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A Response to Frequently Asked Questions about the 2018 Lake Okeechobee, Caloosahatchee and St. Lucie Rivers and Estuaries Algal Blooms

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The heavy rainfall that came with Hurricane Irma in September 2017 and the above-average rainfall in spring 2018 again set the stage for another large-scale summer algal bloom in Lake Okeechobee, the St. Lucie (SLE) and Caloosahatchee (CE) Rivers and Estuaries. Residents and visitors are concerned, upset and confused and these emotions are nowhere more present than on social media. Over the last couple of weeks, we have scoured Facebook and will respond to this set of compiled Frequently Asked Questions that were seen on the comment feed of numerous posts and pages.

1. Why is there a massive algal bloom this year in Lake Okeechobee?

In order to answer this question, we first have to provide some background about algal blooms and Lake Okeechobee. For algal blooms to occur, two things must be present: high concentrations of nutrients (most importantly nitrogen and phosphorus) and adequate sunlight. Warm water temperatures also accelerate the formation of blooms. Lake Okeechobee is a large, shallow, nutrient-enriched lake. The shallow depths, particularly around the edges of the lake, provide the light needed to support high algae growth rates. The location of the lake in the sub-tropical environment of south Florida provides a long season of high water temperatures.

This year, south Florida received record rainfall in May which delivered extra nutrients from the local watershed into the lake, adding to the ingredients that already had been built up from the rainfall and runoff during Hurricane Irma. It created perfect conditions for an intense algal bloom. As with many lakes and reservoirs around the world, blue-green algae, also known as cyanobacteria, are common in Lake Okeechobee. These algae have special adaptations that help them dominate blooms, such as the ability to adjust their position vertically in the water column through buoyancy regulation, thereby allowing them to find the depth of optimal light or nutrient availability. June 2018 satellite images produced by NOAA show the development of a cyanobacteria bloom in Lake Okeechobee, beginning in the middle of the month, then intensifying and spreading to other parts of the lake.

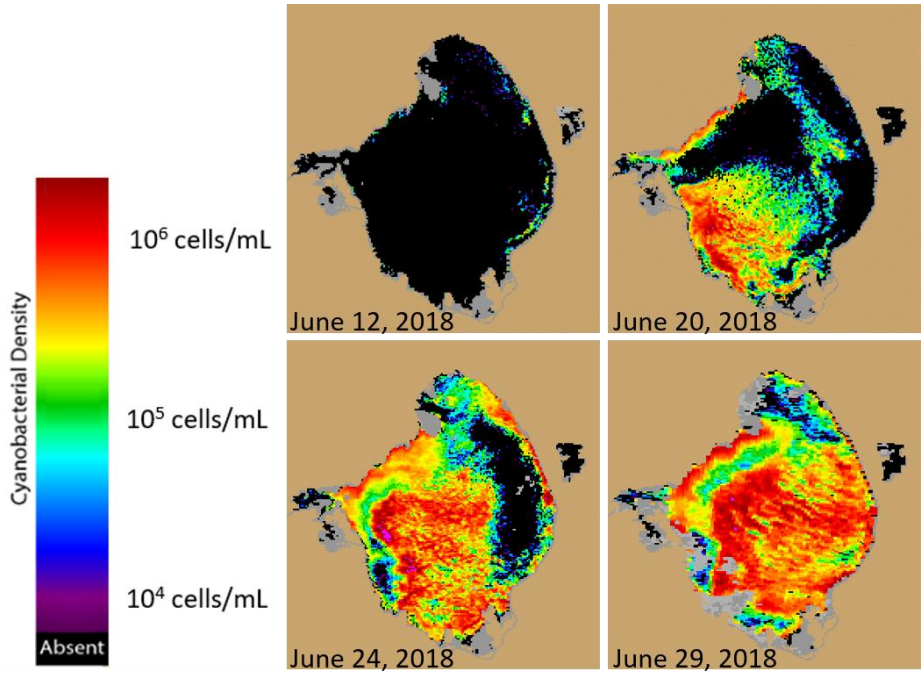

Image source: NOAA, derived from Copernicus Sentinel-3 data from EUMETSAT

Sources:

Havens, K. 2013. *Deep Problems in Shallow Lakes: Why Controlling Phosphorus Inputs May Not Restore Water Quality*. SGEF-128. University of Florida Institute of Food and Agricultural Sciences and Florida Sea Grant College Program. http://edis.ifas.ufl.edu/sg128.

