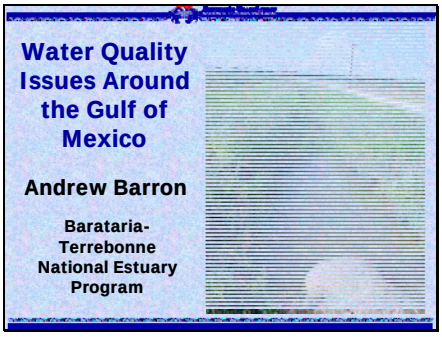
Slide 1



Hello. My name is Andrew Barron, and I work for the Barataria-Terrebonne National Estuary Program. I am going to be talking about water quality issues around the Gulf of Mexico for my presentation today, and I am going to start out in general talking about water quality, then I am going to focus down the presentation about the relationship between nutrients and water quality, and then finally I will look at case studies that feature watershed programs in the five states that surround the Gulf of Mexico.

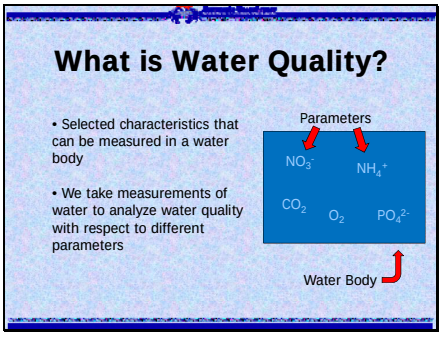
Slide 2

So, why are we interested in water quality? Actual variability could be a first reason, and we might just be interested in the range of values for a given parameter within a specific water. We might also be using that data to corroborate other data, like measurements we're taking on a certain fish population. Human health might be a second reason: drinking water, personal hygiene, industrial use and sewage treatment, things that are pretty pedestrian, that we take for granted and use on a daily basis, or things that affect human health. Third, environmental health. So, given a certain water body, what is the ability for that water body to support certain species such as fish or animal life. So, that is what I mean when I say environment. Finally, esthetics would be a fourth reason. This is just the way the water body looks. The color of the water. Does it smell funny? Is there a bunch of garbage in the water? This is usually the first thing that people see.

Slide 3

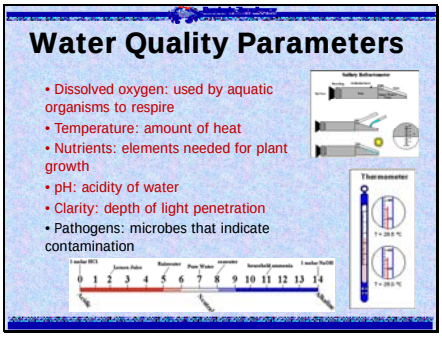
Now, I made this slide just to get people thinking about water quality. So, which of these two glasses, the one on the left or the right, would you be more prone to drinking? If it is me, I probably would tend to drink the one on the left. But, there is no guarantee that that water is clean or safe for me to drink. So, this is one of the reasons we use instruments to measure certain parameters within a water body, and that is so that we know exactly the levels, or quantities of pollutants, or how pure the water is.

Slide 4



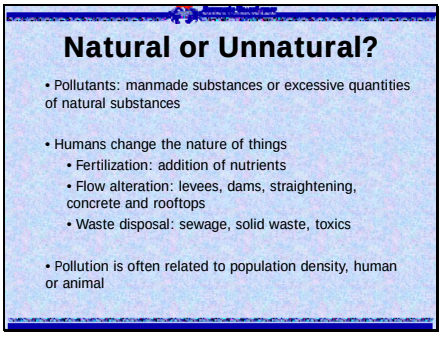
So, what exactly do I mean by water quality? Water quality is the collection of characteristics that can be measured in a certain body of water. In general, we take these measurements in order to analyze water quality with respect to certain parameters. What do I mean by parameters? Well, these are the different characteristics of that water body. It might be different compounds in the water, but it might also be something like the depth that light would penetrate within that body.

Slide 5



This slide gives you some examples of water quality parameters. There is a long list of possible parameters, and it is certainly not restricted to this list. But, these are some of the common ones that scientists tend to measure when they are out in the field. Dissolved oxygen is very important for aquatic organisms, because it allows them to respire and use up energy within the water that they collect as food. Temperature is the amount of heat in the water body at any given time. Nutrients are elements needed for growth in all creatures, but what we are going to talk about in regards to water quality is going to be really geared towards nutrients that are needed for plant growth and phytoplankton growth. pH is the level of acidity that's within a given body of water. Certain creatures and species can only tolerate certain levels of acidity or alkalinity. Clarity is the depth of light penetration in the upper part of a water body. This is important specifically for primary producers like phytoplankton (these are small single celled or multi-celled organisms that are very much like plants, in that they are able to photosynthesize). Finally, pathogens are bacteria or viruses that can contaminate a water body and can be a threat to human health. If you notice that some of the parameters here are in red, and the pathogens are in black. The reason the parameters are in red is that you can make a case that those parameters are related to one another, or have some kind of impact on one another.

