Source: Greater New Orleans Expressway Commission

A NATURALIST CROSSES LAKE PONTCHARTRAIN

By **Robert A. (Bob) Thomas**, Center for Environmental Communication, School of Mass Communication, and The Environment Program, Loyola University New Orleans (Certified Master Naturalist, Louisiana Master Naturalists of Greater New Orleans Chapter) – rathomas@loyno.edu, 504-865-2107

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OPENING COMMENTS

This adventure began from natural history observations as I drove across the Causeway between Metairie and Mandeville, Louisiana. I was amazed at what a naturalist can see while safely driving at 60 mph, and equally amazed by the number of seemingly simple natural history elements for which I had no explanation. I began making notes and, as a naturalist tends to do, expand my knowledge one step at a time. A host of local naturalists were my main resource, and many of them are mentioned herein.

For the most part, the following commentary is based on the near surroundings of the Causeway, but additional Lake Pontchartrain stories are added where relevant.

Sorry if your interest is piqued and your drive becomes less relaxing and more observant. In the end, it will be good for you and our beloved lake.

All photos by me, unless otherwise credited.

THE LAKE'S STEWARD

The steward of the lake is the Pontchartrain Conservancy (formerly the Lake Pontchartrain Basin Foundation). Founded in 1989, the Pontchartrain Conservancy was formed by the Louisiana legislature with the expressed purpose of protecting the quality of the overall watershed.

In the end, the true stewards of the Lake Pontchartrain Basin watershed are the people who live and work in the region. The fate of the lake rests in their (our) hands, and a bright future for the watershed will result if we accept and act upon Aldo Leopold's sage advice:

We abuse land because we see it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.

We tend to think about "places" we go, or "where to find a certain species." We need to recalibrate how we view such "places" as components of the ecosystem to which they belong. We talk, as we will generally do below, about our *Lake Pontchartrain*, but in fact all things natural history are responding more to the entire watershed (ecosystem) instead of just the lake. Remove the watershed, and the lake fails; remove the lake and the estuary to the south will fail. Everything is connected.

Map showing the Lake Pontchartrain Basin watershed.
Source: Lake Pontchartrain Basin Foundation.

Interesting view of most of the watershed of the Lake Pontchartrain Basin, plus the Barataria-Terrebonne Basin on the west side of the Mississippi River. Source unknown.

Although we call it the "lake," Lake Pontchartrain is actually an ***estuarine embayment*** (that understood, we will call it the “lake” throughout this discussion). It formed 4000 years ago, with the driving forces being 1) down-warping of the surface near the Pleistocene terrace where Mandeville resides today, 2) faulting along the terrace margins, and 3) gradual filling in of the shallow seaward zone to the south as the subdelta formed. The result: an estuary virtually surrounded by land, some from the Pleistocene and some recently laid down by sediment deposit from the Mississippi River, and with openings to the east and rivers flowing in from the north and west.

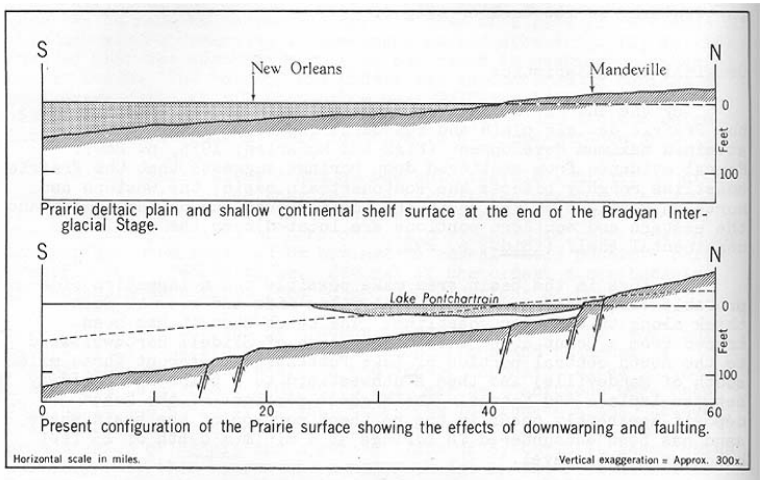


Fig. 13. Generalized cross sections through the Pontchartrain Basin showing the results of downwarping and faulting of the Prairie surface.

As an estuary, by definition, there is an opening to the salty sea (in this case, the Chef Menteur and Rigolets passes to the east), and freshwater runoff from surrounding lands and inflow from rivers such as the Amite, Blind, Tangipahoa, Tickfaw, Tchefuncte, and the following bayous and their drainages - LaBranche, Lacombe, and Bonfuca/Liberty.

Source: NASA.

FACTOIDS REGARDING LAKE PONTCHARTRAIN: DEPTH, SALINITIES, AND WIND

Size: 40 miles long and 24 miles wide.

Average depths are 12-14 ft. The deepest areas are over 80 ft and are located near southshore where they were artificially dredged.

Salinities: Freshest to the west, with salinities to the east ranging from 4-10 ppt. There have been years when there were many high saline loving critters in the lake such as sea nettles (*Chrysaora quinquecirrha*), phosphorus jelly (*Mnemiopsis mccradyi*), and

possibly sea sparkle (*Noctiluca scintillans)*. When the Bonnet Carré Spillway is opened, flooding the lake with an additional 250,000 cubic feet per second of river water, salinities can become very fresh. During those times, aided by freshwater and many nutrients, the estuary can become overridden by algae for a few months, and have large floating mats of water hyacinths (*Eichhornia crassipes*) and duckweed (*Lemna* sp.). A careful eye may also see floating carcasses of Nutria and Beaver that drowned in the Bonnet Carré.

Southeast winds: Persistent southeast winds push salt water into the Chef Menteur and Rigolets openings from the open Gulf, making the "lake" deeper and more saline (as high as 20 ppt or so).

Northwest winds: While southeast winds increase lake salinity, northwest winds have a different effect, especially around New Orleans. Due to the relatively shallow depths of the lake and the far reach over which the winds blow, these winds produce heavy "rollers," wind-blown long waves that push to the southeast. These churn the lake, making it less clear, and are rough on sailboats and other small craft.

Shadowing: When winds blow from the north, the trees and buildings of the northshore block or minimizes the winds from the water, so a “shadow-effect” occurs and northshore water is smooth. The farther one goes from northshore, there is a gradual increase is surface turbulence on windy days.

On the same day, a naturalist will note driving from south to north that the water is much rougher to the south and gradually becomes smooth to the north.

The opposite occurs when the wind comes from the south.

LAKEFRONT NEW ORLEANS: ITS FORMATION

Throughout most of the 19th Century, the lake was distant in time of travel from the central City. As the 1800s progressed, entertainment facilities flourished at West End. There were outdoor performance stages, restaurants, small beaches, casinos, marinas, and much more. Mass public transportation arriving there began first as a steam engine train that followed the course of the New Basin Canal (now the neutral ground between West End Boulevard and Pontchartrain Boulevard), later replaced by a streetcar. Many people built camps beside or over the water, and its popularity continued for many years.

In the early 20th Century, the northshore of the City of New Orleans still ended as a somewhat murky wetland-dominated shoreline. During the heyday of the Works Progress Administration (WPA) period, New Orleans sought to expand and make hospitable new land along the south edge of Lake Pontchartrain. At that time Robert E. Lee Boulevard was the developed limits of the city. In the 1920s, a wall (weir) was constructed in the lake and sand was pumped behind it to create land. By the 1930s, the land was dry enough for construction, so the famous stepped seawall was built on the water’s edge followed by construction of Lakeshore Drive.

As World War II approached, much of the new land was leased to the U.S. military for bases that served the war effort. A huge hospital complex was built where UNO now stands. These were entirely gone by the 1960s, but UNO still had a number of Quonset huts and other military buildings. When I taught at UNO in the early 1980s, my classes were held in the "Biology Annex," a wooden building that was full of termites and the story was that they only reason it didn't collapse was that the termites were holding hands!

After the war, housing development began and today some of the most popular neighborhoods such as Lake Vista and Lakeshore are a major part of the fabric of New Orleans.

The zone between the levee and the seawall is the iconic linear park so popular among local citizens. It is a lovely place to visually enjoy Lake Pontchartrain, including an array of animals that inhabit its waters and a nice place to just relax and watch boats sail and motor by. Not too long ago, the seawall was often crowded with people and their crab traps catching a nice seafood meal. It is common to see folks fishing there today, and bird watching is great along the seawall.

THE CAUSEWAY BRIDGE

The Causeway, operated by the Greater New Orleans Expressway Commission, has been listed since 1969 by the Guinness Book of World Records as the World's longest bridge entirely over water – 23.83 miles. Some think its first place position has been taken by the Jiaozhou Bay Bridge opened in China in 2011, but the length of that bridge does not span entirely over water.

The original span is that on the west, opened in 1956. The second, on the east, opened in May 1969.

AN INTERESTING GEOLOGICAL PHENOMENON IMPACTS THE CAUSEWAY: THE CAUSEWAY FAULT

We don't normally think of coastal Louisiana as a seismically active area, but we do have a number of fault lines that can occasionally result in an obvious tremor. For the most part, the faults are in marshes or open water, but the Causeway Fault crosses beneath the Causeway Bridge. It is located on the south-bound lanes 3.1 miles (5.0 km) from the north shore toll booths on the right side rails (see image below). The visible "jog" (off set) is only 3 inches. Look closely at the rail, but keep your main focus on your driving!

Faults in Lake Pontchartrain. Note the Causeway Fault near the north end of the Causeway Bridge. Source: Environmental Atlas of Lake Pontchartrain.

A "fault offset" is visible on the south bound lanes 3.1 miles from the toll booths. The image above was taken when there were only 2 lanes on the Causeway. Source: Environmental Atlas of Lake Pontchartrain.

WATER QUALITY

Back in the years prior to the 1950s, the lake was used as we use the Florida shores today. It was lined with camps and homes, and there were many businesses there, especially around the New Basin Canal. In fact, there was a train that people took from downtown to the lake to enjoy the entertainment, restaurants, and the water.

As the metro area enlarged, the water became contaminated with runoff and sewage. The first no swimming sign appeared in the lake in 1962.

In the 1970s and 1980s, the near-shore lake waters were laden with pathogens, and swimmers reported boils and other infections.

Source: Lake Pontchartrain Basin Foundation.

Mostly due to the public work of the Lake Pontchartrain Basin Foundation, people around the lake began to believe the lake water quality could and should improve. It steadily became safer, until in 2004 it was declared safe for swimming along the shore. Because of its vast size and volume, the water away from shore was always somewhat safe and boaters commonly swam offshore, but entering the water along the edge was considered unhealthy.

Today, there are times when discretion should be observed:

- After severe storms (Katrina was an excellent example) – at these times, lots of chemicals and other contaminants wash into the lake from urban areas.
- After heavy rains that follow periods of drought. Don't forget how the urban southshore is drained. The culverts along streets capture rainwater that eventually reaches the pumps and is pushed into the lake. During droughts, the sewers (not sewerage, which is a separate system that culminates at the sewage treatment plants) have loads of critters (nutria, possums, raccoons, rats, and more) living (and pooing and dying) in them; people are using herbicides and insecticides on their yards; people are illegally (and ignorantly) pouring oil, dangerous chemicals, yard cuttings and more down street drains; hydrocarbons are building up on all roadways; and much more. Along comes a hard rain and all this washes immediately into drains, flows through the sewers and canals, and is pumped into the lake. DO NOT SWIM OR WADE AT THESE TIMES!
- Periodic spillway openings may introduce nasty water into the lake that should raise caution.

NURSERY MARSHES

Before modern settlement, most of the lake was surrounded by bands of marshes and swamps that served as filters that cleansed runoff into the lake and served as nursery grounds to locally abundant fish stocks. These wetland nurseries are now greatly diminished and simply must be protected at whatever cost.

Swamps to the west of Lake Maurepas.

LaBranche Wetlands in St. Charles Parish. The lake and I-10 are to the top. From the right of the photo, Bayou LaBranche curves toward the lake at its intersections with Bayou Trepaignier coming from the bottom of the photo. The LaBanche Wetlands are crossed on I-10 between MileMarkers 214.4 and 219.4.

GoogleEarth image from near Manchac. Note the spokes radiating off of human-made canals. These are "cypress drags," where a pull/wench boat sat in the middle and used chains to pull cypress logs to the canals where they could be floated out of the swamp during logging. Image captured November 29, 2016.

This GoogleEarth image shows linear, parallel cypress tree drags. This area encompasses the Turtle Cove Environmental Research Center. Image captured November 29, 2016.

A PROBLEM RELATED TO THE LOSS OF MARSHES AT THE EDGE OF THE LAKE:

As you drive from Kenner to LaPlace (toward Baton Rouge) on I-10, make note of the unhealthy appearing **bald cypress (*Taxodium distichum*)** around MileMarker 214.1-2 on the east side of the highway (and to the left for that matter). It has long been thought that the demise of these beautiful trees was due to increased salinity in the lake. In fact, this is true, but the cause is indirect. In the past, that margin of the lake had dense, healthy marshes with the cypress growing on the western side. They were buffered from the estuarine salinities and grew very well. After the construction of the I-10, the marshes virtually disappeared, allowing water too salty for the cypress to surround their roots. Although the lake is freshening slightly since the Mississippi River Gulf Outlet was closed, there is probably too much salt to allow full recovery of the once dominant cypress forest.

