial photography and/or historical maps will likely reveal additional causes of land loss.

Examination of spatial land loss trends from 1956 through 2006 shows that overall the MRGO study area is located in a relatively stable land loss area of the deltaic plain lacking the larger land loss hotspots typifying the deltaic plain within the Baratraia basin and Terebonne basin, and the Mississippi River Delta basin (fig. FA8). The most noticeable recent loss areas are from Hurricane Katrina. The MRGO has caused land loss in the study are but there are other causes of loss requiring more detailed

investigation. Detailed land loss information for each assessment unit is contained in the accompanying spreadsheet (MRGO_USGS_Analysis_Barras "Trend" worksheets)..

Chalmette Wetland AU and Golden Triangle to Proctor Point AU Land Loss Trends

Land loss trend within the Chalmette Wetland AU and the Golden Triangle –Proctor Point Wetland AU were specifically examined to determine possible MRGO land loss impacts (together, these units comprise the area commonly referred to as the Central Wetlands Unit). The net loss from 1956 to 1978 for the Golden Triangle to Proctor Point Wetland AU was 5,431 acres. Total net loss from 1978 and 2006 was 1,691 acres indicating that the MRGO did cause significant loss in the area. Current liner regression loss rates using ten land-water data points from 1985 to 2006 is 124 ± 28 acres/yr. The net loss from 1956 to 1978 for Chalmette Wetland AU was 1,351 acres. Total net loss from 1978 and 2006 was 2082 acres. Examination of the 1956 habitat data (fig. FA2) and the1978 habitat data (fig. FA3) along with the TM land-water data sets shows that the MRGO did cause some direct loss in small areas of the western portion of the unit but that loss is more likely caused by slowly increasing water area within the AU. Examination of multiple TM images shows that the marsh often exhibits wet spots in the western portion of the unit and that these areas tend slowly to convert to open water. Hurricane Katrina caused some removal of marsh and pond expansion in this area as well. Current linear regression loss rates using ten land-water data points from 1985 to 2006 is 89.3 ± 18 acres/yr. See detailed calculations in Appendix 1: MRGO_USGS_Analysis_Barras Assessment Units Worksheet.

Closing and General Statements

I intend to use photography and other materials cited in my report or included in plaintiffs' expert reports to support my testimony at trial. I have read the expert reports by Day and Shaffer (2008) and Fitzgerald, et al. (2008), and I reviewed the 1932 T-sheet demarcation used in the plaintiffs' reports, but the plaintiffs' experts have not yet been deposed on their reports. Therefore, I may also rely on the deposition testimony of plaintiffs' experts or their testimony at trial, or any exhibits used by plaintiffs' experts at trial, as a basis for my testimony at trial.

My opinions and conclusions, whether stated at the beginning of this report, throughout the body of the report, or as reflected in the attached figures and appendix, are stated to a reasonable degree of scientific certainty.

As an employee of the U.S. Geological Survey, I am receiving no additional compensation for the preparation of this report.

I have not testified before as an expert witness.

Materials Reviewed

Expert Reports of John Day (September 2007; April 2008; July 2008);

Expert Report of Shea Penland (September 2007);

Expert Report of FitzGerald, Penland, et al. (April 2008; July 2008);

Expert Report of Paul Kemp (July 2008, excerpts);

Photography produced in the litigation from the U.S. Army Corps of Engineers Archives;

ArcGIS shapefile of modeling study area;

CD including materials relied upon by Day/Shaffer and Fitzgerald/Penland in the creation of their expert reports;

CDs of 1943 and 1952 photography from U.S. National Archives and Records Administration and index;

1945 photography from U.S.D.A. Forest Service.

