the Baton Rouge area (average displacement of 2.5 ft/century). Roger Saucier (1963) related geomorphic features on the north shore of Lake Pontchartrain to this fault system and traced the fault into the lake.

Highway and railroad bridges built across Lake Pontchartrain cross faults of the Baton Rouge system (Figure 3-16). Surface offsets of bridge structures caused by fault movement, measured to be from 0.83 to 3.33 ft/century at various bridge locations, have been documented (Lopez, 1991; Lopez et al. 1997). There has also been "minor apparent earthquake activity" in the region associated with the Baton Rouge fault system (Stover, et al. 1987; Lopez 1991; Lopez et al. 1997). The pattern of faults in this system in the eastern end of Lake Pontchartrain is en echelon, indicating shearing (Lopez et al. 1997), with the southern block moving east in reference to the northern block. Individual faults in this system have been identified in the subsurface on subbottom and high-resolution seismic profiles (Kolb et al. 1975: Lopez et al. 1997).

Fault traces in this system coincide with what E. G. Anderson (1979) referred to as the "inferred edge, Mesozoic shelf and Ouachita system." Spearing (1995) calls this the "Early Cretaceous Shelf Margin." This fault system is apparently deep seated and, at least in part, is a line of delineation between areas of uplift and subsidence. Fisk called this a "hinge line"; the fulcrum of isostatic adjustment to crustal loading. Landward of the hinge line the land is stable or rising and seaward of it the land is sinking. Figure 3-4 shows regional patterns of uplift and subsidence north and south of the hingeline faults, as determined from sequential survey of benchmarks (Holdahl and Morrison 1974; Watson 1982).

Saucier (1994), in a synthesis of structural elements in the Mississippi River Valley, includes the Baton Rouge Fault Zone with the South Louisiana growth faults. He states that, "several lines of evidence suggest that most of the fault zones have had some noticeable but geomorphologically unimportant effect on near-surface deposits of Pleistocene age." Only the Baton Rouge Fault Zone has had major geomorphic impact and is known to be currently active. Saucier (1994) considers the Baton Rouge fault zone to be second only to the Reelfoot Rift, (located in northeast Arkansas, southeastern Missouri and northwestern Tennessee and which was the locus of the New Madrid earthquake of 1811-1812), in the entire Lower Mississippi River Valley area in terms of the extent and recentness of Quaternary displacements.

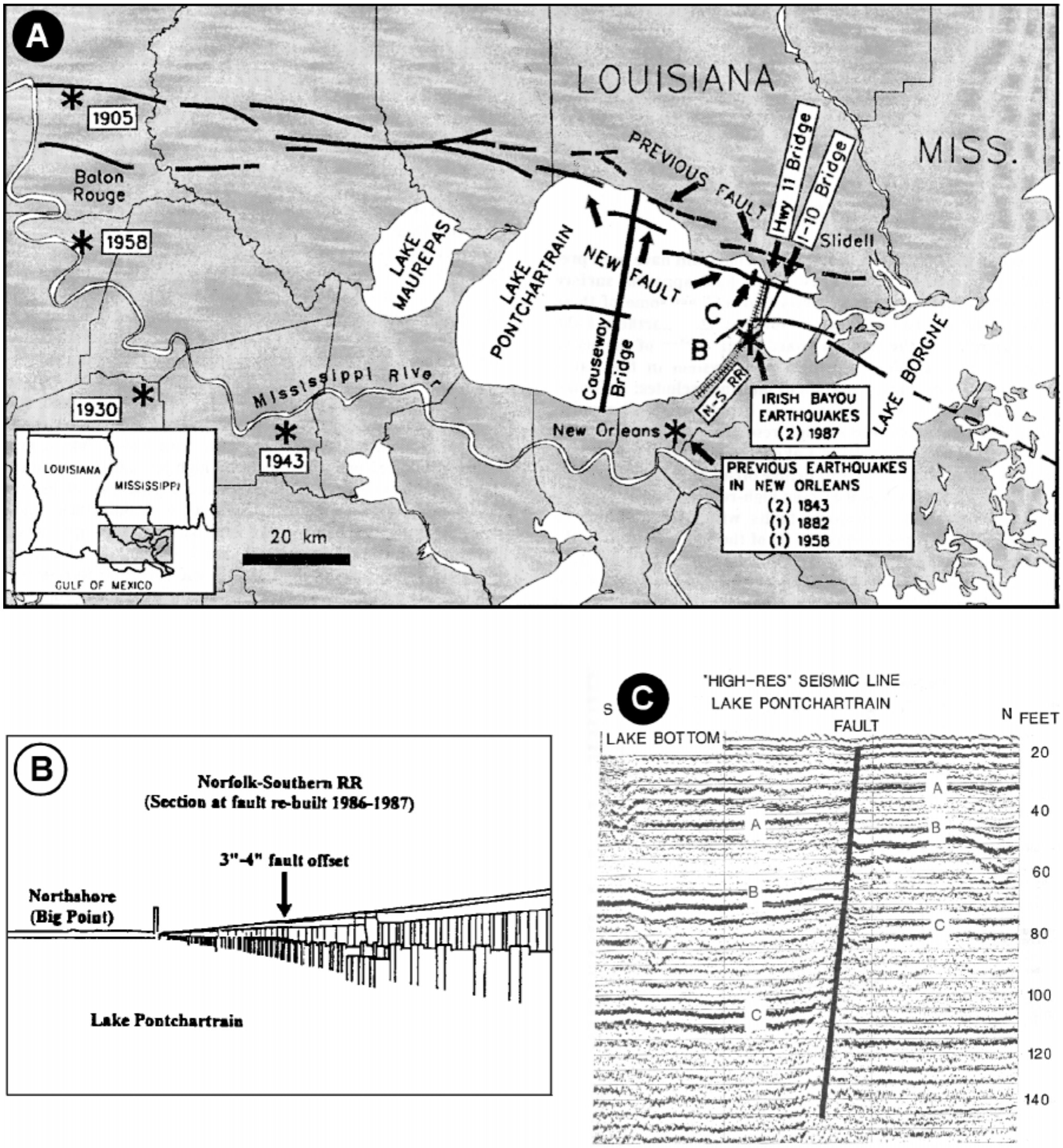

Figure 3-16. Baton Rouge fault system.

A. Fault traces from the Mississippi River to Lake Borgne. Displacements have been measured on bridges shown. Reported earthquake occurrences are also shown.

B. Drawing showing fault offset in re-built section of Norfolk-Southern Railroad bridge in eastern Lake Pontchartrain.

C. Displacement of beds by south dipping normal fault as recorded on U.S.G.S. high resolution seismic line from eastern Lake Pontchartrain. Abrupt terminations of shallow reflectors indicate that the fault is within 10 ft of the lake bottom (after Lopez et al. 1997).

SW-NE Fault Systems and Alignments

Three parallel fault systems cut diagonally across south Louisiana: the Calcasieu Lake Fault Zone, the Lake Sand-Frenier Alignment, and the Mauvais Bois Alignment (Figure 3-15).

The Calcasieu Lake Fault System is a long straight trend of faults cutting across the Uplands and Calcasieu Lake and intersecting the Gulf of Mexico shore in the Holly Beach area.

The Lake Sand-Frenier Alignment is a strong trend of faults, some of which branch or fan toward the southwest. The trend terminates at its northeast end under Lake Pontchartrain where it runs into northwest-southeast aligned systems.

The Mauvais Bois Alignment is well defined at its southwest end by faults under Point au Fer. The Mauvais Bois ridge, a prominent landform, follows the alignment. Toward the northeast it cuts across the ends of a series of east-west growth faults. The alignment terminates under Lake Borgne, where it runs into northwest-southeast aligned systems.

NW - SE Alignments or Shear Faults

Fault patterns, variations in subsidence rates, and other data examined during the course of this study indicate a regionally important, apparently deep seated fault system herein called the Terre aux Boeuf Fault System (Figure 3-15). In the Lake Borgne area, patterns of splinter fault fans at the eastern end of growth-faults terminate at the Terre aux Boeuf fault. The pattern suggests shearing, with the southern block moving east in reference to the northern block. In the active Mississippi River delta, this fault system merges with a circular fault pattern around an apparent collapse feature. The Lafayette Fault System is another apparently deep-seated fracture or fault system that brackets the Deltaic Plain on the west. It is defined by splinter fault fans on growth faults, which terminate at the Lafayette Fault System. No published references to these two postulated fault systems have been found in the literature.

E-W Growth Fault Systems

This is the predominant trend of growth faults in the Gulf Coast Salt Dome Basin. A series of long and continuous fault systems extend across the southern part of the state from Texas to the east and terminate at the Biloxi and Tere aux Boeuf Fault Systems.

The Golden Meadow-Theriot-Forts Fault System is one of the most continuous and distinctive. From the standpoint of coastal erosion and deterioration, it is the most important fault system in the region. The Golden Meadow Fault System, as depicted by Murray (1960; Figure 3-9) would include the Theriot and Forts faults as defined in this paper. The Golden Meadow trend is clearly identified on the Wallace map. Onshore it extends from Point au Fer to Bayou Lafourche, where it branches to the east. Wallace classifies a segment of the system (at the Gulf of Mexico shore and under Point au Fer) as a major fault (2,000 to 5,000 ft displacement). Immediately south of the fault, where it crosses Bayou Lafourche, there is a graben structure. To the east, two salt domes fall within the alignment in the

Barataria Bay area, and the area between the two domes is classified by Wallace as a major fault. It is also interesting to note that the fault cuts into the Lake Washington salt dome. East of this dome, the fault trend continues as the Forts Fault. It crosses the Mississippi River and probably influenced the configuration of the Forts Bend, a sharp bend in the river. Wallace also classifies this as a major fault in the area where it crosses the Mississippi River. It is classified as a major fault along more of its length than any other south Louisiana fault. The Theriot fault is north of, and trends subparallel to, the Golden Meadow fault.

Surface traces of faults in these three systems have become increasingly evident on aerial photographs and images in recent decades. For example, the trend is not evident on 1955 Ammann International Corporation aerial photographs, but is clearly visible on the November 1990 Landsat TM Satellite Imagery, bands 4, 5 and 3. Traces are defined by linear contacts between marsh and open ponds and broken marsh patterns (land loss and marsh deterioration) on the down-thrown block. Some traces are parallel to, but do not coincide with, fault traces as shown on the Wallace map. This is due to the fact that Wallace used subsurface data, which was not necessarily projected to a surface datum.

The Lake Pelto Fault System is identified from the Wallace map. It contains seven salt domes, including the Lake Washington dome, into which it anchors at its eastern end and where it merges with the Golden Meadow-Theriot-Forts Fault System. The system exhibits reverse faulting and sets of fault traces along some segments. This system is less important than the Golden Meadow system. Land loss and marsh deterioration patterns along the south side of the fault trace suggest rotation of the down-dropped block.

The Eugene Island Fault System is defined primarily by a string of nine or more salt domes extending generally parallel to the Gulf shore, partially offshore and partially onshore. Defined faults between the domes tend to be reverse faults.

Sinking Land and Rising Sea

If fault bound blocks along the coast are sinking and are being inundated by the sea it becomes important to determine the rate of change between the elevation of the land and the level of the sea, the combined effect of which is relative sea level rise.

As shown in Figure 3-17, the task of determining rates of relative sea level rise is complicated by the large number of process variables that contribute to vertical change. The land elevation on the blocks, the rate of sinking of the land surface (subsidence) and the rate of rise of the sea (eustatic sea level rise) are primary factors. To further complicate the task, subsidence has a number of components, the two principal of which are compaction of poorly consolidated sediments (compactional subsidence) and geosyncline down-warping, one expression of which is fault movement (fault induced subsidence).

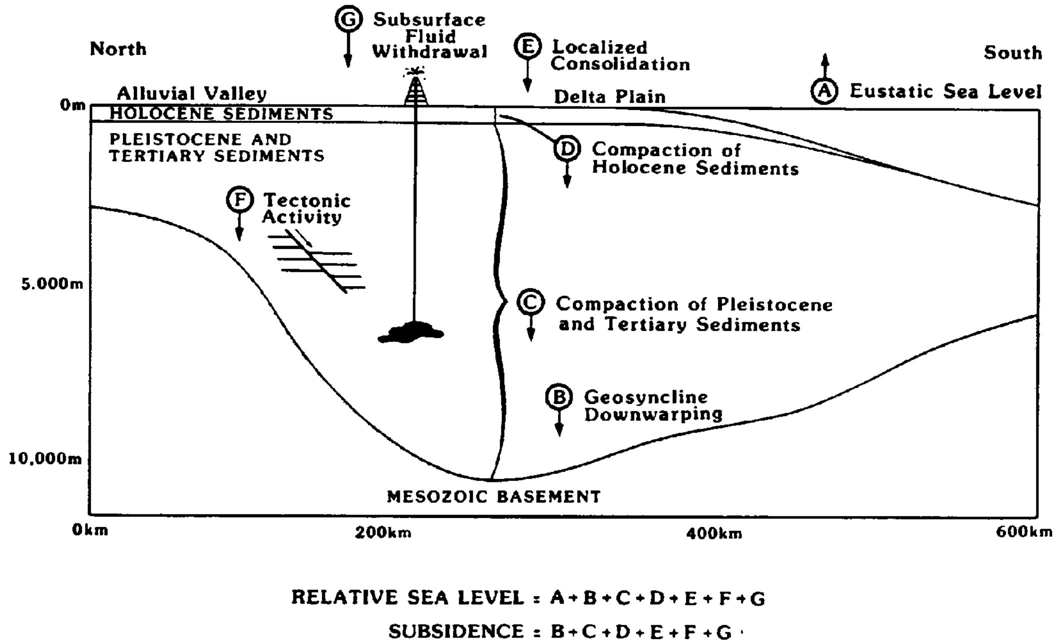

Figure 3-17. Factors contributing to relative sea level rise and subsidence in the Louisiana coastal region (after Penland et al. 1989:8; adapted from Kolb and Van Lopik 1958:95).

In their study of the geology of the Deltaic Plain, Kolb and van Lopik (1958) considered tectonic activity as a component of relative sea level rise (total subsidence). They noted that "most movement probably occurs in spasms, and average rates of movement, which would allow a prediction of the tectonic portion of total subsidence, would be very difficult to establish". A further discussion of the components of relative sea level rise and methods and results of measurements follows.

Rising Sea

The current average eustatic sea level rise rate is 0.49 ft/century. Until recently the sea level rise rate has been low, but the rate is increasing. The best estimate of sea level rise experts have provided is that the level of the world's oceans will increase 0.67 ft over the next 50 years and 1.53 ft during the next century (Wigley and Raper 1992).