Slide 6



Now, when we talk about compounds that go into bodies of water, some of those compounds we think of natural, and others as unnatural. Generally, manmade compounds are going to be considered unnatural. Another way of looking at it is if you have naturally occurring compounds that are in excessive quantities, those could also be considered to be pollutants.

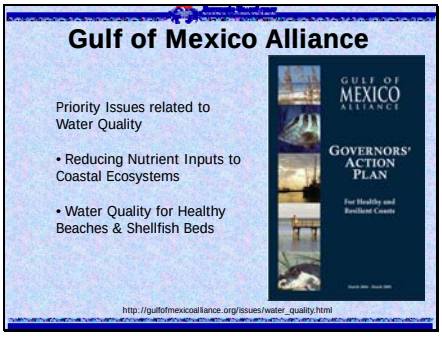
Humans tend to change nature. One way might be through fertilization, the addition of excessive nutrients on an agricultural field or lawns within urban areas. Flow alteration: we levee, dam, straighten, put out impervious surfaces like parking lots and rooftops. Then there is waste disposal. We concentrate our wastes out there, through sewage, solid wastes, and then there are some of the nastier stuff like toxic wastes. Pollution is often related to population density, whether it is human or animal. If animals are in unusual or sensitive population densities, it is usually because humans concentrate them there.

Slide 7

Back when the Clean Water Act was passed in 1972 (at least the first time it was passed), it dealt with point sources of pollution. So, people think of point sources as what is coming out of a pipe. Examples of this would be industrial and municipal discharges. These are considered "permitted discharges", so those facilities have to get a permit from either the state or the Environmental Protection Agency (EPA) in order to discharge to local bodies of water. These account for about 40% of all water pollution out there.

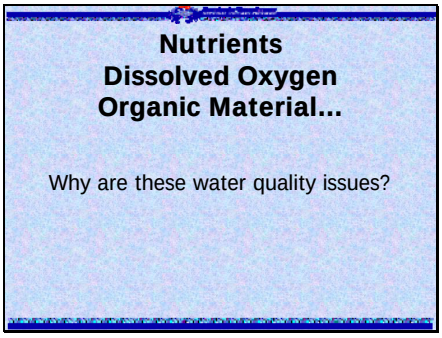
When the Clean Water Act was implemented after passing in 1972, they put into place regulations that dealt with point sources pretty well; however, when EPA continued to measure water bodies out there, they noticed that the waters were still about 60% polluted by nonpoint sources of pollution. A simple way to think of this is of pollution that is carried off by rainfall runoff. This can be either natural sources of pollutants or manmade. They can account for some of the same parameter problems that you would have with point sources, such as: low dissolved oxygen, excessive nutrients, sewage and toxic compounds.

Slide 8



Since we are all participating in the Gulf of Mexico COSEE, I thought it would be good to focus in on priority issues from the Gulf of Mexico Alliance with regard to water quality. They have two priority issues: reducing nutrient inputs to coastal ecosystems and water quality for healthy beaches and shellfish beds. The second issue is related to human health and it is related to untreated waste water. It is fairly straight forward issue in some ways. But, I thought for this talk, I would focus in on nutrient inputs to coastal ecosystems.

Slide 9



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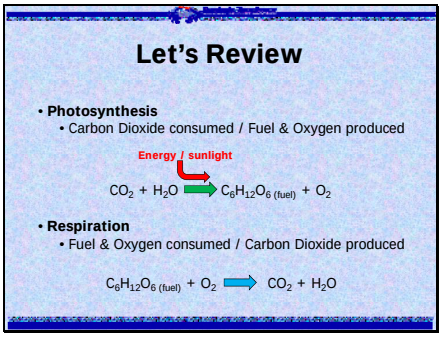
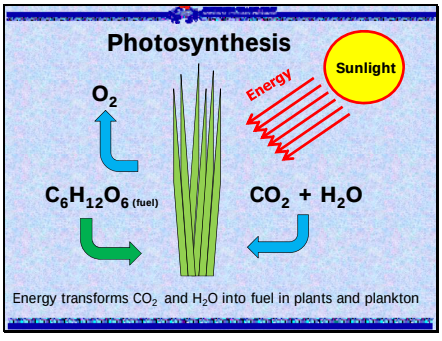


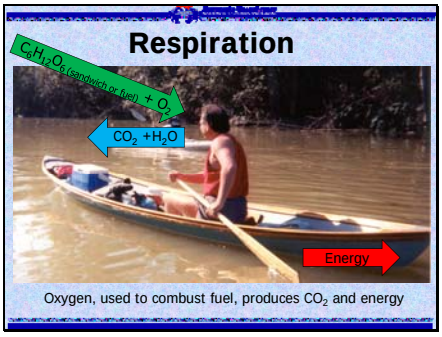
Let's review two basic reactions that we learn about in biology: photosynthesis and respiration. In photosynthesis, carbon dioxide is combined with water and utilizes sunlight to turn that into a fuel such as glucose and oxygen. In respiration, the reverse of photosynthesis occurs. So, the fuel and oxygen are burned and the byproducts of the reaction are carbon dioxide and water.

