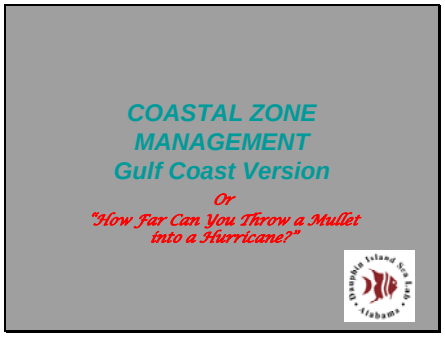
Slide 1



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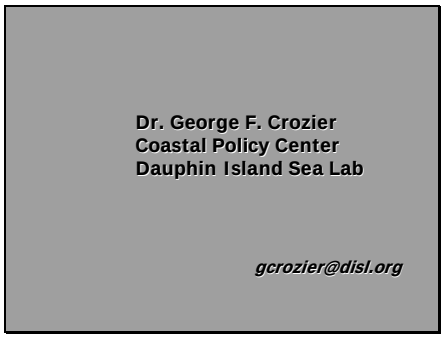
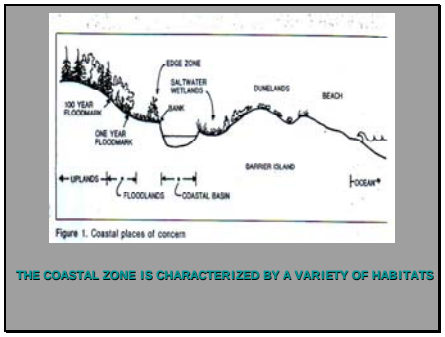
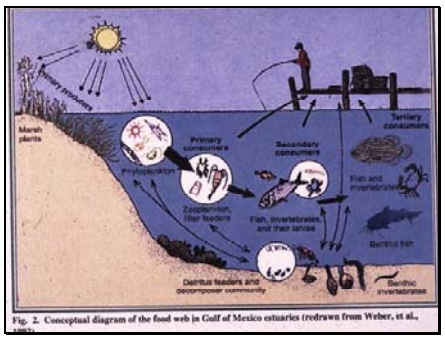


Slide 3



The coast transitions from the open ocean through, past (and sometimes over) barrier islands. These features usually define the limits of the coastal estuary, the basin where salt and fresh water meet and mix, forming "brackish" waters. The estuary is bordered by a variety of wetlands and then the elevations rise to what are called "uplands" because they are relatively "up"! With an emphasis on relative because the so-called "100 year floodmark" really means that there is a 1 in 100 (1%) chance that the water may get that high **every** year – not that floods occur only once every 100 years!!!

Slide 4



This graphic is a simplistic representation of most coastal estuaries and particularly the Gulf of Mexico. Sunlight provides virtually all of the energy available on the planet through photosynthesis. Even fossil fuels were originally generated through the process of carbon dioxide fixation into carbohydrates and subsequent conversion to coal and other hydrocarbon products like oil and gas.

Primary production is attributed to semi-terrestrial marsh grass, submerged aquatic vegetation, and/or microscopic phytoplankton at the bottom of the food chain. Animals consume the primary producers, each other and produce a variety of waste material which may be eaten by scavengers and eventually broken back down by the decomposers.

Slide 5

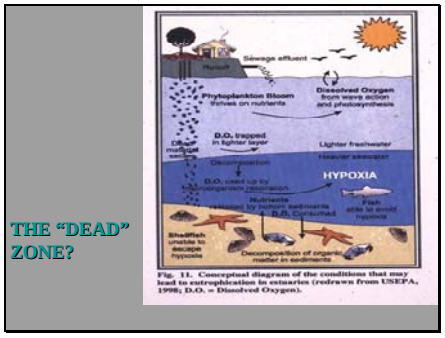


Fig. 11. Conceptual diagram of the conditions that may lead to eutrophication in estuaries (redrawn from USEPA, 1998; D.O. = Dissolved Oxygen).

Unfortunately, estuaries are not perfect mixing zones and the fresher water may create a separate layer on top of the more dense salt water. This "stratification" effect can create barriers to effective delivery of atmospheric oxygen to the bottom layer -
Materials that may be beneficial at some levels can be toxic or damaging at higher levels. This can even include nutrients that stimulate plant growth – too much of a "good thing" can become a problem and can lead to eutrophication and subsequent fish kills.