Compaction

Compaction is related to the type and thickness of Holocene Period (modern) sediment that has accumulated on top of the weathered surface of the Pleistocene formation during the past 7,500 years. This buried top of the Pleistocene is a continuation of the upland surface, and prior to burial it was exposed by low sea level stands during the last ice age. A prism of modern sedimentary deposits (sand, silt, clay, peat beds and shell beds) accumulated above the weathered surface during the rise and the relative "still-stand" of the sea that followed glacial melting. The poorly consolidated clay and peat beds had higher water content at the time of deposition. After burial, they compacted and lost volume.

This compaction process, which still continues, contributes to subsidence. Where the Holocene deposits are thick, compaction and subsidence rates are higher.

Ramsey and Moslow (1987) attribute 80% of the observed relative sea level rise in coastal Louisiana to "compactional subsidence." Del Britsch (personal communication) has compiled data from innumerable borings in the coastal zone and from analysis of this data has concluded that subsidence rates are directly related to thickness of the Holocene deposits, and compaction thereof. Kuecher (1994) has studied relationships between land loss, thickness and characteristics of Holocene sediment, subsidence rates and faulting and has also concluded that compaction is a primary cause of subsidence. Most researchers have recognized that fault induced subsidence is a contributing factor, but the consensus has been that the majority of relative sea level rise can be attributed to compactional subsidence.

Methods of Measuring Rates of Relative Sea Level Rise and Subsidence

Data for measuring relative sea level rise and subsidence comes from a number of sources. These include: 1) change in elevation of surfaces upon which human structures (prehistoric Indian village sites, lighthouses, forts, roads, etc.) were built, 2) radiometric dating of buried peat deposits, 3) tidal gage records, and 4) sequential land surveying. The latter technique provides the best measure of present day subsidence rates.

Tide Gage Data

Shea Penland, Tom F. Moslow, Karen E. Ramsey, and their colleagues, in an important series of studies and papers, have grappled with the problems related to causes, effects, and rates of relative sea level rise in south Louisiana. (Ramsey and Moslow 1987; Penland et al. 1988; Penland et al. 1989; Ramsey and Penland 1989; Nakashima and Louden 1989; Penland and Ramsey 1990). The team conducted a comprehensive study of historical water level records from 78 tide gage stations and 342 line miles of geodetic leveling data from south Louisiana and adjacent areas of the northern Gulf of Mexico region for the period 1942-1982.

Figure 3-18 shows a typical water level time series from the Grand Isle gage, as analyzed by the Penland et al. team (1989). Water levels generally "climb the gage" through time. The records from each state were analyzed to determine the rise rate for the entire period of record as well as for two twenty year time epochs. Epoch one included the period 1942 - 1962 and Epoch two the period 1962 - 1982. Records from many south Louisiana stations also showed a distinctive increase in rate of rise.

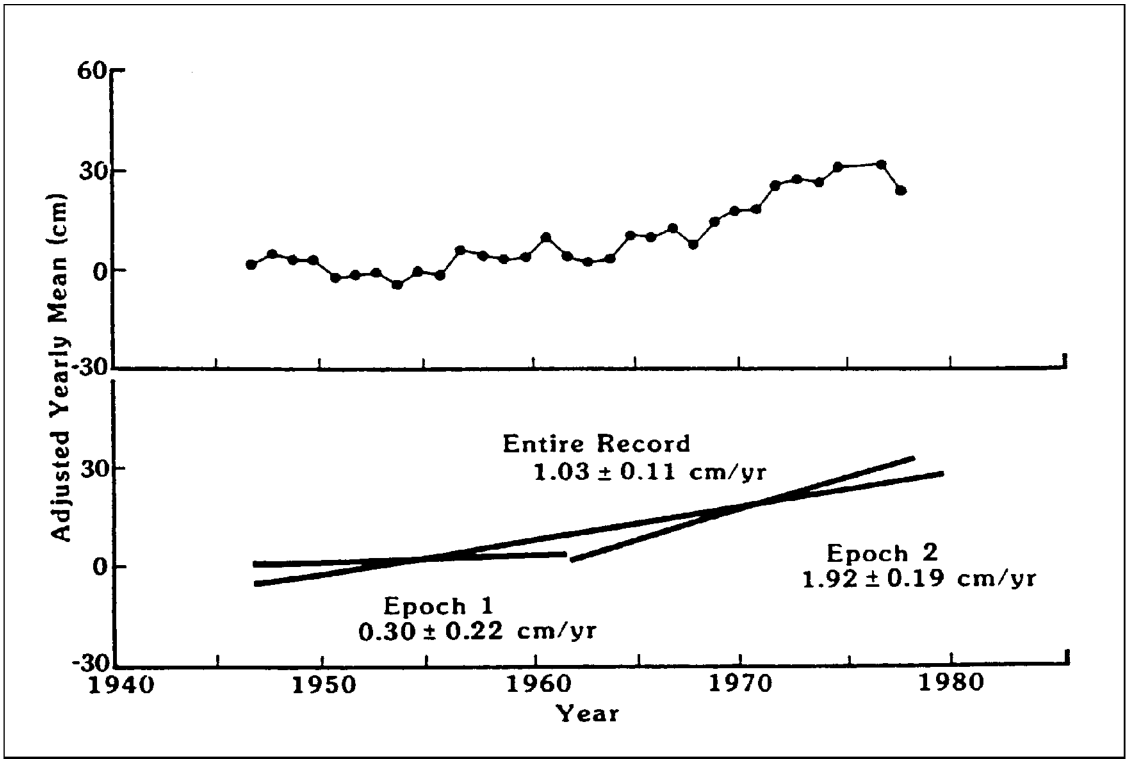

Figure 3-18. Water level time series from National Ocean Survey, Grand Isle, La. tide gage between 1947 and 1978. A change in the rate of rise between the period 1947 - 1962 (Epoch 1), and the period 1962 - 1978 (Epoch 2) has been found on many of the records from gages in south Louisiana (after Penland et al. 1989:24).

Gage records from the northern Gulf of Mexico, from Cameron, La to Cedar Key, Fl, were analyzed. Most records indicated a relative rise in the level of the sea through time, but as shown in Figure 3-19, the rates of relative rise varied from east to west, with the lowest rates being along the coasts of Florida-Mississippi and the highest being along the Deltaic Plain of Louisiana. Land leveling data indicated that the Pensacola location has remained relatively stable and for this reason the rate of relative rise at Pensacola was selected as the best measure of eustatic sea level change for the northern Gulf of Mexico region (see Figure 3-3). Thus, the rate of 0.75 ft/century, as determined from the Pensacola record, was used by the Penland et al. team as a correction factor in adjusting relative sea level rise rates to subsidence rates and vise versa. This same correction method and factor are also used in this paper.

As mentioned above, many of the tide gage records from coastal Louisiana also exhibit a distinctive increase in rate of relative rise, beginning in about 1962 (Figures 3-18 and 3-20). This change is most pronounced in three areas, the South Shore-Little Woods area in the eastern end of Lake Pontchartrain, the Deltaic Plain west of the Mississippi River, and the Mermentau River area in the Chenier Plain. These changes in rate suggest fault movement. Further, they specifically suggest that the rate of movement on faults in the three areas has increased during the 1962-1982 interval.

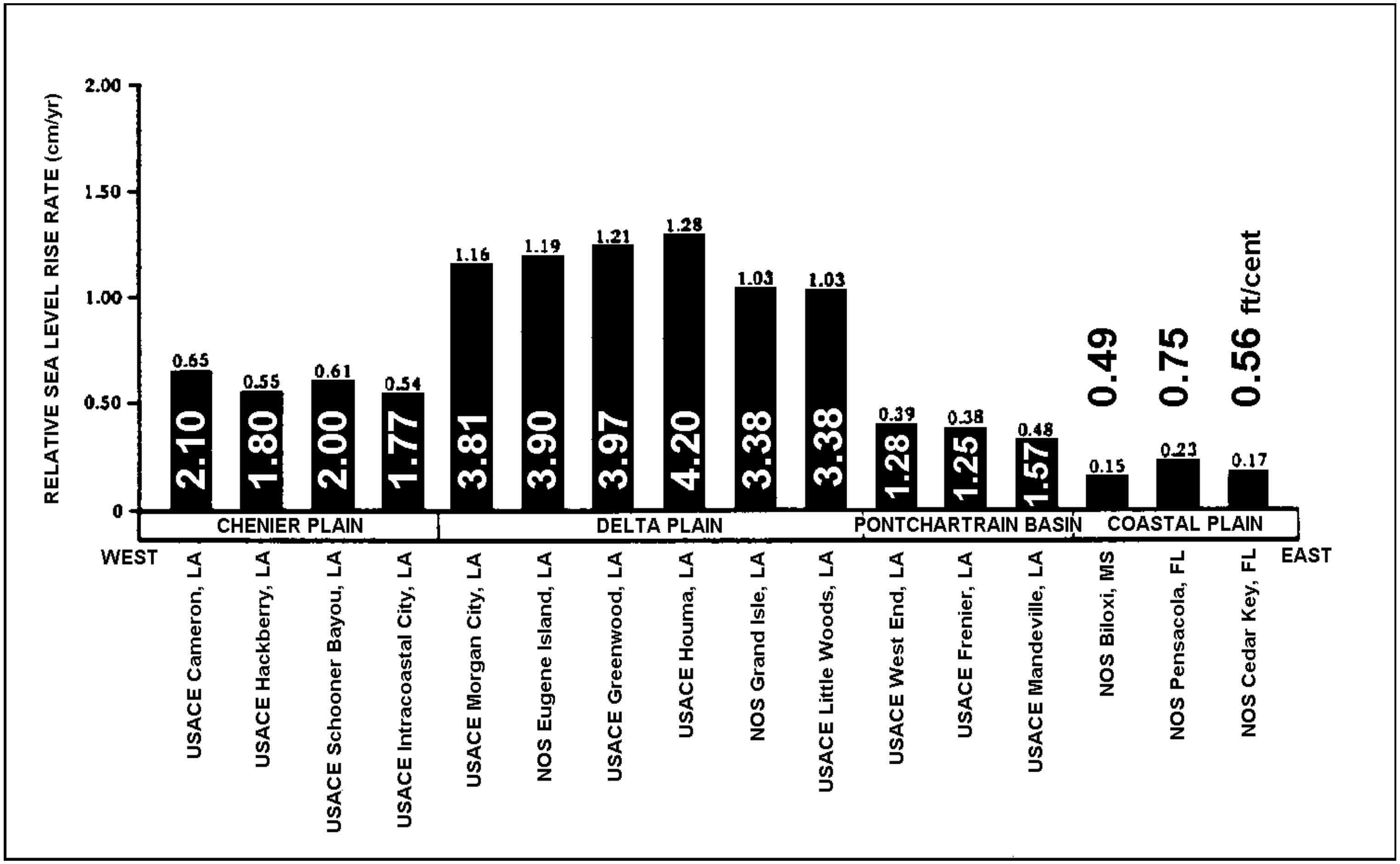

Figure 3-19. Rates of relative sea level rise across the northern Gulf of Mexico region from Cameron, LA to Cedar Key, FL based on records from the National Ocean Survey and U.S. Army Corps of Engineers tide gage stations. The Pensacola, FL gage land location is considered to be stable, and this gage provides a record of eustatic sea level rise in the Northern Gulf Region. The rates of rise of all stations in coastal Louisiana exceed the rate of eustatic rise. The differences are attributed to subsidence (after Penland et al. 1988).

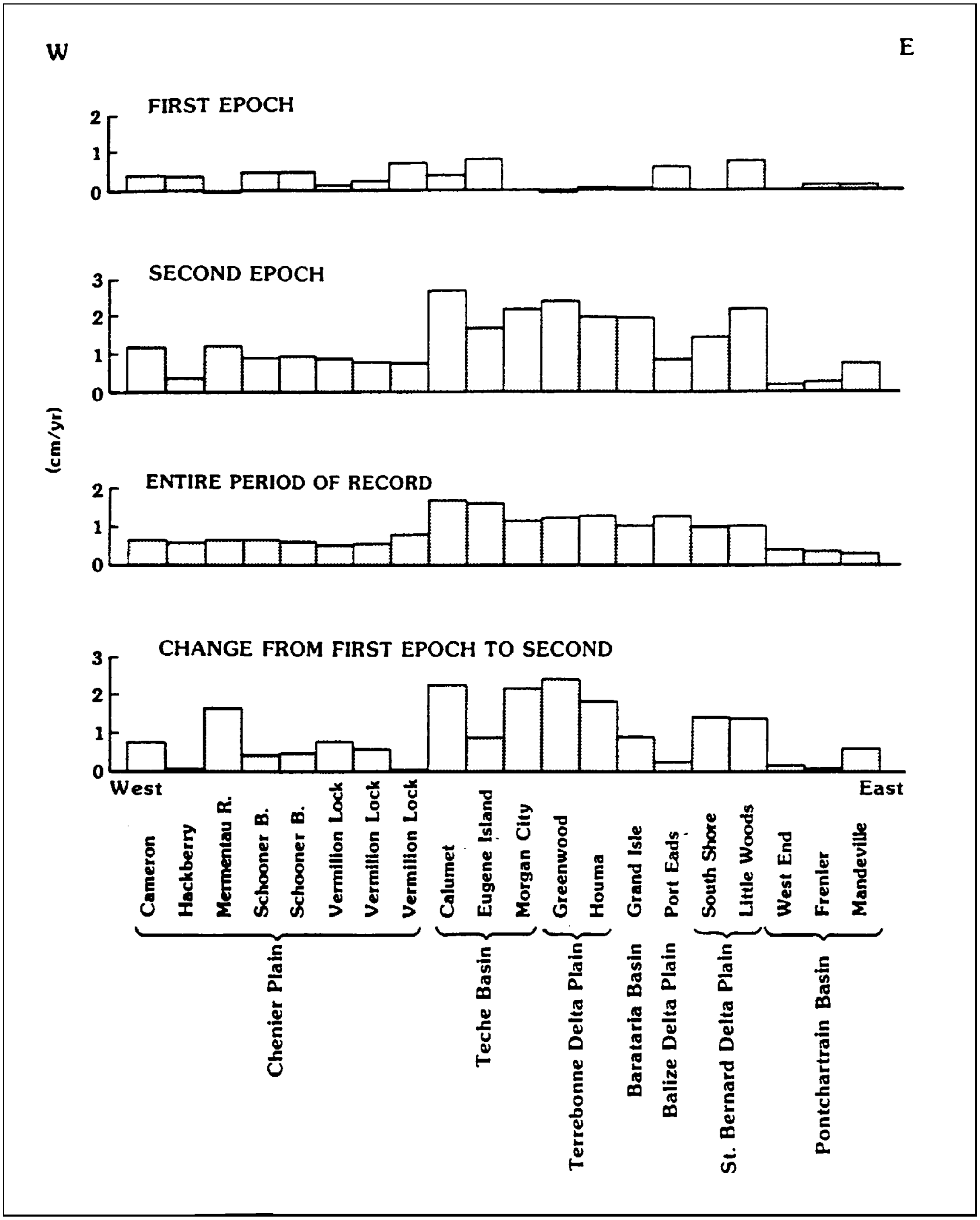

Figure 3-20. Relative sea level rise based on readings from U.S. Army Corps of Engineers tide gage stations in Louisiana. Note change in rate of rise between 1947-1961 (Epoch 1) and 1962-1978 (Epoch 2), (after Penland et al. 1989).