THE LAKE PONTCHARTRAIN DIVIDE: THE AFFECT OF THE LAKE ON DISTRIBUTIONS OF FLORA AND FAUNA

A body of water of this size can have huge impacts on the ecology of the region. Later we will discuss the "hot water bottle" effect of the lake on temperature differences north and south of the lake at certain times of the year.

A very interesting effect of the lake's size is termed the ***Lake Pontchartrain Divide***. The sheer size of the lake and its ecological characteristics has a limiting effect on the distribution of many species of organisms. Dr. Peter Yaukey, University of Holy Cross, shares that many species of birds are not found (using resources) south of the lake, but find the northshore an important part of their life needs. They may pass through southshore during migration, but their nesting and feeding does not occur there, despite the presence of similar habitats.

This is certainly true of many groups of animals and plants. For many, there are simple ecological or biogeographic explanations, but for others we simply do not know why this divide exists. I have no doubt that future research will reveal more evidence and give us a better understanding of the Lake Pontchartrain Divide.

TYPICAL ANIMALS ENCOUNTERED IN AND ON THE LAKE:

Common rangia clam, *Rangia cuneata* –

Live rangia clams from Lake Hermitage, Plaquemines Parish. December 9, 2016.

These clams prefer to live in low salinity water and can be very abundant. Most of our brackish waters are naturally laden with dense layers of dead, white rangia shells. For decades, they were extremely important in construction in Greater New Orleans due to several reasons: 1) their abundance, 2) their relative cheapness, 3) the need to create a hard, firm surface on organic or clayey soils as a building platform, and 4) their valves separate when they die and exist as half shells that interlock as they cup together giving them more tensile strength.

It's most important contribution to the ecosystem is that it is a filter feeder, and in doing so it removed particles of all sorts from the water column and clarifies the lake.

This species was an important food item to Native Americans before the European invasion. They ate so many and dropped the shells as they ate, and overtime large piles of rangia clams marked former human habitations. They are called *middens*.

Rangia clams are also a major food source for black and red drum and blue crabs.

Blue crabs, *Callinectes sapidus* – Blue crabs are abundant in the lake and have played an important role in local cuisine since the early settlers arrived – and to the natives long before that. As females soften in preparation for their final molt, they mate (and it is the only time they mate; they store sperm and that allows them to continue producing fertilized eggs). Their new shells harden and in summer and fall, the females migrate out of the lake to higher salinity waters in the Gulf of Mexico, each carrying an orange "sponge" containing as many as 2 million eggs. Studies have found that a female can produce about seven sponges in a year, and there are reports of a female producing 18 sponges over 2-3 years. Tulane's Dr. Susan Chiasson explains that due to predation, most females only produce two or three sponges before they venture to crab heaven.

Blue crabs destined as a culinary delight!

The eggs hatch just inside and outside the barrier islands, and their developing young float on the currents as zooplankton, being very important to the base of the ecosystem. The earliest stage is called a zoea, and it is a filter feeding plankton shedding 7 or 8 times over 1-2 months. Final size is about 1 mm wide.

The next named stage is megalopae, resembling a tiny lobster. They begin at about 1 mm in width, take 6-20 days to develop, spend most of their time near the bottom, and make their way toward the lake as they develop. They do not molt as stages of megalopae, but when they do molt, they become "first crabs," because they finally look like crabs!

As plankton, they are barely mobile, and move at the whims of the currents and winds. The megalopae transform to first crabs in and around Lake Borgne (some may even do this in the lower Lake Pontchartrain).

The first crabs are about 2.5 mm wide (spine to spine), and continue their migration into the estuaries.

During the winter months (water temperatures down in the 50s°F), blue crabs tend to be less active, burrowing into the mud on the bottom. They are most active and do best in water in the 70s° and low 80s°. The best time for crabbing is roughly late April to late May (meatiest and largest crabs, but it varies; some argue they are better in the fall), but this may shift with a late cool season.

Shrimp – Lake Pontchartrain has both **white** (***Litopenaeus setiferus***) and **brown** (***Farfantepenaeus aztecus***) **shrimp**.

White shrimp, often called lake or fall shrimp, tend to gather at the western end of the lake because they prefer less saline water than brown shrimp. They are common inhabitants of our estuaries, hence they were the first commercially important shrimp in the U.S. They are typically larger than browns, and may be identified by lacking grooves along the midline of the carapace (head) and short antennae (about as long as the carapace). They overwinter in the lake, and by spring are large (15 count – that is, 15 shrimp weigh one pound).

Brown shrimp begin entering the lake in March as tiny (1 cm long) post-larval shrimp that are at the mercy of moving water driven by currents or winds. They may be identified by having obvious grooves down the midline of the carapace, extending almost to the rear margin, and having antennae that are about as long as the full length of the shrimp.

Chris Schieble of the Louisiana Department of Wildlife & Fisheries shares that the exact date for opening of shrimp season depends on the phase of the moon, water temperature, and salinity – if not more. It usually opens – for both species – the first or second week of May. There will be a good mixture of whites and browns, and whites will be large (15 count) and browns will be smaller at 80 count. If the population is strong, it will open "across the board" (throughout the lake); if not, then it will open by zones that can withstand a harvest.

A second season will open in July or August and run until December. It closes when white shrimp sizes drop to 100 count and postlarval white shrimp begin to arrive.

Monarch butterflies, *Danaus plexippus* - Late September and October are exciting months for monarch butterfly lovers. 'Tis the season when monarchs are moving everywhere. They are in migration heading toward Reserva de las Biosphera Mariposa Monarca in Michoacán, Mexico, and those who drive across the Causeway may see many because they tend to follow its path. That said, sailors will tell you they commonly see them crossing the lake.

A fall monarch butterfly.

Monarch populations have plummeted in recent years. There were an estimated one billion monarchs in 1996. Cumulative average populations over the following 20 years were decreasing. In 2012-2014, the populations were at all-time lows (2014 population was 34 million). In the next two years there was a 600% increase over that low. The 2016-2017 population was in the neighborhood of 145 million.

There is no doubt about population decline, and we know generally why:

- Fragmentation of habitat
- Herbicide and insecticide use throughout the country
- Bark beetles and logging in their migratory refuges
- Poor practices in roadside management
- Spread of the protozoan parasite ***Ophryocystis elektrosirrha*** (OE). There is research that says when the butterflies stay in our area, i.e., they fail to migrate to Mexico, they get higher infestations of OE from the locally commonly used **tropical butterfly weed, *Asclepias curassavica*** and live shorter and less healthy life spans.

Not all monarchs continue their passage through our area – many spend our mild winters with us and take advantage of winter blooming flowers as a source of food. When it gets too cool for flight, they remain seated on objects until they warm again.

Sage advice from The Bug Lady, Linda Auld of Barber Laboratories in Harahan: If there are milkweed plants in the area, these residual monarchs will lay eggs and caterpillars will develop and metamorphose. In order to prevent OE infestation, during dry periods simply spray water on the milkweed in order to remove OE spores, splotchy poo from milkweed beetles, and tachinid fly eggs (the latter are consumed by the caterpillar, and those that survive eat the caterpillar from the inside – there may be a TV horror show on this theme soon!

Common fish of the lake –

Adult Gulf menhaden, or pogy (*Brevoortia patonus*). Source unknown.

Gulf menhaden, or pogy, schools rippling the surface of Lake Pontchartrain. Photo taken near the center of the lake on June 9, 2015.

During the summer you may see many large slowly moving rippled areas on the surface of the lake. These are indicative of the presence of large schools of juvenile (about 2 inches long) **Gulf menhaden, or pogy (*Brevoortia patronus*).** Pogie is one of the most important fisheries offshore in Louisiana, and they must spend their early stages in estuaries like Lake Pontchartrain. No estuaries, no pogy. So why are pogy so valuable? Not in and of themselves. They are rather small (up to 8 inches total length), very oily, and swim in schools of millions – annual harvest averages over 1 billion lbs. They are fished from spring through fall offshore, rendered down to yield fish oil and fishmeal. FDA doesn't allow us to consume the oil, so we do the "American thing" and sell it overseas – notably in France. The French then do the "French thing," using it to glaze those wonderful French pastries and to make cosmetics, which they then sell back to Americans with value added prices! We then use the fishmeal to give a protein boost to our chicken and pond-reared catfish industries. Without this high protein food source, we could not possibly produce enough high-quality chicken and catfish to feed our nation and provide exports to bolster our economy!

Next time you eat fried chicken, be sure to tell your dinner mate, "This is the best processed pogy I've ever eaten!"

Striped mullet, *Mugil cephalus*, are also abundant in the lake. As do pogy, they spawn offshore in salty water. There is a reason so many estuarine dependent organisms migrate to the salty barrier island zone to lay eggs (others that do this include black drum, croaker, speckled and white trout, sheepshead, and flounder) – it makes their eggs more buoyant. Additionally, most produce oils that are absorbed around the yolk (the process

is called "hydration"), which adds even more buoyancy. One of the values of the mullet fishery has been "poor man's caviar," their roe. It is graded from low if yellow (least amount of oils) to high if red (highest amount of oil).

Striped mullet (*Mugil cephalus*) gulping air in the lake. New Orleans Yacht Harbor, July 2015.

Fall, often associated with fronts moving through, is the time when large schools of 10-12 inch long mullet begin to move to the Gulf to continue their life cycle. The surface of Lake Pontchartrain is often covered by ripples caused by the migrating mullet.

You won't see this startlingly different fish as you cross the lake, but there are **Gulf sturgeon, *Acipenser oxyrinchus desotoi***, roaming about. They are presumably breeding in the Pearl River and Bogue Chitto Creek, and specimens up to about 80 lbs in size prowl the lake for food during parts of the year. This is an endangered species.

Photo by Louisiana Wildlife & Fisheries.

Other fish: Many species of fish occur in the lake. Among them are these of interest:

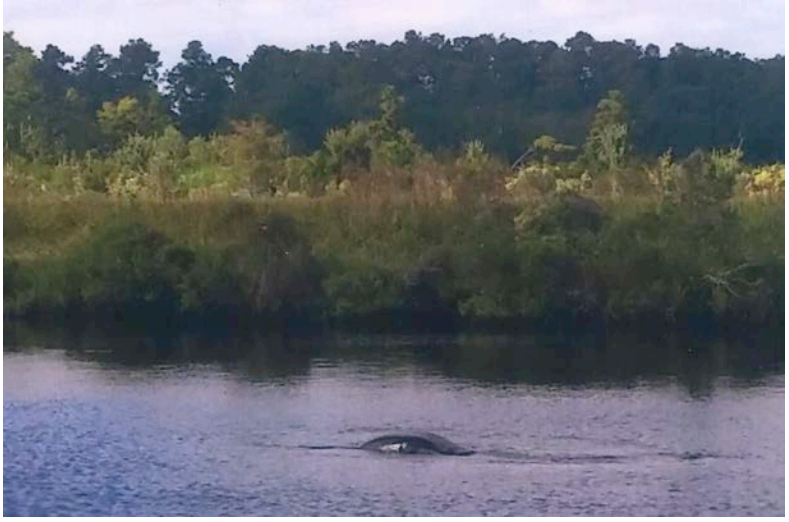
- **Atlantic tarpon, *Megalops atlanticus*** - these large sport fish enter the lake when it is salty due to southeast winds push Gulf of Mexico water to the northwest. I

once saw one jump entirely out of the water as I drove across the Causeway. Glorious!

- **Black drum** (the small ones popular in restaurants are called "puppy drum"), ***Pogonias cromis***, and redfish red drum), *Sciaenops ocellatus* – large schools frequent the lake and are a component of the fisheries. Sailors often encounter them.
- **Jack cravalle, *Caranx hippos*** – small schools of this highly predatory, large fish may be observed. My son Patrick and his friends used to catch them from the Bonnabel Boat Launch.
- **Southern sheeps head, *Archosargus probatocephalus***, and **speckled trout** (spotted seatrout), ***Cynoscion nebulosus*** – these are fished around structures, especially roadways and peers, around the lake.
- **Southern stingray, *Dasyatis americana*** – This is a very common species in the lake, so caution must be exercised when wading in shallow water.
- **Bull shark, *Carcharhinus leucas*** – This is the principal shark of our coastal estuaries, and they are known to enter freshwater rivers and bayous. They are somewhat common in the Atchafalaya and Mississippi Rivers – the northernmost specimen was found near Cairo, Illinois. The females give live birth in the Gulf of Mexico outside the Chandelier Islands, and the pups make a bee-line into Lake Pontchartrain and other coastal estuaries. They do so to escape large predators in the Gulf, and because they will be the top predator in a very productive environment, allowing them plenty of food for growth.

Bottlenosed dolphin, *Tursiops truncatus* – although plentiful along the coast of the Gulf of Mexico, dolphins are not common in the lake. As the lake becomes more saline in the summers, they tend to be more frequently encountered.

West Indian manatee, *Trichechus manatus* – Louisiana is within the range of distribution for manatees, but at its northern and western limits in the Gulf of Mexico. They show up during summer months in variable numbers from year to year, and typically leave in fall for warmer waters in Florida. They may be encountered almost anywhere in the lake and along its margins.



Manatee swimming in Bayou Liberty October 4, 2015. Photo by Jerry Hayes.

Kemp's Ridley sea turtle, *Lepidochelys kempii* - Although rare, this protected species is known to forage along the Louisiana coast and one is occasionally reported from the lake, especially during southeast winds.

Juvenile Kemp's Ridley Seaturtle (*Lepidochelys kempi*) from Lake Pontchartrain. Photo May 1984.