Slide 6

PEOPLE AND THEIR WATER

- Coastal population density is increasing
- Waste is inevitable according to the second law of thermodynamics
- The amount of water available in the hydrologic cycle does not change

So – what's the problem?

Slide 7

Figure 1-2. Population density from 1960 to 2015 (NOAA

And unfortunately more people are drawn to the coast than any other part of the country. Beaches actually draw the majority of our foreign tourists as well. All demographic data seem to indicate that the coastal populations will continue to grow and much of it is due to people moving from the center of the United States, as absolute population and legal immigrant growth are relatively stagnant.

Slide 8

Note the striking correlation between human population densities and the consequences described for the coastal ocean

It should be noted that vertebrate livers are toxic waste dumps of the body and that's where you look for toxic chemicals even though it is not part of our diet.

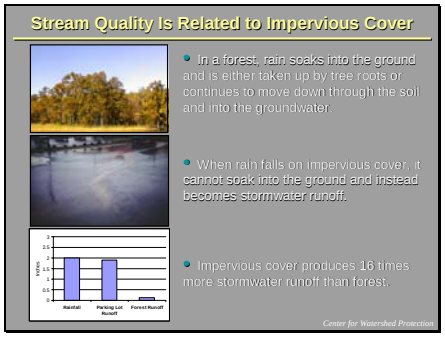
2) There are two very different chemical contaminants presented. The PCBs (Polychlorinated biphenyls) were heat sinks in electrical transformers and the potent carcinogenic nature was not appreciated until the dumping of worn-out transformers released them into the environment. Pesticides, on the other hand, were manufactured by our chemical industries and deliberately put in the environment to kill things that annoy us.

3) The oxygen deficient areas are due to high levels of organic carbon loading which can be due to over-enrichment of local plants, large and small, by nutrient levels of nitrogen or phosphorous. Salt water can only hold about 10 parts per thousand of dissolved oxygen while we are adapted to 20 parts per hundred (20%) in our atmosphere. It is amazing that organisms in the water at all!

4) The shellfish icons actually represent areas in which the shellfish, usually oysters, cannot be harvested since they gather and concentrate contaminants which make them dangerous for us to eat. They themselves may flourish in contaminated water.

It is further interesting to note that many of the most impacted areas are among the most popular and attraftive areas – southern California and the pacific northwest! Clearly we have to recognize the waste envelope that inevitably surrounds populations of people, at the house, subdivision, and metropolitan level.

Slide 9



The quality of our streams is directly linked to land cover. In a forest, rain soaks into the ground where it is either taken up by tree roots or continues to move down through the soil and into the groundwater

When rain falls on impervious cover, rain cannot soak into the ground and becomes stormwater runoff

Impervious cover produces 16 times more stormwater runoff than forest. The chart illustrates, that if it were to rain 2 inches on a parking lot, 1.9 inches would become stormwater runoff. In a forest, only 0.12 inches would become stormwater runoff with the remainder soaking into the ground.

Slide 10

This slide illustrates how stream quality, as measured by bank stability, water quality and available habitat, deteriorates when impervious cover increases in a watershed.

Watersheds with less then 5% impervious cover, have stable stream banks, good water quality and provide a variety of habitat.

The second picture shows a stream that has about 10% impervious cover in its watershed. While relatively stable, the stream shows some signs of erosion.

The third stream has about 20% impervious cover in its watershed. Stream erosion has become serious. Note that the amount of erosion has been so great that the drain pipe that once rested on the stream bottom and within the stream bank is now 2 feet above the water and protrudes nearly 6 feet from the stream bank

The fourth picture shows a stream with about 30% impervious cover. The stream channel has “blown out” and is about five times larger than it was before development. The water quality is poor and there is very little suitable habitat for aquatic life.

The last picture shows a stream that has 65% impervious cover in its watershed. Stream erosion has become such a problem that the stream was channelized with concrete. The concrete provides no habitat to support aquatic life.