The statewide sea level rise rate was calculated to be 1.148 ft/century for 1942-1962 period and 3.67 ft/century for 1962-1982 period. The relative sea level rise rate for the study area was found to be 3.2 times greater in the second 20-year epoch. Projections of future trends of relative sea level rise were made based on the tide gage records (Figure 3-21).

Ramsey and Moslow (1987) grouped the gage data into seven hydrographic basins. The data show great variation both temporally and spatially throughout coastal Louisiana. Using average values for the entire period of record (1942 through 1982) rates of rise of 3.28 to 3.94 ft/century were found in the areas immediately along the Louisiana coast. Relative sea level rise in the southwest portion of the Deltaic Plain was determined to be 5.91 to 6.23 ft/century. In most cases there was a pronounced decrease in rate landward.

Figure 3-22 depicts a map adapted from Ramsey and Moslow (1987). The map shows a large area of high relative sea level rise rates south of the Theriot-Golden Meadow-Forts fault systems. A local area of high rates occurs along the south shore of the eastern end of Lake Pontchartrain. This is on the down-thrown block of the Baton Rouge Fault System, where movement has been documented by Lopez et al. (1997). Another area of

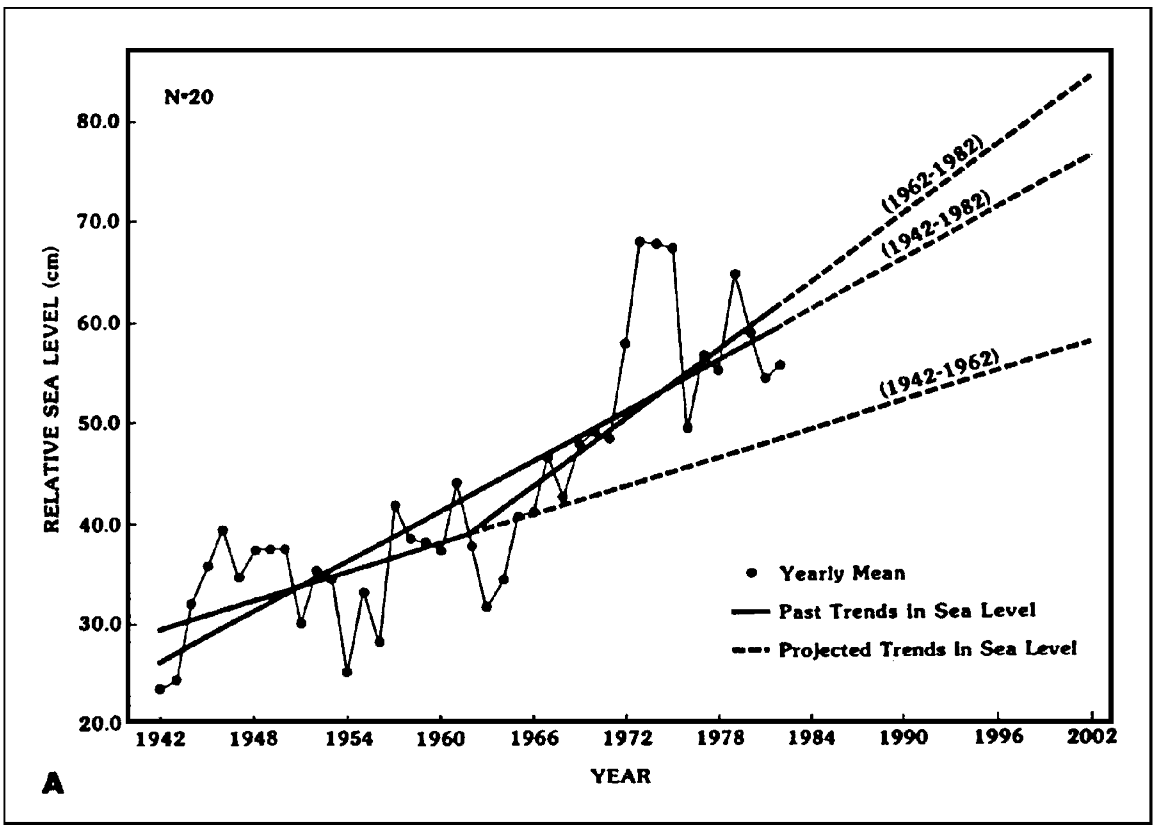

Figure 3-21. Present and future trends of relative sea level rise based on tide gage records from coastal Louisiana (after Ramsey and Moslow 1987).

relatively high rates is found at the mouth of the Mermentau River in the Chenier Plain. This is where the Grand Chenier Fault System reaches the coast.

After subtracting the isostatic rate of rise of 0.75 ft/century, Ramsey and Moslow determined the "compactional subsidence" rate. From this analysis the authors concluded that approximately 80% of the observed relative sea level rise in Louisiana was attributable to compactional subsidence. They also concluded that compaction and loading account for the spatial variation in rate.

The implications of this map are far reaching. Do relative sea level rise rates in the Terrebonne area meet the reality test? The rate of 8.0 ft/century equals two feet of vertical change during twenty years. During the 20 years from 1962 - 1982 did the relative sea level rise rate in the Barataria Basin exceed the rate in the Balize Delta Lobe area, where historically relative sea level rates have been reported to be the highest in the region?

Sequential Land Leveling

Perry C. Howard (in Van Beek et al. 1986) studied subsidence in Plaquemines Parish, which includes the Mississippi River from New Orleans to its mouth. A review of the geological literature

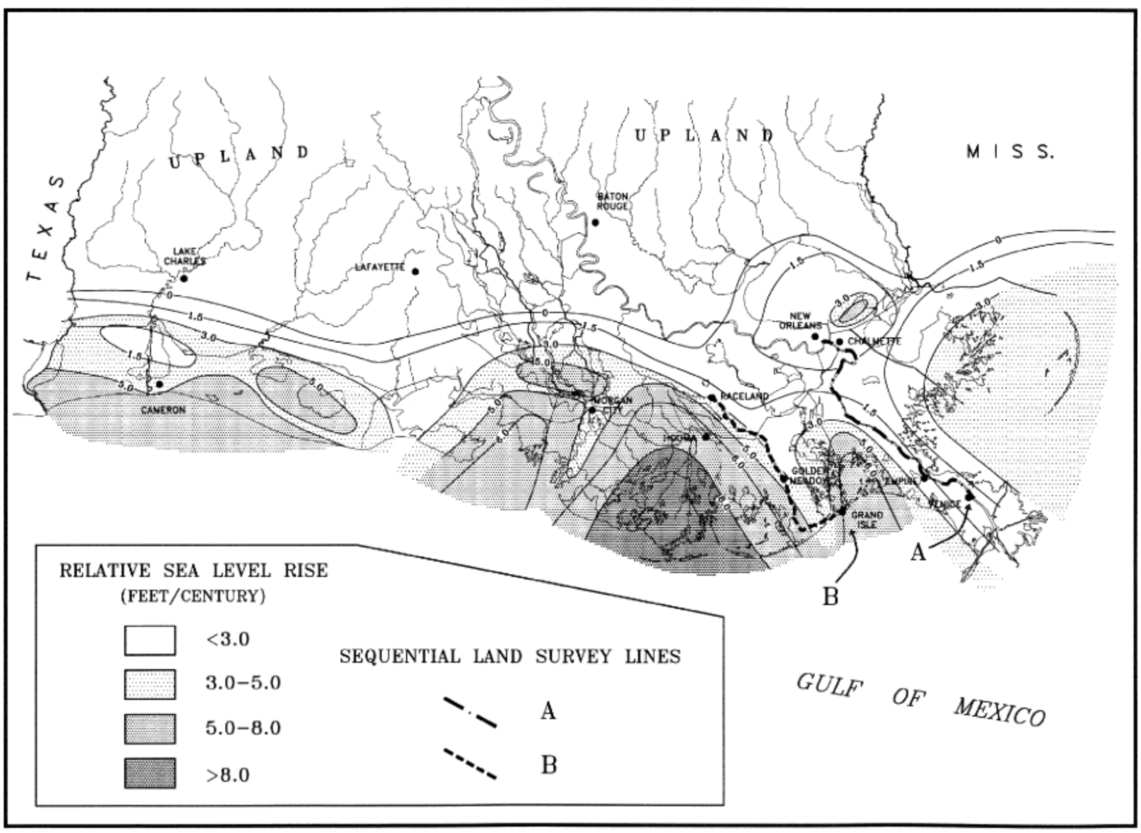

Figure 3-22. Isopleth map of sea level rise rates in coastal Louisiana based on 1962-1982 (Epoch 2) tide gage data (adapted from Ramsey and Moslow 1987). Locations of sequential land leveling lines are also shown. Line A is located along the Mississippi River natural levees (see Figure 3-23). Line B is located along the Bayou Lafourche natural levees (see Figure 3-24).

disclosed subsidence estimates for the Active Mississippi River Delta area ranging from 4 to 14 ft/century. From the published estimates Howard concluded that the minimum value of subsidence is 4 ft/century and the upper maximum is probably about 8 to 10 ft/century. In either case, the maximum subsidence value for the delta exceeds the Ramsey-Moslow rate for the Barataria Basin. It should also be noted that "subsidence" as used by Howard is equivalent to "relative sea level rise" as used herein.

Howard also evaluated data from National Geodetic Survey vertical benchmark surveys along the Mississippi River natural levees between Chalmette, La and Venice, La. The dates of the surveys were 1938, 1946, 1951, 1964, and 1971. Figure 3-23a shows vertical movement between 1938 and 1971 for benchmarks and Figure 3-23b, shows average movement for the period of record. There is an apparent gradual decrease in subsidence towards Venice. The highest rates were found at Braithwaite, with an average rate of 4.0 ft/century, and just north of Phoenix, with an average rate of 4.5 ft/century. The average rate of benchmark movement for the entire section and period of record was determined to be 2.2 ft/century. The National Geodetic Survey data does not include the effect of sea level rise as the benchmark elevations are determined by survey networks that are referenced to stable bench marks well outside of the coastal zone. To determine relative sea level rise, an adjustment must be added for the rate of eustatic rise. Howard added an additional 0.5 ft/century for the rate of sea level rise, and thus concluded that the average rate of relative sea level rise was 2.7 ft/century for the line of section. When an eustatic sea level adjustment of 0.75 ft/century is made the average rate of relative sea level rise for the section is 2.95 ft/century.

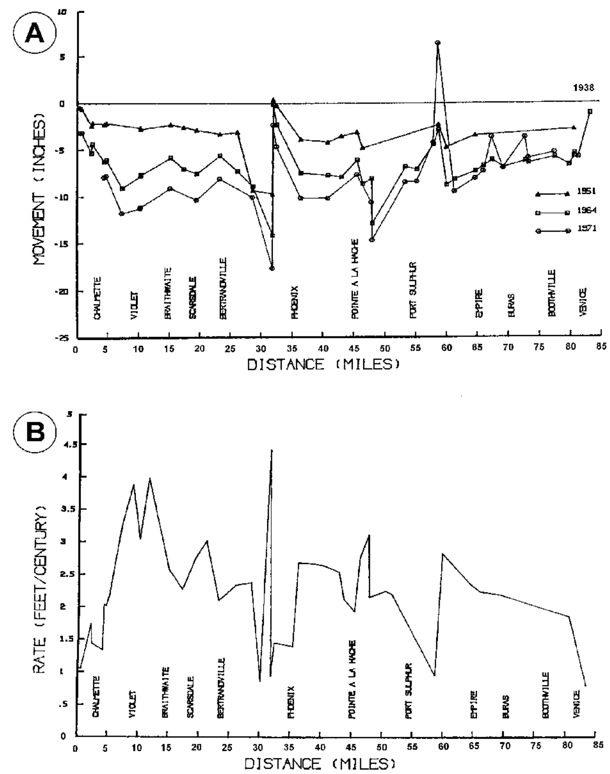

Figure 3-23. Changes in land elevation along Mississippi River natural levees between Chalmette and Venice.

A. Benchmark movement between New Orleans and Venice for period 1938 to 1971.

B. Average movement of individual benchmarks for period 1938 to 1971 (after van Beek et al. 1986).

Ramsey and Moslow (1987) and Penland et al. (1988) also used sequential land leveling data to measure subsidence. The most important traverse that they studied follows the natural levee ridges along Bayou Lafourche (Figure 3-24). In contrast to the section along the Mississippi natural levee ridges south of New Orleans (Figure 3-23), the rates of subsidence down Bayou Lafourche increase toward the coast. Both the Lafourche and the Mississippi section exhibit spikes and valleys in rates. As shown in Figure 3-24b, Kuecher (1994) has compared the location of benchmarks showing spikes along the Lafourche section with locations of the Golden Meadow and Lake Hatch fault traces. He concluded

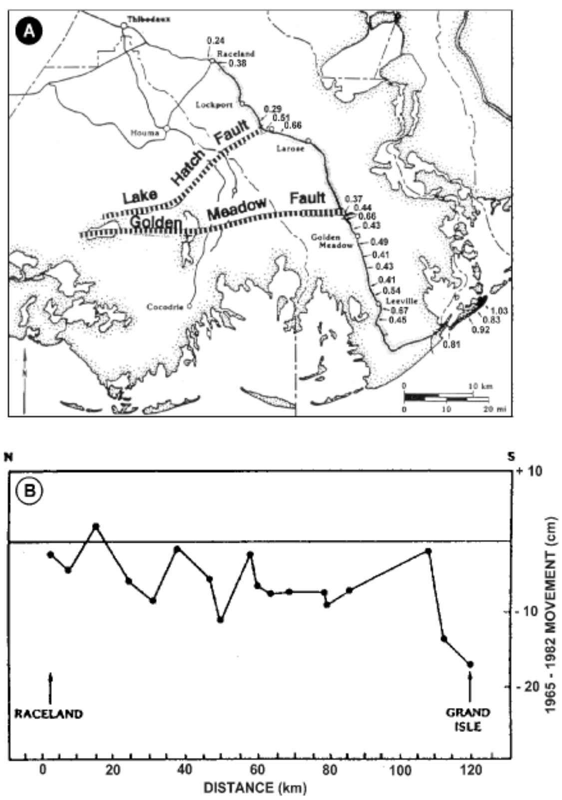

Figure 3-24. Changes in land elevation along Bayou Lafourche natural levees between Raceland and Fourchon, (including the Grand Isle barrier island).