Brown pelican, *Pelecanus occidentalis* – The species is native to Louisiana, and had stable populations as late as the 1950s, with 5000 adults and nestlings on East Timbalier Island alone in 1955. Each of the next two years, the Louisiana coast was ravaged by strong hurricanes and in 1961 no nesting pairs were found in the state. Some specialists believed the hurricanes had killed most birds and destroyed nesting sites. In 1963, not one brown pelican was found in the state and all red flags were raised. It soon became apparent that the loss was primarily due to DDT and other chlorinated hydrocarbons becoming concentrated especially around the mouths of major rivers like the Mississippi. Pelicans are near the top of the food web and are fish eaters so they got a strong dose of

the chemicals as a result of bioaccumulation in the food chain. The mentioned chemicals interrupted their calcium cycle, causing their egg shells to be thin and thus breaking during incubation. This was the perfect formula for the precipitous decline. It took the U.S. until 1972 to ban DDT use in the country.

Brown pelicans on nests, Queen Bess Island near Grand Isle, La. April 2004.

Brown pelicans were reintroduced to Louisiana from Florida populations beginning in 1968. Birds were placed on Queen Bess Island, Isle aux Pitre, and North Island. The first step was to establish the birds as local residents, so the first couple of years birds where clipped in order to prevent them from leaving the islands. Reestablishment occurred quickly. Between 1968 and 1980, 110 birds per year were restocked in former breeding areas in Louisiana. The following numbers showed the impact:

- 1971-1992 - 12,384 nests produced 18,547 fledglings
- 1993-2001 - 103,727 nests produced 175,116 fledglings

Louisiana brown pelicans were BACK!

On February 10, 1988, my ornithology class at UNO was the first group to observe a brown pelican sitting on a pylon at the New Orleans lakefront. Brown pelicans are presently, thankfully, abundant throughout the lake.

Contrast that first siting with a recent (October 26, 2020) Causeway drive across the lake and return to Metairie during which I saw crossing north (10 am) 39 pelicans (2 on the water, 7 on the wing, and the rest sitting on roofs of the small booster station houses or other structures), followed by 45 (5 on the wing and the rest sitting on booster station roofs) as I drove south at noon.

Peregrine falcon, *Falco peregrinus* – There are a number of birds that culinarily specialize on other adult birds, but around the structure of the Causeway dwells the sleek bird predator - the peregrine falcon. With luck, you may see one on-the-wing at eye level as you drive on the Causeway, but it's also a joy to see one perched along the way, eyeing its domain and selecting its next prey.

Known as the "fastest animal on earth," peregrine falcons can stoop (dive) at speeds in excess of 200 mph! They use this speed as bird feeding specialists, catching their prey on the wing. Thus, not only speed, but also maneuverability, are extremely important to them.

Peregrine falcons faced potential extirpation in the United States back in the 1960s from the same threat described above for brown pelicans – DDT and other chlorinated hydrocarbons biomagnifying in our region. As a top predator, peregrine falcons got a huge dose of these chemicals just as did brown pelicans, American bald eagles, and other species in this category.
Following public outcry and the resulting laws that regulated the widespread use of DDT and related chemicals, accompanied by an extensive program of captive breeding, hacking (a process of raising and releasing young birds), and restocking lost populations of peregrines, the species is recovering and the peregrine falcons once again give us a thrill with their annual visits to points all along the Gulf coast.

Common loon, *Gavia immer* – These wonderful birds are native to Louisiana in winter and are commonly seen on the lake in their somewhat dull winter plumage.

American coot (locally called "pouldeau"), *Fulica americana* – Huge rafts of these birds may be seen on the lake. They are the only totally black smaller bird with a "white" (actually gray) beak. When they take off, they run on the surface of the water until airborne.

Scaup (locally called "dos gris") – These ducks often form large flotillas of ducks, with obvious white sides, on the lake. There are two species that may be observed, but close examination with binoculars is usually required to discern the species:

- the more common **lesser scaup, *Aythya affinis*** - smaller size and peaked rear of head
- the less common **greater scaup, *Aythya marila*** - larger size and rounded head

Gulls – There are several common gulls that frequent the lake, and a few others that are rare and fun sightings.

- **Laughing gull, *Leucophaeus atricilla*** – these are our common black-headed gull that is the most abundant gull during the summer months, but some are present year-round.
- **Ring-billed gull, *Larus delawarensis*** – These are larger than the laughing gull, never have black heads, and have a distinct dark ring around the anterior end of the beak. They are the most common gull in the lake during winter
- **Herring gull, *Larus argentatus*** – These are the largest of the common gulls in the lake. They confuse new birders due to their numerous gradations of patterns shown during molts to the adult form.
- **Bonaparte's gull, *Chroicocephalus philadelphia*** – These may be easily seen in winter and tend to fly in flocks. They demonstrate "buoyant" flight, meaning that they have a rapid wing beat and seem to move up and down as they fly, often in groups, rather slowly along the shore. Their winter plumage is very pale with a dark spot behind the eye; adults have a black hood similar to our laughing gull, but this pattern appears when breeding in northern Canada and Alaska.

  Gulls and friends in parking lots: Ever notice that on foggy or rainy days, the parking lots, like those at Lakeside Shopping Center, may host lots of gulls (primarily ring-billed and laughing), with occasional terns? Believe it or not, no one knows for sure why they do this. I checked with a couple of local bird experts (Peter Yaukey and Dave Muth), and we all speculate that it may be due to several issues: 1) Not all gulls only live near the sea, so they find parking lots similar to their normal open habitats such as beaches; 2) flying in wet or damp air is inefficient so they just sit it out; 3) such weather often has still air, so flying takes more energy; 4) since parking lots are spacious, they allow the gulls an open view of their surroundings so they feel safe; and 5) they are opportunistic feeders and there is plenty of edible matter dropped in lots and spilling from dumpsters, and plenty of areas around for foraging on small critters (including worms on concrete during wet weather). Since they are known to fly great distances daily to feed, they may find parking lots a safe and comfortable place to rest before their next journey. Keep in mind that they also love to congregate on shopping center rooftops. In Greater New Orleans, there have been many studies and observations of gulls and especially terns nesting on rooftops during the summer months. Maybe they just like to go "shopping" for food just as we like to go shopping and feeding in food courts!

Double-crested cormorant, *Phalacrocorax auritus* – A very common, large black bird in the lake. It may be seen resting on the booster house roofs, towers, or any other surface; if in the water, they dive and pursue prey under water. When they climb out of the water, the spread their wings so they will dry. It was formerly thought that they do not have enough oil in their uropygial (oil, or preen) gland, but the prevailing thought now is that the reason lies in the structure of their feathers. Since they actually fly under water when pursuing their prey, they have adaptations that allow water to freely move through their outer feathers, aiding their hydrodynamic design and decreasing their buoyancy, while their inner feathers remain dry and hold air to insulate the body. When

they emerge from a hunt, they hold their wings open to facilitate drying. Yes, they can fly, albeit clumsily, on exiting the water – they prefer the efficiencies they gain by drying.

Source: allaboutbirds.org.

Purple martins, *Progne subis* – Purple martins are prominent citizens of the lake due to their having two major spring/summer roosts, one at each end of the Causeway, that have been in the vicinity since the days of John James Audubon in the 1830s. Audubon wrote about seeing Purple martins concentrating over the Vieux Carré on summer afternoons then moving to the northwest as dusk set in. He followed them and found them roosting in trees along the lakefront in the area where the Causeway now spills traffic onto the land. As many as 100,000 birds have been noted roosting at each end – those at southshore are at the very end, and those at northshore are a half-mile or so from shore. When the male scouts arrive from their Amazon retreats in February, they feed around the city, search for nesting sites, and roost each evening under the Causeway. When the females arrive a bit later, they build/refurbish and stay on the nest, while the males help with nest building but continue roosting at night under the Causeway. By June, migrants from as far north as Canada begin to arrive as they head south. These new arrivals feed by day and roost under the Causeway by night. When the local young begin to fledge, they spend their days at the nesting site with the females, feed in the area, then both juveniles and females spend the evenings in the roost under the Causeway.
This is how the population under the Causeway expands in size as mid-summer approaches.
In late July, over a short period of time, the birds launch on their migration to the south (largely the Amazon and Argentina) and soon the Causeway is quiet until the next season.
NOTE: There are spans of chain-link fencing at each end of the Causeway over the purple martin roosts. Each evening when the birds approach their roost, they typically dance about in dense flocks, going under then exiting, only to repeat the dance until they are ready to land for the evening. Some years ago, many birds where being hit by cars as the birds flew under then above the roadway. The Expressway Commission erected the fences to force the birds to cross the Causeway above the level of the cars and trucks. It works and saves many birds

Source: audubon.org.

OUR TROPICAL CITIZENS OF THE LAKE:
It is not uncommon for non-local birds to visit in different seasons. In April 2015, there was a flurry of excitement from a report of a **brown booby, *Sula leucogaster***, a Caribbean sea bird, being seen near the Causeway. The species is occasionally reported in Louisiana, but normally near the mouth of the Mississippi River, or in southwest Louisiana, and never for an extended period of time. This sighting was in the middle of Lake Pontchartrain. It was not just one, but as many as 20 brown boobies took up residence in the vicinity of mile-marker (MM) 16, sitting on the supports for the roadway on the west span. They usually sat two per support, and the concrete soon became whitewashed by their guano. Naturalists wondered why they were only using the west side until Dave Muth suggested that the supports on the west are more easily used, and the birds may just enjoy the sunsets!

There were constant reports of sightings as birders crossed the lake. Finally, a group including Dave Muth, Steven Liffman, and Peter Yaukey visited the location in a boat and got photos of the birds. What an adventure.

Brown boobies, Causeway over Lake Pontchartrain Photos by Dave Patton, , 7-26-15.

At 7:30 am on November 7, 2015, my herpetology class traveled to the Mandeville area and at MM 16 we noticed a boat at anchor and about 15 brown boobies flying about over the boat. On the way south at about 2 pm the same day, in a light, but steady, rain, we saw one booby landing, and two sitting on separate booster building roofs (one before the MM16 point, and the other at MM10). What fun!

Being tropical birds, brown boobies were expected to be very sensitive to our cold winters, but they seemed to do well and remain active through the winters of 2015-16 and 2016-17. Unfortunately, on January 17, 2018, we experienced a hard freeze with temperatures dropping to 20°F at Armstrong International. The last registered sighting along the Causeway (on eBrid.com) was February 2, 2018, near MM 11.1. No one is positive what happened. The hard freeze may have killed many of them, or they were induced to leave for warmer climes. One thing for sure, they will be missed. It was a thrill to see them flying around the Causeway.

Frogs: The only time one normally hears frogs calling in Lake Pontchartrain is when the Bonnet Carré Spillway is open. Otherwise, salinity is too high for frogs. It follows that other salinity loving critters are also absent when the spillway is open, such as sea nettles, bottlenose dolphins, sea turtles, etc.
There is an abundance of frogs in marshes and swamps that surround the lake.

Other Bonnet Carré Spillway critters: It is common that non-aquatic animals are often washed into the lake. Many may swim to shore, but others drown and may be encountered floating in the lake. Examples we've seen include nutria, beaver, terrestrial and water snakes, deer, armadillos, opossums, and more.

Inside the spillway, the same dynamics are working. One very common event, seen after many flooding events, is that **fire ants, *Solenopsis invicta***, are flooded out of their underground nests, and they exhibit a behavioral activity that protects the queen, thus the future of the colony. The workers form a floating mass, often ball-shaped, with the queen in the middle. If the floating colony encounters a bush, tree, or leg of a human, they boil over the new surface in order to abandon the water. Try to avoid this experience.

Fire ants forming a bridge on the surface of flood waters. October 2002.

IMPORTANCE OF STRUCTURE AND DEPTH FOR WILDLIFE

The fauna of a region rarely just exists in open space. Not always obvious to the human eye are components that are necessary for faunal species occurring where they do. These components are requirements for attracting or housing food, providing protection and safety, a place to attach and live, areas that serve as gathering spots, and the like.

Open areas of water are not devoid of life, but if higher forms of life occur there it is because something attracts it. As an example, pogie (menhaden) are filter feeders preying on phyto- and zooplankton. Since plankton floats randomly in water, then schools of pogie and other filter feeders may be expected in those zones.

As every naturalist and sportsman knows, predatory creatures most often frequent some sort of structure in water for the reasons stated above. Small things grow on structure, some of which are enumerated below, and larger things eat them, then still larger things eat those, and so forth and so on.

Classic in Louisiana waters is the effect of oil rigs/platforms in the open Gulf of Mexico. What used to be open water has become since 1938 (the first offshore rig built by Pure Oil and Superior Oil Company) populated with thousands of rigs/platforms whose underwater support system has become a huge complex of coral reefs. The legs are covered with corals, mollusks, barnacles, and small invertebrates, and diving the rigs is like dropping into the world's most beautiful aquarium. A naturalist's adventure of enormous proportions!