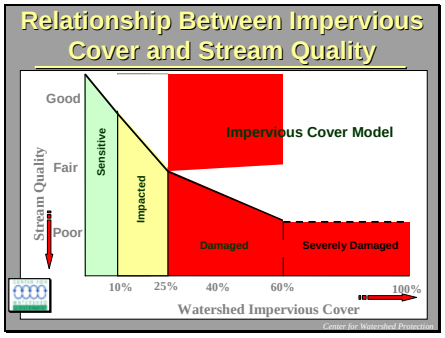
It is important to note that these impacts generally apply to headwater streams, which are composed of first- and second-order streams. Since these small headwater streams comprise about 75% of all the river and stream mileage in the contiguous U.S., their proper management and protection is essential to the protection of our larger lakes, rivers, and estuaries.

Slide 11

The different types of harmful pollutants found in stormwater runoff include the following:

Bacteria that can threaten our water supply or close beaches and shellfish beds
Nutrients that can cause algal blooms
Pesticides, oil and grease that can be harmful or deadly to aquatic life
Muddy water can block sunlight from reaching plants, clog waterways, and physically harm animals
Heavy metals, such as zinc, copper, and lead, that can be toxic to organisms. Some heavy metals accumulate in organisms, causing them to be unsafe for human consumption.

Slide 12



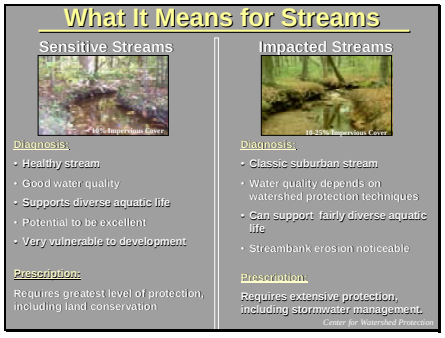
As mentioned in the previous section, water that can not soak into the ground flows over the land surface, eventually ending up in a waterway. The amount of impervious surface in a watershed directly affects the amount of runoff, influencing the stream quality.

This graph shows that as the percentage of impervious cover increases, the stream quality decreases. A stream receiving runoff from a watershed that is composed of less than 10% impervious cover is considered to be "sensitive." This stream is in good shape. At 10% impervious cover, stream quality really begins to decline. Between 10-25%, streams are categorized as "impacted." At levels between 25% and 60% streams are considered "damaged" and at above 60% impervious cover streams are considered "severely damaged."

Slide 13

Perhaps the simplest example is that of what happened before the discarded mountains of used tires were piled up. They wore down on roads and bridges, dumping tons of biodegradable rubber into our streams adding to the consumption of oxygen in the water environment.

Slide 14

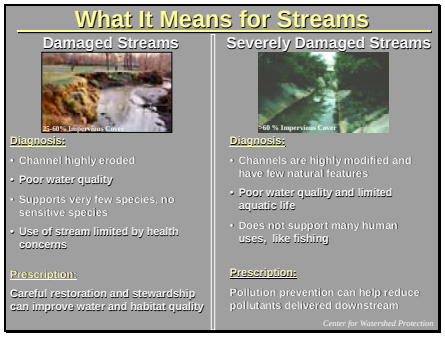


A knowledge of how much impervious cover is present in the watershed can be used to diagnose the health of streams and come up with a prescription to make them better. Classifying the stream into management categories makes this process easier.

Sensitive streams are currently in good condition and supporting a variety of aquatic life, including sensitive species like trout and salmon. These streams, if properly managed, have the potential to be excellent. In order to protect sensitive streams from the impacts of development, land conservation and stream buffers should be used.

Impacted streams show some effects of surrounding development but can often still support several different populations of aquatic species if the stream habitat and water quality is still in the good to moderate range. In order to improve the overall quality of impacted streams, preservation of less impacted areas and restoration of degraded areas is needed.

Slide 15



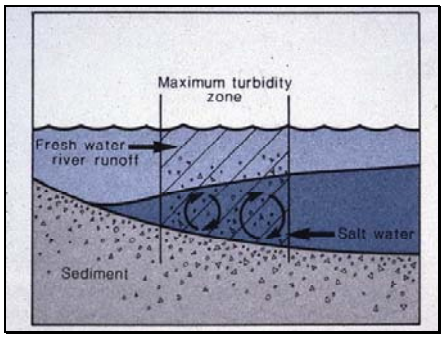
Damaged streams are typically found in urban areas with 25-60% impervious cover. These streams are particularly susceptible to runoff pollutants. The streams do not support any sensitive aquatic species like trout or salmon, due to the poor water quality and lack of suitable habitat. Recreational activities such as fishing may be banned due to risk of bacteria and other pollutants.