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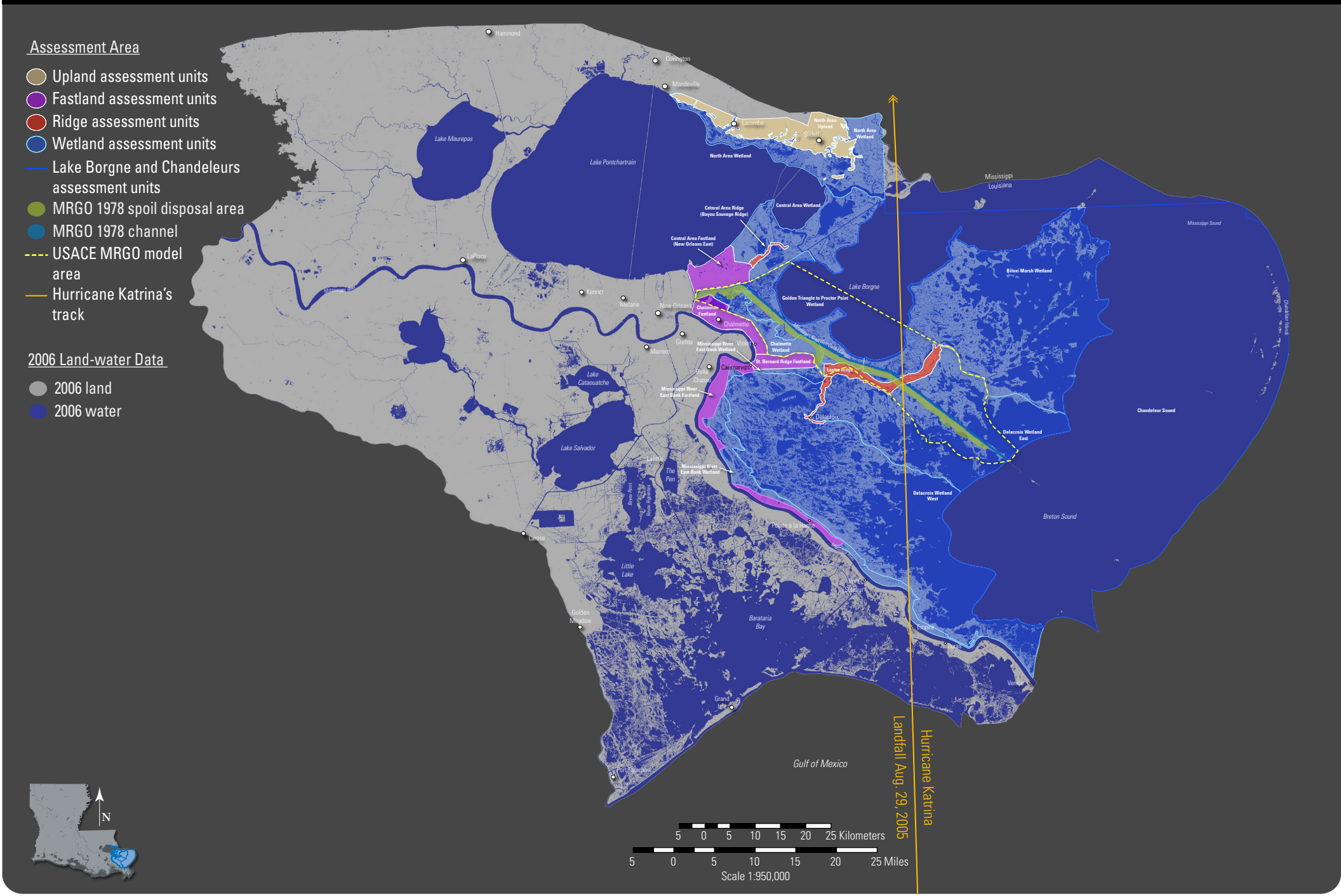
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