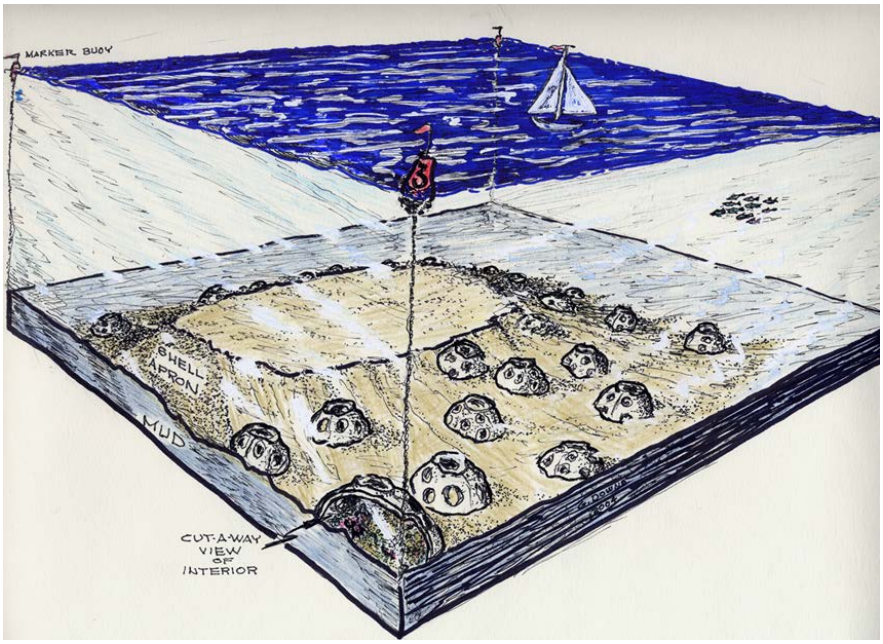
What structures are prominent in Lake Pontchartrain?

- The pylons of the Causeway, U.S. Hwy 11, and the Frank Davis "Naturally N'awlins" Memorial Bridge (Twin Spans). The evening fishing reports on TV

always have fishers catching speckled trout and sheepshead under these structures, fishing against the pylons.

- Domed artificial reefs placed in the lake by the Lake Pontchartrain Basin Foundation.

Artificial reefs about to be placed on the lake bottom. Courtesy the Lake Pontchartrain Basin Foundation.



Artificial reefs as they appear on the lake bottom. Courtesy the Lake Pontchartrain Basin Foundation.

- Concrete around certain edges, such as the Bonnabel Boat Launch in Metairie.
- Any floating debris (see Langmuir Circulation below).

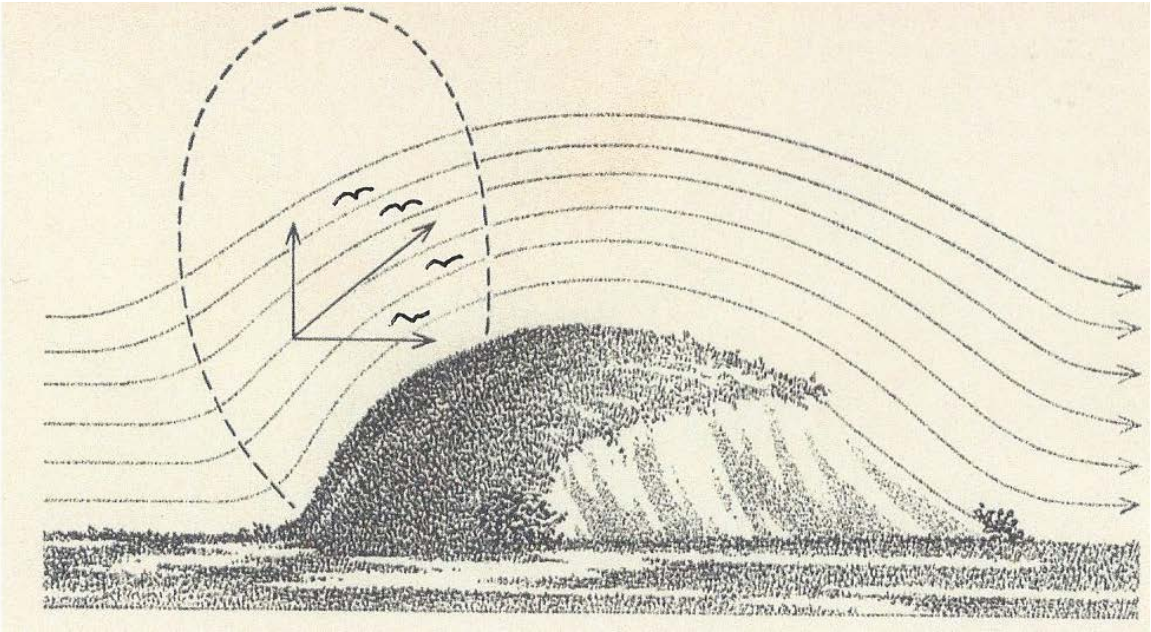
- Pilings jutting above (and even below) water – fish and other critters below, birds on top.
- Fishing peers
- Boat bottoms – barnacles, ugh!

CAUSEWAY BOOSTER STATIONS – WHAT ARE THE LITTLE HOUSES ON THE WEST SIDE?

Causeway over Lake Pontchartrain. Photo by Dave Patton, , 7-26-15.

There are 19 small houses attached by a gangway to the west lanes of the Causeway. These have equipment that boosts the electrical flow from point to point across the lake. Note that they often have birds of various species sitting on their roofs, and the birds typically face in one direction – especially when there is a nice breeze. Birds are aerodynamically designed, and typically face into the wind – whether standing on a beach, sitting on a wire or rail, or sitting on a booster station roof. As you drive south across the lake, keep an eye on the booster stations for interesting birds – but keep a focused eye on the highway!!!

THE CAUSEWAY & LAZY (ENERGY EFFICIENT?) BIRD FLIGHT: DECLIVITY CURRENTS



Adapted from Cone, 1962, Sci. Amer. 206(4[April]):131.

In a natural estuary, the wind blows great distances unimpeded. In our lake, the wind eventually hits the Causeway or, to the east, the Twin Spans of I-10. This structure deflects the wind upward, thus forming declivity currents that allow birds to get an energy-free ride – sometimes the entire length of the Causeway.

In the photos below, note the motionless glide (although they do continually adjust their feathers to maintain stability), always at the perfect angle to the wind.

One of the interesting strategies in nature is to find and use the most energy efficient method of movement, and riding declivity currents always trumps flapping wings!

Here is a brown pelican riding the declivity currents along the Causeway.

Another brown pelican gliding along declivity currents on the Twin Spans of I-10.

DYNAMIC SOARING

Burton, R. Bird Flight. 1990. An illustrated study of birds' aerial mastery. Facts on File, NY.

A technique wherein the bird faces into the wind and is lifted, then glides downwind until it gets too low, then faces the wind again. Yes another excellent energy saving strategy. This is VERY obvious in the open seas where most birds use this constantly – especially albatrosses and other open sea birds.

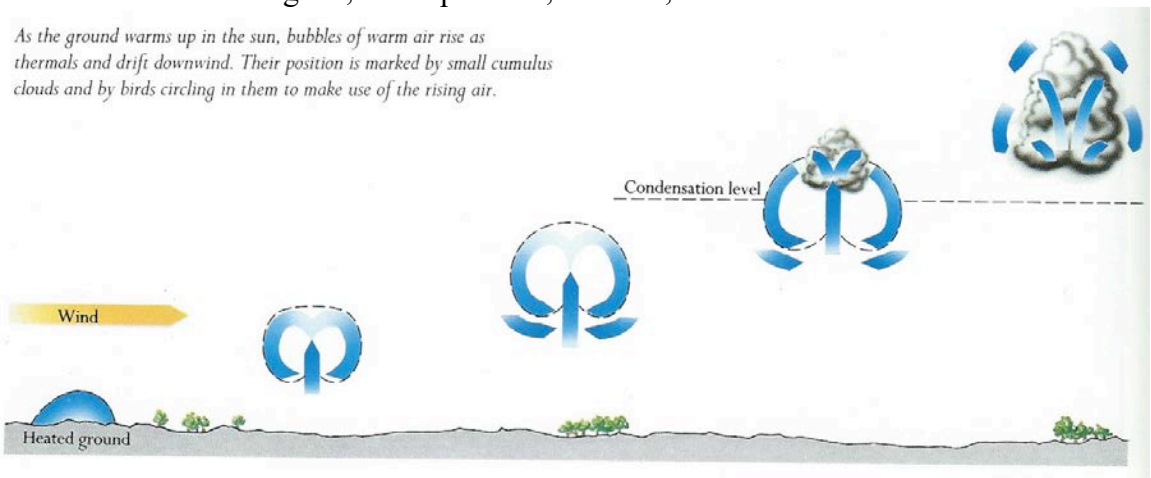
RIDING THERMALS

Birds are experts at finding any element of air that effortlessly gives them lift. One often sees "kettles" of birds drifting aloft in circles that are moving through lateral space. Stand and watch and the spiral of birds are obviously moving. And, at some point, their organized gliding and movement will end and all the birds will begin flapping their wings and flying until they mysteriously begin to glide in circles again. What is happening?

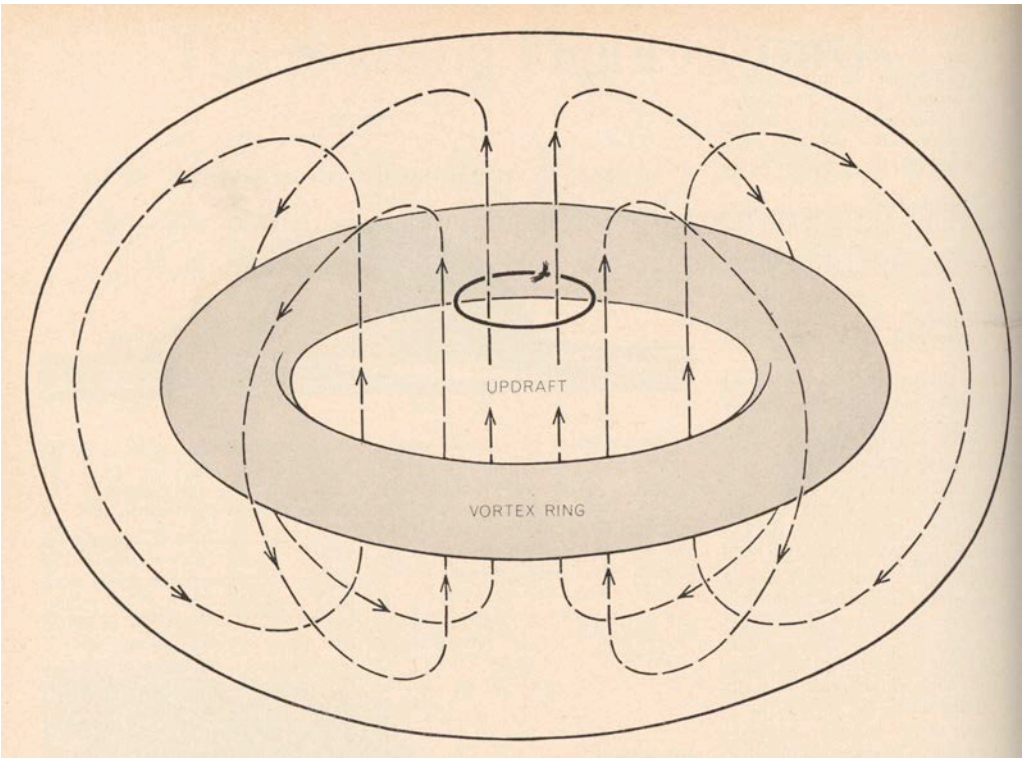
The answer is simple. In warm months air heats when sunlight is reflected off some surfaces. The heated air rises. As it does, it often becomes a doughnut-shaped circulation of air - called a ***thermal shell*** - that is shaped somewhat like a mushroom with a circulating doughnut on top of the "stalk" of rising air. When and if the reflective surface no longer supplies rising air to the thermal shell, it may break free and float off in the winds. If a group of birds are using the thermal shell to lazily glide in circles, then they drift away with the invisible doughnut - until it no longer circulates and ceases to

provide lift. That is when the birds begin to actively fly about searching for another thermal shell of lift.

All soaring birds may do this behavior, and common species seen doing so over Lake Pontchartrain include gulls, white pelicans, vultures, and more.



The development of thermal shells; the "bubbles" of this figure are actually vortex rings – see figure below (Burton, R. Bird Flight. 1990. An illustrated study of birds' aerial mastery. Facts on File, NY).



The vortex ring (or torus) is more like a doughnut, with air circulating within to structure that gives birds lift (see the bird near the center); as the vortex ring eventually weakens, the birds glide until they find a fresh donut to ride (from Cone, 1962, The Soaring Flight of Birds, Sci. Amer. 206: 132).

COMPRESSION LIFT IN FLIGHT OVER WATER

Brown pelican. Photo by Thomas Finnie.

One of the most fascinating areas of study is the realm of functional morphology, especially as it relates to animal behavior and adaptive physiology.

That may seem like a mouthful, but to a naturalist trying to understand why animals do what they do and how they do it, it is a font of discovery that usually results in saying, "Now that is really cool!"

If you love watching brown pelicans flying over water in and about America's WETLAND (coastal Louisiana), you've no doubt noticed how often they zip along near the surface. This may occur over smooth water surfaces, or in troughs between waves breaking toward a beach.

Most people who just sit on a beach and watch pelicans glide by don't notice the relationship. Why would they? They are simply birds flying by, and sometimes they are near the water and sometimes they fly higher.

As one comes to better understand animals in their natural habitats, it may become apparent that everything they do has a purpose. It is fun to see them do something and ask, "Why are they doing that? Might they be gaining an advantage?"

Brown pelicans are large birds, having a wingspan of over seven feet, tip to tip, and weighing 10 lbs. To any animal, efficiency of movement has physiological value. Flying more efficiently saves energy, thus requiring less food and less time feeding.

In fact, brown pelicans fly close to the water, as do other birds, to take advantage of a concept of physics called *the ground effect*, or sometimes *compression gliding*.