Slide 11



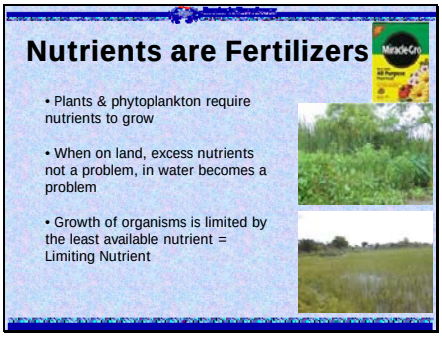
Just to examine photosynthesis a little more, the cells within algae or plants have chloroplasts, and those chloroplasts are able to take energy in the form of sunlight and then combine carbon dioxide and water into plant matter. We can also think of this as organic matter. It is either living organic matter or dead when it comes to our discussion of water quality. Again, as a byproduct of photosynthesis, oxygen is released.

Slide 12



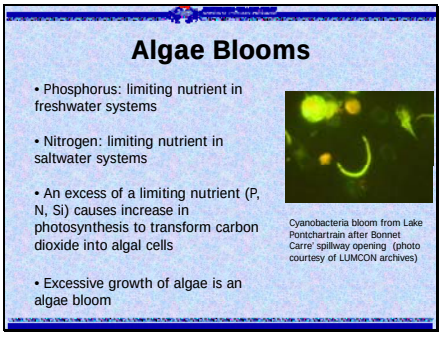
As discussed before, respiration is the reverse of photosynthesis. So, this guy who is paddling along on the bayou needs energy in order to do work, to paddle himself down the bayou. So, fuel for him may come in the form of a sandwich, for instance. So that provides the fuel, but he also needs oxygen in order to combust that that fuel and turn it into energy. So the byproducts of respiration are carbon dioxide and water. This same reaction occurs in humans all the way through fish and bacteria.

Slide 13



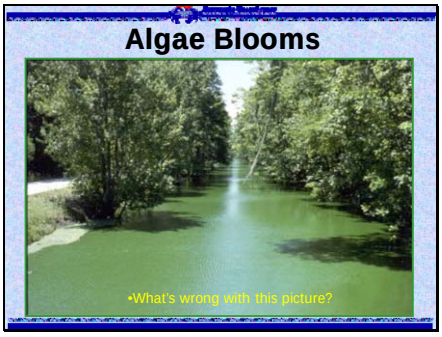
Increasingly as time goes on, we are finding that nutrients are becoming more and more of a problem. This is related to population densities of humans in the coastal zones, as well as just throughout the planet. Plants and phytoplankton, like any organism, require nutrients to grow. When these nutrients are on land, they don't represent a problem. However, when they end up in the water, they do become a problem. Unfortunately, nutrients do eventually end up in the water through rainfall runoff as we have talked about before. When scientists were looking at nutrients, they found that the growth of organisms is usually limited by the least available nutrient, and this is known as a limiting nutrient.

Slide 14



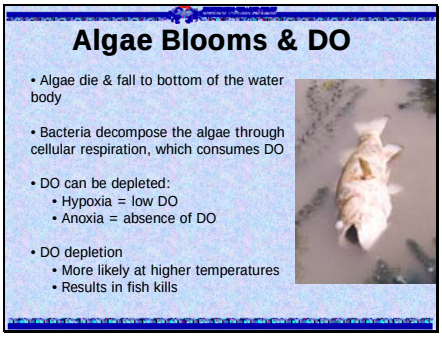
We can make a few generalizations about limiting nutrients. Phosphorus tends to be the limiting nutrient in freshwater systems, while nitrogen tends to be the limiting nutrient in saltwater systems. An excess of a limiting nutrient is going to cause a dramatic increase in photosynthesis. That will, in turn, result in an increase in the number of algae cells in the water. Anytime we have such a excessive growth in algae, it is called an algae bloom.

Slide 15



So, what is wrong with this picture? As you can see, this is one of our slow moving Louisiana bayous, but as you can see it is probably having an excessive amount of nutrients, or at least a limiting nutrient going into this system. So, I ask the question, what is wrong with this picture? Is this water body really supposed to be this green?