Havens, K.E., Hanlon, C. and R.T. James. 1994. *Seasonal and Spatial Variation in Algal Bloom Frequencies in Lake Okeechobee, Florida, U.S.A.* Lake and Reservoir Management. 10:2, 139-148, DOI: 10.1080/07438149409354185.

Havens, K.E., Hoyer, M.V. and E.J. Phlips. 2016. *Natural Climate Variability Can Influence Cyanobacteria Blooms in Florida Lakes and Reservoirs*. SGEF-142. University of Florida Institute of Food and Agricultural Sciences and Florida Sea Grant College Program. http://edis.ifas.ufl.edu/sg142.

Phlips, E. J., F. J. Aldridge, P. Hansen, P. V. Zimba, J. Ihnat, M. Conroy and P. Ritter. 1993. *Spatial and temporal variability of trophic state parameters in a shallow subtropical lake (Lake Okeechobee, Florida, USA)*. Archive Fur Hydrobiologie 128:437-458.

2. Why are there blooms in the estuaries?

Algal blooms in estuaries are dependent on the same basic ingredients as blooms in lakes, including high nutrient levels and sufficient light availability. However, estuaries can be subject to high rates of tidal flushing with the ocean, which limits the time needed to allow large accumulations of algal biomass. The latter factor helps to explain the intense blooms that have been observed in the northern Indian River Lagoon, which has very low rates of flushing.

Two major estuaries in south Florida are directly connected to Lake Okeechobee via canal systems; the St. Lucie estuary (SLE) on the east coast of Florida and the Caloosahatchee estuary (CE) on the west coast. As with Lake Okeechobee, record rainfall in May washed nutrient-laden stormwater runoff from the surrounding land into the estuaries. Additionally, the U.S. Army Corps of Engineers discharged large

volumes of lake water to the east and west as per the requirements of the Lake Okeechobee Regulation Schedule to prevent the Herbert Hoover Dike from being compromised.

The U.S. Army Corps of Engineers initiated large-scale discharges out of the S-77 Canal (west coast) and S-380 Canal (east coast) on June 2nd. This discharged water is rich in nutrients and algae, as indicated by NOAA imagery. The amount of freshwater that was released turned the normally saline estuary primarily fresh, providing conditions favorable for the growth and survival of freshwater cyanobacterial blooms that otherwise would not have occurred in saline water. Intense blooms of freshwater cyanobacteria in the St. Lucie and Caloosahatchee estuaries, possibly related to discharges from Lake Okeechobee is a re-occurring phenomenon, most recently in 2005 and 2016, both periods of exceptionally high rainfall.

On average, over 60% of the water and nutrients that go into the estuaries come from their own watersheds, not from the lake. During the month of May, only 11% and 10% of the water that was flowing into the CE and SLE, respectively, was from the lake. As discharges began in June, this contribution increased to 51% and 77%.

Sources:

Phlips, E. J. 2015. *Phytoplankton blooms*. In: M. Kennish (Ed.). Encyclopedia of Estuaries. Springer, Dordrecht, The Netherlands. Pp. 493-494. ISBN:978-94-017-8800-7.

Phlips, E. J., S. Badylak, J. Hart, D. Haunert, J. Lockwood, H. Manley, K. O'Donnell, D. Sun, P. Viveros and M. Yilmaz. 2012. *Climatic influences on autochthonous and allochthonous phytoplankton blooms in a subtropical estuary, St. Lucie Estuary, Florida, USA*. Estuaries and Coasts 35:335-352.

US Army Corps of Engineers Jacksonville District Water Management Daily Report. Accessed July 5, 2018 http://w3.saj.usace.army.mil/h2o/reports.htm

3. Is the algae in the estuaries from the lake?

When water is discharged from lakes, rivers and canals into estuaries, it can introduce bloom concentrations of algae to the receiving estuary. Anecdotal and pictorial evidence of algae-bloom water flowing through the St. Lucie and Caloosahatchee canal systems suggest that Lake Okeechobee was a contributor to at least some of the algae blooms that have sprung up in the SLE and CE. Research is needed to definitively confirm or deny this link.

4. What kind of algae make up the blooms?

The Florida Department of Environmental Protection (FDEP) has been collecting water samples at sites with visual indication of a surface water algal bloom throughout the SLE and CE. Data from Lake Okeechobee water samples is limited to a few sites along the shoreline.