Since damaged streams have been so degraded, preservation is often not an option. Instead, the focus should be on restoration and stewardship efforts. Improving stream stewardship includes educating watershed residents and businesses to alter their habits in order to reduce the amount of pollutants created as well as the amount that goes untreated to the streams.

Severely damaged stream are found in areas with more than 60% impervious cover. In order to manage the high streamflow and erosion, those streams are often channelized with concrete or rocks. These streams cannot support aquatic life because there is no habitat structure remaining and the water quality is so poor.

Watershed stewardship is the best focus for severely damaged streams. In particular, residential and commercial education can be an effective tool to improve the water quality. By reducing the amounts of pollutants that enter the stream system, degradation of downstream waters can be reduced.

Slide 16



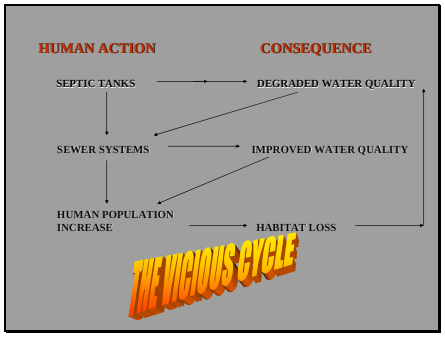
Why are the problems magnified in the coastal ocean and estuaries?

Physically the rivers draining the continents run "downhill" to the ocean, but then the "stream" not only widens and flattens out, but it encounters an ocean whose level actually rises once or twice a day depending on where the coastline is. Consequently the fresh water slows dramatically depending on the hydraulic "push" that it is getting, so something being carried by the energy of the moving water will settle out of suspension. Tidally influenced streams may stop or flow backwards at high tide!

From the perspective of the chemistry of materials (including contaminants) dissolved in the moving fresh water, the mixing with salt water creates yet another problem. Salt water isn't as good a solvent as fresh water so something that may have moved hundreds of mile down the river may come out of solution, become a particle subject to gravity and sink to the bottom of the estuary/coastal ocean.

In contrast to the fresh water biosphere, estuarine and coastal communities are dominated by benthic (bottom) animals that feed largely on particles from above. These materials may or may not be a problem for them, but they may be for us since many of these particle feeding animals are of great interest as fisheries – shrimp, oysters, blue crab, even mullet!

Slide 17

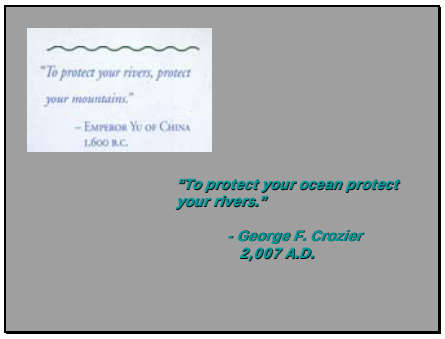


In an effort to control our personal waste, humans have traditionally resorted to “onsite disposal systems” better known as septic tanks. When properly designed, sited, built, and maintained these effectively use the natural soil systems to treat domestic waste.

Unfortunately all four conditions are rarely met and they frequently become sources of pollution. So we have learned to build larger centralized sewer treatment plants that improve the water quality.

Which then leads to more human population growth that invariably leads to native habitat loss which decreases the ability of the natural system to treat our waste as well as dramatically altering the natural community.

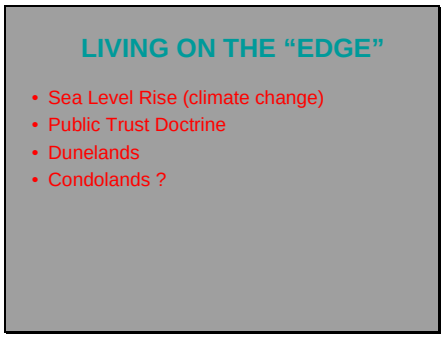
Slide 18



Recent reports by both the Pew Ocean Commission and the U.S. Commission on the Oceans have clearly stated that what humans do on the continents and neighborhood streams is putting the ocean in great jeopardy. Therefore it is in our “backyard streams”, large and small that we have to start to repair the coastal oceans!

