

RED TIDE: What is it? What causes it? What can be done about it?

Quick Summary: Red Tide is caused by a naturally occurring one-celled organism that multiplies fast in warm salt water that has lots of nutrients. The nutrients, nitrogen and phosphorus, provide the “fuel” for huge expansions of red tide blooms. The red tide organism produces neurotoxins that have killed millions of fish and animals and causes health problems for people. The current year-long 2017-2018 red tide episode has hit the southwest Florida economy hard causing millions of dollars of lost tourist and commercial fishing income, lost tax income for local communities, and loss of income or employment for hotel, restaurant, and other tourist industry workers. Humans cause most of the nutrient problem. Some work, but not enough, has been done to control and reduce the nutrients from getting into southwest Florida rivers and the Gulf of Mexico. There are many plans and projects either ready to go with funding or needing State legislation and leadership by elected officials to quickly start to solve the problem that will get bigger if not aggressively addressed starting now. The central Florida phosphate mines, cattle manure, and sugar cane nutrient contributions need to be dramatically curbed. Sewage and septic discharges carrying huge amounts of nutrients need to be greatly reduced. Fertilizer applications on crops, lawns, and other places need to be restricted and reduced. This paper includes recommendations.

What Is Red Tide (and other alga blooms)?

Red Tide is an algae bloom of *Karenia Brevis* a single celled organism that in high concentrations causes the water to look red or reddish brown. It's like a plant; it makes its own food by photosynthesis (nutrients + sunlight). It's also like an animal; it is a dinoflagellate meaning it has 2 tails that provide it with the ability to move/swim to get better positioned for growth. Normal ambient concentrations in the Gulf of Mexico are a few thousand up to 100,000 per liter (about one quart)

of sea water. But with optimal growth conditions the K. Brevis multiplies by cell division in an explosive manner and can reach many hundreds of thousands of organisms per liter. The K. Brevis produces a neurotoxin which is deadly to fish, reptiles and mammals. While it is not harmful to most shellfish like oysters, the neurotoxin is concentrated in the shellfish and is poisonous when eaten by animals or people. When the neurotoxin is atomized into the air it causes respiratory and eye irritation and triggers asthma attacks.

What Causes Red Tide?

Since the K. Brevis is always present in the Gulf, all it takes for a near-shore large scale bloom of red tide is warm water (it does best in water that's 70 F to 90F), full sun or partially cloudy days, and nutrients (nitrogen and phosphorus).

There is some evidence that many of the red tide blooms begin 10 to 50 miles offshore when the Gulf currents bring nutrient-rich water up from the deep. Iron also appears to play a role in blooms. Iron is found in all water and is provided in increased quantities to the Gulf from the Peace River and oddly from long distance transport from the Sahara Desert. Trichodesmium bacteria in the Gulf use the iron to "fix" nitrogen from the air and when these bacteria die, they provide nitrogen for K. Brevis blooms. Nonetheless, when those offshore blooms are pushed to shore, the nutrients there fuel the blooms like pouring gasoline on a fire. Red tide blooms diminish with many days of cloud cover, with colder water, with lessened salinity at the surface due to rain storms, winds/waves which cause the K. Brevis cells to burst, and with reduced nutrients. Blooms should stop when cold weather from winter arrives, but the Gulf water is so warm that the blooms persist longer into the winter and start back earlier in the spring.

The latest long-term large-scale red tide bloom has been in almost continuous bloom since November 2017 and continues on-and-off into November 2018. It has plagued the west coast of Florida from south of Naples to north of Clearwater. K. Brevis' "colleague", the blue-green fresh water alga, have clogged inland waterways, Lake Okeechobee, and canals and marinas. And, to make matters worse, when the blue-green alga dies and gets washed to the Gulf they provide a food source of nutrients for more K. Brevis to multiply.

These blooms, both red and blue-green, bring serious economic, environmental, and human health problems. The Chambers of Commerce along the southwest

Florida coast can tally tens to hundreds of millions of dollars in lost tourism income and businesses going bankrupt. Counties and communities can list millions of dollars in lost tourist taxes thus putting a burden on providing services or causing larger tax levies on local residents. Commercial fishermen, coastal and canal residents, and environmental groups can provide data and stories about the millions of fish, turtles, dolphins, and manatees that have died and the stink and health concerns of rotting carcasses on the beaches and in the canals and marinas. Doctors and hospitals reported large increases in asthma and other health-related impacts.

Of the two primary factors that promote red tide blooms, warm water and nutrients, the only one that people can have an impact on reducing in the short-term is to reduce nutrient flows into rivers and the Gulf. The water is getting warmer due to climate change and that is not going to be reversed anytime soon, in fact it is getting worse quicker than had been thought. A study just published in the Journal Nature done by Princeton University and the National Oceanic and Atmospheric Administration found the oceans have absorbed 60% more heat each year than previously known. The oceans absorb 90% of excess heat energy in the atmosphere caused by man-made climate warming: almost all observed climate warming since 1860 has been caused by people.

The nutrients come from natural decomposition of plants and from human activities. Fertilizers for agriculture, especially around Lake Okeechobee in the southern central part of Florida, wash into rivers and are carried to both coasts but more so to the southwest coast of the State. Fertilizers for green lawns, parks and golf courses also contribute. Phosphorus is washed out of the huge phosphate mines in central Florida. Nitrogen rich manure from the large cattle ranches in the center of the state gets washed into the rivers. Poorly sited and leaking septic tanks contribute large amounts of nutrients and older sewage treatment plants do not remove enough nutrients prior to discharge into rivers.

