**Key Issues and Concepts for Tidewaters to Oceans**

**The Gulf of Mexico is one of 49 Large Marine Ecosystems (LME) around the world and vital to the energy and environmental security of the USA.** According to the publication “The Gulf of Mexico Large Marine Ecosystem: Assessment, Sustainability, and Management”, it is one of the living wonders of productivity. This region, for example, harbors some of the only remaining fully functional native oyster reefs left in the North America. This geography also holds a milieu of highly productive habitats that harbor in turn support an important economy regionally and nationally.

The Gulf of Mexico is a place of incredible biodiversity with over 15,000 species calling it home. It also serves as an economic engine for the region and our nation, supplying half of the nation’s oil and gas, 40 percent of its seafood, and housing seven of the nation’s largest ports. It is also the site of historically significant and culturally rich communities. All depend on a healthy and sustainable ecosystem for their future existence and prosperity.

Over the last 90 years, however, the Gulf and the natural systems that support its resource-based economies have changed dramatically. The Gulf has already lost up to 50 percent of its inland and coastal wetlands, up to 60 percent of its seagrass beds, over 50 percent of oyster reefs, and up to 33 percent of its mangrove forests. Most experts believe this chronic, long-term loss represents the greatest threat to the ecosystem. Compounding the challenge is that the Gulf region is among the fastest-developing in the world and vital to the economy of the U.S.

Seagrass beds or meadows are an important and critical habitat in the Gulf of Mexico. They are a conspicuous habitat all along the Gulf shores from the Yucatan Peninsula in MX all around to the Florida Keys in Florida. Not only do they harbor a very high biodiversity as well as productivity but serve as critical habitat for many recreational and commercial species, including but not limited to shrimp, crabs and fish. Over the decades, seagrasses have been declining rapidly, estimates suggesting as much loss as the equivalent of a football field every 24 hrs. Seagrass habitat values per-hectare for recreation and storm protection have been estimated from $4,000 to $11,000 per acre based on evaluation of wetlands in the Gulf area.

The Gulf’s once-extensive oyster reefs have been a major factor in the great productivity of estuaries on the Gulf of Mexico in the United States. Oyster reefs provide high-quality habitat for countless marine species, including many that are important to commercial or recreational fishing. Oysters also function as filters, making them critical to water quality. These shellfish play an essential role in keeping the delicate balance of nutrients in estuarine waters. Unfortunately, Gulf oyster beds have been decimated by human activities and have been declining for decades.

Unsustainable fishing practices and its relationship to habitat destruction in the Gulf of Mexico, as with many marine systems, is probably one of the greatest stresses to marine ecological integrity in the marine ecosystem. Between by-catch, bottom habitat alteration and unsustainable fishing effort (over capitalization and unrestricted access) in the open waters of the gulf as well as shoreline hardening, unsustainable development and urban growth, have placed the whole of the Gulf of Mexico marine system under stress that can only lead to reduced capacity and production over time. Because all species are an integral part of a larger ecological complex, that includes among others, critical habitat (spawning, feeding, rearing, etc.), it is of the utmost importance to have resource management move towards ecosystem based management approaches. As part of this approach, habitat conservation and sustainability is essential for healthy fisheries, resilient coasts, productive estuaries and in general healthy near and offshore environments to exist in the long run.

Recently, the Gulf was presented with another significant threat: the Deepwater Horizon spill. In addition to the tragic loss of life, the full effects of the spill on the environment and economy of the Gulf Coast remain unclear. What *is* clear is that this accident will have continued and potentially long-term impacts in the region. Thousands of acres of state and federal waters were closed to commercial and recreational fishing, and once pristine beaches were empty for much of the summer. These events sent a rippling effect through the Gulf Coast economy – shucking houses have shut down, coastal tourism industries have suffered, and even charitable giving has declined. A healthy environment is essential to a healthy economy – this is one lesson all can take away from this oil spill.

**Freshwater Inflows** by definition create estuaries by creating salinity gradients; supplying sediments to build wetlands; and, delivering nutrients that help power these remarkably productive ecosystems. Freshwater inflows are key to healthy estuaries.

Texas estuaries annually produce over 100 million pounds of seafood and generate $5.4 billion in economic impacts from tourism and $1.7 billion from sportfishing. More importantly, healthy estuaries provide ecosystem services we all depend upon: treating municipal wastes; diluting industrial discharges; and, supporting wetlands that protect us from storm surge.

Estuaries face many challenges to maintaining this health and productivity and loss or alteration of freshwater inflows is chief among them. Reservoirs capture or reduce floods, essential to estuarine health. They can also extend periods of freshwater releases as they slowly release flood waters over perids of time not nseen in nature. Long periods of low or no salinity can be detrimental to estuaries. Because natural variability may mask these impacts, it is difficult to know how close we are to exceeding the resiliency of these ecosystems. There are indications that we may be close or even passed that limit. Pressures will continue to increase with a growing population.