Slide 19

Slide 20



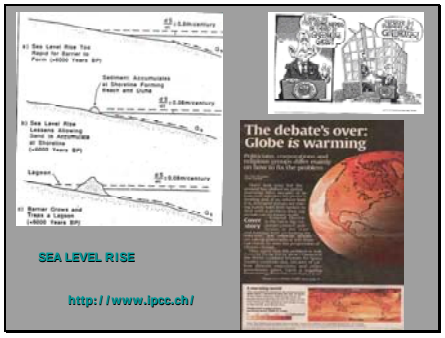
The allure of walking the beach and living at the edge of the ocean is enormous. Ancient philosophers believed that the similar salinities of seawater and our blood indicated that we had indeed come from the ocean.

The threat of rising sea levels is pretty obvious but the conflict of a changing boundary between public and private land is less well appreciated.

A functional beach and dune system has been shown to be the most cost effective mechanism of barrier protection.

Is the conversion to high density living the only solution?

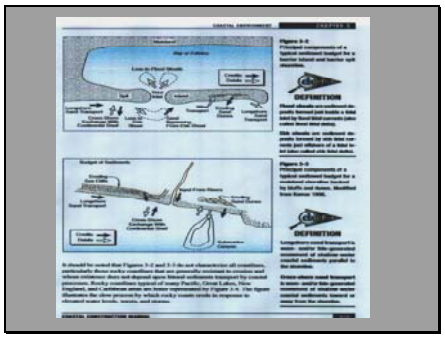
Slide 21



Global sea level began its current rise about 20,000 years BP (before present) – long before fossil fuels were being burned in abundance. The rate of rise has not been steady but proceeded at different rates at different times. It appeared to stall about 6000 years ago but has since demonstrated a rate of increase coincident with the accumulation of greenhouse gases. During relatively slow movement of sea level, sediment accumulates at the interface of land and the ocean creating the barrier features.

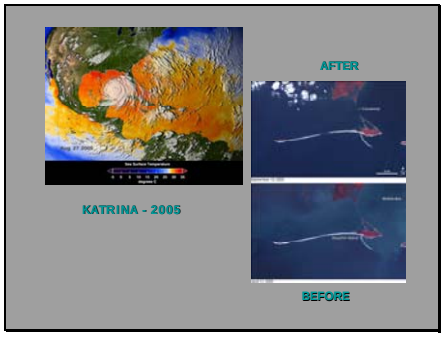
The only viable debates that remain concerning global warming are 1) whether it is directly impacting tropical storm increases in number and intensity and 2) whether we can reverse that which we have changed!

Slide 22



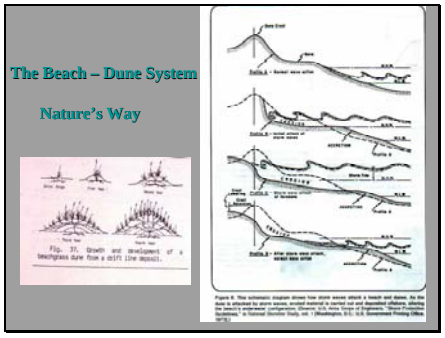
Barrier features may take several forms – deltas, either inside or outside inlets; islands, peninsulas, etc.
At the shore there is sand movement both parallel and perpendicular to the beach depending on the wind field, velocity and direction, and the rotation of the earth. This latter effect is called the *Coriolis Force* after the name of the French scientist who first described it in 1835 (http://en.wikipedia.org/wiki/Coriolis_effect). In the north-central Gulf of Mexico the longshore current moves from the east to the west. Management of the barrier islands depends largely on understanding the forces that move sand in and out of these features.