The cyanobacterium *Microcystis aeruginosa* was identified as the dominant taxon in 6 of 8 samples collected along the shore of Lake Okeechobee and 38% (n = 25) of the 66 total samples collected throughout the entire region in the last 30 days (since July 2, 2018). The scope and results of the research associated with the 2018 blooms in Lake Okeechobee have not yet been fully reported by the groups involved, so further details will likely be forthcoming.

Source:

Florida Department of Environmental Protection. Florida Algal Bloom Monitoring and Response. Accessed July 2, 2018. https://floridadep.gov/dear/algal-bloom/content/algal-bloom-sampling-results

5. Are they toxic? Are they harmful to people?

Blue-green algae (aka, cyanobacteria) are some of the most common kinds of bloom-forming algae in Florida's aquatic ecosystems. Some, though not all blue-green algae can produce toxins. *Microcystis aeruginosa*, one of the dominant bloom-forming species in Lake Okeechobee, has been shown to produce the hepatotoxin (liver toxin) microcystin, which can result in gastro-intestinal problems associated with oral intake of untreated contaminated water, and in extreme cases, result in liver damage. Impacted water resources used for human consumption are typically treated with chlorine or ozone to destroy the toxin. In addition to hepatotoxins, some blue-green algae can produce other types of toxins, including neurotoxins (nervous system toxins) that also can cause respiratory distress and eye irritation, and dermatoxins associated with skin irritation, although they appear to be less prominent and less commonly occurring than hepatotoxins in Florida.

In Florida, FDEP coordinates water sampling and tests for algal species and toxicity in both freshwater and marine environments, and the Florida Department of Health takes the lead in determining if an algal bloom presents a human health risk. For whatever the reason might be, many of us who have conducted research on Florida lakes with cyanobacteria blooms have found that some people develop a rash when their skin contacts the bloom. To avoid possible adverse symptoms and effects of exposure to toxins, avoidance by humans and pets is the best practice when water is contaminated with blue-green algal blooms.

Sources:

Phlips, E. J., E. Bledsoe, M. Cichra and S. Badylak. 2003. The distribution of potentially toxic cyanobacteria in Florida. In Johnson, D. and Harbison, R. D. (Eds.), Proceedings of Health Effects of Exposure to Cyanobacterial Toxins: State of the Science. Florida Department of Health and the Center for Disease Control. St. Petersburg, Florida.

Center for Disease Control. *Physician Reference: Blue –green Algal Blooms. When in doubt, it's best to stay out*! CS223677-A https://www.cdc.gov/nceh/hsb/hab/HABSphysician_card.pdf

Florida Department of Environmental Protection. *Freshwater Algal Blooms Frequently Asked Questions*. https://floridadep.gov/sites/default/files/freshwater-algal-bloom-faq.pdf

6. Why do toxin levels vary in time and space?

Concentrations of algal toxins in ecosystems are often roughly proportional to the amount of toxin-producing algae present. However, environmental conditions and the condition of algal cells (such as age and health) can affect toxin levels. For example, blooms of *Microcystis aeruginosa* frequently form surface scums which can be driven by wind onto shorelines, resulting in massive accumulations of biomass and very high, but spatially restricted, toxin levels. Methods used to collect samples for analysis can also affect the level of toxins detected. For example, monitoring efforts focusing on the collection of samples from hot spots in algal biomass accumulation can overestimate the average and total toxin levels in an ecosystem.

7. Is this a wider-spread issue right now in the USA?

Algal blooms, including cyanobacteria blooms, are a problem not only in Florida but throughout the U.S. and the world. Although algal blooms are naturally occurring, human activities and inputs (stormwater, agriculture, urban landscapes, sewer and septic) have significantly increased the amount of nutrients available for bloom formation in many environments around the world. In addition to Florida, algal

blooms have been reported this year in Utah, Lake Erie, New York, North Carolina, Oregon and as far away as New Zealand, Australia, the Philippines and the Middle-eastern country of Oman. The problem of harmful algal blooms is expected to grow with continuing increases in nutrient loads and warming climate, particularly those involving cyanobacteria, which are known to favor high temperature conditions.

Sources:

Havens, K. 2018. *The Future of Harmful Algal Blooms in Florida Inland and Coastal Waters*. TP-231. University of Florida Institute of Food and Agricultural Sciences and Florida Sea Grant College Program. http://edis.ifas.ufl.edu/sg153.