Slide 16

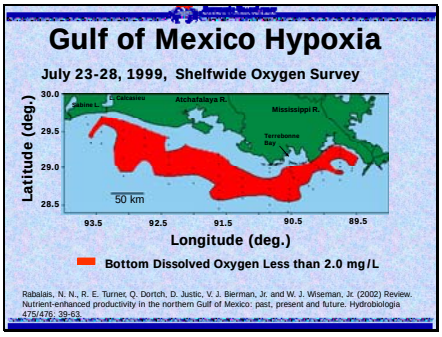


So, how do algae blooms cause problems for our water body? During an algae bloom, the algae grow and you eventually get an over abundance of algae cells. But, eventually they die and fall to the bottom of the water body. Naturally occurring bacteria then decompose the algae though cellular respiration. So, if you remember the slide of the guy that was canoeing down the bayou, he is very much like the bacteria, but in this case instead of the bacteria trying to get to a sandwich to provide energy for them, they are using the algae cells and decomposing those cells through cellular respiration. If you recall, during the process of cellular respiration, you consume oxygen. So, at the bottom of the water body, where the bacteria are, they are consuming dissolved oxygen.

There are different terms we use when we talk about dissolved oxygen depletion. Hypoxia means low dissolved oxygen. Scientists usually cut off this term hypoxia at a dissolved oxygen content of 2 mg/l (or 2 parts per million [ppm]). Anoxia means the absence of dissolved oxygen, or 0 mg/l.

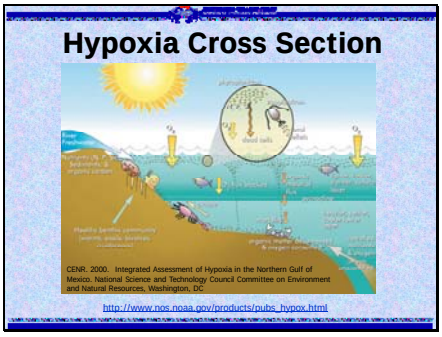
Dissolved oxygen depletion is more likely to occur at higher temperatures. This is because as you increase temperature, you tend to decrease the solubility (ability to dissolve) of a gas within water. This can be dissolved oxygen or carbon dioxide. When it comes to aquatic health, such as for fisheries or macro invertebrates, we are more concerned about dissolved oxygen. So, in general, when high temperatures and excessive cellular respiration occur, it can result in fish kills. Thus, we are more likely to see fish kills in the summer when temperatures are higher.

Slide 17



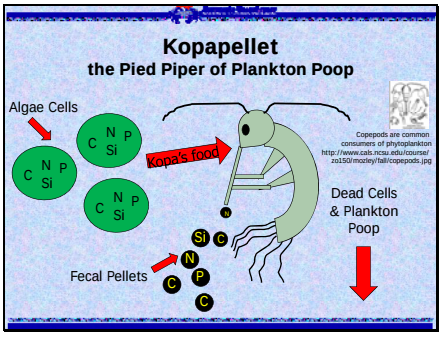
So, let's talk about an issue that affects a large amount of water, and takes into account some of the processes we have talked about so far. It is referred to as Gulf of Mexico Hypoxia. Each year off the coast of Louisiana, scientists at the University of Louisiana's Marine Consortium do oxygen surveys to map out the areas of hypoxia. You probably have heard about this particular environmental issue, which is sometimes referred to as the "Dead Zone". The reason that it is an issue or problem is that it affects a large number of marine organisms. When you have low bottom dissolved oxygen, it can kill a lot of organisms that cannot swim out of the hypoxic zone like crabs or benthic organisms such as brittle stars. These organisms, of course, are very important in the food webs of the Gulf of Mexico. This particular graphic shows a survey that was conducted back in 1999.

Slide 18



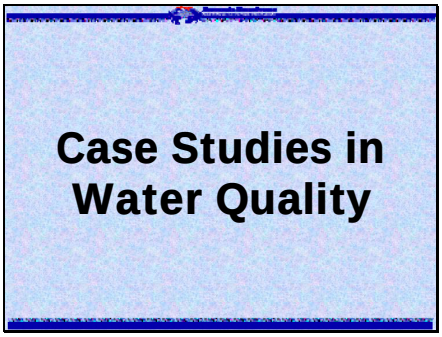
This is a graphic that shows how hypoxia occurs quite nicely. Each year, especially during the springtime, the Mississippi River delivers high levels of nutrients to the Gulf of Mexico. This fresh river water is lower in density than the heavier saltier Gulf water. This difference in density is called a picnocline. It is important because it restricts the amount of oxygen that can diffuse down to the bottom of the water column. So, as the summer months progress, these nutrients result in algae blooms off the coast of Louisiana. As we have talked about before, during an algae bloom, you are going through the process of photosynthesis, and generating a large amount of oxygen in the upper part of the water column, but eventually those algae die, and their cells along with fecal pellets from zooplankton fall to the bottom of the water column where naturally occurring bacteria use up oxygen in order to use the algae cells and zooplankton pellets as energy. This results in low oxygen levels which can cause mortality in some species like crabs, brittle stars and other benthic organisms. Fin fish are generally able to swim out of the hypoxic zone, but sometimes they are pushed up against barrier islands resulting in an event called a jubilee. So you might have fish flapping up onto the beach or crabs following them to get out of the hypoxic zone.