A. Growth fault traces superimposed on subsidence rates (cm/yr). Subsidence rates increase abruptly on downthrown side of fault (after Kuecher 1994, subsidence rates from Penland et al. 1988).

B. Graph showing rates of land movement along Bayou Lafourche (Penland et al. 1988).

that pronounced spikes occur immediately south of the traces.

Buried Peat Deposits

Another important data set comes from radiocarbon dating of buried organic deposits, primarily peat. The advent of radiocarbon dating in the 1950s made it possible for the first time to date geologic features and events. David E. Frazier (1967), working under the direction of H. N. Fisk for the Esso Production Research Company, collected hundreds of samples of buried organic deposits from the Deltaic Plain. These were taken from undisturbed cores and dated at the Esso Production Laboratory. Not only did the dates provide the basis for a more detailed understanding of delta building events, but the dates and other relevant data from the core holes were published for use by other researchers.

Coleman and Smith (1964) used radiocarbon dates of buried peat deposits from south central Louisiana to determine the approximate time that sea level reached its present stand following the end of the last continental glaciation. Using the Coleman and Smith technique and dates and sample data from Frazier’s list and other sources, Gagliano and van Beek (1970) plotted radiocarbon dates against depth of burial. The resulting plot shows rates of relative sea level rise for the period 7,200 - 400 years before present (yrs. B.P.). The data indicate that between 7,200 and 4,256 yrs. B.P. the relative sea level rise rate was 0.83 ft/century, and for the interval 4,256 to 400 yrs. B.P. it was 0.35 ft/century. These are average rates for the Deltaic Plain area.

Penland et al. (1988:94-5) plotted age of buried peat against rate of subsidence. They concluded that, "...a comparison of data sets from the youngest (0 - 500 yrs. B.P.) and the oldest (500 - 3,000 yrs. B.P.) portions of the Terrebonne Delta Plain indicates that, if we assume a stable eustatic regime, the rate of compactional subsidence decreases with time after delta-plain abandonment. This decrease occurs because the sediment de-watering that begins upon abandonment diminishes with time."

Del Britsch, a geologist with the USACE New Orleans District, has studied this relationship. He has a comprehensive compilation of radiocarbon dates of buried organic deposits and has used them to develop maps of the rates of subsidence in coastal Louisiana (Britsch personal communication).

H. Roberts (1995) used radiometric dating of buried organic deposits from a selection of core holes to determine subsidence rates across the central Louisiana coastal plain. The data show rates of 0.3 ft/century for a shallow area of the Holocene (recent) sediment fill over the Pleistocene surface increasing to 1.2 ft/century for an area of thick fill, a four fold increase. This section has been used to illustrate the relationship between thickness of Holocene sediments and subsidence rates (Reed, ed. 1995).

The relative sea level rise rates based on dates and depth of buried organic deposits are considerably lower than those from tide gage and sequential land leveling data. However, they do provide a long-term base for evaluating both temporal and spatial changes in rates.

Summary of Relative Sea Level and Subsidence Data

The different data sets discussed above are each unique pieces in the relative sea level rise puzzle, as numerous researchers over a wide period of time approached the issue from a variety of perspectives using different data sources. The data sets, while alone depicting different figures for relative sea level rise, taken together, they demonstrate the same trends in relative sea level rise and identify important anomalies in the data.

The radiocarbon peat dates demonstrate that compaction rates slow with time after delta or depositional abandonment. The tide gage data demonstrate the spatial variation of relative sea level rise rates across the Gulf of Mexico coast, as well as the temporal increase in the rate of relative sea level rise from the first to second epoch. The land leveling data, the most verifiable data set, validate the other data sets and identify fault effects on subsidence.

The anomaly that these data sets identify is the temporal change in relative sea level rise demonstrated by Ramsey and Moslow. While the relative sea level rise rate variation across the coast (spatial variation) could be explained by compaction due to respective variations in Holocene sediment thickness, the increase in rates over time (temporal variation) at some locations can not be explained in the same way. Since compaction at a given location has been shown to decrease over time, the temporal relative sea level rise rate increase demonstrated at given locations can not be due to compaction. The cause of this regional, episodic variation in relative sea level rise is explainable when fault induced subsidence is taken into account. Selected relative sea level rise and subsidence rates are presented in Table 3-1.

Table 3-1. Summary of published findings regarding rates of relative sea level rise in coastal Louisiana.

		cm/yr	in/yr	ft/cent	Data type	Source
EUSTATIC SEA LEVEL RISE						
Observed global sea level rise		0.15	0.06	0.49	tide gage	
Projected global sea level rise, 100 years		0.47	0.18	1.53	projection	Wigley and Raper, 1992.
Eustatic SL rise, northern Gulf of Mexico						
Pensacola, FL		0.23	0.09	0.75	tide gage	Penland et al., 1988
ISOSTATIC CHANGES*						
Subsidence, S. Central La.	(Neg. value)	0.40	0.16	1.31	land survey	Holdahl and Morrison, 1974.
Uplift, S. Mississippi & S. Alabama		0.40	0.16	1.31	land survey	Holdahl and Morrison, 1974.
RELATIVE SEA LEVEL RISE RATES, COASTAL LA. 1942 - 1982						
Areas immediately along coast,	from	1.00	0.39	3.28	tide gage	Penland et al., 1988
	to	1.20	0.47	3.94	tide gage	
SW portion of Deltaic Plain	from	1.80	0.71	5.91	tide gage	Penland et al., 1988
	to	1.90	0.75	6.23	tide gage	
Deltaic Plain subsidence	from	0.90	0.35	2.95	tide gage	Penland et al., 1988
	to	1.30	0.51	4.27	tide gage	
Chenier Plain subsidence	from	0.40	0.16	1.31	tide gauge	Penland et al., 1988
	to	0.60	0.24	1.97	tide gauge	
Miss. R. natural levees,						
New Orleans to Venice		0.82	0.32	2.70	land survey	van Beek et al., 1986
B. Lafourche natural levees						
Raceland to Grand Isle		0.72	0.28	2.36	land survey	Penland et al., 1988
EASTERN LAKE PONTCHARTRAIN						
Little Woods Tide Gauge		1.03	0.41	3.38	tide gage	Penland et al. 1989, Fig. 38, p. 6
Bridge Movement						
Hwy. 11, I-10 west		0.25	0.10	0.82	observation	Lopez et al.1997
Norfolk Southern, RR		0.80	0.31	2.62	observation	Lopez et al.1997
PREHISTORIC RELATIVE SEA LEVEL RISE RATES, COASTAL LA.						
Avg. Relative SL - Deltaic Plain	7300-4200YBP	0.25	0.10	0.83	peat, C14	Gagliano and van Beek, 1970
Avg. Relative SL - Deltaic Plain	4200-400YBP	0.11	0.04	0.35	peat, C14	Gagliano and van Beek, 1970
RELATIVE SEA LEVEL RISE RATE, COASTAL LA. - Epoch 1.						
StatewideSL rise - 1942-1962		0.45	0.18	1.48	tide gage	Penland et al., 1988
RELATIVE SEA LEVEL RISE RATE, COASTAL LA. - Epoch 2.						
StatewideSL rise - 1962-1982		1.12	0.44	3.67	tide gage	Penland et al., 1988

* Not adjusted for isostatic sea level change

Effects of Fault Induced Subsidence on Coastal Lowlands

Unmasking of Fault Displacement (Aggradation vs Subsidence)

Until the twentieth century, movement of growth faults within the coastal area was masked by aggradation resulting from river derived sediment deposition and accumulation of organic materials. Surface traces of faults became exposed by patterns of erosion and marsh deterioration.

Reduction of Overbank Flow and Sediment Supply

Construction of flood protection levees along the Mississippi River and closure of distributary channels have cut off virtually all over-bank flow into the estuarine basins of the Deltaic Plain (Gagliano et al. 1971; Gagliano and van Beek 1976; Reed, ed. 1995). The amount of sediment transported by the Mississippi River has deceased by 50% since 1953 due primarily to construction of five large dams on the upper Missouri River (Meade and Parker 1985). This in turn has reduced the river's capacity to fill the holes resulting from relative sea level rise. Much of the loss in the active delta area of the Mississippi River (Delta Hydrologic Unit) can be attributed to this change.

Reduction of Organic Matter Build up and Deterioration of Floating Marshes

Some swamp and marsh plants can adjust to subsidence and resulting increase in hydroperiod by elevating their root zone. This occurs where peat and other deposits accumulate and the plants maintain their relative position to the water level by constantly sprouting and seeding on the top of the accumulating deposits. As long as subsidence rates do not exceed accretion rates of the swamp and marsh floor, the living surface survives. In many areas subsidence rates have exceeded aggradation rates (Nyman et al. 1990; Reed, ed. 1995; and others).

Floating marshes represent another way in which vegetation responds to subsidence. By producing and maintaining a floating root mat, marsh plants are able to maintain their position relative to water level independent of the elevation of the firm substrate. Floating marshes require freshwater conditions, a firm skeletal framework (natural levees, cheniers, spoil banks, lake rims, etc.) and low water energy conditions. Alteration of required conditions has resulted in extensive breakup and loss of floating marsh mats (Sasser 1994).

Penland et al. (1988) compared rates of sediment accumulation with subsidence rates in the Terrebonne region. They concluded that, "...wetland sedimentation rates lag behind the rates of relative sea level rise in Terrebonne Parish" (Figure 3-25). The relationship between wetland sedimentation and relative sea level rise controls Deltaic Plain land loss. When sedimentation rates exceed sea level rise rates, the delta plain aggrades and maintains its subaerial integrity. When sedimentation rates fall below relative sea level rise rates, land loss ensues. The mean modern (0-50 yr. B.P.) relative sea level rise rate of 4.20 ft/century (based on the average rate record at the Houma USACE tide gage station) exceeds the mean sedimentation rate for the Terrebonne coastal region of 2.76 ft/century. Under these conditons, which have existed for the last 25 years, sedimentation cannot maintain the Terrebonne delta plain. The mean subsidence rate of 0.48 ft/century for 0-500 yr B.P. calculated from the radiocarbon data indicates that wetland sedimentation rates were previously capable of maintaining the stability of the Deltaic Plain. (Penland et al. 1988). For a through review of the accretion process and their relationships to relative

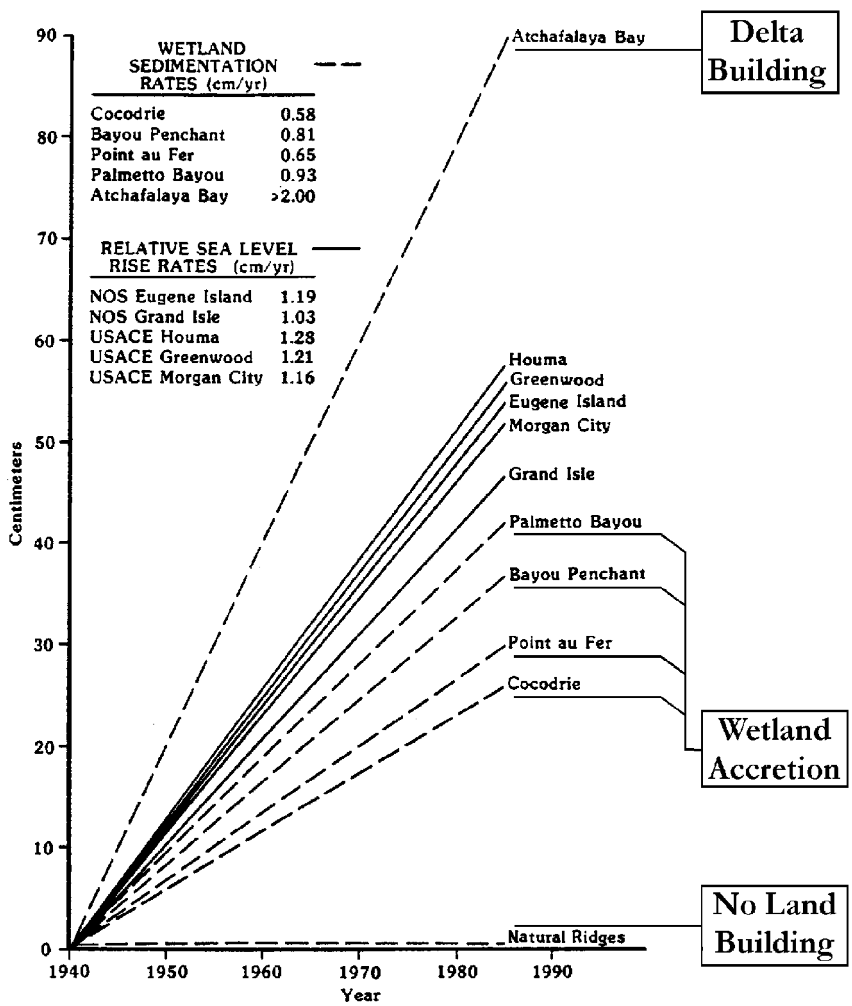

Figure 3-25. Comparison of relative sea level rise rates and wetland sedimentation rates for the Terrebonne Parish region. Only in the Atchafalaya River Delta was land building up at rates higher than relative sea level rise. Wetland sedimentation rates are from DeLaune et al. 1985, and relative sea level rise rates based on records from USACE and NOS tide gages (adapted from Penland et al. 1988).

sea level rise the reader is referred to Reed (ed. 1995).

