SYNERGISTIC DEGRADATION

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PHOTOGRAPHIC HISTORY and EVALUATION of the HAMMOND SEWAGE DISPOSAL SITE

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Synergistic Wetland Degradation (by Sewage)

Definition: Multiple manifestations of negative impacts caused directly or indirectly by the introduction of sewage into a predominantly freshwater wetlands that is secondarily influenced by tidal fluctuations.
Healthy *Panicum*...Sister Marshes...Photo same day...Ponding + Veg. die-off
Many species including these cypress which were planted survived better in the control marsh than in the sewage discharge zone.

Nutria did not cause this.
Plug Islands: Signatures of Weakened Marsh Breaking up
Signature of weakened soil that took place only in the discharge zone and broke free during Hurricane Ike. This was not seen in any of the four control marshes.
Disease (Background Stressors)

Disease is prevalent in most wetland vegetation and in combination with other environmental stresses plays an important role in wetland degradation. The synergistic significance of disease in sewage impacted wetlands needs higher recognition.

(Diseases in the following photos were identified by the LSU Plant Pathology Diagnostic Center)
Typha...Not infected

Typha infected with Fusarium fungi

Here *Typha* outside the cage is doing better than the planted *Typha* inside the cage. Nutria has nothing to do with the differences ...both photos taken same day at opposite ends of the discharge zone.
Panicum infected with anthracnose caused by the fungi Colletotrichum spp... ammonia toxicity, physical suffocation by decaying mats of organic material and sulfide toxicity are likely contributing factors to the massive die-off that occurred. Elevated levels of phosphates and copper could contribute as well... herbivory would only be a factor due to stress sensitive abnormalities in the plant’s physiology caused by excessive nutrients.
Algae Plays an Important Role in Degradation of the Wetland Ecosystem
Massive bloom of green and blue/green algae on the north and west side of the discharge zone...the entire discharge zone was negatively impacted by this bloom.
One of many green algae blooms (approximately 50 acres) in the water column...this type of green water is typical in oxidation ponds and raises D.O. and pH to very high levels in the day. This favors accelerated decomposition and destabilizes populations of denitrifying bacteria.
Dead algae (black... consistency of a light oil) mixing with duck weed (green) over a large area

Spontaneous bubbling of undisturbed area indicating shallow and rapid decomposition increased in part by elevated pH
Photo on the left is old *Panicum* with deep roots that is dying....photo on the right is new growth with spring-like foliage in late October...its roots are basically floating...ammonia levels in the pore water are much higher than the surface water...lodging is seen in the photo on the right. The succulent *Panicum* did not survive the winter ...both colonies of were in the Southeast portion of the Discharge Zone.
October 16, 2009

Abnormal Succulent growth (floating in open water)

Stressed and Dying (attached) taken along the edge of the main colony of *Panicum*

Healthy (attached) taken 100 m into the main colony.
White roots indicate growth phase and brown roots indicate storage phase...this matches the research literature that concludes plants, when exposed to excessive nutrients tend to shift carbohydrates towards sucrose that is used faster than starch which is used to carry the plant over through the winter.
Spontaneous Plug Island ... Dead *Sagittaria* stumps (typical of the bottom in open water) Prior to sewage this would be sequestered into the bottom... now it breaks up and floats to the surface, decomposes and leaves the area.
Acres of dead *Sagittaria* rising to the surface to form mats that decompose rapidly. Prior to discharge, this would become peat under acidic and anaerobic conditions.

Close up of floating and decaying *Sagittaria stalks*. 
Decomposition and Transport are the End Result of Floating Vegetation
October 4, 2009

Looking north toward the discharge pipe from the south...the floating mat of duckweed/\textit{Salvinia}/algae gets thicker and turns darker as I moved to the tree line on the south edge...pirogue trail.
This is a disturbed area of the floating mat turned to muck along the south edge of the marsh...this produced a strong stinking smell over the southern third of the marsh...as decomposition progressed the particulate matter becomes very fine and with rain and water movement get transported further out of the area...This dynamic is prevalent in the sewage zone but not in the control marshes. By January this all reverted back to open water.
Annual Water Inventory In the Discharge Zone

Hammond Property (135 acres) ......................... Discharge .... 87%  Rain .... 13%

Hammond + Joyce for (640 acres) .................... Discharge ..... 58%  Rain .... 42%

Increased depth and duration of water stresses many species of plants and reduces the consolidation affects of natural wet/dry cycles.
Ludwig spp.