Slide 19



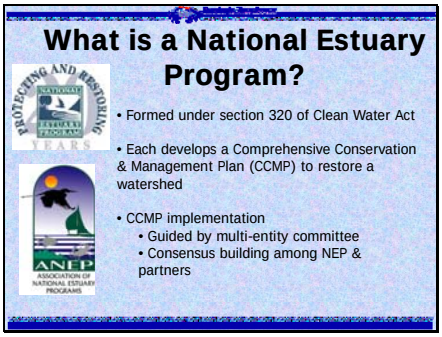
To have a little bit of fun with our discussion of algae blooms and bottom water hypoxia, I came up with this cartoon character named "kopapellet". He is the pied piper of plaktonic poop. He represents a kopapod, which is an organism that preys on algae during a bloom event. Kopapods consume algae cells and then concentrate nutrients within their fecal pellets. Thus, along with the dead algae cells, the planktonic poop falls to the bottom of the water body and then become consumed by bacteria.

Slide 20



Now we are going to talk about case studies in water quality. I am going to use several watershed programs around the Gulf of Mexico.

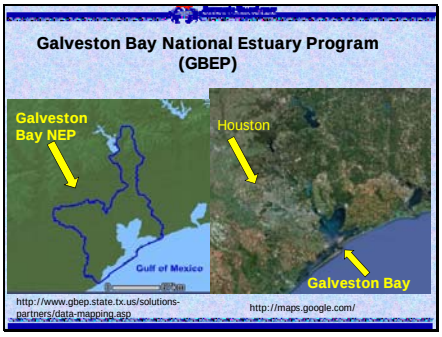
Slide 21



Four out of the five watershed programs I am going to talk about are National Estuary Programs (NEP). The National Estuary Program was formed under section 320 of the Clean Water Act. This was the 1987 reauthorized Clean Water Act which addressed national estuary programs. National estuary programs have a distinctive watershed that they work within and they have to develop a Comprehensive Conservation and Management Plan (CCMP) to restore that watershed.

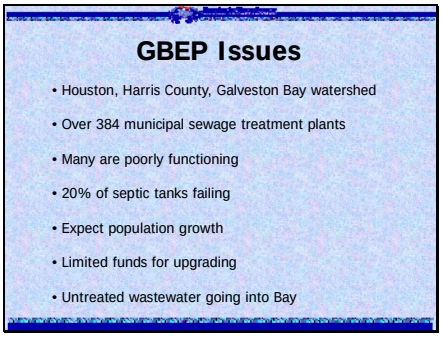
In general CCMP implementation is guided by a multi-entity committee, and in the case of the Barataria-Terrebonne National Estuary Program, it is called the management conference. The NEP builds consensus among these partners, and they build the program from the bottom up, thus a grass roots effort.

Slide 22



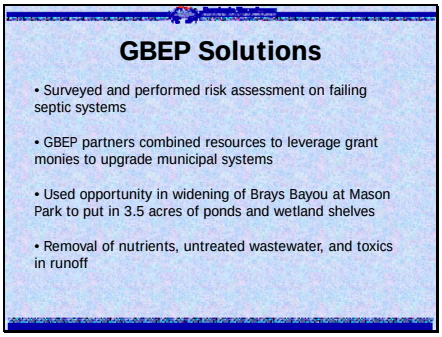
The first program I am going to talk about is the Galveston bay National Estuary Program. In this slide, you can see the image on the left-hand side is the delineated watershed of the Galveston bay National Estuary Program. This is also their program area. On the right-hand side is a satellite screen capture of the Houston area and Galveston Bay, and you can see that there has been a lot of development on the part of Houston that's adjacent to the Bay and watershed that leads into the Bay.

Slide 23



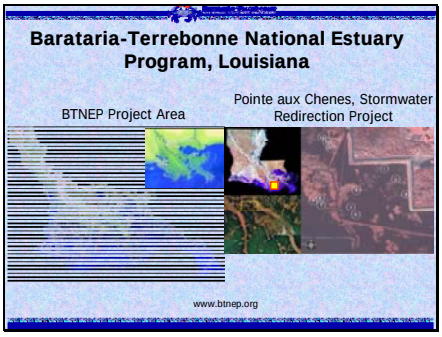
So, within the Galveston Bay watershed we are going to talk specifically about Harris County which incorporates part of Houston. The problems they are facing is that they had over 384 municipal sewage treatment plants, and many of these were failing, poorly functioning, or older systems, and they needed to be replaced. In addition to that, about 20% of the septic tanks or individual waste water treatment systems in that area were failing as well. Of course, Houston is a rapidly growing area, and there were limited funds for upgrading either the municipal sewage treatment plants or the individual waste water treatment systems, and the ultimate result was there was untreated wastewater going into the Bay.