Havens, K. 2018. *Climate Change and the Occurrence of Harmful Microorganisms in Florida's Ocean and Coastal Waters*. SGEF-216. University of Florida Institute of Food and Agricultural Sciences and Florida Sea Grant College Program. http://edis.ifas.ufl.edu/sg136.

Paerl HW, Huisman J. 2008. *Blooms like it hot*. Science 320:57-58. doi: 10.1126/science.1155398

Phlips, E. J. 2015. *Phytoplankton blooms*. In: M. Kennish (Ed.). Encyclopedia of Estuaries. Springer, Dordrecht, The Netherlands. Pp. 493-494. ISBN: 978-94-017-8800-7.

8. What if a pulse release is done to push the bloom out of the Caloosahatchee estuary and it stimulates a near-shore red tide that is occurring right now?

A long-standing process for dealing with cyanobacteria blooms in the Caloosahatchee River, which most often happen during droughts, is for the U.S. Army Corps of Engineers to release a pulse of water from Lake Okeechobee of sufficient volume to push the algae out to sea, where the cells burst and the bloom goes away. This year, there has been a concern about that approach because there has been a red tide (a marine harmful algal bloom) right offshore of the Caloosahatchee Estuary. The thought is that if the cyanobacteria bloom is pushed out to sea and the algal cells rupture and release all of their internally stored nutrients, it will make the red tide worse. It is unclear whether this remains an issue, because as of last Friday (July 6) the red tide had migrated northwards into the Sarasota area.

9. What is being done to stop this from happening over and over?

The existing 2018 bloom in Lake Okeechobee will likely continue throughout the summer until a large storm comes through the area or the water starts to cool. Freshwater releases were temporarily stopped for the SLE and were dramatically slowed for the CE on July 1st; however they have recently started again.

In a longer-term context, there are numerous efforts underway throughout the state of Florida that are addressing water quality, algae blooms, and the discharge of water out to the coasts. An in-depth description of all these efforts is beyond the scope of this response, so here is a general overview of the issue and solutions. There are two main challenges that need to be addresses to prevent the occurrence year after year – water quality and quantity.

First, reductions in nutrients (both nitrogen *and* phosphorus) need to occur in the greater Kissimmee-Okeechobee-Everglades Basin. This includes direct inputs into Lake Okeechobee as well as in the eastern and western watersheds. Algal blooms in Lake Okeechobee in the 1980s were the impetus for the surface water improvement and management plan and certain sectors, such as agriculture, have made

significant reductions in nutrient inputs. Today, Lake Okeechobee, the Caloosahatchee Estuary Basin, and the St. Lucie River and Estuary are all under Basin Management Action Plans (BMAP) that provide a blueprint for reducing pollutant loadings. While significant reductions in nutrients from sources have occurred, there are numerous challenges to reducing inputs to the lake. In fact, there has been no reduction in total nutrient loading to Lake Okeechobee since nutrient control programs began. Much of the watershed now is saturated with phosphorus, to the extent that even if all sources were stopped today, it is estimated that the current high loading rate to the lake would last more than 50 years. It is for this reason, that the South Florida Water Management District (SFWMD) has been pursuing regional nutrient control programs along with controls at sources – in order to stop the sources and also to capture the legacy nutrients from soils, wetlands and other places before they reach the lake.

The second challenge that needs to be addressed is that of water quantity. Lake Okeechobee now acts as a reservoir rather than a lake with fluid boundaries. Water levels in the lake are managed for flood control and human safety. There are numerous existing constraints to moving the water south out of Lake Okeechobee. In order to reduce or eliminate discharges to the west and east coasts - the only viable option right now, alternative water storage and water flow projects need to occur. Some of these options are discussed in more detail in response to question #11.

10. Will the EAA reservoir help?

The Everglades Agricultural Area (EAA) reservoir is one of a number of water storage tools that will help, though not solve, the problem. The 2017 Water Resources Law directed the expedited design and construction of the EAA reservoir. The current proposal will be designed to hold at least 240,000 acre-feet of water and include water quality features necessary to meet state and federal water quality standards. The SFWMD projects that the EAA project, when used in conjunction with authorized CERP projects, will reduce the overall number of discharge events from Lake Okeechobee to the estuaries by 63%, and the volume of discharge by approximately 55%. The proposed plan would reduce the number of high-flow freshwater discharges that are detrimental to oyster populations by 40% for the SLE and 55% for the CE. According to the project schedule, the report will be submitted for congressional authorization by December 2019. It is important to note that the projections provided by the SFWMD are contingent upon the completion of other CERP projects which are estimated to take 35+ years to achieve.