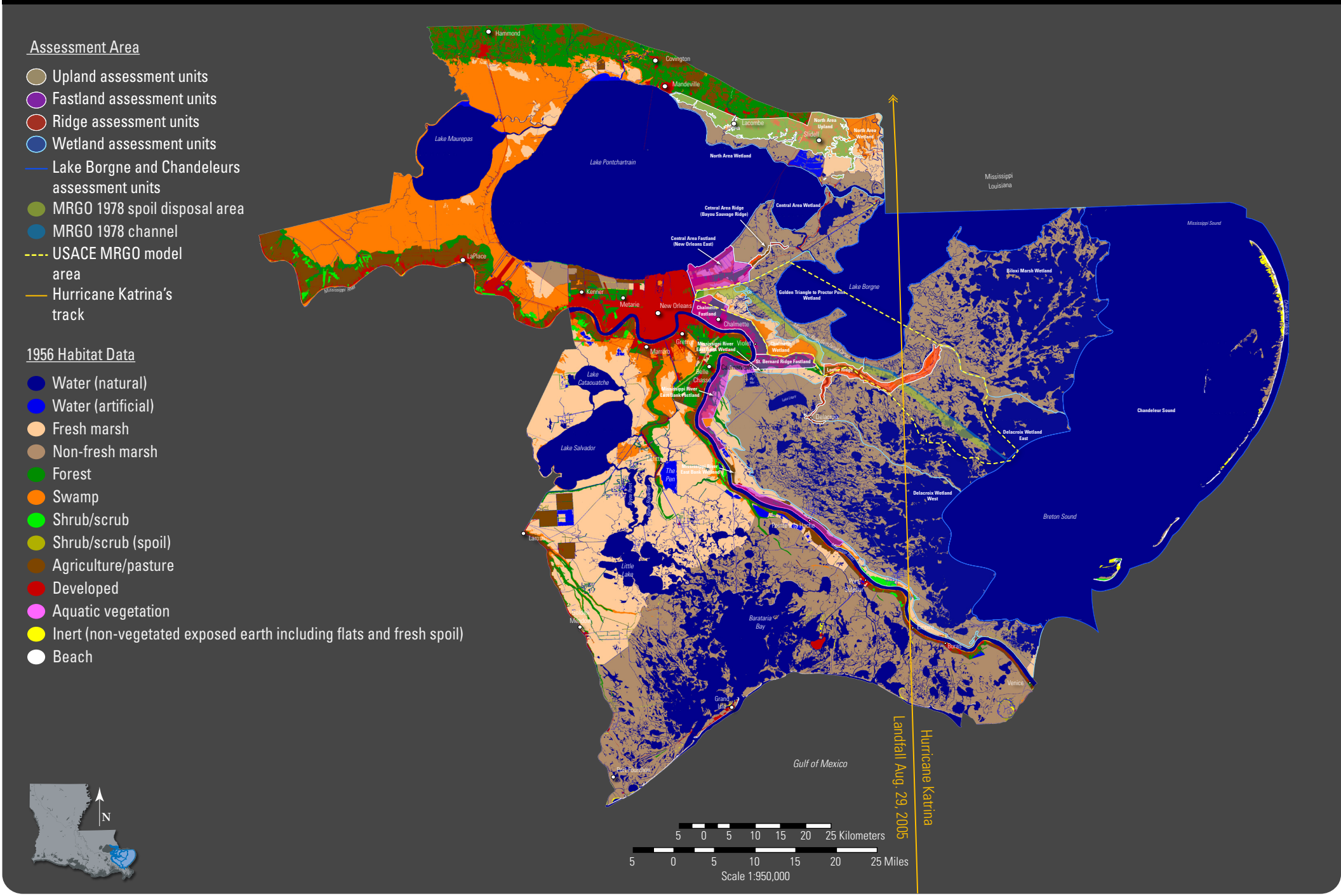
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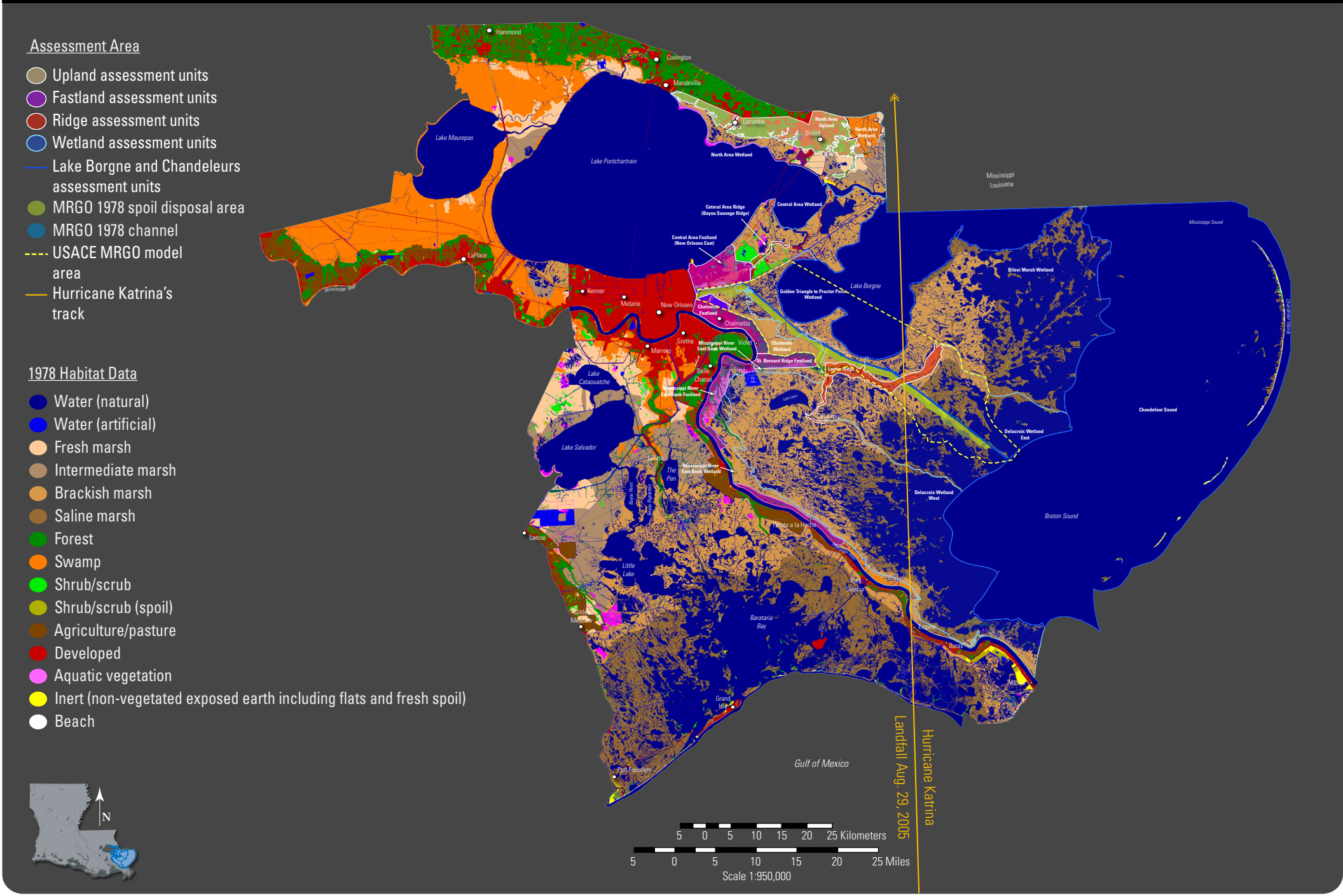