Slide 23



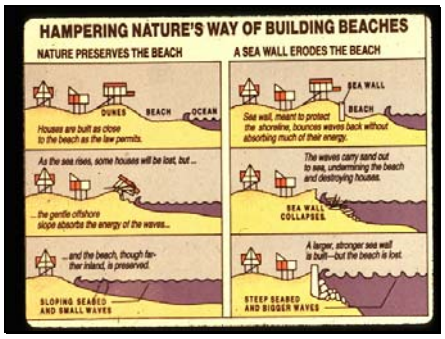
Unfortunately, one of the largest factors are tropical storms. Hurricane Katrina in 2005 brought a new level of attention to the impact of tropical storms creating two islands from Dauphin Island.

Slide 24



As storm waters rise at the leading edge of the storm sand erodes from the dune and "rolls" downhill until it reaches equilibrium and there it accumulates. These are usually sand bars just offshore but may simply lower the angle of the beachfront as shown in the diagram. Either way, the bottom has gotten closer to the surface and the wave energy is reduced by the frictional drag from the accumulated sand. No man-made device has ever proven to be nearly as effective in reducing storm impacts. After the storm passes, the natural system moves the sand on the bar back to the beach. Wind, tides and the residual parts of dune vegetation will restore the dunes to their original height and configuration over a roughly 3-year time period along the central Gulf coast.

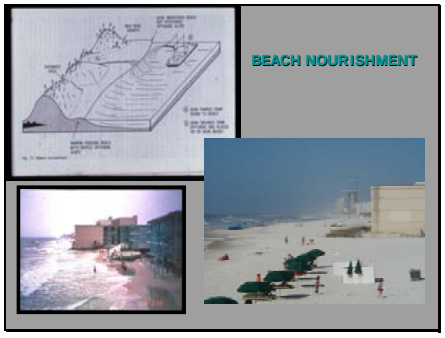
Slide 25



The left side of this graphic from Time magazine 25 years ago shows the natural progression on the left side. It even alludes to the slope change creating smaller waves. The story is incomplete since it does not explain the natural restorative forces of the system.

The right side demonstrates one of the engineering solutions that has been tried in a number of areas, with largely the same result. The shoreline can be stabilized but always at the expense of the beach! This situation is aggravated by the sim0ple fact that in most coastal states, the beach below the average height of high tide belongs to the public and **not** the adjacent landowner.

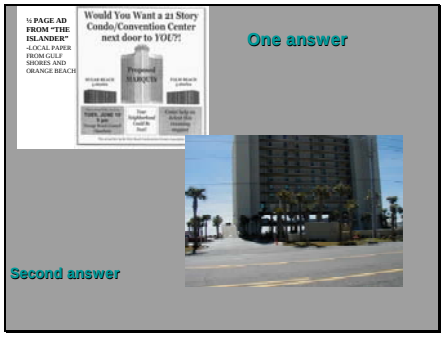
Slide 26



The most commonly accepted mechanism for beach management is referred as beach "nourishment". With careful planning, a lot of money, and plenty of surplus sand, this process can be very successful. The costs have risen to nearly $3M per mile and sand is becoming a larger problem as it is a fixed amount and much less is entering the coastal zone because of dams capturing the sand and holding it upstream.

For communities like Gulf Shores and orange Beach, the expenditure is easily justified by the visitor dollar that depends on having a beach. The scarcity of sand available nearby is rapidly becoming the limiting factor.

Slide 27



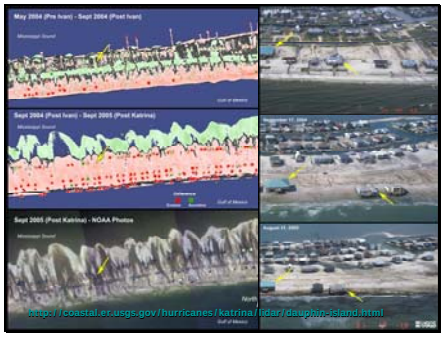
Single family homes and duplexes long dominated the central Gulf coast, but the growing demand for housing, largely second homes and rentals has fed the growth of massive high density residential projects, usually opposed by the previous residents – even "less dense" complexes.

The storm seasons of 2004 and 2005 have raised the consciousness of the vulnerability of living on the edge and the condos are not rebuilding the lower couple of floors but are using these as parking garages, thereby reducing the footprint of the building and allowing the storm waters to pass below the residential units.