**The Gulf of Mexico and Water Quality**. One of the primary drivers of these interactions in the Gulf is the Mississippi River. One of the worlds great rivers, it drains some 41% of the continental US, 31 states and two Canadian provinces, about 1.8 million sq. miles. At a discharge rate of 600,000 cubic feet per second near New Orleans, the river accounts for nearly 90% of the freshwater discharge into the Gulf. That flow moves as much as 159 million tons of sediment a year down the river and with that sediment, all the nutrients and wastes that are not captured and treated along the way.

Like a huge hypodermic needle the Mississippi injects this watery mix into the heart of the Gulf. This discharge is part of the dynamic of the gulf and it is an important element of its character. But even here where the scale of natural processes is so huge, the impact of man is being felt. Because so much of the United States drains into the gulf it acts as a giant septic tank.

So long as the gulf remains healthy it can absorb these “unnatural” impacts as it historically absorbed the natural injections of nutrients, turning them into abundant sea life. What has changed has been the tremendous agricultural development of Middle America. That productivity has been a tremendous boon to the United States, but it is coming at an increasingly high and unexpected cost. The nutrient load of the Mississippi has increased dramatically. Microscopic plankton, feeding off these nutrients, now blooms into numbers and biomass far beyond natural possibilities. That in turn spurs an explosion up the food chain and as these processes wax and wane and the results fall to the shallow bottoms of nearshore Louisiana. They result in an unintended consequence.

The bacterial breakdown of this fallout rapidly uses up all the available oxygen in the water. Unfortunately, we see the results in the form of what has come to be known as a “dead zone” that expands from the mouth of the river each year. The dead zone is more appropriately a “hypoxic zone”, because it is more often low oxygen concentrations that characterize it rather than no oxygen. The marine life affected can rarely tell the difference. Coined by the popular press, the term dead zone seems to have stuck. That may be for the best, if it helps the uninitiated to better understand the possible ultimate consequences. Presently, the hypoxic zone comes with the warm summer season and dissipates with the coming of winter and cooling waters. What if it persisted longer and continued to grow in size? What if the entire upper coast of Texas was encompassed within the hypoxic zone every summer?

Hypoxia occurs around the world’s oceans; however the second largest zone of oxygen-depleted coastal waters in the world is off the Louisiana and Texas shores. The reported size of this zone for 2001 was approximately 20,700 km2. Hypoxia is most prevalent in the spring and summer, and has been more widespread and persistent in some years than in others. Prolonged oxygen depletion can disrupt benthic and demersal communities and cause mass mortalities of aquatic life. The Gulf of Mexico is among the most important commercial and recreational fisheries in the coterminous United States and hypoxia could threaten this nearshore environment based economy.

The primary human-related factor that has been tied to the existence of the hypoxia zone in the Gulf of Mexico is agricultural runoff drained by the Mississippi river. The total watershed, about 3 million square kilometers encompassing about 40% of the lower 48 United States and accounts for about 90% of the freshwater inflow to the Gulf of Mexico. The Mississippi river drains parts of Minnesota, Iowa, Illinois, Indiana, and Ohio (see map), a region of intense agricultural activities.

**Habitat Loss in the Gulf of Mexico**. Coastal erosion is a significant problem around the gulf and particularly in the area known as America’s wetlands in Louisiana. Each year 40 to 60 square miles of Louisiana wetlands disappear. Similar losses occur around the gulf. Some 60% of Texas shoreline is eroding and the state has lost almost half its original coastal wetlands. In Florida more than 20,000 acres of mangroves have disappeared. The Everglades and even the wetlands of the mighty Mississippi are threatened because of the diversion of freshwater to agricultural and municipal needs or for flood control.

Perhaps nothing has brought home the implications of these environmental insults more than the aftermath of the horrific hurricane season of 2005 (a record fifteen hurricanes) and especially *Katrina* and *Rita*. Hurricanes are a natural phenomena integrated into the functioning of a healthy Gulf ecosystem. Shallow coastal habitats have evolved to absorb the high energy impacts generated by these storms and equilibrium can quickly return to the system. Manmade alterations to and destruction of, wetlands and natural infrastructure, like oyster and coral reefs, have diminished this large marine ecosystem’s resiliency. They have strained even its ability to return to those levels of ecosystem health and productivity that might otherwise be anticipated. See accompanying document titled: *An Overview of Ecosystem Services in the Gulf of exico Large Marine Ecosystem.*

**Climate change** will be especially challenging for Texas estuaries as the Gulf of Mexico is a shallow subtropical sea where sea level rise, ocean acidification, invasive species, etc can be problematic. A healthy estuary has an enhanced capacity, a resiliency, to better adapt and absorb these impacts. The result of resilience failure in estuaries can be seen in many areas around the world. The cost for restoration can be prohibitive, but so can the cost of ecosystem failure. Ludwig, Hilborn and Walters writing in Science in 1993, presented five principles to follow that address effective resource management. Forty years of experience have proven these principles sound and seldom violated. They can provide a guide to meeting future challenges in defining adequate freshwater inflows to assure ecosystem health and productivity.

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