Slide 24



Now, the way the Galveston Bay program dealt with these issues was first of all to survey and perform risk assessments on failing septic systems. Then, they met with their partners, and after discussing the issues, they decided to combine resources to leverage grant monies in order to upgrade the municipal sewage treatment systems (at least some of the systems). Brays Bayou was widened near Mason Park, so just on a small scale just as a demonstration project, they wanted to look at wetlands assimilation of nutrients and untreated wastewater. So, they used this opportunity to put in wetland shelves within the bayou itself, and then within Mason Park, they put in a series of ponds that storm water runs through. So, they used a natural system, essentially, to help treat some of these.

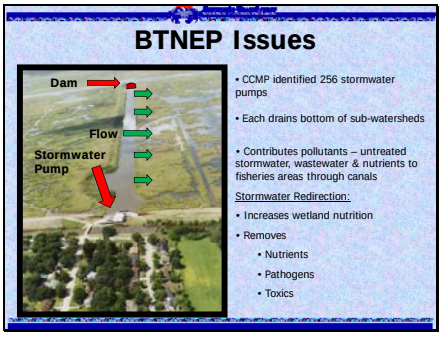
Slide 25



The next program I am going to talk about is the Barataria-Terrebonne National Estuary Program. I happen to work for the Barataria-Terrebonne National Estuary Program as I have mentioned before. On the left-hand side of the slide, is the Barataria-Terrebonne National Estuary Program area. If you look closely at the map you can see that New Orleans is on the easternmost side of the system, and Morgan City is on the westernmost side of the system. So, essentially, it is all of the land between the Mississippi and Atchafalaya Rivers, bounded on the north by old river construction systems and on the south by the Gulf of Mexico.

On the right-hand side of the slide, is an image showing the project area of a particular project, which is one of my projects, which is called Pointe aux Chenes Stormwater Redirection Project, and it is within the Pointe aux Chenes Wildlife Management Area in southeastern Terrebonne Parish.

Slide 26

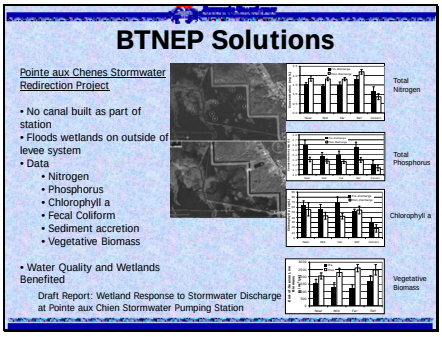


To give some background on this particular project concept, when the CCMP was being written they identified 256 stormwater pumps (this number existed about 15 years ago, but it has been increased since then). Each of these pumps drains a certain portion of the watershed (or if you want to think about it, as a sub-watershed). Each of these stromwater pumps contributes pollutants. They drain areas that have no municipal sewage treatment systems, in addition to pet waste and other things that are put out on the ground, and they end up in our estuary.

If you think about (just to step back) a storm water pump, the way it works is by... In the case of New Orleans, for example, which is completely under storm water pumps. A lot of people are familiar with New Orleans, and familiar with certain parts of New Orleans being below sea level. Well, New Orleans has built levees to protect their community over time, and essentially people think of it kind of like a bowl. Now, when it rains, if you had no way to get rid of the stormwater, then that bowl would fill up with water. So, back in the late 1800s, giant stormwater pumps were put in New Orleans to drain the inside of the levee system, and pump that stormwater over the levees onto the outside of the levee system. Essentially, the image in this slide shows that very thing. You can see where the stormwater pump is identified, and where the trees are in the lower part of the image, that's the community (Port Sulfur in Plaquemines Parish). So, the stormwater pump draws water from the inside of the levee system, where the community is, and pumps it over the levee onto the outside of the levee system.

Traditionally, stormwater pumps were constructed the same way as the one in this slide was constructed, where the water is pumped into a straight canal on the outside of the levee system. This could be a problem for fisheries, such as oysters, because it is delivering pathogens and toxics directly to oyster growing grounds. So the concept behind this particular project was to redirect the storm water into wetlands. This does a number of things: it removes nutrients, pathogens and toxics; but, it also has an added benefit, because when you are adding these nutrients to the wetlands, the wetlands can take up the nutrients and pollutants and actually increases the vitality of these coastal wetlands, and help protect the coastal community that is adjacent to it.