What Can Be Done About Red Tide?

Many actions can be taken now to greatly reduce the amount of nutrients getting into the Gulf of Mexico. Substantial reduction in nutrients will be costly and inconvenient but the 100% predictability of bigger and more frequent red tide events will cost more and be far more inconvenient. The reputation of the State of Florida is at risk if effective, aggressive plans are not developed now and

implemented quickly. TV, printed news, and the internet have covered the red tide problem extensively causing tourists to vacation somewhere else. Businesses may become less interested in staying in Florida or relocating to it when the State seems helpless to find ways to mitigate the problem.

With a problem as large and difficult to get a grip on as red tide, there will be false starts, some projects not invested in enough, and some plans needing mid-course corrections. Red tide is an eminent threat, there is not the time to debate toward a perfect plan: science-based, educated, informed aggressive leadership and action is needed now and some risk taking for some failures must be understood and accepted by elected officials and the public – Risk acceptance is not popular with elected officials, but the public can understand this conundrum if presented factually, clearly, frequently, honestly, and up-front.

Plans and projects and funding for many of them are ready to go and must start now. Here's a starter list:

1. Design and fund a nutrient monitoring program. The State of Florida legislature needs to quickly increase its funding of the state Department of Environmental Protection (DEP) to contract with Universities and other laboratories to design a monitoring program and provide grants to counties to implement the plan. This will provide measurable information to assess if nutrient reduction plans and projects are working.
2. The State needs to re-establish the cooperative work of Florida's five water management districts that was ready to go but abandoned in 2010. This work updates the state storm water design standards and provides other important management and technical support toward clean water.
3. The State needs to quickly build the necessary reservoirs to both the south and north of Lake Okeechobee to catch storm events like Hurricane Irma and then remove the nutrients and/or do managed discharges into the Everglades. The Everglades can filter out much of the nutrients. Large funding sources are ready to be used from the State and Federal Government. One large but probably not large enough reservoir was approved by the Florida legislature in December 2017. The reservoirs will prevent large slugs of nutrient rich storm water, like that which

substantially contributed to the current 2017-18 massive red tide after Hurricane Irma, from flowing into the rivers and the Gulf of Mexico.

4. The State of Florida and US Corps of Engineers need to aggressively implement the Everglades 2000 restoration plan including the planned for 60,000-acre reservoir to hold major storm events and reduce nutrients by buying out what is needed of the sugar cane producing land south of Lake Okeechobee. Some interests will argue that larger reservoirs are not needed, but a substantial safety margin must be built in anticipation of bigger and more frequent major rain events that are coming because of climate change.

5. The State Governor needs to order the DEP to update and enforce storm water permits for the phosphate mines.

6. The State legislature needs to direct the DEP and Florida Department of Agriculture to develop regulations on the use of fertilizers on lawns, plants, and public parkland and recreational areas and other uses as needed to prevent nutrients from these uses getting into rivers and the Gulf.

7. The State DEP needs to rigorously monitor and enforce the 42 consent decrees to repair and modernize sewage treatment plants and ancillary equipment including pumping stations that failed during Hurricane Irma and caused millions of gallons of nutrient rich human waste to be discharged into the Gulf.

8. The State DEP needs to identify which sewage treatment systems need to be upgraded to tertiary treatment to remove 90% plus of the nutrients and find funding for those systems. Further, stop reusing the captured nutrients as a fertilizer in Florida – sell the product where alga blooms are not a problem.

9. The State legislature needs to reinstitute the septic inspection program and increase funding for the DEP and counties to aggressively track down leaking septic systems and poorly operating sewage treatment systems and enter into consent decrees for repairs and conversions from septic systems to sewage treatment systems. State grant money from the legislature will be needed.

10. The State legislature needs to require the DEP to do an immediate review and updates to stormwater permits for manure handling for cattle operations in the central part of the State.

11. The State legislature needs to provide funding for a multi-faceted symposium on red tide to be run by a consortium of universities to bring together scientists, water district planners, regulators, local and state elected officials, agriculture and mining interests, representatives of tourism and fishing interests affected economically by red tide, Chambers of Commerce representatives, watch-dog groups including environmental organizations, and the press/media. The symposium purpose would be to develop specific short and long-term ideas for solving the red tide problem. Then, across the affected parts of the State hold public meetings to inform and gain support for actions that will be difficult to do and potentially costly to parts of the State's economic base but broadly beneficial to the economic interests negatively affected by the alga blooms, the natural environment and public health. Ways to minimize impacts to the economic interests that will be negatively affected by aggressive nutrient reduction plans and projects need to be another key aspect of the symposium.

12. The State legislature needs to provide seed money for a standing consortium of affected tourism and fishing business interests and Chambers of Commerce to have an independent oversight presence to monitor State and county implementation of plans, design standards, consent decrees, reservoirs, restoration projects, and other related projects. Mining and Agricultural interests should be invited to attend to provide information and insights.

Conclusion: Fixing the Red Tide problem will be one of the hardest major issues facing the State of Florida. It will take a multi-faceted approach with many interests involved. It's going to be difficult, costly, and politically messy. The new Governor should consider appointing a Red Tide Executive reporting directly to him. Re-election will be difficult if Red Tide continues year after year.

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