Slide 28

We are nothing if not a persistent species! The house is being built during the summer of 2006 and lots are still being sold even when under water at an unusually high tide!

Slide 29



As demonstrated in the sequence of LIDAR (**LIDAR** (*LIght Detection and Ranging*) is an optical remote sensing technology which measures properties of scattered light to find range and/or other information of a distant target.) images which dramatically demonstrate the elevation of sand and subsequent sand movement across the west end of the island.

Slide 30

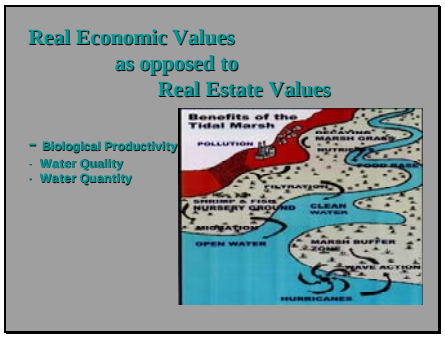
The sand from the north side is now being pumped back to the south side in an effort to protect the infrastructure expenditures already invested. 90% of this project is being paid for by FEMA with federal taxpayer dollars and the rest being paid by the State of Alabama. The property being restored belongs to the private property owner and public access is **not** required as in the case of a true beach nourishment project authorized by Congress and implemented through the Corps of Engineers.

Most importantly this engineered berm does not meet the criteria of a "Duneland" system that would be effective in protecting coastal properties.

Slide 31

The more recognized and valued coastal habitat are the wetlands.

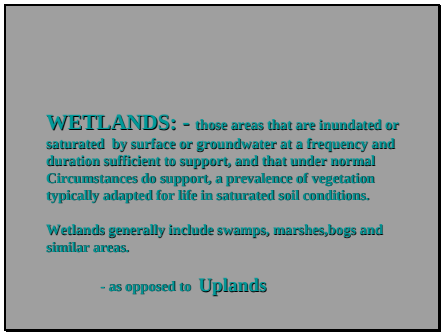
Slide 32



All habitats provide some level of ecological "service" – they may be producing items of value like oxygen, they may be cleansing wastes from water passing through, or they may be housing birds that give us pleasure to watch – and everything in between. The point is that they provide real economic benefit that may be overshadowed though ignorance and greed and not properly appreciated. Consequently the nation has drained and filled over half of its original wetlands and states like Louisiana have lost a great deal more. That loss is believed to have contributed significantly to the damage in New Orleans.

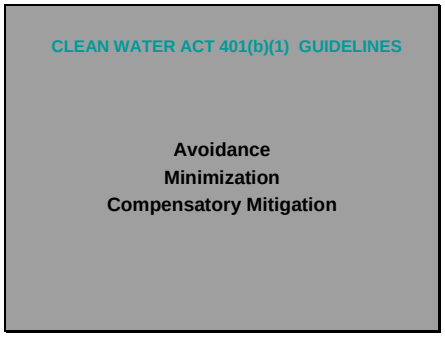
Historically, it was easiest to argue for the biological role using Gulf shrimp as the example and the tidal coastal wetlands were referred to as "nurseries" 25 years ago. Over the past 15 years, their role in cleaning toxics and nutrients from water passing through them became better appreciated. And in the last 5 years, following Hurricane Katrina, the flood/surge protection attributes have come to the forefront and may wind up having the greatest economic impact, at least on an episodic basis.

Slide 33



The wetland program is administered by the U.S. Army Corps of Engineers because of their long history of dredging and maintaining ship channels. Over the years a legalistic definition of wetlands that come under their jurisdiction has evolved. The technical issues revolve around how much **water,** the types of **soils** associated with the site and the **plant** community which depends on both the water and soil characteristics.

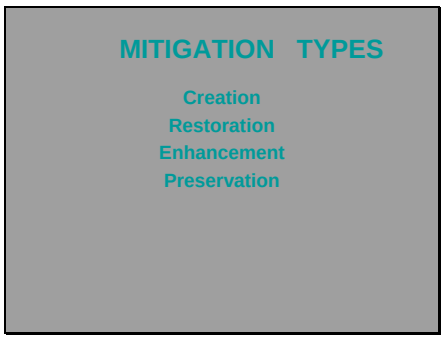
Slide 34



Guidelines are **not regulations** but they are intended to direct policy and the legislation establishes the sequence of review by the Corps. The regulatory group is supposed to do everything they can to avoid destruction of wetlands under their jurisdiction in order to preserve those valuable ecosystem services.