Source:
South Florida Water Management District. March 2018. *Central Everglades Planning Project Post Authorization Change Report Feasibility Study and Draft Environmental Impact Statement.* https://www.sfwmd.gov/sites/default/files/documents/cepp_pacr_main_report.pdf

11. Will CERP solve this problem?

The Comprehensive Everglades Restoration Plan (CERP) is a 35+ year plan to “restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection.” The 68 project components within the plan address the quality, quantity, timing and distribution of freshwater in the natural system. There are a number of projects within CERP that will have direct impacts on Lake Okeechobee and the coastal estuaries. To answer this question in short, we provide a list of projects (ongoing and proposed) that address water quantity since these are the most pertinent to the issue of freshwater discharges.

Reservoirs – In addition to the EAA reservoir, CERP includes construction of the C-43 western basin reservoir, the Indian River Lagoon-South Project which includes the C-44 eastern basin reservoir, C-23, 24, and 25 reservoirs, and a northern Kissimmee River reservoir.

Aquifer Storage and Recovery (ASR) – ASR technology provides the ability to store and recover large volumes of water over longer periods of time. ASR facilities inject treated and untreated groundwater, partially treated surface water and reclaimed wastewater into the Floridan Aquifer. The water is injected in areas where the aquifer is brackish. This creates a freshwater bubble that allows for water to be recovered and returned to the lake for use during drought years. CERP originally planned for 333 wells at 5 million gallons per day. A groundwater modeling study identified numerous constraints to ASR and the number of possible ASR wells has been modified to 130.

Additional water storage opportunities outside of those in CERP are being implemented when available. For example, dispersed water management, or water farming, distributes shallow water across parcel landscapes such as fallow citrus land and is currently being used. Even with all of these water storage projects, the entirety of CERP with take decades to implement and it still more than one million acre feet of water short of the water storage necessary to eliminate freshwater discharges out into the estuaries.

In an independent report to the Legislature from UF in 2015, it was determined that the reduced number of ASR wells that will be built, the fact that a proposed set of reservoirs called the Lake Belt will not be built, and that the lake currently is holding about 500,000 acre feet less water than under an earlier schedule, when CERP is complete, it will fall short by over 1,000,000 to 1,500,000 acre feet of regional storage. A 2016 report by the National Academy of Science affirmed that finding and noted that unless more projects are added to CERP, it will not meet its intended objectives, including not reaching the expected goals for protecting the estuaries.

Source:

Graham, W.D., Angelo, M.J., Frazer, T.K., Frederick, P.C., Havens, K.E., and K.R. Reddy. 2015. *Options to Reduce High Volume Freshwater Flows to the St. Lucie and Caloosahatchee Estuaries and Move More Water from Lake Okeechobee to the Southern Everglades: An Independent Technical Review by the University of Florida Water Institute.* University of Florida.

The National Academies of Sciences, Engineering and Medicine. 2016. *Progress Towards Restoring the Everglades. The Sixth Biennial Review*. The National Academies Press, DC, 246 p.

12. Are deep injection wells a good short-term solution to stop releases of water?

Deep well injection (DWI) is the permanent disposal of water deep below the earth's surface. DWI is currently being considered as an option to use when discharges to the estuaries are necessary. Proposed use of wells would occur only when freshwater would otherwise be lost to the ocean, causing harm to the estuaries on the way. There is debate about the use of DWI since disposed water is not recoverable. Deep well injection is not a new technology and there are currently 180 Class I wells in operation in Florida, most for wastewater disposal into the Boulder Zone. Deep injection wells alone will not entirely eliminate freshwater discharges to the estuaries. An internal South Florida Water Management District analysis of future conditions suggests that the use of 50 deep injections wells in combination with proposed restoration projects reduce the annual volume of Lake Discharge by 67% and 77% for the SLE and CE, respectively.

Source:

Verrastro, R. and C. Neidrauer. *South Florida Water Management District Concept for Deep Injection Wells in the Northern Everglades.* South Florida Water Management District public presentation to the Water Resources Advisory Commission. October 5, 2017. https://apps.sfwmd.gov/webapps/publicMeetings/viewFile/10856

For media questions please refer to:

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