Other Processes Contributing to Land Loss and Coastal Erosion

There is a synergy, between subsidence and hydrologic forces, that accelerates land loss and erosion. Subsidence, whether due to compaction or faulting, undermines the foundation of coastal lowlands by lowering land elevations and thus exposing wetlands, ridges, and human infrastructure to the forces of the Gulf of Mexico that erode away the land. Fluid withdrawal has also been cited as a cause for subsidence (Penland et al. 1988; Coleman et al. 1998; Boesch et al. 1994), but evaluation of this aspect of the problem is beyond the scope of this study.

Of the variety of damaging forces, marine tidal invasion and storms are responsible for removing a vast area of Louisiana's vulnerable coastal lowlands. Herbivory, the loss of marsh plants due particularly to intensive grazing by the multiplying nutria population, and dredge and fill activities, are also responsible for continued losses. Navigation canals dredged for oil and gas extraction, the Mississippi River Gulf Outlet, the Calcasieu and Sabine ship, Houma Navigation, and other channels have all disrupted hydrology, resulted in saltwater intrusion to fresh marshes, and caused extensive land loss through marine invasion of fresh marshes. Storms cause land loss not only because of the tremendous forces they can wield on fragile wetlands, but also because the natural systems that once protected against extensive storm damage are presently in a state of near collapse. The protection offered by barrier islands is disappearing as the islands themselves disappear, the weakened condition of wetlands can not stand up to or recover from intense storms, and the storms accelerate tidal intrusion, furthering tidal induced loss. In addition to inundation of the land by water, all the forces that cause land loss are exacerbated by the reduction of land elevation due to relative sea level rise.

Effects of Fault Induced Subsidence

The subsidence that is caused by fault movement affects Louisiana landforms in definable areas and in characteristic ways. The following discussion outlines where fault induced land loss has the strongest effects, and what landforms it most seriously impacts.

Effects on Wetlands

The areas of highest land loss in the Louisiana coastal area, almost all of which consists of wetland loss, occurs south of the Golden Meadow-Theriot and Forts fault systems and appears to be related to slump induced fault movement (Figure 3-26). Cumulative losses on these fault blocks since 1930 total more than 737 square miles. This is 46% of the total loss along the entire Louisiana coast, and 61% of the loss in the Deltaic Plain for that same period.

Effects on Barrier Islands and Gulf Shore

Louisiana's barrier island systems have undergone landward migration, area loss, and island narrowing as a result of complex interaction among subsidence, sea level rise, wave processes, inadequate sediment supply and intense human disturbance. Consequently, the structural continuity of the barrier shoreline weakens as the barrier islands narrow, fragment and finally disappear. In the past 100 years, the total barrier island area in Louisiana has declined 55% at a rate of 155 acres/yr. This deterioration will continue to destroy Louisiana's coastline until coastal restoration techniques that complement natural processes are implemented to restore and fortify the shoreline (Williams et al. 1992).

Effects on Ridges and Fastlands

Ridges only aggrade or build up when they are being formed along the banks of active distributaries or as active gulf beaches. Surface elevations of all relict natural levee ridges, chenier ridges, man made ridges, embankments, levees, and fastlands become lower through time in response to subsidence. Protection levees around fastlands prevent aggradation; therefore, all fastland areas within the coastal zone are subsiding (Figure 3-27, see also Figure 3-25). The problem of reduction of land surface is exacerbated in forced drainage districts within fastlands, where drained soils shrink and compact. Surface elevations within some fastland areas in eastern New Orleans are more than 16 ft below mean Gulf of Mexico level. Fastland levees are constructed of earth and cannot withstand the marine erosive forces that are gradually approacing many drainage levees. Furthermore, all infrastructure along the corridors is subject to sinking and erosion. Transcoastal corridors, which cross major fault zones, are critically affected by fault induced subsidence. These include: 1) the Mississippi River below New Orleans; 2) Bayou Lafourche-Louisiana Highway 1; and 3) natural levee ridges south of Houma.

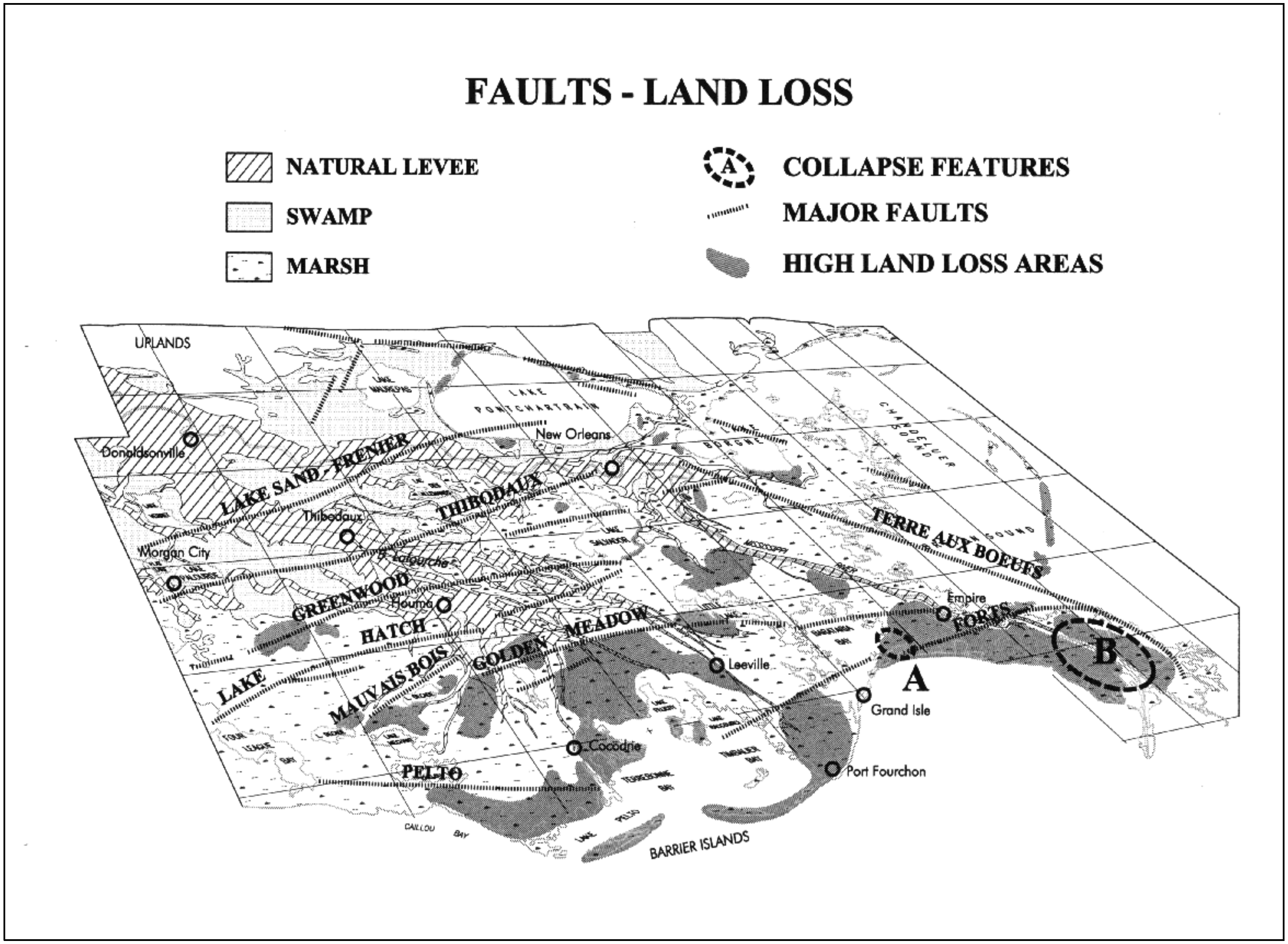

Figure 3-26. Birdseye view of southeastern Louisiana showing relationships between major faults and areas of high land loss.

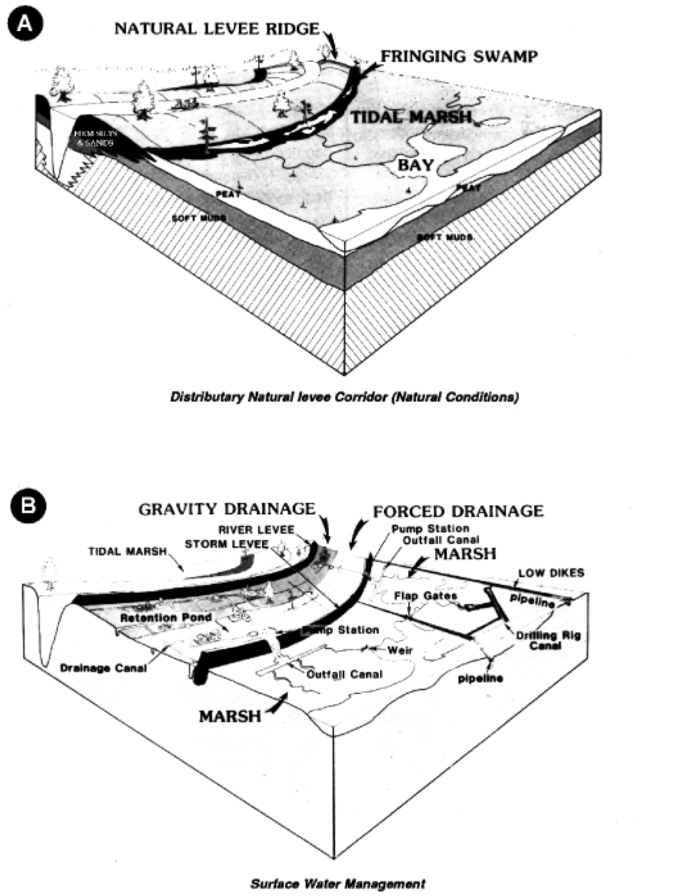

Figure 3-27. Effects of subsidence on ridgelands and fastlands.

A. Distributary natural levee corridor, natural conditions.

B. Subsided distributary natural levee corridor with forced drainage and storm protection levees (after Gagliano 1990).

Delineation of Fault Bound Blocks

As shown in Figure 3-28, the major faults systems and alignments provide the basis for dividing south Louisiana into six mega blocks. Each has distinctive structural and subsidence characteristics. The ability to identify and characterize the conditions on these blocks is a keystone to the integrity of future coastal planning. A brief description of the characteristics of each follows:

Block I Only the southern end of the block lies within the coastal zone. Part of the Calcasieu Lake collapse structure is on this block.

Block II Several major east-west faults run across this block. The Five Island Salt Trend is along the southwest boundary. The Weeks Island and Charenton collapse features are on this block. The Maurepas fault separates uplands and wetlands at the western end of the Ponchatrain basin and the Baton

Rouge fault forms the northern boundary of the basin.

Block III This block is relatively stable, accounting for the low erosion rates in the Biloxi marshes. The block is divided by the Biloxi fault. The northern Chandeleur Islands, which lie north of the fault were relatively stable until impacted by Hurricane Georges in 1998. The southern Chandeleurs and Breton Islands, on the south side of the Biloxi fault, are eroding rapidly.

Block IV Active subsidence on this block is located near the coast. Growth faults come into the Chenier Plain at an angle to the shore zone. These are older, less active faults than those in the deltaic plain.

The breakup of land between White Lake and Grand Lake may be fault induced, as is shoreline erosion at Rockefeller Refuge. Salt collapse feature under Calcasieu Lake area may be a contributing factor to the high historic land loss rates in that area (Figure 3-6).

Block V Fisk (1944) referred to this as the Lake Borgne Fault Zone. It is sliced into many smaller blocks by numerous faults. Many of the large lakes in this zone may reflect the intense faulting. The Chacahoula collapse feature is also on this block.

Block VI This is the area of most active land loss. It is criss-crossed by several major E-W fault zones, which subdivide it into smaller blocks. Three of the smaller blocks are discussed below.

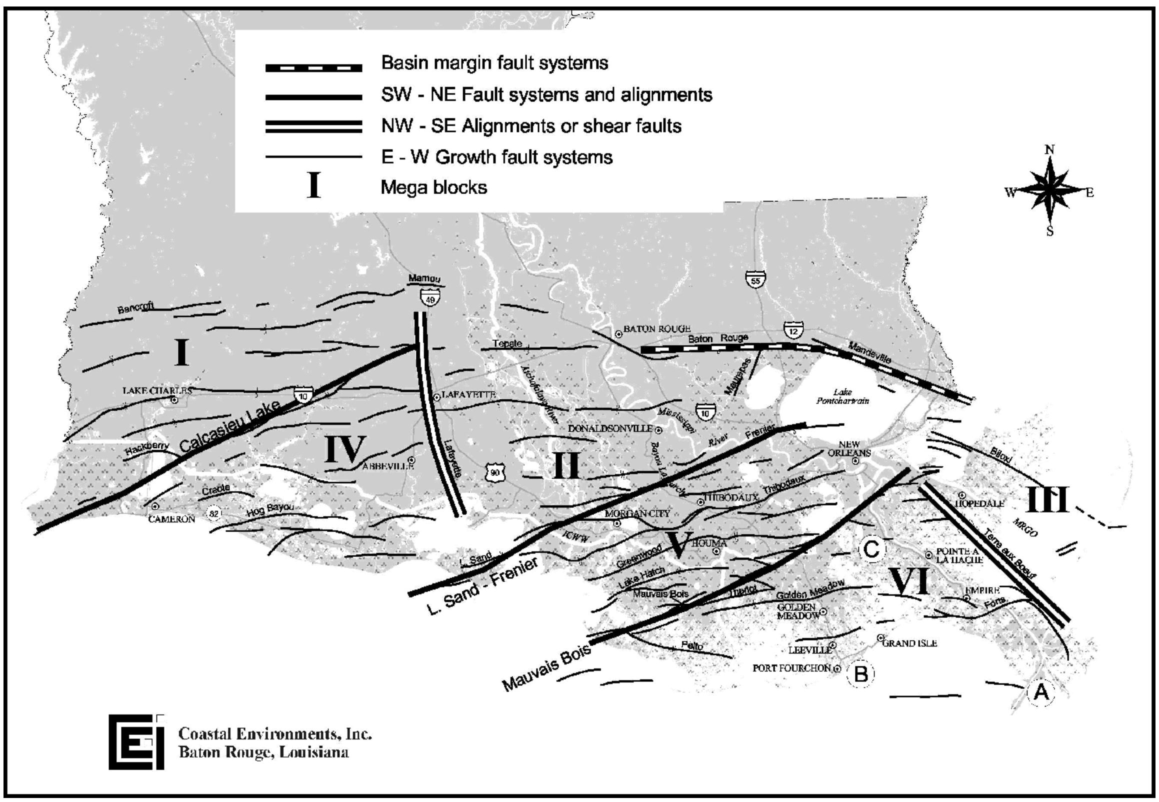

Figure 3-28. Mega blocks with major fault trends of south Louisiana.