If it is impossible to to avoid them completely then the impact should be minimized and if that isn't possible, then, and only then, is mitigation to be pursued

Slide 35



The first type is very difficult since the natural system wasn't conducive to wetlands, it is unlikely that we can make new ones where they weren't before – without spending a great deal of money!

Restoration is the most feasible and acceptable of mitigation types. If conditions allowed wetlands at a site before we destroyed them, then the odds are good that they can be restored.

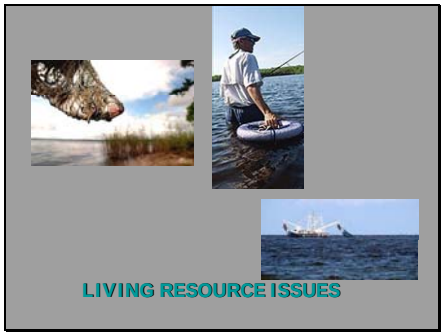
Enhancement means that the functional and economic value of the wetlands is increased somehow, perhaps by creating tidal marsh producing shrimp from a somewhat higher wetland type.

Preservation is partially flawed as a mitigation technique because nothing is actually gained, and it implies that something somewhere else has still been lost.

Slide 36

Mitigation is a good idea in theory but has failed miserably in practice for each of the reasons mentioned in the slide. The National Academy of Science reviewed the process and thoroughly criticized the effectiveness of the program, as did the General Accounting Office. The whole issue is currently under review by the Corps and cooperating agencies.

Slide 37



For many the act of fishing is an enormously valuable recreational activity and others it is a way of life and their livelihood. It is an enormous economic engine in either orientation and a matter of grave concern. The same commission reports mentioned above clearly characterize our fisheries as being in great jeopardy.

The loss of *essential fish habitat*, particularly coastal and tidal wetlands have contributed significantly to the declines noted. The productivity of our coastal areas has almost certainly been cut in half over the past two centuries and we really don't know how productive they were. Visit the web site below for an "over-the-top" but entertaining introduction to the issue.
http://www.shiftingbaselines.org/op_ed/index.html

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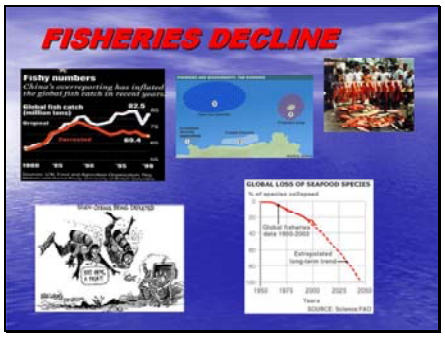

Current data indicate that the global fishery resources are near capacity, probably beyond sustainable harvest levels and may already be on a serious decline. The extrapolation extended to the middle of this century is terrifying. The days are gone when we could have all we want, all the time. Difficult processes of allocating the distribution of these diminishing resources are becoming ever more controversial and emotional.

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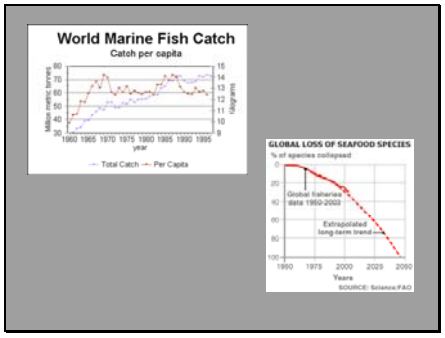

The increases noted the third quarter of the last century are due to two overriding factors:
The harvesting technologies benefited greatly from advances made by the military during WWII, specifically sonar and positioning.

Governments all over the world subsidized their commercial fishing fleets on the erroneous assumption that “food from the sea” would support the growing world population. Even when the U.S. evicted foreign fishing vessels from the Exclusive Economic Zone, the government supported growth of the domestic fleet with the same result – overfishing.

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The title is enough!