Ground effect comes into play when the bird is within its full wingspan of the surface of the water. As the bird nears the surface, the efficiency increases. It has everything to do with the relative length of the wings, and it is commonly seen in high aspect ratio winged birds (those with long, narrow wings) like skimmers, petrels, albatrosses, shearwaters, cormorants, and others.

Basically, as the bird glides over the water the air is "funneled" between the lower surfaces of the wings and the upper surface of the water. The air is thereby compressed and functions like a cushion of dense air that supports the bird aloft, in addition to the normal aerodynamic forces at work. As the bird nears the water surface, the ground effect becomes stronger. It is also more efficient over calm (flat) water.

This aerodynamic phenomenon is very important to aerial wildlife, and it has been mimicked by humans. During World War II, long-range bombers often flew close to the water's surface to conserve fuel. Inexperienced pilots coming in for a landing are often surprised as they gradually drop down as expected, then get within half a wingspan to the ground and are suddenly buoyed upward by the ground effect. It even happens in commercial aircraft. Pay close attention when you are on a landing plane and you may feel an unexpected buoyant sensation just before touchdown.

Pelicans prefer to glide along the surface, but must occasionally gain a bit of altitude in order to flap their wings so they can gain speed and resume their glide. Yes, we may often see the relatively large pelicans flying much higher above the water, but we don't see the physiological tax they pay for escaping the ground effect.

The ground effect also comes into action when the large birds want to land. Pilots often joke that successfully landing an airplane is just a pilot-controlled crash. For the pelican, the ground effect allows the bird to slow its flight while remaining aloft until its landing gear (feet) touch down.

In case you wondered, the ground effect works as well over land as it does over water, but over land there is a higher probability of encountering a rock, tree, cliff, building, telephone pole, or the like. Of course, at sea there are buoys and boats!

Bird flight is complex and fascinating. Maybe that is why books and reams of articles have been written about it, and we learn more every day.

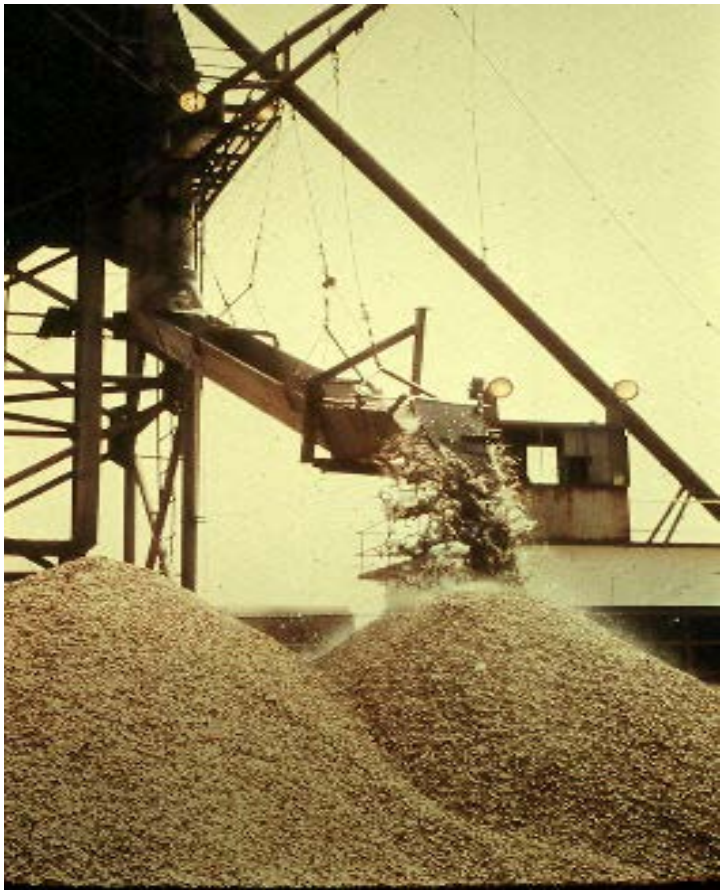
INTERESTING SOILS

Coffee grounds is a type of soil that may pile up in certain areas of the lake. One of the easiest places to see this is on the west shore at the southern end of the Causeway, where folks go to view the purple martins in summer. This type of soil is so named because it looks like discarded coffee grounds. It is formed from formerly freshwater soils that have been dry for 50 years or so have decomposed about as far as they can. They have lost elasticity, are a deep brown in color, are granular and remain so when wet. Very interesting to see coffee ground soils in nature. Nice sculpturing is normally present due to wave action.

Wet coffee ground soils in Lake Pontchartrain at Causeway. 3-3-12

Dry coffee ground soils from the LaBranche Wetland end of Lake Pontchartrain. They have a rich organic aroma and do not soil the hands.

SOURCES OF POLLUTION



Shell dredging was one of the most environmentally harmful activities in the lake. It stopped in 1990. Source unknown.

BONNET CARRÉ SPILLWAY - A MAJOR SOURCE OF EUTROPHICATION IN LAKE PONTCHARTRAIN: AN EXCELLENT EXAMPLE OF TRADEOFFS IN THE HUMAN WORLD

First, let's define and clarify the purpose of the Bonnet Carré Spillway. The "spillway" is the entire system (control structure, guide levees, zone that is flooded when the control structure is opened, and its operations system) that is part of the Lower Mississippi River Flood Control System. Along the Mississippi River, immediately upriver from the town of Norco, is a 1.5 mile long concrete control structure. It protects the river end of a 6 mile long federal floodway, protected on each side by guide levees and ultimately ending at Lake Pontchartrain near the I-10.

If it is crossed on US 61, there are signs at each end defining its presence. If crossing on I-10, it spans between MileMarkers 212.3 and 214.4.

As of 2019, it has been opened 15 times since its completion:

- 1937
- 1945

- 1950
- 1973
- 1975
- 1979
- 1983
- 1997
- 2008
- 2011
- 2016
- 2018
- 2019 (twice)
- 2020

The purpose of the Bonnet Carré Spillway is to divert potential floodwaters from a rising river into Lake Pontchartrain. When completely open, it diverts 250,000 square feet per second of water away from downstream. This is a component of a very sophisticated Lower Mississippi River Flood Protection System that was designed after the Great 1927 Flood to ensure the protection of that portion of the nation's largest and most economically valuable waterway. In addition to the City of New Orleans and other metro areas, it protects shipping lanes, the petrochemical corridor, and adjacent agricultural areas that are vitally important to the well being of the United States. Did you know that every day the Mississippi River is closed, the cost to the U.S. economy is $300 million? Good reason to federally protect the important Mississippi River conduit.

Bonnet Carré Spillway in full operation, diverting 250,000 cubic feet of water per second, into the lake - Mississippi River to the left and the spillway to the right. Source unknown. 2008.

Bonnet Carré Spillway in full operation – lake to the bottom, then I-10, then the railroad, then the flooded spillway. The Mississippi River is across the top, so you are looking westward. Source unknown. 2008.

Bonnet Carré Spillway in full operation – spillway to the left, lake to the right. See organic matter washing out of the spillway into the lake. Source unknown. 2008.

Bonnet Carré Spillway in full operation graphically showing the movement of sediment into the lake. Source: NASA April 29, 2008.

Infrared image of the Bonnet Carré Spillway in full operation – Mississippi River to the bottom. In infrared photography, vegetated areas appear red, freshwater is turquoise, marine water is black, and developed (concrete and buildings) is white. This image was part of the blue crab exhibit at the grand opening of the Louisiana Nature Center in 1980. The dots in the lake were fiber optic lights that illuminated to show the seasonal migration patterns of blue crabs.

THE TRADEOFF? When opened, the Bonnet Carré Spillway allows nutrients and other potentially harmful chemicals to enter the lake. Since salinities are greatly reduced, there is usually about a three year period when the normal fishery patterns are disrupted, thus putting stress on the fishers who make their living in the commons and the restaurateurs who obtain their seafood from the lake. As mentioned, it also may stimulate a massive amount of algal growth. As their population grows, dies, and decomposes, they consume huge amounts of oxygen, thus depleting its availability to the fauna in the lake. This is called *eutrophication*. Obviously, all these have a negative affect on life in the lake.

The good news is that at the end of the three years the nutrients typically cause a rebound that produces huge increases in productivity and the fishers recover well. The algae eventually drop to pre-flood levels, and all is well.

So, in typical critical thinking exercises, we get the benefit to our safety and economics, but there is a biological and social cost for a short period, followed by a welcomed rebound.

Many conservationists who work on wetland issues for advocated for a controlled diversion in this area that would send river water through the LaBranche Wetlands, thus moving freshwater from the river to the lake, with the wetland vegetation removing nutrients and other chemicals while improving the salinity regime of the important LaBranche Wetland nursery grounds. The Bonnet Carré Spillway would still function as an emergency diversion when the Lower Mississippi is threatening to flood.

OTHER SOURCES OF POLLUTION AND EUTROPHICATION

Rivers and other streams, including bayous, serve as arteries moving their contents, mostly washed from land, to the lake. In days gone by, locals loved floating in inner tubes down northshore rivers and creeks, often cooled by the mellow waters and the cold beer. In the 1980s, it became apparent that the streams had a high fecal coliform content resulting from runoff of sewage and fecal matter from municipalities and a multitude of dairies. The result, again, was nutrient enrichment resulting in extensive algal growth and *eutrophication* and exposure to health threatening organisms. Public authorities soon closed the streams to this form of recreation, and people became disconnected from such waterways – not to mention lost a portion of their rural and suburban culture.
In response to environmental concern and public outcry, 1993 saw the Lake Pontchartrain Basin Foundation working with the dairies to build one-cell waste lagoons to treat the fecal runoff from ever-expanding numbers of dairies and their cattle.
Health advisories come and go, but health officials are always conservative. The streams are much cleaner than they used to be, but you should think twice before spending hours in any of the local streams.

There are a number of other conduits entering the lake with nasty water

- Outfall canals & pumps – these canals collect all sorts of runoff, including but not limited to herbicides, pesticides, fertilizers, pet feces, wild animal feces (rats, nutria, raccoons, opossums, alligators, and more), dead/decaying critters in the sewers, oil and other chemicals people dump there thinking it will go "away" with no consequences, rotting vegetation, and household/business sewage illegally connected to the drains. The last named is a huge problem in an old metropolitan area like Greater New Orleans. The Sewerage & Water Board of New Orleans can check for raw sewage using "sniffing" sensors. If they sniff the wrong odors, then they find the culprit and there is a price to pay, as well as a plumbing bill. Although we consider Lake Pontchartrain "swimmable," one should never swim around outfall canals. They have a constant flow of some level, so even on a

pretty day they are removing residual water from the drainage system. The first 30 minutes or so when the pump turns on in a storm, the ejected water is very dirty and must be avoided. After that time, it has cleaned a bit and is at least a modicum safer!

- A related challenge is that people often pour things down street drains without considering that anything placed there *DRAINS TO THE LAKE*. When people personally change the oil in their car, it is likely to go down the drain and into the lake. Same for pesticides and herbicides that they wish to remove from their storage areas. A number of groups, including LPBF and Holy Cross High School, have sponsored programs painting "Drains to Lake" on the street drain covers.

An example from the corner of Live Oak Street and Rose Garden Lane, Metairie.

- Inner Harbor Navigation Canal (IHNC): the "Industrial Canal" – This system is now able to be closed at the lake, so 1) flow into the lake does not affect salinity and 2) storms no longer send large amounts of water into the IHNC during hurricanes. That said, in normal weather, there is a flow of water that has picked up all sorts of contaminants from the movement of shipping through the Gulf Intracoastal Waterway and the locks on the IHNC, so this large water system contributes to pollutants in the lake.
- Metairie sewage - mid 1980s – There was a sewerage plant near the corner of I-10 and Helois Avenue, just west of Bonnabel Boulevard. At night, it was obvious that raw sewage was dumped into the Bonnabel Canal – it could be quite odoriferous. When placed in the canal, it eventually was pumped into the lake. EPA kept warning Jefferson Parish that they were in violation, but the parish ignored them. Finally, EPA sent a formal notice that if they didn't fix the raw sewage problem, the EPA would shut Jefferson Parish down. Somehow, this stimulated them to find the money to get the job done. This was a major enhancement for the lake.

- Motorboats and cars crossing the Causeway – As in any place where oil and gas is being used, leakage, spilling, and a zillion drops find their way onto pavement and/or into water. This is a much bigger environmental problem than most people believe. As an example, it was found in a study around the Chesapeake Bay that the end result of drops of gasoline hitting the pavement when people filled their cars at a gasoline station is that each year about the same amount of hydrocarbon gets into the Bay as was spilled by the Exxon Valdez in 1989! That is lots of drops, and Lake Pontchartrain has thousands of cars crossing each day and hundreds of boats moving about, with thousands tied to docks while each experiences minor leaks - it adds up. NEXT TIME YOU FILL UP, PAY ATTENTION THAT YOU DON'T ALLOW A DROP OF GASOLINE TO FALL! Studies on the east coast have shown that such accidently/in attentive drops in that region annually exceed the total oil spilled in Prince William Sound by the Exxon Valdez. Imagine what is happening nation wide!

17th Street Canal pump station –protects us from flooding, but pumps many nasty things into the lake.

Drainage canal in Kenner – provides a conduit from yards, garages, and streets directly to the lake.

"Toxic soup" in Lake Pontchartrain – 2005 – grave concerns about all sorts of potentially virulent chemicals flooded out of garages and into the community – then into the lake. Source unknown.