Block VI A.
This is located on the down-thrown block of Forts Fault system. This is the active Mississippi Delta area, the area of second highest land loss along the Louisiana coast, second only to neighboring block VI B. The gulf shore and barrier islands along this block are being lost. The Balize collapse feature is on this block.

Block VI B.
Located on the downthrown block of the Golden Meadow Fault System, the Lake Washington and Four Island salt collapse features underlie this block and the Pelto fault that cuts across it. This is the area of highest total land loss along the entire Louisiana Coast. In addition, all barrier islands on this block are eroding. In the case of the Golden Meadow Fault Zone, the active shore zone is in the process of moving inland from its present position along the barrier islands to a new position against the fault trend. All remaining features (landforms and human infrastructure) on the surface of this block are vulnerable to inundation and erosion.

Some of Louisiana's most important and most endangered barrier islands are on the block, including the Derniers and Timbalier chains, the Fourchon headland, Grand Isle and Grand Terre Island.

Block VI C.
On the down-thrown block of the Theriot Fault System, the zone of lakes in west Terrebonne Parish may be related to tilting of this block against the bounding fault on the north side of the block.

Subsidence Rates by Environmental Mapping Unit

For the purpose of the Coast 2050 planning process, a generalized subsidence map of the Louisiana coastal zone was prepared (Figure 3-29). Findings from this study were utilized in preparation of the map. The primary source of subsidence rates for the Deltaic Plain were land level data along natural levee ridges from the most recent period of record. The land level data is considered to be the most accurate measure of subsidence. Rates from the survey lines were extrapolated to the major fault bound blocks. Boundaries for "environmental mapping units" developed for the Coast 2050 project were then superimposed over the fault blocks map to determine applicable rates for each mapping unit. Average values from other data sources, as gleaned from the geological literature, were used for mapping units where sequential land leveling data was not available, such as the Pontchartrain Basin and the Chenier Plain. The map should be regarded as a general tool developed for the Coast 2050 planning process, and not a definitive work intended for engineering design values of subsidence.

Summary and Conclusions

Faults, subsidence and land loss in coastal Louisiana have all been topics of considerable study. Researchers agree that land loss, particularly wetland loss and deterioration, is closely linked to subsidence. They generally acknowledge that geotechnical or fault induced subsidence is a contributing factor, but most tend to agree that subsidence is

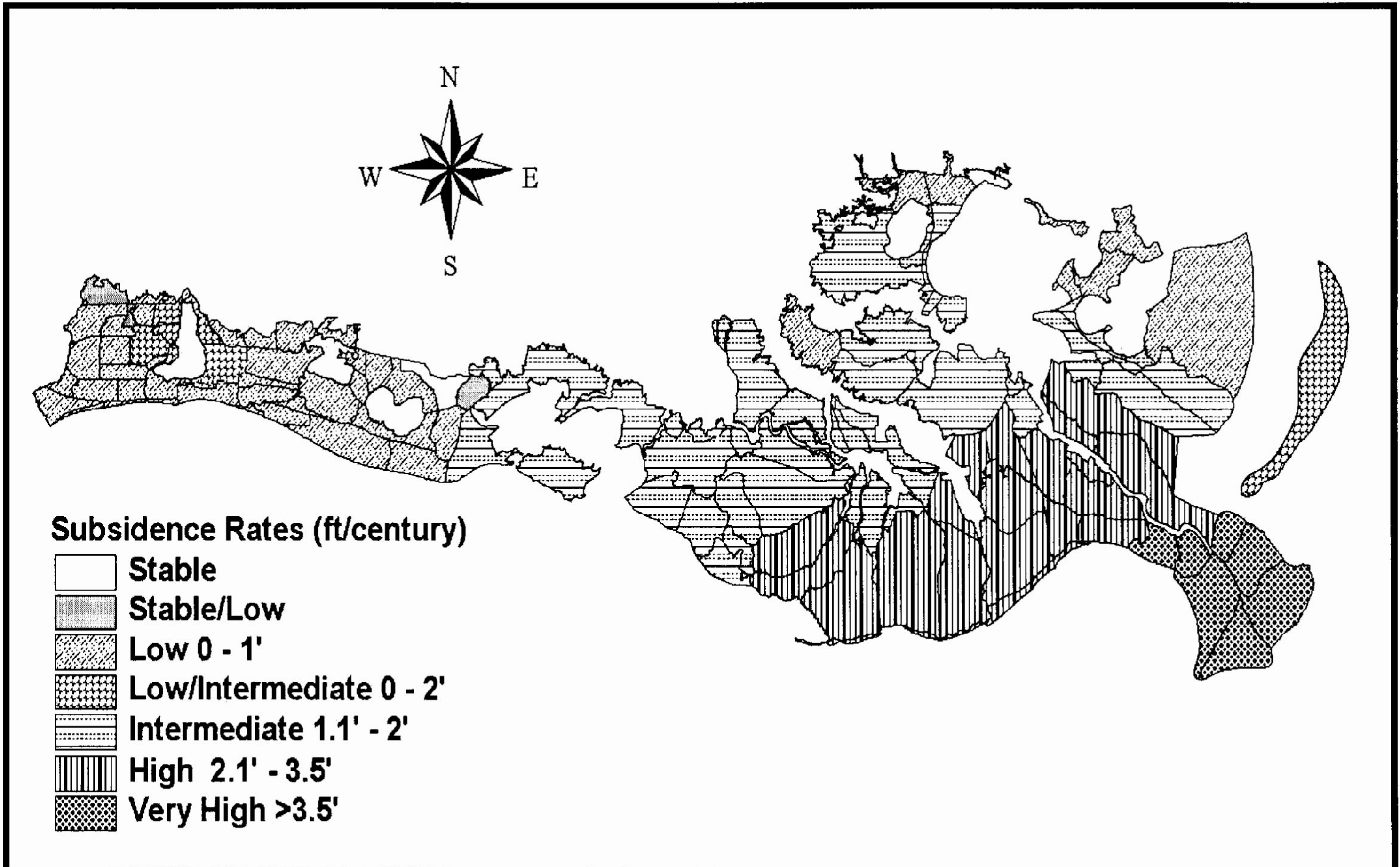

Figure 3-29 Subsidence rates in coastal Louisiana by mapping unit.

predominantly attributed to compaction. Even if compaction of sediments is the major cause of subsidence, most adjustments for compaction probably take place along faults. Vertical adjustments to gravity induced earth movement and isostatic down-warping also occur along fault planes. Cumulative displacement on growth faults and episodic changes in subsidence rates support this conclusion. Much, if not most of the vertical adjustment takes place along fault planes. Therefore, fault induced or geotechnical subsidence, as it has been used in the literature, is a major contributing factor to relative sea level rise. This paper identifies the importance of fault movement, the locations and types of major faults, and identifies blocks bound by the major faults. It establishes a framework for further study and application to coastal restoration. Geotechnical subsidence occurs as movement along circular patterns of faults, which circumscribe collapse features, and along linear growth faults. Collapse features may be induced by salt depletion at depth and/or sediment loading at the surface. Movement along growth faults occurs in response to compaction, geosynclinal downwarping and gravity slumping.

The origin and locations of major growth faults are related to basement topography and earth crust movements. Once established they become zones of weakness where vertical displacement in response to sediment loading occurs. Cumulative displacement of beds indicates that some have been active since Cretaceous times. Thus, the down-thrown blocks of growth faults become depressions which "attract" deposition, and in turn cause movement on the faults.

The coastal region is divided into a mosaic of massive fault-bound blocks. Movement of the blocks is similar to mass movement along the delta front, but on a larger scale and over a longer time period. Some blocks are moving and slumping into the deep Gulf of Mexico through a process of gravity induced slumping which is occurring on a massive scale along the continental margin.

Not all fault-bound slump blocks move at the same time. From the geological time perspective, seaward blocks are more active than inland blocks. Movement along the basin margin fault system (Baton Rouge Fault System) is an exception to this generality. Slump induced movement is episodic. Blocks are subject to abrupt short-term changes in subsidence rates. Rates have increased from prehistoric to historic times. An inferred rate increase occurred in the 1890's, initiating the Twentieth Century Transgression. In the early 1960's, subsidence rates on some blocks increased significantly, resulting in accelerated land loss and barrier island deterioration.

Until recently, fault movement in the coastal lowlands was masked and went unnoticed because of accretion processes. However, within the last 40 years the effects of fault movement have become more evident because of increased rates of sinking and reduction of accretion processes. Fault traces have become visibly delineated by patterns of land loss and marsh deterioration.

Areas of high land loss occur on blocks on the down-thrown side of the Theriot-Golden Meadow-Forts Fault systems. The Baton Rouge Fault System, located along the rim of the Gulf Salt Dome Basin, is active and has caused structural damage to building foundations and bridges. Some minor earthquake activity may be related to movement along this fault system. A zone of intensive faulting (Lake Borgne Fault Zone) occurs between the Lake Sand-Frenier and Mauvais Bois alignments. Occurrence of numerous lakes in this zone may be related to faults. Collapse features which may have contributed to land loss include the Calcasieu Lake, Four Island, Lake Washington and active Mississippi Delta features. The Hog Bayou (Grand Chenier) Fault System may be affecting subsidence in the Mermentau Basin area.

Fault movements of a fraction of an inch per year are almost imperceptible at the surface in upland areas; however, in low-relief coastal areas, small vertical movement can result in subsidence rates that can upset natural system equilibrium and cause catastrophic loss of wetland vegetation and accelerated erosion of shorelines and barrier islands. These changes in turn may make human infrastructure more vulnerable to flooding, storm surge and erosion.

Subsidence rates on these large fault-bound slump blocks show significant increases since the early 1960's. Areas north of the Gulf Coast Salt Dome Basin are being uplifted as a result of isostatic adjustment. The rates of uplift are approximately the same as those of down-warp to the south.

Relative sea level rise rates along the entire Louisiana coast are higher than at Pensacola, Fl, which is considered to be a geologically stable gage responding only to eustatic change. The highest rates are found in the Deltaic Plain and are associated with foundering fault-bound blocks. Rates in the Chenier Plain are higher than at Pensacola. Some of this difference can be attributed to fault induced subsidence. Rates that are higher than the northern Gulf eustatic rise rate also occur in the eastern end of Lake Pontchartrain and appear to be related to a block on the down-dip side of the Baton Rouge Fault System.

Results of geological research in the Louisiana coastal area has been cumulative. A number of different lines of research have contributed to an understanding of the role of fault movement in the Twentieth Century Transgression in the Deltaic Plain. Replication of some aspects of the research by different scientists provides improved confidence in the findings regarding the role of fault movement in coastal change.

All features on the surface of subsiding blocks including wetlands, natural levee ridges, highways, and flood protection levees are affected. Location of faults, thickness of poorly consolidated materials, and rates of relative sea level rise are parameters that must be considered in evaluating and designing coastal restoration projects. The boundaries of the problem have been defined. Nature's driving forces can not be changed, and if coastal sustainability is to be successful, planning and building need to proceed with

acknowledgment of, and consideration
for these critical natural parameters.

Conversion Matrix

mm/yr	cm/yr	m/yr	m/cent	in/yr	ft/yr	ft/cent	
0.004	0.000	0.000	0.00	0.00	0.000	**0.0012**	< 1
0.305	0.030	0.000	0.03	0.01	0.001	0.1	
0.762	0.076	0.001	0.08	0.03	0.003	0.25	
1.524	0.152	0.002	0.15	0.06	0.005	0.5	
2.286	0.229	0.002	0.23	0.09	0.008	0.75	
3.048	0.305	0.003	0.30	0.12	0.010	1	1
4.572	0.457	0.005	0.46	0.18	0.015	1.5	
5.334	0.533	0.005	0.53	0.21	0.018	1.75	
6.096	0.610	0.006	0.61	0.24	0.020	2	2
6.858	0.686	0.007	0.69	0.27	0.023	2.25	
7.620	0.762	0.008	0.76	0.30	0.025	2.5	
8.382	0.838	0.008	0.84	0.33	0.028	2.75	
9.144	0.914	0.009	0.91	0.36	0.030	3	3
9.906	0.991	0.010	0.99	0.39	0.033	3.25	
10.668	1.067	0.011	1.07	0.42	0.035	3.5	
11.430	1.143	0.011	1.14	0.45	0.038	3.75	
12.192	1.219	0.012	1.22	0.48	0.040	4	4
14.478	1.448	0.014	1.45	0.57	0.048	4.75	
13.716	1.372	0.014	1.37	0.54	0.045	4.5	
15.240	1.524	0.015	1.52	0.60	0.050	5	5
16.764	1.676	0.017	1.68	0.66	0.055	5.5	
18.288	1.829	0.018	1.83	0.72	0.060	6	6
19.812	1.981	0.020	1.98	0.78	0.065	6.5	
21.336	2.134	0.021	2.13	0.84	0.070	7	> 7
24.384	2.438	0.024	2.44	0.96	0.080	8	
27.432	2.743	0.027	2.74	1.08	0.090	9	
30.480	3.048	0.030	3.05	1.20	0.100	10	
33.528	3.353	0.034	3.35	1.32	0.110	11	
39.624	3.962	0.040	3.96	1.56	0.130	13	
45.720	4.572	0.046	4.57	1.80	0.150	15	

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SECTION 4

METHODOLOGY FOR ASSESSMENT OF FISHERIES

Identification of Guilds

In order to assess the recent trends and future projections of fishery populations within the Coast 2050 study area, four broad species assemblages were identified based on salinity preferences. These assemblages were marine, estuarine dependent, estuarine resident, and freshwater.

Within each of the four assemblages, guilds of fishery organisms were established. As used in this document, guilds are groupings of ecologically similar species identified by a single representative species and, hereafter, the terms “guild” and “species” are used interchangeably. Fishery guilds common to coastal Louisiana, within each salinity-preference assemblage, are:

- Marine: Spanish mackerel guild,
- Estuarine dependent: red drum, black drum, spotted seatrout, Gulf menhaden, southern flounder, white shrimp, brown shrimp, and blue crab guilds,
- Estuarine resident: American oyster guild, and
- Freshwater: largemouth bass and channel catfish guilds.

In a broad sense, each of the 12 guilds is uniquely identified by the combination of the representative species’ habitat preference, salinity preference, primary habitat function, seasonal occurrence in the estuary, and spawning or migratory seasons (Table 6-1, main report, reproduced as Table 4-1 of this appendix). Habitat and life history information is based on available scientific literature specific to the northwestern Gulf of Mexico, but is somewhat generalized to accommodate the establishment of guilds.