Slide 27



The way this project was conducted... there was an opportunity in Terrebonne Parish where we found out they were going to be building a stormwater pump there to serve the community of Pointe aux Chenes. Terrebonne Parish, working as a really great partner, agreed not to build a canal as part of this pumping station. So, we went in and collected data before the pumping station went online, and then we collected data after the pumping station came online, collecting a variety of different parameters there at the pumping station. In general, what we see is that we had an increase in the total amount of vegetation out there, and it has functioned, for the most part, exactly as we anticipated.

You can see from the aerial photographs in the center part of this slide that the image on the top represents before the pumping station was installed, and the image on the bottom represents after the pumping station was put in place, and after it had been pumping for some time. You can see that there is an increase in the density of vegetation adjacent to the pumping station.

On the right-hand side of this slide, you can see the results, the data that were collected (I used a selected number of data), like total nitrogen, total phosphorus, chlorophyll A and vegetative biomass. Total nitrogen actually seems to be higher after the pumping station was installed, and that's represented by the data in the white boxes. The black boxes represent data pre-discharge. That's probably because you are getting a nitrogen source in the form of stormwater. However, if you look at the data point all the way to the right that is called culvert, you can see that at the culvert, post-discharge, it is actually lower, and that is probably because you had an increase in the total amount of vegetation in this area. The trend with total prosperous is that it is lower post-pumping, and again that is probably because of the trapping of sediment and prosperous that is attached to the sediment due to increased vegetation. Chlorophyll A shows a similar trend, and then of course down at the bottom, vegetative biomass has a significant increase in the post discharge versus the pre-discharge.

Slide 28

The next program I am going to talk about is named Model Urban Natural Resources Conservation Plan (MUNRCP). This particular project is an example of a watershed program that is in the central part of Mississippi and is the only one that is not an example of a National Estuary Program. The area that I am going to be talking about is near the town of Madison, within Madison County, which is just north of Jackson.

Slide 29

Within this area they were experiencing rapid growth and urban sprawl from Jackson, Mississippi. In fact, if you look closely at the satellite image in the previous slide, you can see the urban sprawl that is moving up in the direction of Madison.

The Mississippi Soil and Water Conservation Commission combined with the Madison County Soil and Water Conservation District got some EPA funding to implement projects that can deal with some of the issues with increased population density. So, they developed a comprehensive plan that dealt with nonpoint source pollution, water management, some landscape issues (and when I am talking about landscape issues, I am talking about soil erodability, essentially, and the delivery of nutrients and sediments to streams) and then, of course, wildlife habitats. A lot of times with these projects, they deal with a lot of issues that relate to one another.

Slide 30

Now, the way the folks in Mississippi dealt with these issues were to do a variety of plantings (hillside plantings) with vegetative cover, mainly to cover up exposed soil in some of the erodible soils. They installed porous pavement parking lots at a local church, and they went in and planted native vegetation in a detention area. Riparian is any part of land that is adjacent to a water body, and so they planted this area, this riparian area, with native vegetation which helps to take up nutrients and stromwater. Then, ultimately, they did a mechanical treatment system at the Madison airport.

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The next program I am going to talk about is the Mobile Bay National Estuary Program (MBNEP), and in this slide, the image on the far left shows the watershed area of the Mobile Bay watershed, which is pretty extensive and drains three different states. The image in the center is the program area for the Mobile Bay National Estuary Program, and this is the area where they actually can spend their money and implement projects. Then, on the far right is a satellite screen capture of the Mobile Bay area. If you look closely you can see that Mobile Bay is under quite a bit of development pressure. The area we are going to focus on is on the east side of Mobile Bay, in Baldwin County.

Slide 32

So, the issues that Mobile Bay NEP was facing were specifically in Baldwin County. There were a lot of stormwater inputs to waterways, specifically sediments and nutrient inputs, and they were experiencing a lot of rapid growth. Many of you are familiar with Gulf Shores and Orange Beach as very popular vacation spots. There are a lot of people going to that area and a lot of people wanting to live there, and there is a high population density in those areas. So, they saw they needed to deal with continued stormwater inputs from those areas. So, they formed a Blue Water Commission and held workshops to see the amount of support they had out there in the community.

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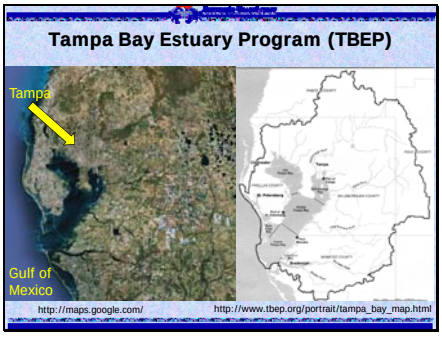
As result of their workshops, they decided to form a regional stormwater authority. Within the state of Alabama, there are some restrictions on the formation of any regional authority, so they had to get legislative approval, and they got legislative approval passed in 2007 (which is fairly recently). As part of the stormwater authority, they were able to levy taxes on homes and businesses, and this was calculated similar to the way that Florida does things, and it is based on the amount of impervious surfaces, which are like parking lots and rooftops, and that goes into stormwater management features.