NUTRIENTS ARE NECESSARY FOR A HEALTHY LAKE, BUT TOO MANY OR THE WRONG KINDS CAN BE A PROBLEM

As mentioned above when discussing the Bonnet Carré Spillway operation, there are several sources of excess nutrients for the Lake.

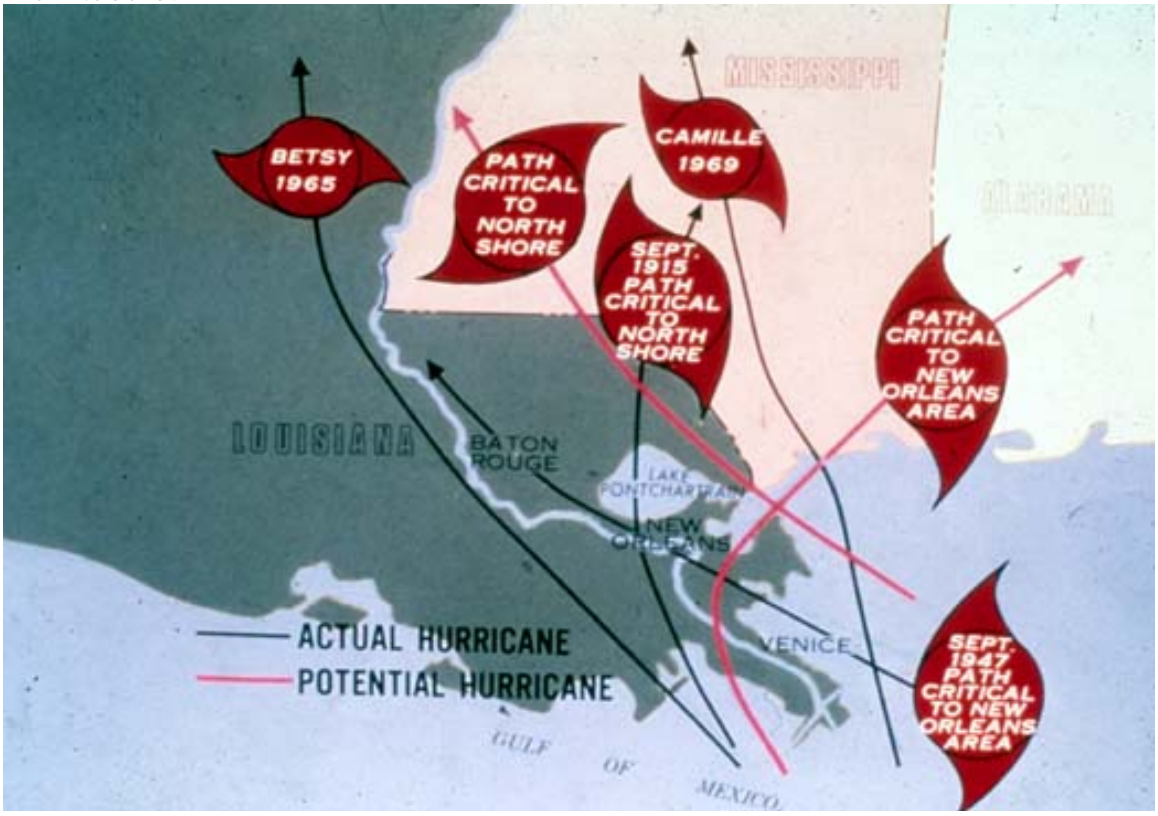
- Surrounding marshes
- Rivers and canals (especially Jefferson Parish and New Orleans for the latter)
- Bonnet Carré Spillway

HURRICANES AND THE LAKE – WHAT HAVE WE FEARED, WHAT DID WE EXPERIENCE IN 2005?

Source: NOAA.

Critical Path Hurricanes for the Greater New Orleans Area.

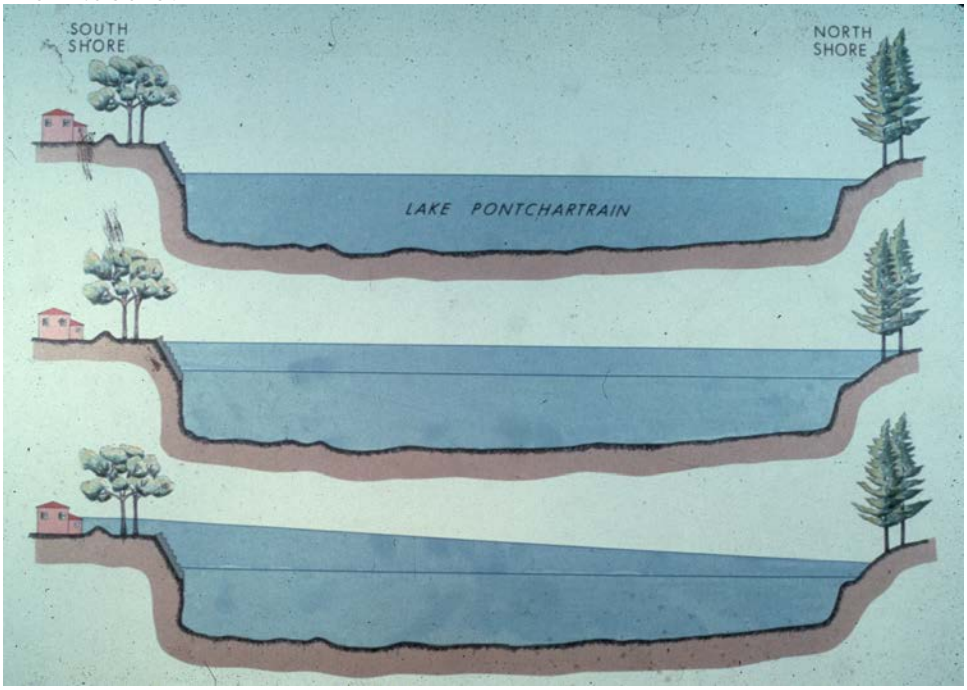
In days gone by, the worst-case scenario hurricane (based on a Category 3 storm) for Greater New Orleans basically followed a path whereby the eye, traveling from the south to southeast passed between the Mississippi River and the mouth of Lake Pontchartrain from the Gulf. Since hurricanes (cyclones) have a counterclockwise wind motion, this path results in the storm pushing water into Lakes Pontchartrain, Borgne, Catherine, and Maurepas. We now understand that the approach of any large storm, even one arriving from the southwest, will result in its northeast quadrant winds blowing into the Chef Menteur and Rigolets, thus producing the same effects.



What the U.S. Army Corps of Engineers formerly called critical path hurricanes – now we must add Katrina and others. Source: USACOE.

As the eye nears the center of the lake (actually anywhere around 30°N latitude), the storm usually curves, sometimes abruptly, to the northeast, thus causing the counterclockwise winds to push the copious amounts of water it has pushed into the lake and piled up on northshore toward the south and presumably over the levees into Greater New Orleans.

Imagine what happens when you drop too quickly into a full bathtub. As you plop in, the water races to the other end of the tub, then sloshes back and usually over the edge of the tub. This water movement is called a ***seiche***, and such a phenomenon has long been considered the primary culprit for filing up the bowl of Greater New Orleans in the event of and aftermath of a major hurricane.



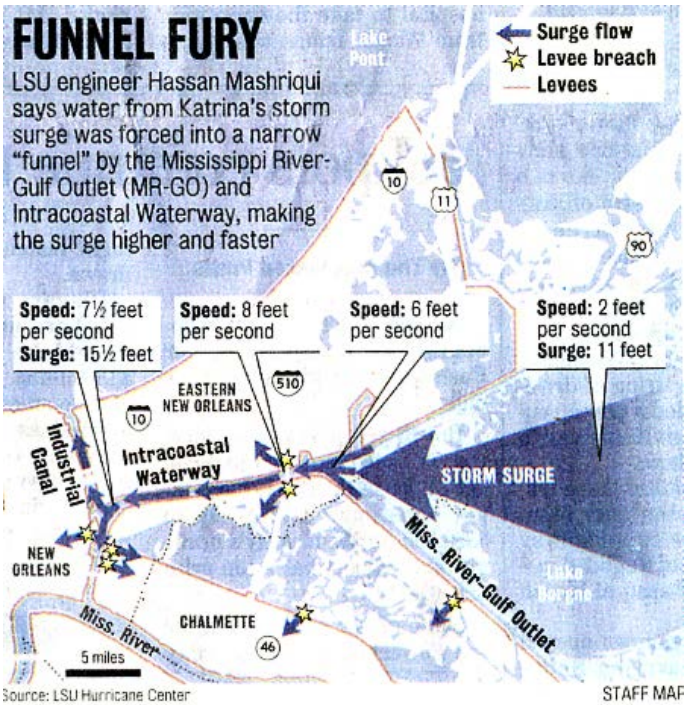
Seiche illustration. Source unknown.

It is projected that such a storm may put about 18-20 ft of water throughout Greater New Orleans.

America's WETLAND campaign event in New Orleans French Quarter, June 1, 2005, to show what 20 feet of floodwater looks like. Source: America's WETLAND Foundation.

In fact, Hurricane Katrina (August 29, 2005) caused the same flood, but not the way described for the Critical Path Storm. In the eastern end of the city, the surge that approached the levees was about 10 ft high (30+ ft to the east in Gulfport, Mississippi). As the surge was forced down the Gulf Intracoastal Waterway (GIWW) between the levee on the north side of the GIWW and the levee running to the southeast along the

Mississippi River Gulf Outlet (MRGO), a "funnel effect" where the water rises as it is pushed into a narrowing channel due to the presence of converging levees created a 15 ft wave (functioning like a tsunami) that ran west down the GIWW and overtopped levees into the city on the west side of the Inner Harbor Navigation Canal (Industrial Canal), then broke the levee on its east side and flooded the Lower 9th Ward neighborhood.



The Funnel and how it turned a relatively small surge into a devastating tsunami. Source: Times-Picayune October 28, 2005.

Photo taken by Don McClosky from the Entergy Michoud Plant located beneath the I-510 bridge over the GIWW (note the concrete piers of the bridge in the photo). Water is cascading over the 17 ft levees, and note the wave of water above the levee that is moving left to right (east to west) in the photo.

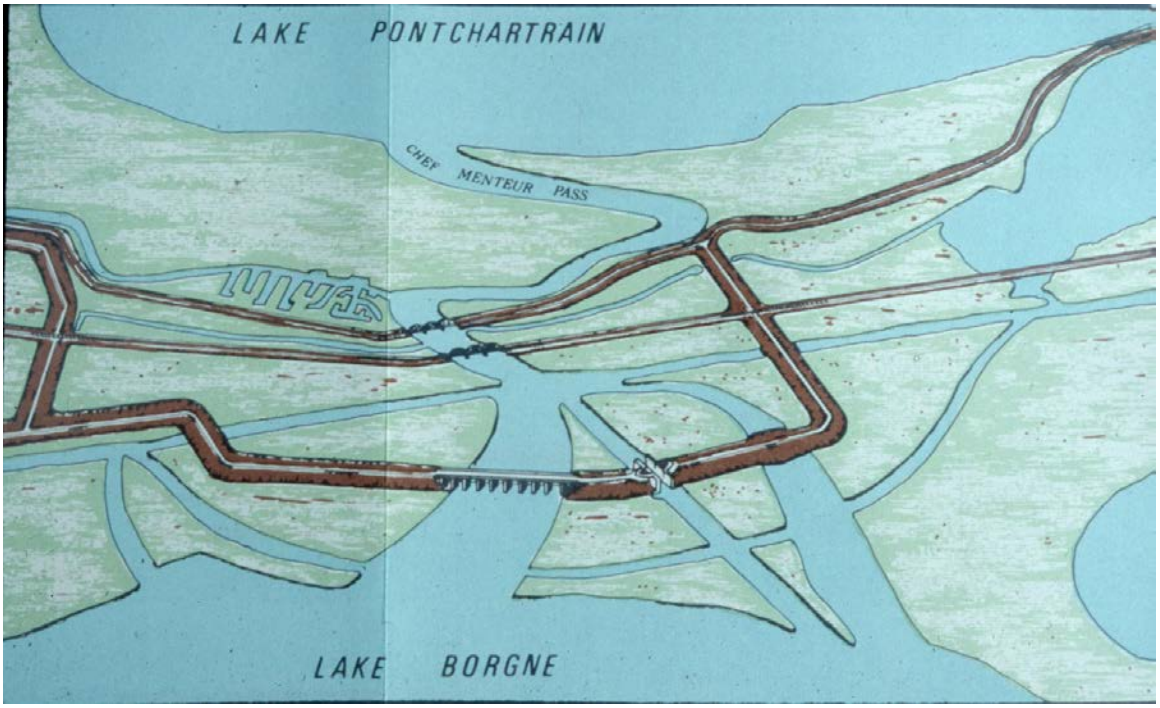
At the same time, the water in Lake Pontchartrain rose by 12 ft, pushing water down the London Avenue, Orleans, and 17th Street canals and Bayou St. John. The weight of this water resulted in collapses at three places in the first and last named canals, and water running into the city at the southern end of the Orleans Canal in the "spillway" (where the I-wall had never been completed near where the I-610 crosses Marconi – still visible today) as well as over the eastern low levees of Bayou St. John. No levees were broken along the lake, nor was there damaging overtopping. Lake water did enter the city at Lakefront Airport where there were no levees.

The canals with red marks where the levees broke, or, in the case of the Orleans Canal, where the water flowed through the uncompleted I-wall levee. Source unknown.