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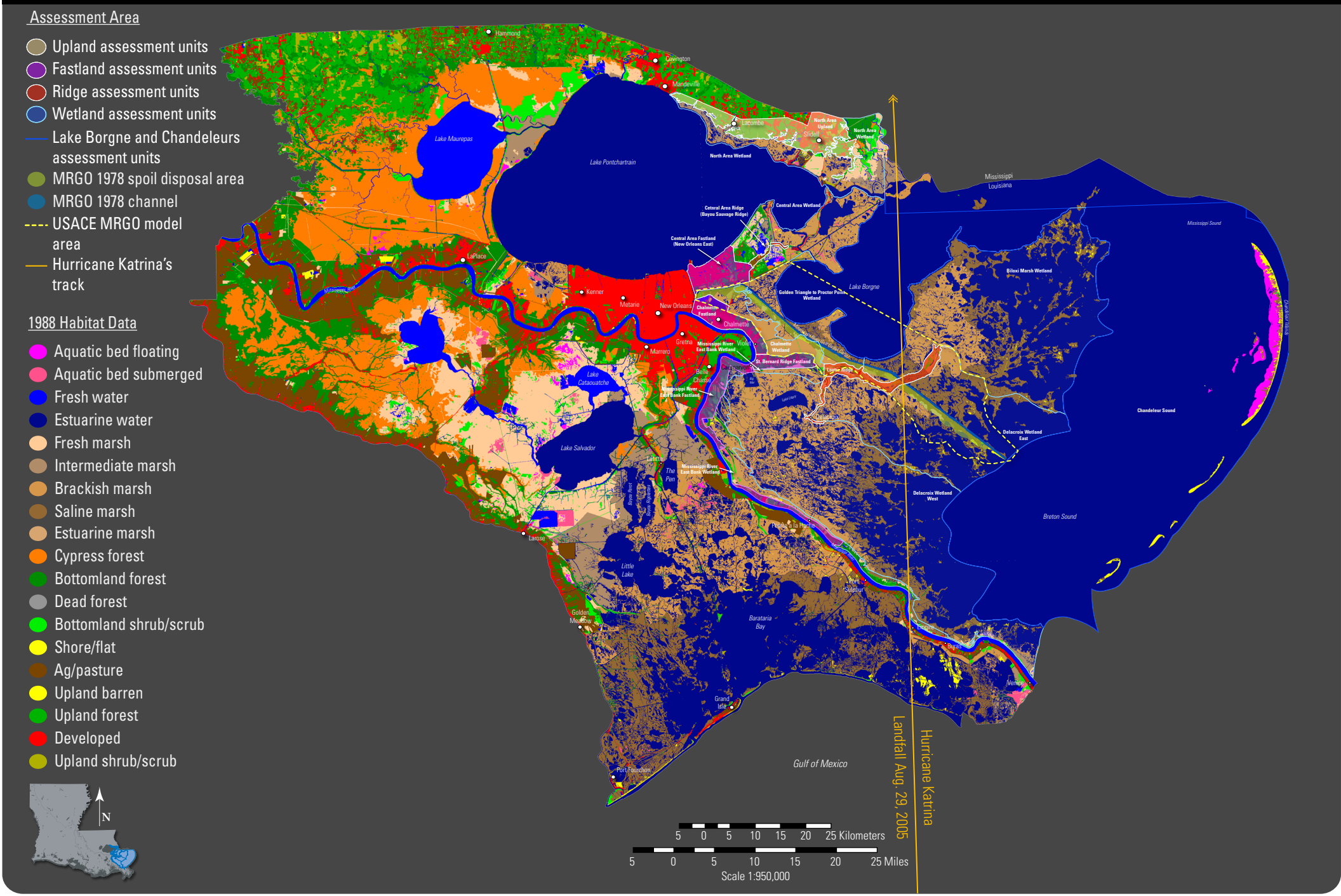
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