Trends and Projections for Fisheries Populations

Once the species representing each fishery guild was identified, population changes of each species were assessed and displayed by using a matrix for each of the four coastal regions (Tables 4-2 through 4-5). The matrices display mapping units and guilds and, within the mapping units, provide information on the population stability (recent change trends) and population projections for each species group. Most of the recent trend information was provided by fishery biologists of the Louisiana Department of Wildlife and Fisheries (LDWF). The assessments were based on LDWF fishery independent sampling data and personal observation by area fishery biologists, and generally span a period of 10 to 20 years. Staff of LDWF believe that, due to selectivity of sample gear, the trend information is most reflective of recent changes in the subadult portion of each guild.

The projections of possible future changes in fishery production for coastal Louisiana, also shown in Tables 4-2 through 4-5, are based solely on landscape change model predictions discussed in the main report. The key parameters in making those projections were percent and pattern of wetland loss in each mapping unit. Numerous other factors which could not be forecast — changes in water quality, fishery harvest levels, wetland development activities (e.g., dredging and filling), and blockages of migratory pathways — could negatively impact fishery production. These factors and the potentially great inaccuracy in predicting land loss 50 years into the future, especially when considering landscape changes at a mapping unit scale, limit the precision of the predicted changes in fishery production.

Individuals Involved in Application of Methodology

Information provided in the matrix was developed through the collaborative effort of the LDWF and the National Marine Fisheries Service (NMFS). NMFS contributors were Ric Ruebsamen and Richard Hartman. LDWF personnel responsible for synthesizing the information displayed in each regional matrix are identified below.

Region 1: John F. Burdon, Mark Lawson, and Glenn Thomas.

Region 2: Robert Ancelet, Mark Schexnayder, Greg Laiche, Clarence Luquet, Keith Ibos, Randall Pausina, Brian McNamara and Glenn Thomas.

Region 3: Vince Guillory, Roy Moffet, Martin Bourgeois, Steve Hein, Paul Meier, Pete Juneau, Paul Cook and Glenn Thomas.

Region 4: Dudley C. Carver, Jerry Ferguson, Michael Harbison and Glenn Thomas.

The overall work effort was coordinated by Ric Ruebsamen of NMFS and Glenn Thomas of LDWF.

Table 4-1. (Table 6-1 from main report.) Representative fish and invertebrate guilds of coastal Louisiana.

		Habitat Preference				Salinity Preference				Primary Habitat Function			Seasonal Preference				
Species (Guild)	Life stage	EM	Sh	DW	FS	F	I	B	Sa	S	Nu	Fo	Sp	Su	Fa	Wi	Yr
Marine Assemblage																	
Spanish mackeral	Adult																
	Juvenile																
Estuarine Dependent Assemblage																	
Red drum	Adult																
	Juvenile														*		
Black drum	Adult																
	Juvenile												*				
Spotted seatrout	Adult																
	Juvenile													*			
Gulf menhaden	Adult																
	Juvenile															*	
Southern flounder	Adult																
	Juvenile															*	
White shrimp	Subadult																
	Juvenile													*			
Brown shrimp	Subadult																
	Juvenile												*				
Blue crab	Adult																
	Juvenile												*	*			
Estuarine Resident Assemblage																	
American oyster													*	*			
Freshwater Assemblage																	
Largemouth bass	Adult												*				
	Juvenile																
Channel catfish	Adult												*				
	Juvenile																

Notes:

Habitat Preference--EM=emergent marsh; Sh=shallow water; DW=channel, open water >6 ft;
FS = fresh swamp

Salinity Preference--F=fresh; I=intermediate; B=brackish; Sa=saline

Primary Habitat Function--S=spawning; Nu=nursery; Fo=foraging

Seasonal Preference--Sp=spring; Su=summer; Fa=fall; Wi=winter; Yr=year round

All preferences denoted by block shading.

* Indicates immigration period for marine transient species & spawning season for resident species.

Table 4-2. Region 1 fish and invertebrate population status and 2050 change.

Mapping Unit	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	Comments
	Fish and Invertebrate Guilds (Species)												
	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	
Amite/Blind	NA/NA	NA/NA	NA/NA	U/U	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Lake Maurepas	NA/NA	NA/NA	NA/NA	U/U	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Tickfaw River Mouth	NA/NA	NA/NA	NA/NA	U/U	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
West Manchac Land Bridge	U/U	U/U	NA/NA	U/U	U/U	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Tangipahoa River Mouth	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	D/D	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
East Manchac Land Bridge	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Lake Pontchartrain	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Sy/Sy	U/U	Sy/Sy	Sy/Sy	
Bonnet Carre	U/U	U/U	U/U	U/U	U/U	NA/NA	Sy/Sy	Sy/Sy	Sy/Sy	NA/	Sy/Sy	Sy/Sy	
La Branch Wetlands	U/U	U/U	U/U	U/U	U/U	NA/NA	Sy/D	Sy/D	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Tchefuncte River Mouth	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	NA/NA	Sy/D	Sy/D	Sy/D	NA/NA	Sy/Sy	Sy/Sy	

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-2. Region 1 fish and invertebrate population status and 2050 change (Cont.).

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
North Shore Marshes	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	NA/NA	Sy/D	Sy/D	Sy/Sy	U/U	Sy/Sy	Sy/Sy	
Pearl River Mouth	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	D/D	Sy/Sy	Sy/Sy	Sy/Sy	U/U	Sy/Sy	Sy/Sy	
East Orleans Land Bridge	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	Sy/Sy	Sy/D	Sy/D	Sy/D	U/I	Sy/Sy	U/U	
Bayou Sauvage	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	U/U	NA/NA	D/I	D/I	Freshwater impoundment
Chandeleur Sound	I/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	NA/NA	
Chandeleur Islands	I/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	NA/NA	
Lake Borgne	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	NA/NA	
South Lake Borgne	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/Sy	NA/NA	NA/NA	
Central Wetlands	Sy/Sy	Sy/Sy	Sy/Sy	Sy/I	Sy/Sy	D/D	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	NA/NA	NA/NA	
Biloxi Marshes	I/D	Sy/D	Sy/D	Sy/Sy	Sy/D	Sy/Sy	Sy/D	Sy/D	Sy/D	Sy/Sy	NA/NA	NA/NA	
Eloi Bay	I/Sy	Sy/D	Sy/D	Sy/Sy	Sy/D	D/D	Sy/D	Sy/D	Sy/Sy	Sy/Sy	NA/NA	NA/NA	

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-3. Region 2 fish and invertebrate population status and 2050 change.

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf menhaden	Southern flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
Baker	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	Sy/Sy	
Des Allemands	U/U	NA/NA	NA/NA	U/U	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Lake Boeuf	NA/NA	NA/NA	NA/NA	U/U	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Gheens	Sy/Sy	NA/NA	NA/NA	Sy/Sy	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Cataouatche/ Salvador	Sy/D	Sy/D	Sy/D	I/Sy	NA/NA	NA/NA	D/D	I/D	Sy/Sy	NA/NA	Sy/Sy	D/Sy	Davis Pond influence
Clovelly	Sy/Sy	I/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	D/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	D/Sy	
Perot/ Rigolettes	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	NA/	D/D	Sy/D	Sy/Sy	NA/NA	Sy/D	D/D	
Jean Lafitte	Sy/Sy	NA/NA	NA/NA	Sy/Sy	Sy/Sy	NA/NA	D/Sy	Sy/Sy	Sy/Sy	NA/NA	I/Sy	D/Sy	
Naomi	I/Sy	Sy/Sy	Sy/D	I/I	I/D	NA/NA	I/I	I/Sy	I/Sy	NA/NA	I/I	I/I	River siphon influence
Myrtle Grove	I/Sy	I/Sy	Sy/D	I/D	I/Sy	I/Sy	D/D	I/D	I/Sy	NA/NA	Sy/I	I/I	
Little Lake	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	I/I	D/D	I/D	I/D	NA/NA	D/D	NA/NA	
Caminada Bay	D/D	D/D	D/D	D/D	Sy/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
Fourchon	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	I/I	NA/	NA/	
Barataria Bay	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
West Pointe a la Hache	I/D	I/D	Sy/Sy	I/D	I/D	Sy/Sy	I/D	I/D	I/D	Sy/NA	I/D	I/D	River siphon influence
Lake Washington / Grand Ecaille	D/D	D/D	D/D	D/D	D/D	Sy/Sy	D/D	D/D	D/D	NA/I	NA/NA	NA/NA	

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-3. Region 2 fish and invertebrate population status and 2050 change (Cont.).

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf menhaden	Southern flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
Bastian Bay	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
Cheniere Ronquille	D/D	D/D	D/D	Sy/D	Sy/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
Grand Liard	D/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/Sy	D/D	D/D	D/D	Sy/Sy	NA/NA	NA/NA	
Fourchon Shoreline	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
Barataria Barrier Islands	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
West Bay	Sy/I	Sy/I	Sy/Sy	Sy/I	Sy/Sy	Sy/D	Sy/I	Sy/I	Sy/I	Sy/D	Sy/I	Sy/I	
East Bay	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/Sy	Sy/Sy	
La Loutre	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/Sy	Sy/Sy	
Cubit's Gap	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/Sy	Sy/Sy	
Baptiste Collette	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/Sy	Sy/Sy	
American Bay	Sy/Sy	Sy/Sy	Sy/Sy	I/Sy	Sy/Sy	I/Sy	I/SY	Sy/Sy	I/Sy	Sy/Sy	NA/	NA/	
Breton Sound													
Lake Lery	Sy/I	Sy/I	Sy/I	I/I	Sy/Sy	I/I	I/I	Sy/I	I/I	NA/NA	I/I	I/I	River siphon influence
Caernarvon	Sy/I	Sy/I	Sy/Sy	I/I	Sy/Sy	I/I	I/I	Sy/I	I/I	Sy/Sy	I/I	I/I	River siphon influence
River aux Chenes	Sy/Sy	Sy/Sy	Sy/Sy	I/Sy	Sy/Sy	I/I	I/Sy	Sy/Sy	I/Sy	Sy/Sy	I/I	I/I	
Jean Louis Robin	Sy/Sy	Sy/Sy	Sy/Sy	I/Sy	Sy/Sy	I/I	I/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-4. Region 3 fish and invertebrate population status and 2050 change.

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue Crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
Atchafalaya Marshes	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/D	Sy/I	Sy/I	Lower river only, estuarine species primarily in fall and winter
Avoca	NA/NA	NA/NA	NA/NA	I/D	I/Sy	NA/NA	NA/NA	NA/NA	I/D	NA/NA	U/U	U/U	
Black Bayou Wetlands	NA/NA	NA/NA	NA/NA	I/I	I/NA	NA/NA	NA/NA	NA/NA	I/I	NA/NA	D/I	U/U	
Boudreaux	I/D	I/D	D/D	I/D	D/D	I/I	Sy/D	I/D	I/D	NA/NA	D/I	D/I	
N. Bully Camp	I/D	I/D	D/D	D/D	D/D	D/I	D/D	D/D	I/D	I/I	NA/NA	NA/NA	
S. Bully Camp	I/D	I/D	D/D	D/D	D/D	D/D	D/D	D/D	I/D	I/I	NA/NA	NA/NA	
Caillou Marshes	I/D	I/D	D/D	D/D	D/D	D/D	Sy/D	I/D	I/D	I/I	D/D	U/U	
Chacahoula Swamps	NA/NA	NA/NA	NA/NA	I/I	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/I	Sy/I	
Devil's Swamp	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/I	Sy/I	
Fields Swamp	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/I	Sy/I	
Four League Bay	I/Sy	I/Sy	D/D	I/Sy	D/D	I/D	Sy/Sy	I/Sy	I/Sy	U/U	D/I	U/U	
GIWW	NA/NA	NA/NA	NA/NA	I/D	I/D	NA/NA	NA/NA	NA/NA	I/D	NA/NA	Sy/I	Sy/I	
Mechant/De Cade	I/D	I/D	D/D	I/D	D/D	I/I	Sy/D	I/D	I/D	I/I	D/Sy	D/Sy	
Montegut	I/D	I/D	D/D	I/D	D/D	I/I	Sy/D	I/D	I/D	NA/NA	D/I	D/I	Influenced by water control structures
NHSC Wetlands	I/D	I/D	I/D	I/D	I/D	NA/NA	I/D	I/D	I/D	NA/NA	D/I	D/I	
Pelto Marshes	I/D	I/D	D/D	D/D	D/D	D/Sy	D/D	D/D	I/D	I/I	D/D	D/D	
Penchant	I/Sy	I/Sy	D/D	D/Sy	D/D	D/I	D/Sy	D/Sy	I/Sy	NA/NA	D/I	U/U	

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-4. Region 3 fish and invertebrate population status and 2050 change (Cont.).

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue Crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
Pigeon Swamp	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	U/U	NA/NA	U/U	U/U	
Point au Fer	I/Sy	I/Sy	D/Sy	I/Sy	D/Sy	I/I	Sy/I	I/Sy	I/Sy	I/Sy	D/I	U/U	
Savoie	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/I	Sy/I	
St Louis Canal	I/D	I/D	D/D	I/D	D/D	I/Sy	Sy/D	I/D	I/D	NA/NA	D/I	D/I	
Terrebonne Marshes	I/D	I/D	D/D	D/D	D/D	D/Sy	D/D	D/D	I/D	I/I	NA/NA	NA/NA	
Verrett Wetlands	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	I/I	NA/NA	U/I	U/I	
Timbalier Island Shorelines	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
Isles Dernieres Shorelines	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	D/D	I/I	NA/NA	NA/NA	
Atchafalaya Subdelta	Sy/I	Sy/I	NA/NA	Sy/I	Sy/Sy	NA/NA	Sy/I	D/Sy	Sy/I	NA/NA	Sy/I	I/I	Support of estuarine species is river stage dependent
N. Wax Lake Wetlands	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	I/I	I/I	Fresh marsh, overflow swamp
WLO Subdelta	Sy/I	Sy/I	NA/NA	Sy/I	Sy/Sy	NA/NA	Sy/I	D/Sy	Sy/I	NA/NA	Sy/I	I/I	Support extuarine species during low water stages-fall winter
Wax Lake Wetlands	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/I	Sy/I	Only shoreline supports estuarine species during low water stages
Big Woods	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	U/U	U/U	Fresh swamp
Cote Blanche Wetlands	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Better habitat during low water years
E. Cote Blanche Bay	Sy/Sy	Sy/D	D/D	Sy/Sy	Sy/D	NA/NA	Sy/I	D/D	Sy/Sy	NA/NA	NA/NA	Sy/I	Better habitat during low water years
Marsh Island	D/Sy	D/Sy	D/Sy	Sy/Sy	D/Sy	NA/NA	Sy/Sy	D/Sy	I/Sy	NA/NA	NA/NA	Sy/I	Weirs, impoundmens and gates causing loss of habitat

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-4. Region 3 fish and invertebrate population status and 2050 change (Cont.).