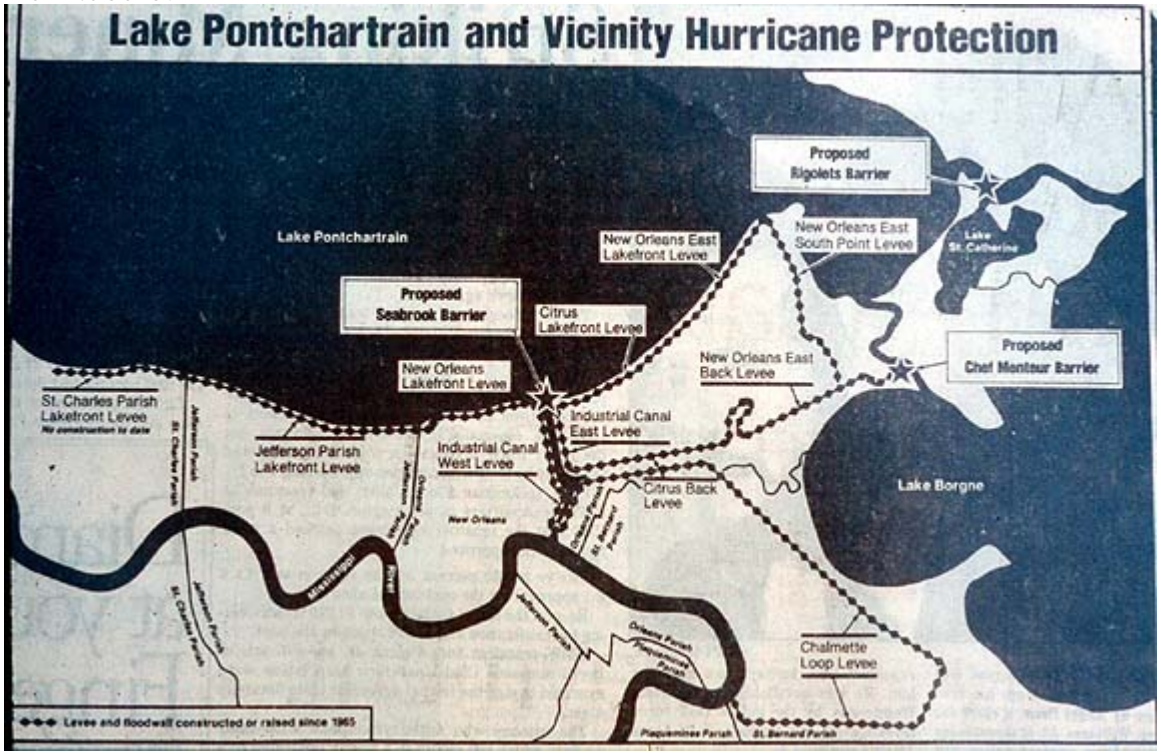
In order to prevent future surges from the lake repeating the Katrina disaster, each of the levees has floodgates that are closed when a storm enters the Gulf of Mexico. The gates have pumps that allow floodwater resulting from rains to be pumped into the lake against the head of water that may exist. This photo is of the floodgates on the Orleans Canal.

1970s GATE PROPOSAL AND LEVEES

What have we done to prevent this catastrophe from happening again?
In the 1970s, the U.S. Army Corps of Engineers proposed to place control structures at the entrances of Lake Pontchartrain that could be closed as a storm approached. Environmentalists feared that the project would interrupt the lake ecosystem in such a way that marine larvae (such as crabs, shrimp, menhaden, etc.) could not move into and out of the lake. A lawsuit was filed by Save our Wetlands, Inc., demanding that the Corps perform an Environmental Impact Study, required by the then very new National Environmental Policy Act of 1970, before proceeding. Instead, the Corps decided it would be more expedient to pursue their designed *high level plan*, composed of 17 ft high levees encircling New Orleans and some adjacent areas.



This was the 1970s U.S. Army Corps of Engineers' plan for the Chef Menteur Pass.
Source: USACOE brochure.



The U.S. Army Corps of Engineers' high level plan, implemented in the 1970s. Source: *The Times-Picayune*.

The high level plan worked until Hurricane Katrina (2005), a Category 3 storm at landfall that was pushing a Category 5 surge, resulted in the failure of a number of levees and floodwalls in the area.

THE LAKE AS A HOT WATER BOTTLE: "THE NOLA LAKE EFFECT"

Map of the New Orleans region, showing how the Lake Pontchartrain embayment, 24 x 40 miles and relatively Shallow, separates the City of New Orleans from the "northshore" – basically the rest of the continent. Source: USACOE?

Any body of water changes temperature slowly – that is why we use a hot water bottle – fill it with hot water and it stays warm a long time. If filled with cold water (is it then a cold water bottle?), the water bottle warms slowly.

Our lake is large (40 by 24 miles, not counting the adjacent lakes) and shallow. It is coldest in winter and hottest in late summer. Land does not hold temperature as long as water and changes quickly.

As winter approaches, the land north of the lake receives cold air from the northwest and cools rapidly. In New Orleans, however, the cold air has to cross the "hot water bottle," so when it arrives here it is warmer, longer. Weather watchers know that during the fall the weather people report temperatures around the lake, and northshore gets colder more quickly than southshore – we on the south are warmer longer because of our hot water bottle (the lake) that sits above us. By mid-winter, northshore and southshore normally share the same temperatures. However, sharp freezes afflict northshore more often than southshore.

As spring and summer approach, the lake is at its coldest. As temperatures rise, the cool water keeps us cooler longer, and it is obvious when you see the weather reports. By the end of June, sometimes a bit earlier, we share the heat with our more northern friends, and this happens because the lake has heated up again and is not moderating the temperature.

Cool stuff to notice.

LANGMUIR CIRCULATION AND PARALLEL STRIPES ON THE LAKE'S SURFACE

> In 1927, as he sailed the Sargasso Sea, future Nobel Laureate Irving Langmuir observed and later explained the mechanics of parallel lines of sargassum floating on the sea surface. These lines are now known as windrows resulting from Langmuir circulation, named in his honor for his description of the mechanisms that cause the lines to form and be maintained.

At least once a year a group of naturalists, most of whom are specialists on birds, gather for a "pelagic" birding trip. We board a boat somewhere along the coast at about 6 a.m., and head to the blue waters of the open Gulf of Mexico. The distance of our destination averages some 50-85 miles offshore, and the principal target is birds that typically never come to land in Louisiana – they live over the sea unless nesting.

We normally have chance encounters with an array of other wildlife species while underway including bottlenose dolphins, whales, sea turtles, flying fish, ocean sunfish, and much more.

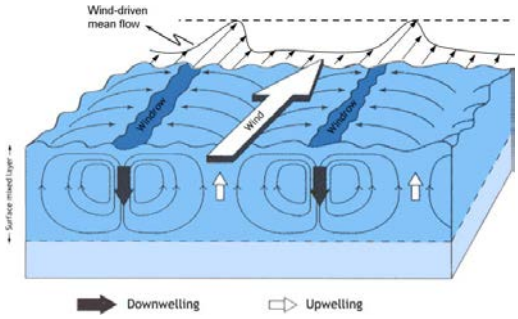
If we see "patches" of natural and/or human-made materials floating on the surface, we speed in that direction. These patches are actually called *windrows*, and they are usually parallel lines of "stuff" sometime stretching for more than a kilometer. In our waters they

are composed largely of sargassum, foam/bubbles, and a mixture of floating polyfoam, plastic, and other jetsam blown or dropped off of boats.

Other names for windrows include foam lines, rip lines, drift lines, slicks, zones of convergence, and wind streaks.

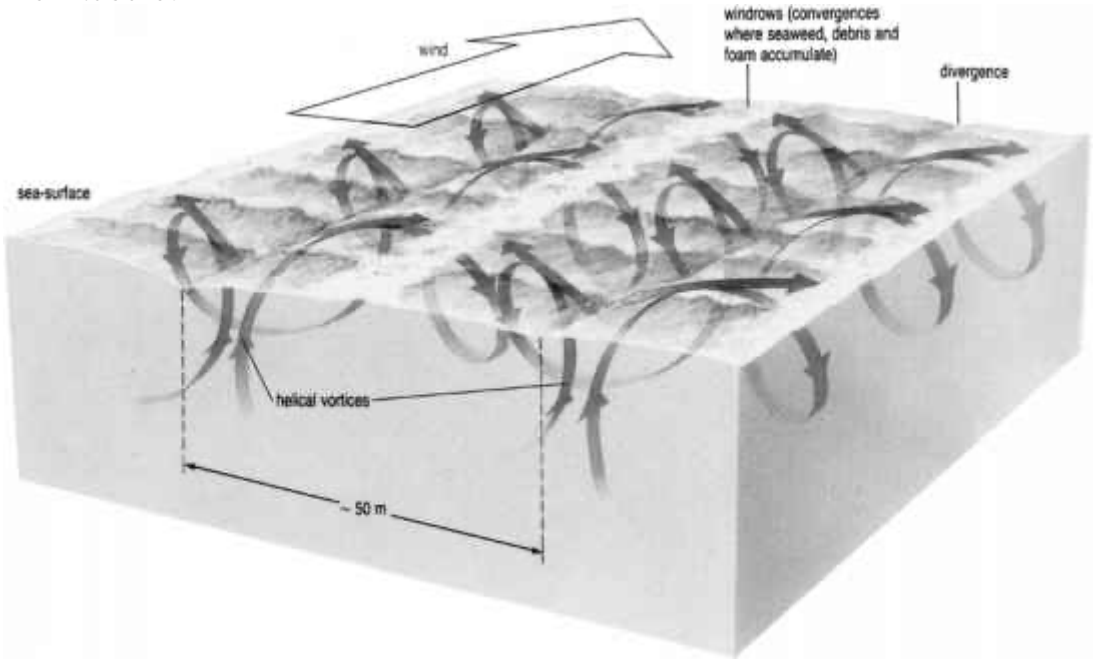
But what causes the formation of these windrows? Wind for sure, but why do they line up as they do and what keeps the floating matter in nice lines? Why are they sometimes present, sometimes not? Why do they form then dissipate as winds stiffen?

The answers to these questions, as is often the case in nature, is physics. As the wind blows across the surface, the friction between wind and water results in a shear force that moves the water in the direction of the wind. Since winds are always variable – slow, faster, slower – what is called a variable shear force is produced resulting in circular rotation of water in a "cell" which we call *Langmuir circulation*. These cells move water in a circle across the surface, down into the water column, back across the bottom, then up again.



Tajada-Martinez et al, 2011. J. Appl. Mech. 79(1).

The above figure illustrates the circular movement of the cells. In reality, the winds are moving the surface of the water so the cells are pushed away from the direction of the wind as spirals, as shown in the figure below.



Open University Course Team, 1989, Fig. 3.26c, Butterworth-Heinamann Ltd.

Adjacent cell tubes circulate in opposite directions, so they move and arrange objects on the surface into lines (windrows) that are easily visible. Studies have shown that these lines and their Langmuir circulation zones generally form parallel to the wind or up to 20° to the right of the wind direction and when the water conditions are somewhat calm with winds over the surface being steady and blowing about 6-40 feet per second in speed. Such winds cause the cells to circulate at speeds of about 1-4 inches per second. And, as pointed out by Loyola physicist Dr. Martin McHugh, an important factor is the spiraling effect of the cells shown in the image above.

Alas, the formation of Langmuir circulation is more complex than simply a response to wind blowing over water. A number of possible mechanisms have been proposed and studied, and the prevailing theory suggests the following are also important contributing factors:

- the complicated interaction of capillary waves (ripples moving along the boundary of a fluid – such as the surface – and affected by the presence of surface tension) and,
- wind-borne films that may be present or absent on the sea's surface.

The result is that anything floating on the surface where Langmuir circulation is occurring is moved to the centerline and kept in place as long as the circulating Langmuir tubes remain. These are our windrows.

As stated, windrows may be simple lines of bubbles (see photo), or mats of sargassum mixed with other debris. Experience has shown that this is the sweet spot for animal observations. Windrows act as convenient shelters in otherwise open water and are

teaming with life, so they attract predators (such as dolphin [fish], sharks, and fishermen), birds that need a rest (bridled terns, phalaropes), sea turtles (those that need to feed and the tiny ones that need to hide), and a host of small animals that are potential prey (crabs, shrimp, sea horses, pipefish, etc.).

Langmuir windrows of foam at the Twin Spans, Lake Pontchartrain, May 3, 2018. Photo by D. A. White.

Of course, the predictable circulation patterns here are affecting all sorts of interactions in the ecosystem. Imagine the effect on distribution of plankton and other organisms floating at the will of water movements. The circulating cells not only make lines on the surface, but they additionally carry organisms to greater depths then return them to the surface, mixing not only the water but the faunal communities themselves.

A striking example of Langmuir circulation along the Louisiana coast was visible streaks of oil and its orange degrading emulsions following the BP debacle of 2010.

A windrow of BP-Macondo oil mousse (a sticky emulsion of oil and sea water), Gulf of Mexico, about 30 miles S Pass a Loutre, April 22, 2010.

So, windrows are formed by Langmuir circulation, and their presence is an attractant to wildlife in the sea that seek shelter or prey, birds that need a rest or food, and fishermen who want to catch the predatory fish!

Keep your eyes open for foam lines when crossing the Lake Pontchartrain Causeway. The steady winds often produce nice views of physics in action in our lake.

WATERSPOUTS ON THE LAKE

Waterspouts are similar in appearance to and are a similar meteorological event as a tornado.