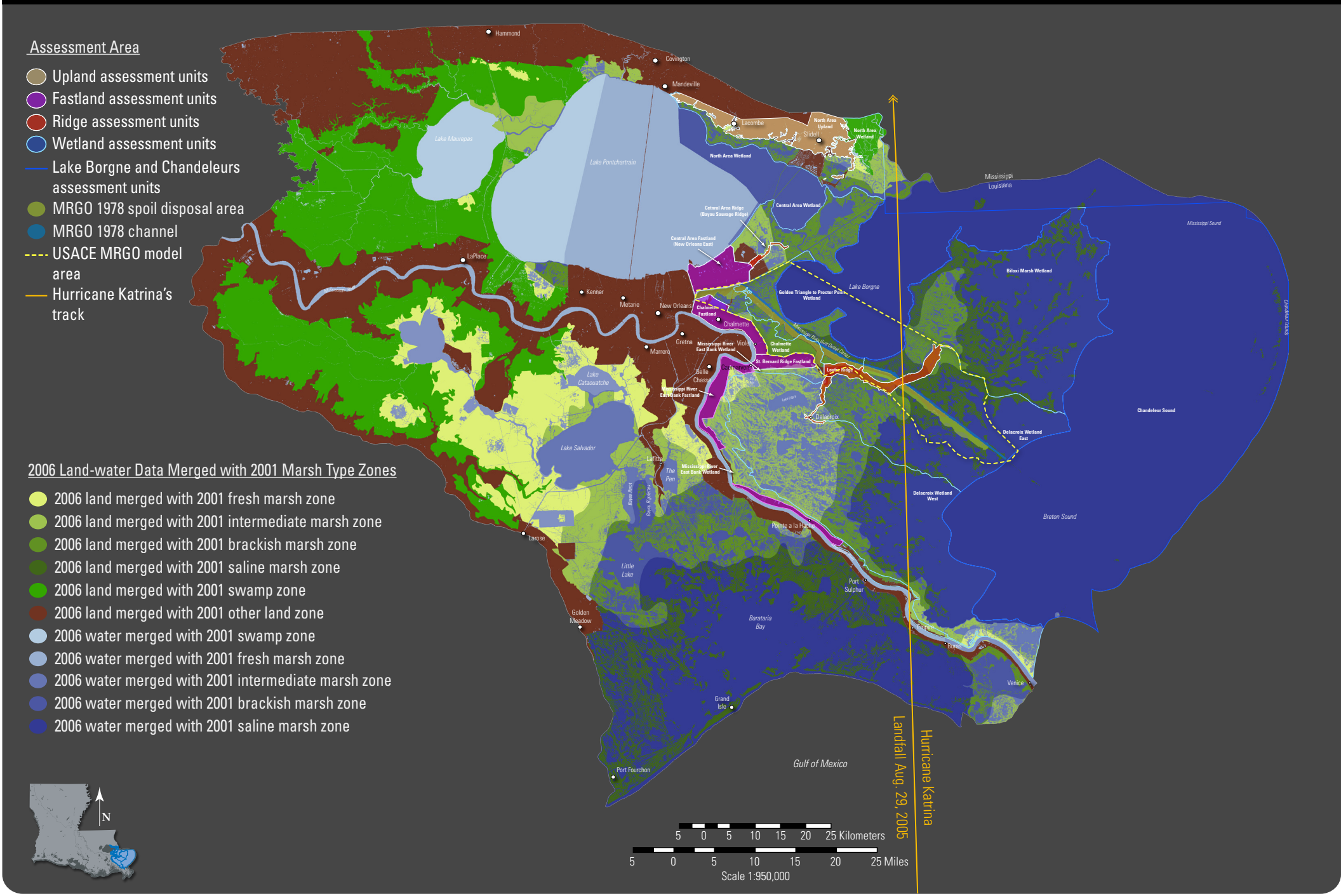
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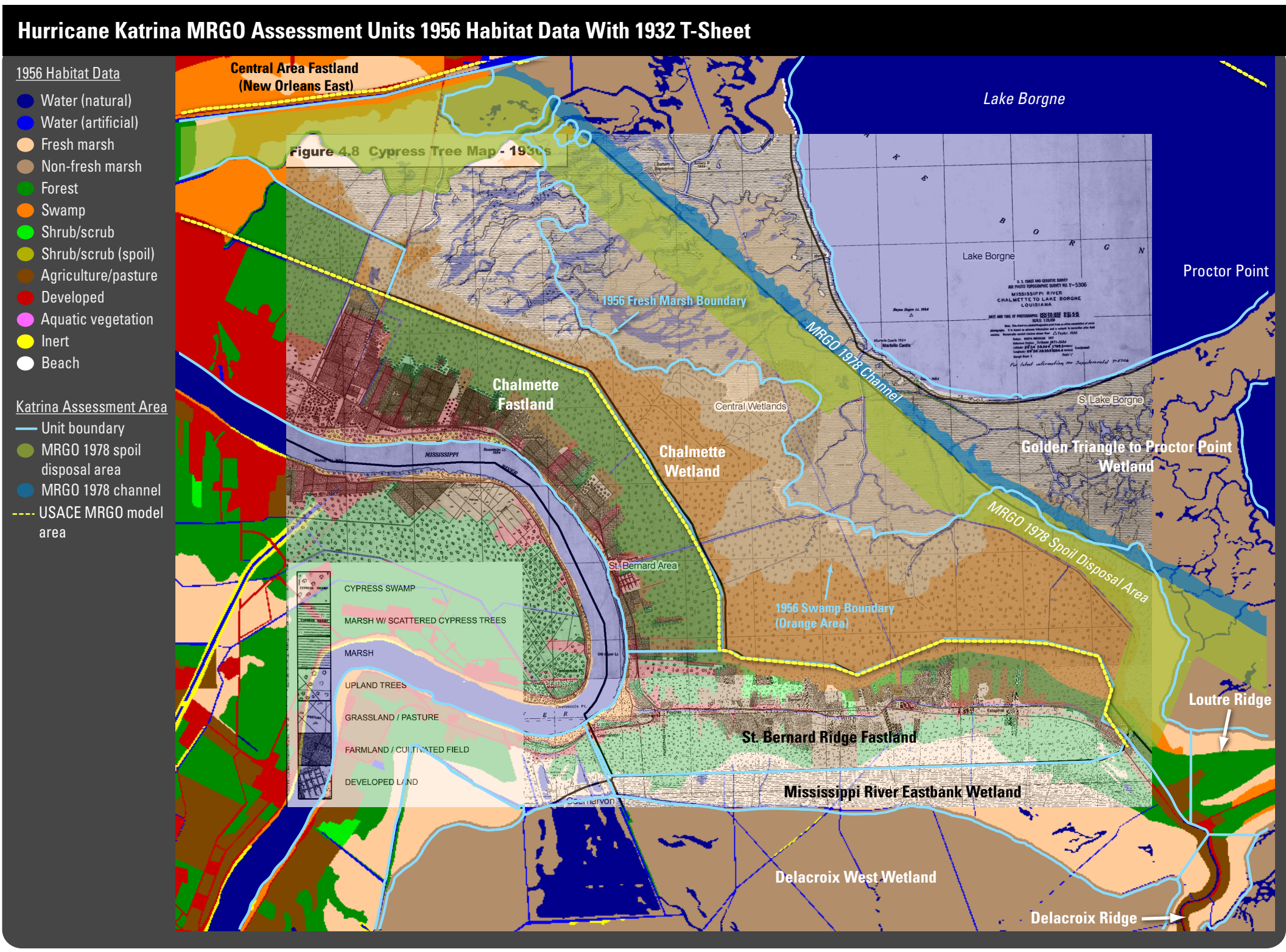
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