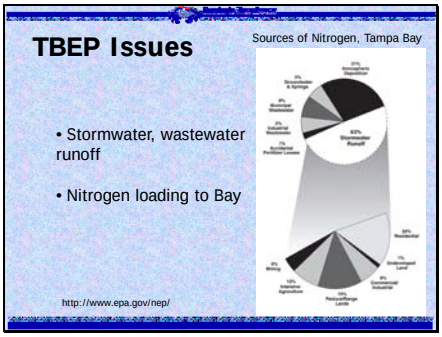
I googled Baldwin County online, and came up with some information from Wikipedia, and apparently, Wolf Bay and Tensaw River were both designated "Outstanding Alabama Waters" by the Alabama Environmental Management Commission. These are both within Baldwin County, so it does seem they are doing something good.

Slide 34



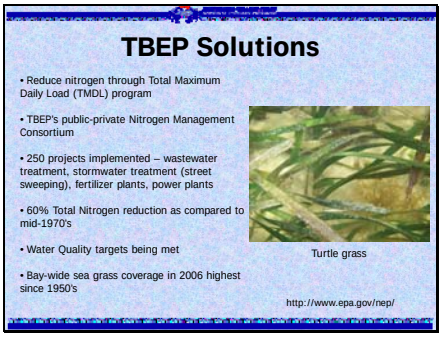
The last case study I am going to talk about with y'all is the Tampa Bay Estuary Program. On the right-hand side of this slide, you can see the watershed area for the Tampa Bay Estuary Program, and I have also pointed out on the left-hand side in the satellite image where Tampa is located with regard to the Bay itself.

Slide 35



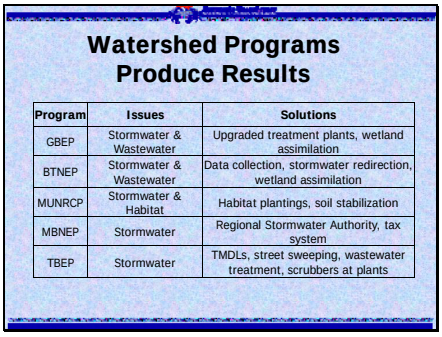
The main issues they were dealing with were stormwater and wastewater runoff. The core problem that they were dealing with was nitrogen loading into the Bay. This was because they had seen a large extend of their grass beds die off within the Bay.

Slide 36



The way Tampa Bay went about dealing with their issues was to work through their TMDL (Total Maximum Daily Load) program. This is a program that is conducted through the Clean Water Act, and it is a requirement upon the states by the EPA that they do these estimates of total amount of pollutants loading into a given body of water. If you exceed that level of pollutants loading into the water body, then it can cause some environmental harm to that waterway. Their first step was to form a public-private Nitrogen Management Consortium that could brainstorm and come up with projects that could deal with nitrogen loading into the Bay. These projects dealt with wastewater treatment, stormwater treatment and point sources like fertilizer plants and power plants. You may not realize it, but Florida does have a huge fertilizer industry. They were very successful in their ability to reduce total nitrogen loading by 60% as compared to the mid-1970s, and their water quality targets were being met as a result of these projects. But, the ultimate example of their success was that they saw huge resurgence in the sea grass in the Bay, the highest since the 1950s.

Slide 37



Just to summarize all the watershed programs we talked about, the one common thread that I seemed to see was in stormwater. The biggest issue in each of these programs seemed to be stormwater, but they all kind of dealt with it in a different way. Mobile Bay and Tampa Bay really took a legislative approach, Tampa Bay in the form of TMDLs and then Mobile Bay in the formation of this regional Stormwater Authority, in addition to doing some non-regulatory projects. The other three programs seemed to approach from a non-regulatory standpoint, and really focused in on what some would call wetland assimilation or habitat plantings.

To me, when we talk about National Estuary Programs, this is one of the strengths of the National Estuary Programs. The fact that they used consensus as an approach to solving problems at the governmental level is really a strength. They gather people together and try to come up with the best way to solve these problems. The only drawback to this approach is that it tends to take some time in order to implement some of these projects, but the project that you end up with usually is a very strong project.

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Well, that concludes my presentation today. You can email me directly at Andrew@btnep.org or you can visit out website at http://www.btnep.org. I hope you were able to learn something about water quality today. Please feel free to contact me, and that's all. Thank you.