Waterspouts we see over Lake Pontchartrain are normally *fair-weather waterspouts*. They are less powerful than tornadoes, producing wind speeds that typically average 30-50 mph, or ranked at the lower end of an F0 (Fujita Scale 0) vortex. Since they are weak, they are typically short-lived (20 minutes or less) and usually dissipate if they move onto land. Due to their normal association with slow moving or static cumulus clouds, they

normally don't move great distances. Fair-weather waterspouts are rarely associated with supercell thunderstorms, as opposed to their cousins – tornadoes.

Several facts:

- A waterspout doesn't ascend from the water; instead, it is a combination of a vortex descending from a cumulus cloud, then its base being surrounded by a spray-ring ascending from the water surface (see further comment below)
- It is not filled with water from the surface below – that is, it doesn't suck up water from the surface into the spiral. The rising spray-ring is filled with water droplets that have condensed when the air cools as the barometric pressure drops in the rising, humid air in the vortex.

Tornadic waterspouts are the same as tornadoes, but are over water. These may result from a tornado moving off land and onto water (rare in the NOLA region), and may have surface winds up to 300+ mph (F5).

Under what conditions do fair-weather waterspouts form? They form over warm water; in the presence of cooler, moist air (the cooler air may be from converging storms or from descending air); and light wind speeds. As a rule-of-thumb, fair-weather waterspouts don't form in the presence of existing thunderstorms.

Waterspout in the Florida Keys. Photo by Dr. Joseph Golden, NOAA, January 20, 2005.

How do fair-weather waterspouts form? They have a five-stage life cycle (www.britannica.com/science/waterspout), that start-to-finish may last from a few to 20 minutes or so; development might include all five stages, or almost any combination of the five:

1. Dark-spot stage – The surface of the water becomes dark and is a bit elevated due to an as yet invisible vortex that exists or is forming.
2. Spiral-pattern stage – The spiral/developing vortex is visible. Enlarged waves may be present on the surface around the dark-spot; they may appear as spirals of dark and light patterns. The spiraling vortex causes barometric pressure inside to drop proportionate to the increasing wind speeds.
3. Spray-ring stage – At wind speeds of about 40 mph, the dark-spot is visibly surrounded by a sheath of water droplets (condensate) lifted by the vortex of swirling air; a lengthening funnel cloud develops from the flat-bottomed dark clouds above.
4. Mature waterspout stage – This is the full-blown waterspout, where we see the funnel associated with and descending from clouds above and the spray vortex of condensed water droplets formed due to the cool air rushing down from above, making the lower rising air clearly visible.
5. Decay stage – The period during which the waterspout disappears, sometimes quickly. It is thought to happen when rain begins to fall nearby, thus cooling the warm inflowing air around the lower end of the vortex.

Waterspouts may be enormous (hundreds of feet across) or rather small, looking threadlike from a distance. Multiple waterspouts may form in the same region.

Two waterspouts in Lake Pontchartrain near Slidell photographed from Eden Isles by Leslie Indorf, July 6, 2008. The thin one to the left is presumably in Stage 5, the Decay Stage.

Three tornadic waterspouts approaching the northshore of Lake Pontchartrain, by WWL-TV cameras, February 23, 2016, 12:15 pm.

The point has been made that these are not as dangerous as tornadoes, but they should be avoided as they can cause damage to a boat, light plane, car crossing the Causeway, or persons swimming or standing on shore. And some may be quite strong and large in size. To avoid contact, always move at a 90° angle from the path of the waterspout. Some experts opine that they may be the primary cause for the mysterious disappearances of craft in the Bermuda, or Devil's, Triangle!

GREEN FLASH: WILL YOU BE LUCKY TO SEE ONE?

Many of us have seen a beautiful sunset in the west or sunrise in the east, but did you know there is a phenomenon called the "green flash" that may been seen for about 2 seconds as the sun dips below or, more rarely, emerges above the horizon? Folks who live in California are more likely to observe the green flash, but it is more seldom seen it in Lake Pontchartrain – but worth the wait!

We just need to go to the world of physics for an explanation. On a clear evening, as the bright yellow top of the sun slides out of view, its light travels its maximum distance to your eye. The atmosphere bends the wavelengths, thus separating the colors (similar to the effect from a prism) and allows a brief flash of the green spectrum of light.

A sunset captured off San Diego on Dec. 13, 2017. Photo by Jim Grant. (source: https://medium.californiasun.co/green-flash-san-diego-947cc485f46b)

FOG: THE BANE OF CAUSEWAY COMMUTERS

Fog is simply air containing lots of condensed water droplets. Air holds more water as it heats, so as it cools the water in the air (that is always there in our area but invisible) condenses and becomes first visible (fog), then drops out of the air (mist or rain).

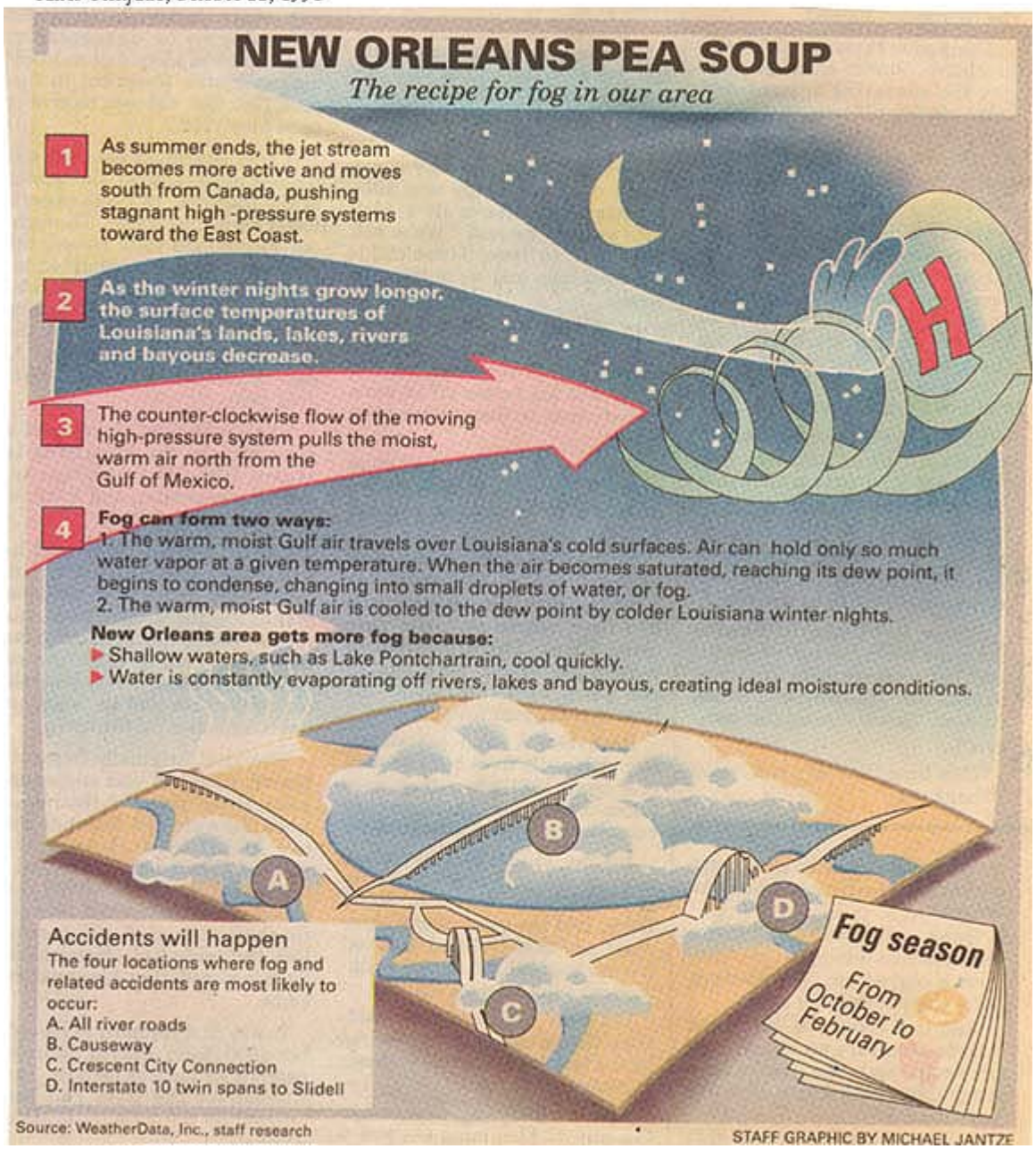
The dew point is the temperature at which air with a given humidity condenses and produces fog or adheres to the glass on your car window. In general, the lower the humidity, the colder the dew point, and vice versa.

Sometimes there is fog each morning, caused by the air reaching its coolest just before sunrise. When this happens several days in a row, and the morning temperatures remain constant, then a naturalist knows that humidity is also remaining constant. If one morning there is fog, and the next morning the air temperature is about the same but there is not fog, then a naturalist knows that there is less humidity.

People who cross the Causeway in the morning know that the foggiest period is December/January/February. That said, fog can appear unexpectedly (but predictably) at other times when the weather is cool. On evenings when the temperatures drop to cooler levels, patches of fog may plague the Causeway and other parts of the lake.

The normal cycle is that as the sun comes up and the air heats as morning progresses, the air is able to hold more humidity so it clears. If fog remains later in the morning, then the air is NOT warming.

Times-Picayune, October 22, 1991



Mysterious moments occur in Greater New Orleans when massive clouds of fog roll off the Mississippi River into the French Quarter and neighborhoods along River Road. The answer to why this occurs when it does is explained once again by low temperatures coming in contact with humid, warmer air. In this case, if the air has high humidity and blows over the surface of the river when its water is cool/cold (this often happens in winter and spring when the river flow is reaching its maximum in its annual cycle and the source of the water is from snowmelt or just northern polar air), then the water content of the air condenses and fog forms. At this time of the year (often March/April), the wind

often blows from the South, so as fog forms, the fog is blown from the river to the East Bank. Most locals have experienced this event – a relatively warm, humid night and the Vieux Carré becomes enshrouded with dense fog, thus adding a bit of chill to the air. This helps us understand the stories of "haunted New Orleans," and the feelings are enhanced by the shadowy movements of people moving along the narrow streets!

From the internet, February 19, 2016

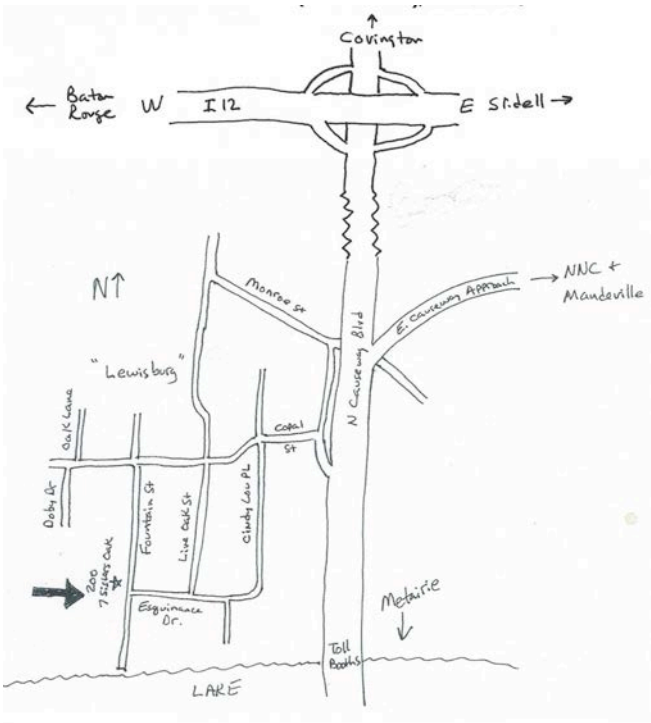
NEAR THE CAUSEWAY ON NORTHSHORE IS THE LARGEST LIVE OAK TREE (*Quercus virginiana*) IN LOUISIANA.

Seven Sisters Oak. Photo by Coleen Periloux Landry

At the north end of the Causeway, enjoy a spiritual moment visiting the largest live oak tree in Louisiana – the Seven Sisters Oak, located at 200 Fountain Street in historic Lewisburg. As the largest individual, this tree is designated as the President of the Louisiana Live Oak Society. Its trunk is 38.9 feet in circumference, and it is estimated to

be 1500 years old. This tree has been verified to be derived from a single acorn. What a tree!

Enjoy the view from the street – please honor the wishes of the homeowners and do NOT pass their fence.



ALL THIS, AND WE MUST MENTION THE BEAUTIFUL VIEWS OFFERED BY OUR WONDERFUL LAKE PONTCHARTRAIN!

View of the lake. Clarendon filter used on Instagram, 5:39 pm, November 3, 2015.
Photo by Jennifer Thomas Phillips.

Acknowledgements: Thanks to the many people who offered their comments and expertise as this story was developed. They include Carlton Dufrechou, Dinah Maygarden, Rusty Gaudé, Carol Franzen, Mike Poirrier, David Muth, David White, Jim Wee, Phil Bucolo, Craig Hood, Don Hauber, Frank Jordan, Paul Barnes, Mark Tobler, Patricia Dorn, Mark Meunier, Nancy Newfield, Peter Yaukey, Aimée K. Thomas, Kristi Trail, John Lopez, Mark Schexnayder, Julia Lightner, Chris Schieble, Susan Chiasson, Mike Efferson, and all those who offered info and I've overlooked here. I promise I'll continue to add as I recall all the great contributions. Also, all those who are acknowledged for the use of their photos.

-end-

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