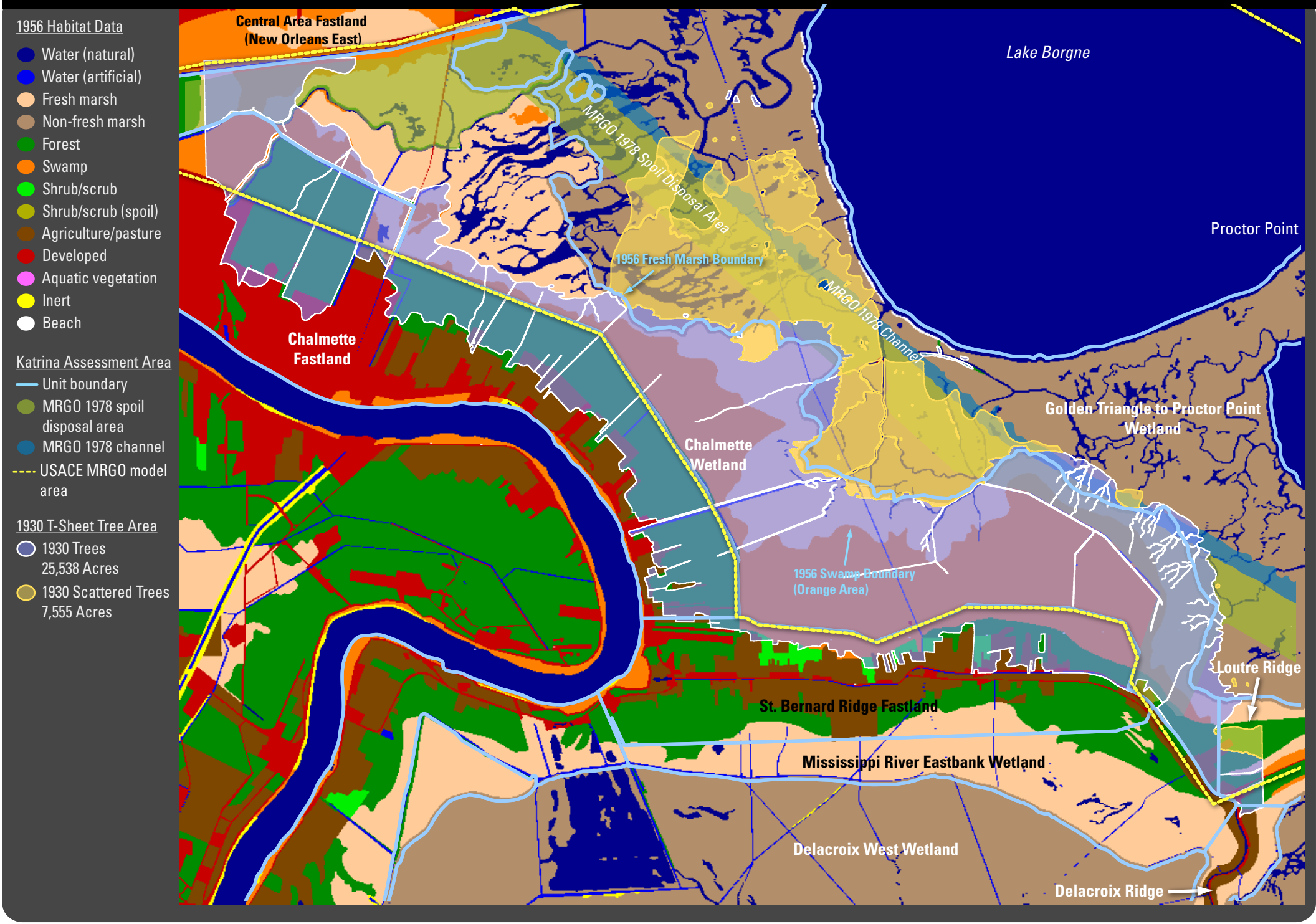
Hurricane Katrina Mississippi River Gulf Outlet (MRGO) Assessment Units 2006 Land and Water Data with 2001 Marsh Types



Hurricane Katrina MRGO Assessment Units 1956 Habitat Data With 1932 T-Sheet



Hurricane Katrina MRGO Assessment Units 1956 Habitat Data With 1930 T-Sheet Tree Area



Hurricane Katrina Mississippi River Gulf Outlet (MRGO) Assessment Units 1956 to 2006 Trends