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue Crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
Rainey Marsh	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/D	NA/NA	Sy/Sy	NA/NA	Sy/Sy	NA/NA	Sy/I	Sy/I	Eastern portion is more viable estuarine fishery habitat
Vermilion Bay	Sy/Sy	Sy/D	D/D	Sy/Sy	Sy/D	D/D	Sy/I	D/D	Sy/Sy	NA/NA	NA/NA	NA/NA	Strongly influenced by Atchafalaya River flows
Vermilion Bay Marsh	Sy/Sy	D/D	Sy/D	D/Sy	NA/NA	Sy/D	U/I	Sy/D	Sy/Sy	NA/NA	Sy/I	Sy/I	Higher use by estuarine species in fall and winter, mainly edge habitat
W. Cote Blanche Bay	Sy/Sy	Sy/D	D/D	Sy/Sy	Sy/D	NA/NA	Sy/I	D/D	Sy/Sy	NA/NA	NA/NA	NA/NA	Habitat conditions influenced by Atchafalaya River discharge

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-5. Region 4 fish and invertebrate population status and 2050 change.

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
MERMENTAU													
Amoco	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/D	Sy/D	Impounded and influenced by locks
Big Marsh	Sy/Sy	Sy/Sy	U/Sy	NA/Sy	NA/NA	NA/NA	Sy/Sy	Sy/D	Sy/Sy	NA/NA	Sy/I	Sy/I	Impounded and influenced by locks
Big Burn	U/NA	U/NA	U/NA	U/NA	U/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	NA/NA	Sy/I	Sy/I	Impounded and influenced by locks
Cameron Prairie	U/NA	U/NA	U/NA	U/NA	U/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	Sy/Sy	
Grand Lake	D/Sy	D/Sy	D/Sy	Sy/Sy	D/Sy	NA/NA	D/Sy	D/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Impounded and influenced by locks
Grand/White Lake Land Bridge	D/D	D/D	D/D	Sy/D	D/D	NA/NA	D/D	D/D	Sy/D	NA/NA	Sy/Sy	Sy/Sy	Impounded and influenced by locks
Grand Lake East	D/D	D/D	D/D	Sy/D	D/D	NA/NA	D/D	D/D	Sy/D	NA/NA	Sy/Sy	Sy/Sy	Impounded and influenced by locks
Hog Bayou	Sy/D	Sy/D	Sy/D	I/D	Sy/D	Sy/I	Sy/D	Sy/D	Sy/D	NA/NA	NA/NA	NA/NA	
Lacassine	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	Sy/Sy	
Little Prairie	NA/	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/Sy	Sy/Sy	Impounded and influenced by locks
Little Pecan	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Restricted by weirs and water control structures
Locust Island	U/U	U/U	U/U	U/U	U/U	NA/NA	U/U	U/U	U/U	NA/NA	Sy/I	Sy/I	Impounded and influenced by locks

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-5. Region 4 fish and invertebrate population status and 2050 change (Cont.).

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
Middle Marsh	U/U	U/U	U/U	U/U	U/U	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/I	Sy/I	
N. White Lake	NA/	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	D/Sy	U/U	Sy/Sy	NA/NA	Sy/I	Sy/I	Inside Catfish & Schooner structures
N. Grand Lake	NA/	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	D/D	U/U	Sy/D	NA/NA	Sy/I	Sy/I	
Oak Grove	NA/	NA/NA	NA/NA	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	
Rockefeller	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/I	Sy/D	Sy/D	Sy/D	Sy/Sy	Sy/I	Sy/I	Restricted by weirs and water control structures
S. Pecan Island	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	NA/NA	Sy/D	Sy/D	Sy/D	NA/NA	Sy/I	Sy/I	Restricted by weirs and water control structures
S. White Lake	Sy/D	Sy/D	NA/NA	Sy/D	Sy/D	NA/NA	Sy/D	Sy/D	Sy/D	NA/NA	Sy/I	Sy/I	Influenced by locks & weir
White Lake	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	D/Sy	D/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Influenced by locks & weir
CALC/SABINE													
Big Lake	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	U/I	U/I	
Black Lake	I/D	Sy/D	Sy/D	I/D	Sy/D	Sy/Sy	D/D	D/D	Sy/D	NA/NA	I/Sy	I/Sy	
Black Bayou	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	NA/NA	Sy/D	Sy/D	Sy/D	NA/NA	Sy/Sy	U/Sy	
Brown Lake	D/D	D/D	D/D	D/D	D/D	NA/NA	D/D	D/D	D/D	NA/NA	U/U	U/U	Restricted by weirs and water control structures
Calcasieu Lake	I/Sy	I/Sy	I/Sy	Sy/Sy	Sy/Sy	Sy/Sy	D/Sy	D/Sy	D/Sy	Sy/Sy	NA/NA	NA/NA	
Cameron	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/I	Sy/I	
Cameron Creole Watershed	D/Sy	D/Sy	D/Sy	D/Sy	D/Sy	D/Sy	D/Sy	D/Sy	D/Sy	NA/NA	I/Sy	I/Sy	Influenced by weirs and gates
Choupique Island	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	U/U	Sy/Sy	

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-5. Region 4 fish and invertebrate population status and 2050 change (Cont.).

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
Clear Marais	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	NA/NA	D/Sy	D/Sy	Sy/Sy	NA/NA	Sy/I	Sy/I	
Hog Island Gully	Sy/I	Sy/I	Sy/I	I/Sy	Sy/I	Sy/D	Sy/D	Sy/I	Sy/I	NA/NA	NA/NA	NA/NA	
E Johnson's Bayou	Sy/I	Sy/I	U/I	Sy/I	Sy/I	NA/NA	U/I	U/I	Sy/I	NA/NA	NA/NA	NA/NA	
W Johnson's Bayou	Sy/I	Sy/I	U/I	Sy/I	Sy/I	NA/NA	U/I	U/I	Sy/I	NA/NA	NA/NA	NA/NA	
Johnson's Bayou Ridge	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	D/Sy	D/Sy	Sy/Sy	NA/NA	U/U	U/U	
Lower Mud Lake	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	Sy/Sy	D/D	D/D	Sy/D	NA/NA	U/NA	U/NA	
Martin Beach Ship Canal Shore	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	Sy/Sy	D/Sy	D/Sy	Sy/Sy	NA/NA	U/NA	U/NA	
Mud Lake	D/D	D/D	D/D	D/D	D/D	NA/NA	D/D	D/D	D/D	NA/NA	NA/NA	NA/NA	Partly restricted by weirs and water control structures
Perry Ridge	U/U	U/U	U/U	U/U	U/U	NA/NA	U/U	U/U	U/U	U/U	U/U	U/U	
Sabine Lake	I/Sy	I/Sy	I/Sy	Sy/Sy	Sy/Sy	I/Sy	D/Sy	D/Sy	Sy/Sy	NA/NA	U/U	Sy/Sy	Lower/brackish portion of lake
Sabine Lake Ridge	I/Sy	I/Sy	I/Sy	Sy/I	Sy/Sy	I/Sy	D/Sy	D/Sy	Sy/Sy	NA/NA	Sy/I	Sy/I	
Sabine Pool #3	NA/	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	I/Sy	I/Sy	Fresh impoundment
Second Bayou	Sy/Sy	U/U	U/U	U/U	U/U	NA/NA	U/U	U/U	U/U	U/U	U/I	U/I	Restricted by weirs and water control structures

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

Table 4-5. Region 4 fish and invertebrate population status and 2050 change (Cont.).

	Fish and Invertebrate Guilds (Species)												
	Red drum	Black drum	Spotted seatrout	Gulf Menhaden	Southern Flounder	American oyster	White shrimp	Brown shrimp	Blue crab	Spanish mackerel	Largemouth bass	Channel catfish	
Mapping Unit	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Trend/ Projection	Comments
SE Sabine	D/Sy	D/Sy	D/Sy	D/Sy	D/Sy	NA/NA	D/Sy	D/Sy	D/Sy	NA/NA	I/Sy	I/Sy	Restricted by weirs and water control structures
SW Gum Cove	NA/	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	U/U	NA/NA	U/U	U/U	Restricted by weirs and water control structures
Sweet/Willow Lakes	NA/	NA/	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	Sy/D	Sy/D	
W. Black Lake	D/D	D/D	D/D	D/D	D/D	NA/NA	D/D	D/D	D/D	NA/NA	I/Sy	I/Sy	Restricted by weirs and water control structures
West Cove	Sy/D	Sy/D	Sy/D	Sy/D	Sy/D	U/U	D/D	D/D	Sy/D	NA/NA	Sy/I	Sy/I	
Willow Bayou	I/D	I/D	I/D	Sy/D	Sy/D	I/D	D/D	D/D	Sy/D	NA/NA	U/U	U/U	

NOTES: Steady=Sy, Decrease=D, Increase=I, Unknown=U, Not Applicable=NA

SECTION 5

METHODOLOGY FOR ASSESSMENT OF WILDLIFE

Species and Species Groups

Louisiana's coastal wetlands, extending from the forested wetlands at the upper end to the barrier shorelines bordering the gulf, provide a diverse array of habitats for numerous wildlife communities. In addition to fulfilling all life cycle needs for many resident species, coastal wetlands provide wintering or stopover habitat for migratory waterfowl and many other birds. The bald eagle and brown pelican, protected by the Endangered Species Act, are recovering from very low populations experienced over the last three decades. Increasing populations for those two species are projected to continue in the future, independent of near-term wetland changes. The fate of other species groups in coastal Louisiana will be influenced by habitat conditions there. The prediction of extensive land loss and habitat change by the year 2050 prompted an examination of the effect of such losses and changes in the abundance of wildlife.

To assess habitat functions and the status, recent trends and future projections of wildlife abundance within the Coast 2050 study area, 21 prominent wildlife species and/or species groups were identified on the basis of prominence and/or availability of information:

- Brown Pelican,
- Bald Eagle,
- Seabirds, such as Black Skimmer, Royal Tern, Common Tern, Laughing Gull,
- Wading birds, such as Great Blue Heron, Snowy Egret, Roseate Spoonbill,
- Shorebirds, such as Piping Plover, Black-necked Stilt, American Avocet, Willet,
- Dabbling ducks, such as Mallard, Gadwall, Mottled Duck, Wood Duck,
- Diving ducks, such as Greater Scaup, Ring-necked Duck, Redhead, Canvasback,
- Geese, such as Snow Goose, White-fronted Goose, Canada Goose,
- Raptors, such as Northern Harrier, Peregrine Falcon, American Kestrel,
- Rails, gallinules, and coots, such as King Rail, Sora Rail, Purple Gallinule,
- Other marsh and open water residents, such as Anhinga, Least Bittern, Seaside Sparrow,
- Other woodland residents, such as Pileated Woodpecker, Carolina Chickadee, Belted Kingfisher,

- Other marsh and open water migrants, such as Tree Swallow, Barn Swallow, Savannah Sparrow,
- Other woodland migrants, such as Hermit Thrush, American Robin, Cedar Waxwing,
- Nutria,
- Muskrat,
- Mink, Otter, and Raccoon,
- Rabbit,
- Squirrel,
- White-tailed deer, and
- American alligator.

Matrices

A matrix was developed for each region to present the habitat function and the status, trend, and projection for the above listed species and/or species groups for each habitat type within each mapping unit (Tables 5-1 through 5-4). Each matrix reflects available data and professional judgments.

"Habitat functions" considered were: nesting (Ne), wintering area (W), stopover habitat (St), and multiple functions (Mu). "Status" categories included the following: not historically present (NH), no longer present (NL), present in low numbers (Lo), present in moderate numbers (Mo), and present in high numbers (Hi). "Not historically present" means that the species or species group has not been present in the given area for more than about 50 years. "No longer present" means that the species or species group was present in the given area sometime during the last 50 years, but is not currently present.

"Trend" refers to changes in abundance over the last 10 to 20 years, and "projection" refers to a prediction of changes in wildlife abundance through the year 2050; "trend" and "projection" categories include steady (Sy), decrease (D), increase (I) and unknown (U).

"Habitat Types" reflect 1988 conditions and include the following: open water (OW), aquatic bed (AB), fresh marsh (FM), intermediate marsh (IM), brackish marsh (BM), saline marsh (SM), fresh swamp (FS), hardwood forest (HF), barrier beach (BB), agriculture/upland (AU). Habitat types comprising less than 5% of a unit are shown only if that habitat type is particularly rare or important to wildlife in the given planning unit.

"Habitat function," "status," and "trend" information displayed in each regional matrix represents common understandings of the selected species and/or species groups, field observations, data, and recent habitat changes. "Projection" information is based almost exclusively on the predicted conversion of marsh to open water and the gradual relative sinking and resultant deterioration of forested habitat throughout the study area. Such predictions may or may not prove to be accurate. Additionally, numerous other factors including water quality, harvesting level, and habitat changes elsewhere in the species' range cannot be predicted and were not considered in these projections. Therefore, the projections are to be viewed and used with caution.

Individuals Involved in Application of Methodology

The individuals responsible for synthesizing the information displayed in each regional matrix are identified below.

The matrices were compiled by Gerry Bodin (U.S. Fish and Wildlife Service) and Quin Kinler (Natural Resources Conservation Service).

Species or Species Group	**Individuals**	**Agency Affiliation**
Brown Pelican, Bald Eagle	Tom Hess Larry McNease	LDWF
	Terry Rabot	U.S. Fish and Wildlife Service
Seabirds, wading birds, shorebirds, raptors, rails, gallinules, coots, other marsh and open water residents, other woodland residents, other marsh and open water migrants, other woodland migrants	Bill Vermilion	LDWF
Dabbling ducks, diving ducks, geese	Robert Helm	LDWF
Nutria, muskrat, mink, otter, raccoon, American alligator	Noel Kinler Larry McNease	LDWF
Rabbit, squirrel, white-tailed deer	Mike Olinde Dave Moreland	LDWF
	Quin Kinler	Natural Resources Conservation Service