A shallow rooted annual that displaces deep rooted perennials and adds to the “Soupification” process
Aerial roots of *Ludwigia*... Oxygen uptake and transpiration taking place directly in the air. Aerial roots also adapt to provide buoyancy and become more prolific in deeper water during growth phase. They disappear when the plant reaches maturity, dies and then quickly decomposes.
Lodging *Ludwigia* exposes sediment to aerobic conditions that accelerate decomposition and weakens the soil (one of the Soupification processes).
Designed to exclude nutria, these cages function as sediment traps...at high water you can see the floating litter that would otherwise drift off...this litter serves as substrate that traps finer particular matter...next photo shows the buildup when the water drops.
1. Increase in water depth/duration/pH
2. Excessive ammonia/other constituents
3. Algae and Floating/shallow Rooted annuals favored
4. Stress and die off of emergent perennials
5. Build up of floating mats and Accelerated decomposition
   a. Floating veg. originating at the surface
   b. Bottom organic matter rising to the surface
6. Alteration of plant physiology
   a. Confused biological clock
   b. Shift towards sucrose rather than starch
   c. Prolonged tender cellular structure favoring lodging, disease susceptibility

Soupification Process $\rightarrow$ Synergistic Degradation

Sediment Transport

A. Hydrology predominantly influenced by rain and fresh water run off
B. Hydrology secondarily influenced by tidal/wind influence in Lake Pontchartrain/Maurepas
Discharging Sewage into Natural Wetlands is a Flawed Concept

I. The addition of municipal discharge into a natural wetland inevitably increases water depth and flooding duration.

II. The addition of sewage raises pH and introduces other factors which favor accelerated decomposition.

III. The addition of sewage introduces excessive nutrients which alters normal plant physiology and eventually causes many species to be less resilient.

IV. Claims that discharging sewage into natural wetlands is more cost effective are based on lower permit limitations. These limitations should not be relaxed.

V. Post discharge assimilation is not part of the treatment process. To identify it as treatment and compare it to predischarge treatment methods is very misleading.

VI. Once sewage discharge enters a natural wetland, most of the control over it is lost and “adaptive management” can only address superficial aspects.

VII. Plants are favored which are less desirable because they are floating or shallow rooted and often displace more desirable species.

VIII. Converting a natural wetland into a sewage disposal site makes for repugnant conditions and causes many undesired impacts that are associated with this utilitarian purpose.
Sewage vs wastewater. Sewage is the more specific term that include human waste while wastewater is a more general term and can be anything from industrial to agricultural etc.

"Plug Islands" are sections of marsh that float up and are pushed on top of nearby marsh, especially occurred during Hurricane Alex. Its a sign that weak marsh soils are breaking up. There are also spontaneous plugs created that float up and have vegetative stems in them. This vegetation died, it was not eaten by nutria.

There was high tree death when comparing on the non discharge versus the discharge side of the ridge. Willow, tallow and red maple all died on the discharge site.

Disease has been overlooked an is a combination of many factors.

Fusarium blight of Typha, Phoma fungus on button bush, Doassinacea deformans or smut fungus on Sagitarria cuasing galls and Anthracnose on Panucim causing purple leaves.

There are many algal blooms in the spring including green, red, pea green algae which are typical of oxidation ponds and indicate swings in pH and DO between day and night.
Panicum is stressed by high nutrients, dying back from the edge. It is demonstrating abnormal succulent growth in areas of high nutrients because the plant thinks its spring when it should be beginning senescence. It was not killed by nutria.

Sagitarria roots shift to rapid growth in high nutrient conditions making thin whit roots and produce sucrose over starch. Sucrose is used quickly by the plant while starch is a storage molecule. Roots are brown in the control marsh and are in storage phase not growing phase. The roots/rhizomes decompose a rise to the surface in chunks rather than forming peat.

Typha roots have adapted to grow deeper to get out of high nutrient zone, stalks extending 45 centimeters in discharge zone and only 8 centimeters in control marsh.

Floating vegetation is pushed to the south end where it thickens into a mat 3-5 inches thick, then rots = soupification.

Ludwigia- shallow rooted annual that displaces perennials

Ammonia levels are high in the winter when the thermophyllic nitrifying bacteria in the plant are not active because of the cold.

There is milky water in the discharge zone.

When the discharge is in the west end, water short circuits into the I-55 canal. When discharge is in the east the water runs south east and east.